

**CROW LANE LANDFILL  
Newburyport, Massachusetts**

**Corrective Action Design (CAD)  
Final Landfill Closure**

**TECHNICAL SPECIFICATIONS**

**October 2010 Submittal  
*Revised November 2010***

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**CROW LANE LANDFILL  
NEWBURYPORT, MASSACHUSETTS**

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## SECTION 01036

### HEALTH AND SAFETY

#### PART 1 - GENERAL

##### 1.01 SCOPE

- A. The Contractor shall submit to the Owner prior to beginning the work a written "Health and Safety Plan" for review and approval. Partial payments will not be made to the Contractor by the Owner until the "Health and Safety Plan" has been approved.
- B. The Contractor shall provide such equipment and medical facilities as are necessary to supply first aid to anyone who may be injured in connection with the Work and shall provide for the capability for immediate removal and hospitalization if required.
- C. The Owner may stop the Work if in his sole judgement safety laws, or safe work practices are not being observed; provided, however, that none of the foregoing shall relieve the Contractor from being fully responsible and liable for meeting all safety laws and safe work practices in connection with the Work, nor should the failure of such persons to stop the Work be construed to mean that all safety laws and safe work practices are being met. Notwithstanding the above, the Contractor is solely responsible for the compliance with safety laws and maintaining safe work practices.

##### 1.02 HEALTH AND SAFETY PLAN

- A. Prior to construction start-up, Contractor shall prepare a site specific health and safety plan (the "HASP"). If the Contractor does not have the capability to prepare the HASP, the Contractor shall contract for the preparation of the HASP. The Contractor is solely responsible for the preparation, monitoring, management, and enforcement of the HASP.
- B. The Contractor is encouraged to include any information that the Contractor believes is relevant. Contractor shall submit a copy of the HASP to the Owner prior to starting construction. Submittal of the Contractor's HASP to the Owner is to inform the parties of the details of the program. Submittal of the HASP does not, in any way, impose a responsibility on the Owner for adequacy of the program nor does it relieve the Contractor from full responsibility to comply with, and liability for, the appropriate laws, rules or regulations regarding health and safety of on-site personnel.
- C. The Health and Safety Plan shall, as a minimum, address the following:
  - 1. Description of work to be completed.
  - 2. Identification of possible site chemical exposure hazards, including but not limited to gases and leachate typically found in landfills, refuse and ash.

3. Identification of possible explosion hazard from methane released from the landfill.
  4. Monitoring equipment and procedures for use on site (eg. explosimeter, oxygen meter, photoionization meter).
  5. Site operating procedures and safety guidelines.
  6. Emergency procedures and information for personnel injury, fire, explosion, or equipment failure.
- D. The Health and Safety Plan shall as a minimum be consistent with the requirements of the latest versions of:
1. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926), including amendments, or current amendments at the time of contract performance as stated in Fed Reg December 19, 1986: 45654-45675 (Interim Final Rule, 29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response").
  2. United States Environmental Protection Agency (USEPA) Standard Operating Safety Guidelines, Office of Emergency and Remedial Response, Hazardous Response Support Division, Edison, New Jersey.
  3. Corps of Engineers Accident Prevention and Safety and Health Requirements Manual, EM 385-1-1.
  4. NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Site Activities, October 1985, DHHS (NIOSH) Publ. No. 85-115.

### **1.03 GENERAL SAFETY CONSIDERATIONS**

- A. Workers shall be advised of the presence of methane or hydrogen sulfide gas emanating from the natural decomposition of refuse buried at or near the job site and take precautions to ensure the safety of workers and the public.
- B. A person shall be designated as Safety Monitor who is trained in the use of gas detection instruments and safety equipment. He shall be present at all times with appropriate instruments to test for oxygen deficiency and the presence of methane or hydrogen sulfide gas. An Emmet CGS-10 Gas Detector, or similar unit, shall be available for this purpose. The Safety Monitor shall periodically test the excavation areas, utility vault, structure, etc., for safe working conditions and be responsible for the appropriate safety equipment being available at the site.
- C. Workers shall not be allowed to work alone at any time in an excavation. Work parties of at least two shall be mandatory, with one worker outside of possible gas effects. Access to the open trench shall be via ladders spaced no further than 30 yards apart. Trenches shall be shelved to prevent possible caving in on workers.

- D. No welding shall be permitted in trenches, enclosed areas, or over refuse filled areas unless performed over ground mats or in areas of the site approved by the Safety Monitor.
- E. Workmen shall not be permitted to enter excavations where there is an oxygen deficiency or a combustible mixture of methane or other explosive gases, without taking precautionary measures.
- F. As construction progresses, all valves, pipe and other conduit openings shall be closed as soon as installed to prevent the migration of gases through the pipeline system, unless they are so intended, and to prevent extraneous matter from entering the system.
- G. Smoking shall be prohibited in or near open excavations and in the vicinity of excavation activities. No excavation or drilled hole greater than 2 feet deep shall be left unattended or left open overnight unless securely covered in a manner acceptable to the Owner. Precautions shall be taken to prevent open excavation from the introduction to stormwater.
- H. Entrance into utility access manholes shall be done with extreme caution. Sparks can occur from metal manhole covers and rings. Always test the air in a manhole or enclosed space with a detector before entering. Positive ventilation should be considered when working in any underground structure. All enclosed entries will be performed under full mask and suit conditions (pursuant to OSHA requirements) by certified personnel.
- I. Fire extinguishers shall be available and be rated at least A, B and C.

#### **1.04 PRECAUTIONS WHEN WORKING ON OR NEAR REFUSE LANDFILLS**

- A. Workers shall be cautioned regarding the potential unstable soil and refuse material and the strong possibility of caving during excavation operations. All workers entering open excavations shall be secured with a safety belt, harness, or short rope to enhance rescue operations in the event of accidents.
- B. Workers in the excavation area shall have access to acid vapor masks for temporary protection in the event hydrogen sulfide (H<sub>2</sub>S) gas is present and triggers the H<sub>2</sub>S alarm on the gas detector. Vacate the area immediately when H<sub>2</sub>S is detected.
- C. Construction equipment shall be equipped with vertical exhaust and spark arresters.
- D. Motors utilized in refuse excavation areas shall be explosion-proof.
- E. Start-up and shutdown of equipment shall not be done in areas of exposed refuse.
- F. Soil shall be stockpiled adjacent to operations in areas of exposed refuse for fire fighting purposes. Probably the most effective way to extinguish landfill fires is to smother the fire with soil (which eliminates available combustion oxygen).
- G. The use of explosives is not permitted.

- H. Any refuse exposed during construction activities shall be covered as soon as possible after exposure with at least a 6-inch layer of earth or deposited into approved containers. In no event shall the refuse remain exposed overnight.
- I. All refuse excavated during construction activities shall be disposed of in an appropriate disposal manner.
- J. Inhalation of landfill gases shall be avoided as much as possible. Such gases (or oxygen deficient air) may cause nausea and dizziness, which could lead to accidents.
- K. Workers shall avoid contact with exposed refuse where possible. Irritants or hazardous materials may be present.
- L. Workers shall not leave open wells or excavations unattended. Open boreholes must be covered to prevent accidental entry. Wells must be barricaded, flagged, and protected sufficiently to prevent entry of dirt and run off water.
- M. Landfill gas (LFG) is compiled of approximately equal portions of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) with other trace constituents. It is a product formed by the anaerobic decomposition of refuse. Methane gas is the primary component of natural gas, and is combustible when the methane concentration in air is between 5 and 15 percent by volume. The 5 percent level is called the lower explosive limit (LEL). Below 5 percent, there is insufficient methane for combustion. Above 15 percent, called the upper explosive limit (UEL), there is insufficient oxygen for combustion. However, it is important to note that a concentration of methane above 15 percent is considered at least as dangerous as a concentration between 5 and 15 percent, because as the methane dilutes with air, it will pass through the explosive range. When gas concentrations are low, it is common to express methane concentration as a percentage of the LEL. For example, 100 percent LEL is 5 percent methane in air, and 50 percent LEL is 2.5 percent methane in air.
- N. Because the decomposition of buried refuse typically produces methane at concentrations ranging from 40 to 55 percent, methane will always pass through the combustible range as it vents to the atmosphere and dilutes with air. Methane is lighter than air, and will rise in the absence of a typical barriers. LFG, being a mixture of methane and carbon dioxide, may be heavier than or lighter than air depending on the specific mixture. LFG may escape from the refuse, both vertically through the landfill cover, and laterally through surrounding soils. LFG moves in response to the pressure buildup within the landfill and through diffusion in the absence of a pressure differential. Diffusive movement nearly always produces explosive range concentrations of methane.
- O. The Contractor shall consider any concentration of methane at or above 10% LEL as one to cease construction activities or operations.

**END OF SECTION**

## **SECTION 02100**

### **ABANDONMENT OF EXISTING LEACHATE COLLECTION TANKS**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to perform all related work as specified, herein, as shown on the Drawings.
- B. The work of this Section shall include, but not necessarily be limited to: excavating, separating, hauling, stockpiling, backfilling, compacting and grading of soils and landfill waste. The work of this Section pertains to the abandonment of three (3) existing leachate collection tanks identified on the Drawings as Leachate Tank 1, 2 and 3.
- C. The Contractor shall conform to the dimensions, lines and grades indicated on the Drawings.
- D. Excavations into the landfill may create hazardous conditions due to the presence of methane gas and other organic compounds. The Contractor shall be responsible for continuously monitoring conditions associated with the excavation and shall employ appropriate health and safety protocol for the protection of the Contractor's employees and all subcontractors. The Contractor shall implement all applicable provisions of his Health and Safety Plan as required under Section 01036 of these specifications.

##### **1.02 RELATED SECTIONS**

- A. Section 02200 - Earthwork
- B. Section 02500 - HDPE Geomembrane

##### **1.03 EXISTING UTILITIES, STRUCTURES AND FACILITIES**

- A. The locations of existing underground structures as shown on the Drawings are approximate only and are shown only for the convenience of the Contractor, who must verify the information to his own satisfaction. The Owner disclaims any responsibility for the accuracy or completeness of the information shown on the Drawings with regard to existing underground utilities or structures, and the Contractor shall not be entitled to any additional compensation because of inaccuracy or incompleteness of such information.
- B. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, the Contractor shall inform the Owner of such piping or utility immediately. The Contractor shall make modifications as approved by the Owner.

- C. The Contractor shall be held responsible for the cost of repairing all utilities, landfill cap components, structures and subsurface drains which become damaged due to his construction operations, whether or not they appear on the Drawings.
- D. Furnish all the necessary equipment and assume the entire cost of handling any water from storm, surface and flood flows which may be encountered at any time during construction of the work. The manner of providing for these flows shall meet with the approval of the Owner, and the entire cost of said work shall be included in the work to be done under this Contract.

## **PART 2 - PRODUCTS**

### **2.01 SAND**

- A. Sand for leachate tank cavity shall consist of granular mineral soils having the gradation as specified in Section 02200, 2.04.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. The existing castings shall be carefully removed and satisfactorily stored as directed by Owner. If requested by Owner, castings shall be removed from project site by Contractor.
- B. Upper portions of masonry riser sections shall be removed to a depth of three (3) feet below the landfill cap system subgrade elevations. Removed masonry material shall be disposed of by Contractor.

### **3.03 BACKFILLING METHODS**

- A. Excavated landfill material will be permitted to be used for backfill material.

### **3.04 REPAIR OF DAMAGED GEOMEMBRANE**

- A. All areas of damaged geomembrane shall be repaired in accordance with Section 02500, 3.04.
- B. All components of landfill cap system shall be fully restored.

**END OF SECTION**

## **SECTION 02200**

### **EARTHWORK**

#### **PART 1 - GENERAL**

##### **1.01 SCOPE**

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to perform all related work as specified, herein, as shown on the Drawings.
- B. The work of this Section shall include, but not necessarily be limited to: excavating, separating, hauling, stockpiling, backfilling, compacting and grading of soils. The work of this Section may pertain in whole or in part to construction of the following: subgrade preparation, embankment fill placement, final cover system construction, drainage structures and channels and general site grading.

The Contractor is advised that related sections contain additional detailed specifications and testing requirements for the various layers of the landfill cap and drainage structures to be installed and constructed under this project.

- C. The Contractor shall conform to the dimensions, lines and grades indicated on the Drawings.
- D. Excavations into the landfill may create hazardous conditions due to the presence of methane gas and other organic compounds. The Contractor shall be responsible for continuously monitoring conditions associated with the excavation and shall employ appropriate health and safety protocol for the protection of the Contractor's employees and all subcontractors. The Contractor shall implement all applicable provisions of his Health and Safety Plan as required under Section 01036 of these specifications.

##### **1.02 RELATED SECTIONS**

- A. Section 02210 - Sand
- B. Section 02220 - Riprap
- C. Section 02240 - Drainage Structures
- D. Section 02290 - Topsoil and Seed
- E. Section 02500 - HDPE Geomembrane Liner
- F. Section 02596 - Geotextile Filter Fabrics
- G. Section 02715 - Corrugated Polyethylene Pipe

##### **1.03 PROTECTION**

- A. The Contractor shall protect trees, shrubs, lawns and other features remaining as part of final landscaping.
- B. The Contractor shall protect benchmarks, survey markers, fences, roads, sidewalks, paving, curbs and other existing structures from damage due to the Contractor's activities.
- C. The Contractor shall repair damage caused by the construction operations at his cost.
- D. Erosion control must be maintained. Erosion control measures shall be implemented in conformance with the minimum guidelines presented on the Drawings. These controls include, but are not limited to the installation and maintenance of haybales and silt fence at the perimeter of the landfill along the northerly easterly and westerly perimeter of the landfill and at the area downgradient of the venal pool storm water discharge structure.

#### **1.04 REFERENCES**

- A. Latest version of American Society for Testing and Materials (ASTM) Standards:
  1. ASTM D 422 Standard Test Method for Particle-Size Analysis of Soils
  2. ASTM D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
  3. ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil In Place By the Sand-Cone Method.
  4. ASTM D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
  5. ASTM D 2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
  6. ASTM D 2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  7. ASTM D 2922 Standard Test Methods for Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth).
  8. ASTM D 2937 Standard Test Method for Density of Soil In Place By the Drive-Cylinder Method.
  9. ASTM D 3017 Standard Test Method for Water Content of Soil and Rock In Place By Nuclear Methods (Shallow Depth).

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|-----|-------------|--|
| 10. | ASTM D 4220 | Standard Practices for Preserving and Transporting Soil Samples.                     |
| 11. | ASTM D 4318 | Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. |

#### **1.05 EXISTING UTILITIES, STRUCTURES AND FACILITIES**

- A. The locations of existing underground structures as shown on the Drawings are approximate only and are shown only for the convenience of the Contractor, who must verify the information to his own satisfaction. The Owner disclaims any responsibility for the accuracy or completeness of the information shown on the Drawings with regard to existing underground utilities or structures, and the Contractor shall not be entitled to any additional compensation because of inaccuracy or incompleteness of such information.
- B. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, the Contractor shall inform the Owner of such piping or utility immediately. The Contractor shall make modifications as approved by the Owner.
- C. The Contractor shall be held responsible for the cost of repairing all utilities, structures and subsurface drains which become damaged due to his construction operations, whether or not they appear on the Drawings. The notification of all utility companies before the start of work and the locating of underground structures which may be encountered during the course of construction are the responsibilities of the Contractor. All costs, including the costs of services of representatives of the affected utilities, incurred in such location operations shall be included in the work to be done under this Contract.
- D. Furnish all the necessary equipment and assume the entire cost of handling any water from storm, surface and flood flows which may be encountered at any time during construction of the work. The manner of providing for these flows shall meet with the approval of the Owner, and the entire cost of said work shall be included in the work to be done under this Contract.
- E. Should it become necessary to permanently or temporarily move any conduits, pipes, wires or structures in order to permit the Contractor to execute the work, the Contractor shall notify the Owner of the location and circumstances, and shall cease work if necessary, until satisfactory arrangements have been made by the owners of said obstructions to properly care for the same. No claims for damages shall be allowed on account of any delay occasioned thereby. The entire cost of the changes or temporary removal shall be included in the work to be done under this Contract.
- F. The Contractor shall, at his own expense, shore up and protect any poles, or other public or private structures which may be encountered or endangered in the prosecution of the work, and that may not be otherwise provided for, and he shall repair and make good any damages caused to any such property by reason of his operations. All existing structures which due to the prosecution of the work are

removed shall be replaced by the Contractor. No extra payment will be made for said work or material.

#### **1.06 SUBMITTALS**

- A. The Contractor shall submit to the Owner the required information and samples for all proposed fill materials a minimum of 14 days prior to delivery of the material to the Site, unless otherwise approved by the Owner.

#### **1.07 SOURCE QUALITY CONTROL**

- A. All fill and backfill materials shall be procured from off site sources unless otherwise approved or allowed in these specifications. Approval of materials will be based on tests performed by the Contractor's independent testing laboratory.
- B. Testing laboratory will determine maximum dry density and optimum water content of fills in accordance with ASTM D 1557. Provide samples of each fill material from proposed source of supply. Allow sufficient time for testing and evaluation of results before material is needed. Submit samples from alternate source(s) if required.

#### **1.08 PRODUCT DELIVERY AND HANDLING**

- A. Handling Materials: Keep public roads clear of all spillage from trucks hauling earthwork materials either from or to project site.

#### **1.09 SUB-GRADE SOIL TESTING REQUIREMENTS**

- A. CONTRACTOR shall retain the services of a qualified geotechnical laboratory to conduct quality control/assurance tests on samples of Subgrade Layer Soil.

CONTRACTOR shall conduct a minimum of one grain size test (ASTM D422) on a representative sample of each source of Subgrade Layer Soil. This testing shall be conducted prior to the delivery of Subgrade Layer Soil to the project site.

CONTRACTOR shall conduct shear tests (ASTM D-5321) to determine the strength of the interface between each source of the Subgrade Layer Soil and a sample of the geomembrane to be used for the project. Each test shall determine interface strength at normal stresses of 0.5 pound per square inch (psi), 2 psi and 4 psi. Additional testing shall be required if the Subgrade Layer Soil source has changed or the characteristics of the source have changed. Additional samples shall be collected and tested if the material does not meet specifications as of Part 2.01 of this Section at no cost to the OWNER. The CONTRACTOR shall conduct direct shear tests (ASTM D-3080) to determine the internal shear strength of the sub-grade materials. Each test shall determine internal strength at normal stresses of 0.5 pound per square inch (psi), 2 psi and 4 psi.

CONTRACTOR shall conduct hydraulic conductivity testing of the subgrade material at a frequency of 1 test/3000 cubic yards.

**1.10 JOB CONDITIONS**

- A. Contractor shall examine the site prior to submitting his Bid, taking into consideration all conditions that may affect his work. The Owner will not assume responsibility for variations of subsoil quality or conditions.
- B. Contractor shall barricade open excavations occurring as part of this work, and shall post and operate warning lights as recommended by authorities having jurisdiction.
- C. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, not designated to be demolished, from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

**PART 2 - PRODUCTS**

**2.01 GENERAL**

- A. This section specifies those classes of soils most commonly used or encountered in earth work construction. The Contractor shall use or furnish such types as are called for on the Drawings and/or in the Specifications.

**2.02 SELECT GRANULAR FILL**

- A. Select granular fill shall be natural mineral soil consisting of durable granular aggregates. The gradation of the soil shall conform to the limits specified below. The material shall be obtained from approved sources.

- 1. Granular Fill: Clean granular fill for use under footings and slabs-on-grade, subbase or and elsewhere as specified or indicated shall conform to the following gradation requirements:

<u>Square Sieve Size</u>	<u>Percent Finer By Weight</u>	
	Borrow	Subgrade Borrow
6-inch	100	--
3-inch	--	100
2-inch	90-100	--
1 ½-inch	--	70-100
½-inch	--	50-85
No. 4	20 to 65	30-60
No. 200	0 to 12	0-10

Excavated material falling within the above requirements may be stored in segregated stockpiles for use as granular fill.

**2.03 PIPE BEDDING MATERIAL**

- A. Fine Gravel Bedding: Clean gravel for pipe bedding and elsewhere as specified or indicated shall conform to the following gradations requirements:

<u>Square Sieve Size</u>	<u>Percent Finer By Weight</u>
3/4-inch	100
3/8-inch	40 to 85
No. 4	15 to 60
No. 10	0 to 20
No. 200	5 maximum

## 2.04 PROCESSED AGGREGATES

- A. Processed aggregates shall be obtained or produced from approved sources and shall consist of granular mineral soils having gradations as specified below:

### 1. Washed Sand

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>
3/8-inch	100
No. 4	70 to 100
No. 200	0 to 5

### 2. Crushed Stone

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>				
	Peastone (1/4")	Grad. A (3/4")	Grad. B (1-1/4")	Grad. C (1-1/2")	Grad. D
6 inch	---	---	---	---	95 - 100
3 inch	---	---	---	---	10 - 30
2-inch	---	---	---	100	---
1-1/2-inch	---	---	100	95-100	---
1-1/4-inch	---	---	85-100	---	---
1-inch	---	100	---	35-70	---
3/4-inch	---	90 - 100	10 - 40	0-25	---
1/2-inch	100	10-50	0-8	---	---
3/8-inch	85 - 100	0-20	---	---	---
No. 4	20 - 50	0-5	---	---	<10
No. 8	0 - 15	---	---	---	---
No. 16	0 - 5	---	---	---	---

- a. For crushed gravel, at least 50 percent of the materials retained on the 1-inch sieve shall have a fractured face.

### 3. Screened or Crushed Gravel

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>		
	Type A	Type B	Type C

	Aggr.	Aggr.	Aggr.
1/2 inch	45 to 70	35 to 75	
No. 4	30 to 55	25 to 60	25 to 70
No. 40	0 to 20	0 to 30	0 to 30
No. 200	0 to 5	0 to 5	0 to 5

- a. Type A aggregates for base shall not contain particles of rock which will not pass the 2-inch square mesh sieve.
- b. Type B aggregate for base shall not contain particles of rock which will not pass the 4-inch square mesh sieve.
- c. Type C aggregate for base shall not contain particles of rock which will not pass the 6-inch square mesh sieve.

## 2.05 PROCESSED RECYCLED MATERIALS

- A. Processed recycled materials shall consist of hard, durable angular shaped materials which are the product of the primary crushing of asphalt, brick and concrete. Rounded materials, boulders or soft stone or irregularly thin slabs will not be acceptable. The processed recycled materials shall be free from overburden, spoil, organic material, metals, plastics or other deleterious debris and shall meet the following gradation requirements:

Size of particles	Passing Percentage
8 In.	95-100
4 in.	0-25
2-1/2	0-5

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Remove all unsuitable material including topsoil, fill, organic soils and waste within areas upon which granular fill is to be placed.
- B. In cross country areas within which excavations are to be made, cover material, loam and topsoil shall be carefully removed and separately stored to be used again as directed.
- C. The Contractor shall make excavations in such manner and to such widths as will give suitable room for building the structures or laying and joining pipe; shall furnish and place all sheeting, bracing, and supports; shall do all pumping, and draining; and shall render the bottom of the excavation firm and dry and in all respects acceptable.
- D. In no case shall the earth be plowed, scraped, or dug by machinery so near to the finished grade at the bottom of the excavation as to result in disturbance of

material below said grade. All loose material shall be removed from the bottom of the excavation so that the bottom shall be in an undisturbed condition. If removal of the loose material results in excavation beyond the limits shown on the Drawings and over excavation has not been ordered, the restoration of the excavation to grade shall be done at no additional cost to the Owner.

### **3.02 LANDFILL SURFACE PREPARATION**

- A. The Contractor shall conduct landfill surface preparation with the intent of utilizing existing cover soils as much as possible. Select granular fill provided by the Owner will be used to bring areas to grade, as directed by the Owner. Organic or vegetative support soils shall be striped from the landfill surface and stockpiled on site, in a location directed by the Owner.
- B. The Contractor shall not damage the existing facilities and shall repair all damage to them in accordance with the specifications.
- C. The Contractor shall rough grade the landfill cap subgrade surface and adjacent areas to required levels, profiles, contours and elevations ready for finish subgrading.
- D. Grading shall be done by bulldozer or other appropriate means. Areas adjacent to structures and other areas unaccessible to heavy grading equipment shall be graded by hand.
- E. The landfill surface, including sideslopes of the existing landfill areas shall be fine graded to a smooth and uniform surface free from depressions and high spots conforming generally to the slopes indicated on the Drawings. The surface shall then be thoroughly compacted. Landfill surface compaction shall be provided by a minimum of four complete passes of a 10 ton vibratory smooth compaction equipment traveling at a speed of not greater than 5 miles per hour.
- F. Upon completion of vibratory compaction the prepared area shall be rolled smooth free of ruts and depressions to a dense and uniform surface.
- G. The prepared landfill surface shall be proof rolled in order to demonstrate that the compaction effort has been successful and that no soft spots remain.
- H. Proof rolling shall be conducted by the Contractor utilizing an articulated dump truck or equivalent which has been loaded to maximum capacity with soils material, (total weight 60 tons  $\pm$ ).
- I. Proof rolling shall be conducted in the presence of the CQA Consultant. The intent of the proof roll is to identify soft or yielding areas within the existing landfill surface areas.
- J. Should the Owner determine that soft spots or yielding areas remain after the compaction effort is completed, corrective measures shall be taken. These measures shall include the excavation of the yielding materials and backfill and

compaction with gravel borrow soils to suitable subgrade elevations. The affected area shall be re-tested to ensure adequate stabilization.

- K. The horizontal and vertical extent of all excavation shall be determined by the Owner.

### **3.03 EXCAVATION NEAR EXISTING STRUCTURES**

- A. Attention is directed to the fact that there are existing pipes, drains, and other utilities in certain locations. An attempt has been made to locate all utilities on the drawings, but the completeness or accuracy of the information given is not guaranteed. Where such structures are not to be demolished, unless otherwise approved by the Owner, excavation work shall be conducted in accordance with this section.
- B. As the excavation approaches pipe, conduits, or other underground structures, digging by machinery shall be discontinued and the excavation shall be done by means of hand tools, as required. Such manual excavation when incidental to normal excavation shall be included in the work to be done under items involving normal excavation.
- C. Where determination of the exact location of a pipe or other underground structure is necessary for doing the work properly, the Contractor may be required to excavate test pits to determine such locations. When such test pits may be properly considered as incidental to other excavation, the Contractor shall receive no additional compensation, the work being understood to be included as a part of the excavation.

### **3.04 PROTECTION OF PROPERTY**

- A. All surfaces which have been injured by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun. Suitable materials and methods shall be used for such restoration.

### **3.05 PROTECTION OF EXISTING STRUCTURES**

- A. All existing pipes, poles, wires, fences, curbing, property line markers, perimeter gas ventilation trenches, monitoring wells and other structures not designated for demolition, unless otherwise approved by the Owner, which the Owner decides must be preserved in place without being temporarily or permanently relocated, shall be carefully supported and protected from injury by the Contractor. Should such items be injured, they shall be restored by the Contractor, without compensation therefore, to at least as good of a condition as that in which they were found immediately before the work was begun.

### **3.06 CARE AND RESTORATION OF PROPERTY**

- A. The Contractor shall enclose the trunks of trees adjacent to his work and not to be cut, with substantial wooden boxes of such height as may be necessary to protect

them from injury from piled material, from equipment, from his operations, or otherwise due to his work. Excavating machinery and cranes shall be of suitable type and be operated with care to prevent injury to trees not to be cut and particularly to overhanging branches and limbs.

- B. Branches, limbs, and roots shall not be cut except by permission of the Owner. All cutting shall be smoothly and neatly done without splitting or crushing. In case of cutting or unavoidable injury to branches, limbs, and trunks of trees, the cut or injured portions shall be neatly trimmed and covered with an application of grafting wax or tree healing paint as directed.
- C. Cultivated hedges, shrubs, and plants which might be injured by the Contractor's operations shall be protected by suitable means or shall be dug up, balled and temporarily replanted and maintained. After the construction operations have been substantially complete, they shall be replanted in their original positions and cared for until growth is re-established. If cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish their beauty or usefulness, they shall be replaced by items of kind and quality at least equal to the kind and quality existing at the start of the work.
- D. On paved surfaces the Contractor shall not use or operate tractors, bulldozers, or other power-operated equipment the treads or wheels of which are so shaped as to cut or otherwise injure such surfaces.
- E. All surfaces which have been injured by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun. Suitable materials and methods shall be used for such restoration.
- F. The restoration of existing property and structures shall be done as promptly as practicable and shall not be left until the end of the construction period.

### **3.07 SHEETING AND BRACING**

- A. The Contractor shall furnish, put in place, and maintain sheeting, bracing, etc., as may be necessary to support the sides of the excavation and to prevent any movement of earth which could in anyway diminish the width of the excavation to less than that necessary for safe and proper construction, or could otherwise injure or endanger adjacent structures or human life. If the Owner is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor.
- B. The Contractor shall leave in place to be embedded in the backfill, or concrete, all sheeting, bracing, etc., in which the Owner may direct him in writing to leave in place.
- C. The Owner may direct that timber used for sheeting and bracing may be cut off at any specified elevation.
- D. Wherever possible, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the

sheeting shall be driven. Care shall be taken to prevent voids outside the sheeting; but, if voids are formed, they shall be filled immediately with sand and compacted.

- E. All sheeting and bracing not to be left in place shall be carefully removed in such manner as to not endanger the construction or other structures. All voids caused or left by the withdrawal of sheeting shall be backfilled immediately with approved material and compacted.
- F. The right of the Owner to order sheeting and bracing left in place shall not be construed as creating any obligation on his part to issue such orders, and his failure to exercise his right to do so shall not relieve the Contractor from liability for damages to persons or property occurring from or upon the work as a result of negligence or other causes growing out of the Contractor's failure to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.

### **3.08 TRENCH EXCAVATION**

- A. Trench excavation, backfill and compaction shall be conducted in general accordance with these specifications and the Drawings.
- B. Trenches shall be excavated to such depths as will permit the pipe to be laid at the elevations, slopes, or depths of cover indicated on the drawings.
- C. Where pipe is to be laid in crushed stone bedding or concrete cradle, the trench may be excavated by machinery to, or to just below the designated subgrade, provided that the material remaining at the bottom of the trench remains undisturbed.
- D. Where pipe is to be laid directly on the trench bottom, the lower part of the trench in earth shall not be excavated to subgrade by machinery, but just before the pipe is to be placed, the last of the material to be excavated shall be removed by hand tools to form a flat or shaped bottom, true to grade, so that the pipe will have a uniform bearing and support on firm and undisturbed material between joints except for limited areas where the use of pipe slings may have disturbed the bottom.

### **3.09 TRENCH EXCAVATION IN FILL**

- A. If pipe is to be laid in embankments or other recently filled material, the material shall first be placed to the top of the fill or to a height of at least 1 foot above the top of the pipe whichever is the lesser. Particular care shall be taken to ensure maximum consolidation of material under the pipe location. The pipe trench shall be excavated as though in undisturbed material. Material under the pipe location shall be compacted to 90 percent maximum density according to ASTM D1557, Method C.

### **3.10 WIDTH OF TRENCH**

- A. Pipe trenches shall be made as narrow as practicable and shall not be widened by scraping or loosening materials from the sides. Every effort shall be made to keep

the sides of the trenches firm and undisturbed until backfilling has been completed and consolidated.

- B. Trenches shall be excavated with approximately vertical sides between the elevation of the center of the pipe and elevation 1 foot above the top of the pipe.

### **3.11 EARTH EXCAVATION AND BACKFILL BELOW NORMAL GRADE**

- A. If, in the opinion of the Owner, existing material below trench grade is unsuitable for properly placing bedding material and laying pipe, the Contractor will excavate and remove unsuitable material to the required width and depth and replace it with granular fill as directed by the Owner.

### **3.12 UNAUTHORIZED EXCAVATION**

- A. If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted specified borrow for pipeline not having a concrete encasement or cradle. For concrete structures and pipelines having concrete encasement or cradle, the void shall be filled with concrete with a minimum compressive strength of 3000 psi.

### **3.13 COMPACTION REQUIREMENTS**

- A. The requirements for compaction of backfill shall conform to the following guidelines based on ASTM D1557 Method C:

<u>Location</u>	<u>Percent Maximum Density</u>
Below pipe midline	92
Above pipe midline	92
Below pipe in embankments	92
Below pavement (upper 3 feet)	95
Embankments	95
Adjacent to structures	92
Below structures	95
Landfill Liner Subgrade	90

- B. The Owner reserves the right to perform additional tests on any area.

### **3.14 STRUCTURAL EXCAVATION**

- A. Excavate areas to the elevation indicated on Drawings or as may be required for the Contractor's selected equipment. Extend excavations a sufficient distance from structures to allow for placement and removal of forms, installation of services, and inspection.
- B. Slope sides of excavation maximum of 45 degrees from horizontal, except adjacent to existing structures.

- C. Final excavations shall be hand trimmed. Do not disturb soil below final excavation grades.
- D. Excavation shall not interfere with normal 45 degree bearing splay of foundations.
- E. Proof roll entire excavation.
- F. Remove soft areas of excavation discovered during proof rolling and backfill with granular fill as specified.
- G. Backfill excavation to required subgrade with suitable excavated materials or granular fill as specified.

### **3.15 BACKFILLING**

- A. In general, and unless other material is indicated on the Drawings or specified or classified as unsuitable material by the Owner, excavated material removed in the course of the construction excavation shall be suitable material for backfilling trenches, waste removal areas, or filling to final subgrades.
- B. Care shall be exercised in placing fill adjacent to piers, walls, grade beams, footings, and other structures to prevent lateral movement. Fill on opposite sides of such items shall be kept at approximately the same elevation to prevent an unbalanced earth pressure, and shoring shall be used as necessary. Foundation walls and footings will not withstand unbalanced earth or equipment loadings.
- C. Frozen material shall not be placed in the backfill nor shall backfill be placed upon frozen material. Previously frozen material shall be removed or shall be otherwise treated as required, before new backfill is placed.
- D. All backfill shall be compacted to the specified percent of maximum density at optimum moisture as determined by ASTM D1557.
- E. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction. No compacting shall be done when the material is too wet, from either rain or too great an application of water, to compact it properly; at such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or such other precautions shall be taken as may be necessary to obtain proper compaction.
- F. Material used for backfilling trenches or around structures shall be brought up to the grades as indicated on the drawings.

### **3.16 BACKFILLING PIPE TRENCHES**

- A. As soon as practicable after pipes have been laid, backfilling shall be started. Pipeline cover shall be as indicated on the Drawings or directed by Owner.
- B. Pipe bedding shall be placed with hand shovel up to a level of 12-inches above the top of pipe. This area of backfill is considered the zone around pipe and shall

be thoroughly compacted before the remainder of the trench is backfilled. Compaction of the zone around pipe shall be done by use of power-driven tampers weighing at least 20 pounds and approved by the Owner. Care shall be taken that material close to the bank, as well as in all other portions of the trench, is thoroughly compacted.

- C. Granular fill shall be placed from the top of the select backfill to grade. Backfill and compaction in the remainder of the trench shall be done in layers not exceeding 12 inches in depth and by use of power driven tampers weighing at least 20 pounds and approved by the Owner. Water jetting and puddling will not be permitted.
- D. The Contractor shall maintain the trench surface as work progresses. If settlement takes place he shall immediately deposit additional material to restore the level of the ground.

### **3.17 BACKFILL GRADES**

- A. Material used for backfilling trenches or around structures shall be brought up to normal grades.

### **3.18 FILL SUPPORTING STRUCTURES AND REQUIRED COMPACTION**

- A. Material to be used as fill for supporting structures shall be Fine Gravel Bedding as directed and approved in advance by the Owner. Where fill is required to support proposed footings, wall, slabs, and any other structure, the material shall be placed and compacted in layers not to exceed 8 inches. Compaction of each lift shall be to a dry density of 95 percent of the maximum dry density determined by ASTM D1557 and shall be by hand-guided vibratory equipment or mechanical tampers.
- B. Following the placement and compaction of the fill material, crushed stone, if required, shall be placed immediately below the structures as detailed on the drawings.

### **3.19 BACKFILLING AROUND STRUCTURES**

- A. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads to which they will be subjected. Excavated material approved by the Owner shall be used in backfilling around structures and shall be compacted. Backfilling material shall be spread in horizontal layers not exceeding 9 inches in thickness (loose) and thoroughly compacted to at least 92 percent of the maximum dry density as determined by ASTM D1557.
- B. Tree stumps or roots more than 12 inches long or more than 1/2-inch in diameter and stones or rocks larger than 6 inches in greatest dimension shall not be considered suitable material for backfill around structures.
- C. Should an insufficient quantity of suitable material, as determined by the Owner, be available for backfill around structures, the Contractor shall use gravel borrow,

as approved by the Owner at no additional cost to the Owner.

### **3.20 ADDITIONAL GRANULAR FILL**

- A. Should the Owner classify material above the trench bottom as unsuitable for backfill, and there is no available backfill material stockpiled, then the Owner shall order additional granular fill to be furnished and installed by the Contractor.
- B. Backfilling and compaction requirements for the granular fill shall otherwise conform to the trench details.

### **3.21 ADDITIONAL CRUSHED STONE**

- A. Should the Owner order additional crushed stone for utility supports or for other purposes, the Contractor shall furnish and install the crushed stone as directed.

### **3.22 RESTORING TRENCH SURFACE**

- A. Where the trench occurs adjacent to paved streets in shoulders or sidewalks, the Contractor shall compact as specified elsewhere in these specifications the backfill and shall maintain the surface as the work progresses. If settlement takes place he shall immediately deposit additional fill to restore the level of the ground.
- B. Adjacent to streets and highways the top 12-inch layer of trench backfill shall consist of compacted gravel base course. If in the opinion of the Owner, the existing top 12-inch layer is unsuitable for use as subgrade or shoulder material, he may order the Contractor to remove this layer and to backfill with gravel borrow compacted to at least 95 percent of maximum dry density as determined by ASTM D1557, Method D.

### **3.23 EMBANKMENTS AND STONE BUTTRESSES**

- A. Perform all necessary foundation preparation including the removal of unsuitable materials from within areas of proposed embankment construction. These areas include the westerly side of the landfill beyond the base of the existing berm where the slope will be extended at a 2:1 slope and areas along the north side of the landfill where slope reduction to 1.5:1 and stone buttress construction is to be performed.
- B. All unreinforced backfill material used to reduce the steepness of the landfill slopes shall consist of materials that are free from organic or other unsuitable or deleterious material. The materials to be utilized in the construction of the unreinforced embankment slopes shall be comprised of rock fill or other inert material, such as broken concrete or brick, earthen materials or a combination of these components. Earthen materials proposed for use shall have no greater than 15% by weight passing the #200 sieve.

The material shall exhibit an angle of internal friction of not less than 40 degrees, as determined by the direct shear test ASTM D3080, utilizing as sample of the material compacted to 95% of ASTM D1557, at optimum moisture content.

The material shall have an organic content no greater than 1% (AASHTO T-267-86)

The frequency of sampling the unreinforced backfill necessary to assure the above mentioned requirement shall be directed by the Owner's Engineer

Surplus, uncontaminated, as determined by the Owner, excavated material available from the excavations and other on-site areas may be used for filling and constructing embankments, except as otherwise specified.

- C. Material needed in addition to that available from construction operations shall be furnished by the Contractor at his own expense, and shall conform to the requirements specified above.
- D. The Contractor shall remove loam and topsoil, loose vegetable matter, stumps, large roots, etc., from areas upon which embankments will be built or material will be placed for grading. The subgrade shall be shaped as indicated on the drawings and shall be so prepared so that the first layer of the new material placed there on will be well bonded to it.
- E. After the subgrade has been prepared as herein before specified, the material shall be placed thereon and built up in successive layers until it has reached the required elevation.
- F. Layers shall not exceed 12 inches in thickness (loose) and shall be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557, Method D. In embankments the layers shall be slightly dished toward the center.

Each layer of earthen material shall be compacted by the use of vibratory compaction equipment, rollers or other mechanical means to achieve at least 95 percent of maximum dry density as determined by ASTM D1557, Method D. At such points as cannot be reached by mobile mechanical equipment, the materials shall be thoroughly compacted by the use of suitable power-driven tampers.

- G. Stone Buttress construction shall be completed at the locations and in accordance with the details provided on the design drawings. Stone buttresses shall be constructed on a suitably prepared subgrade foundation that includes the installation of geotextile fabric.

Place the rock in a stable orientation with minimal voids. Offset the rock to produce a random pattern. Use spalls smaller than the minimum rock size to chock the larger rock solidly in position and to fill voids between the large rocks.

Construct the exposed face of the rock mass reasonably uniform with no projections beyond the line of the slope that are more than 12 inches.

### **3.24 SURPLUS EXCAVATED MATERIALS**

- A. No excavated material shall be removed from the site of the work or disposed of by the Contractor except as directed or approved by the Owner. All surplus material

removed from the site shall be disposed of by the Contractor at the Contractor's expense.

- B. Surplus, uncontaminated, excavated materials shall, with the approval of the Owner, be used to backfill normal excavations in rock or to replace other materials unacceptable for use as backfill; shall be neatly deposited and graded so as to make or widen fills, flatten side slopes, or fill depressions; or shall be neatly deposited for other purposes indicated by the Owner, within its jurisdictional limits; all as directed or approved and without additional compensation.
- C. Surplus, uncontaminated, excavated material, other than that suitable for backfill, shall be neatly deposited for other purposes as indicated by the Owner, within its jurisdictional limits, as directed or approved and without additional compensation.
- D. Surplus, uncontaminated, excavated material not needed as specified above shall be hauled away and dumped by the Contractor; at his expense, at appropriate locations, and in accordance with arrangements made by him.
- E. Refuse and debris excavated during these operations shall be disposed of by the Contractor at a location within the limits of the landfill, as approved and directed by the Owner. The Contractor shall limit the disposal area to as small a section of the landfill as is possible.

### **3.25 DITCHES AND GUTTERS**

Excavation of ditches, and gutters shall be accomplished by cutting accurately to the cross sections, grades, and elevations required. Excessive open ditch or gutter excavation shall be backfilled with satisfactory thoroughly compacted material or with suitable stone or cobble to grades shown at the Contractor's Expense. Material excavated shall be disposed of as directed, except that in no case shall material be deposited less than 4 feet from the edge of a ditch. The Contractor shall maintain all excavations free from detrimental quantities of standing water, leaves, brush, sticks, trash and other debris until final acceptance of the work.

### **3.26 SUBGRADE AND EMBANKMENT PROTECTION**

- A. During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until subgrade, subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished subgrade will not be permitted. No subgrade, subbase, base course, or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subgrade, subbase, base surfacing or pavement be placed on a muddy, spongy, or frozen subgrade.

**END OF SECTION**

## **SECTION 02210**

### **SAND**

#### **PART I - GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of the sand drainage layer component of the landfill cap construction as specified herein and as shown on the Drawing.
- B. The Contractor shall coordinate the construction of the sand drainage layer with other construction activities at the site.

##### **1.02 RELATED SECTIONS**

- A. Section 02200 - Earthwork  
Section 02500 - HDPE Geomembrane

##### **1.03 REFERENCES**

- A. Latest version of American Society for Testing Materials (ASTM) standards:
  - 1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
  - 2. ASTM D 2434, Standard Test Method for Permeability of Granular Soils (Constant Head).
  - 3. ASTM D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method.

##### **1.04 SUBMITTALS**

- A. The Contractor shall submit the following information and samples to the Owner a minimum of 14 days prior to the start of placement of the sand drainage layer materials:
  - 1. the proposed material source or sources;
  - 2. the results of particle size-analysis in accordance with ASTM D 422;
  - 3. the results of the laboratory permeability test in accordance with ASTM D 2434;
  - 4. the results of the laboratory interface shear test in accordance with ASTM D 5321; and

5. a 10-pound bag sample of each proposed soil and authorization to access the borrow source or sources for sampling.
- B. The Contractor shall conduct interface shear tests (ASTM 5321) to determine the strength of the interface between each source of the sand drainage layer sand and the geomembrane cap to be used for the project. Each test shall determine interface strength at normal stresses of 1 pounds per square inch (psi), 2 psi and 4 psi. Additional testing shall be required if the material source has changed or the characteristics of the source have changed. Additional samples shall be collected and tested if the material does not meet specifications.
- C. The Contractor shall notify the Owner in writing a minimum of 7 days prior to starting construction. The notice shall state the source of the material to be used, the equipment to be used, the date and time that placement operations will start, and the name of the person in the field who will be in charge of the construction.
- D. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner immediately and provide a plan schedule for resumption of work.

## **PART 2 - PRODUCT**

### **2.01 MATERIAL**

- A. The sand materials shall be free of any metals, roots, trees, stumps, concrete construction debris, or any other organic matter or deleterious material that are not compatible with landfill leachate.
- B. The sand materials shall conform to Washed Sand as specified in Section 02200 with a maximum particle size of 3/8 inch diameter and shall be smooth and rounded.
- C. The sand layer material shall have the following minimum hydraulic conductivity (k) based on laboratory permeability testing conducted in accordance with ASTM D 2434:  
  
Drainage Layer:         $1.0 \times 10^{-2}$  cm/sec.
- D. The interfaces with the geomembrane and the internal shall have minimum peak shear strength (Friction Angle) of  $27^\circ$ , under saturated conditions.

## **PART 3 - EXECUTION**

### **3.01 FAMILIARIZATION**

- A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all the portions of the work falling within this Section and related Sections specified elsewhere.
- B. Inspection:

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

### **3.02 FIELD QUALITY CONTROL**

- A. The minimum frequency of quality control testing shall be:
  1. Sieve analysis (ASTM D 422) at 1 per 1,500 cubic yards.
  2. Hydraulic conductivity (ASTM D 2434) at 1 per 3,000 cubic yards.
- B. The Contractor shall take this testing frequency into account in planning his construction schedule.
- C. The frequency of conformance testing shall apply to all material delivered to the site.
- D. The Contractor shall provide necessary personnel, tools and equipment for the purpose of conducting layer thickness verification. Thickness verification will be performed by hand digging shallow test pits for direct measurement. Layer thickness verification shall be conducted at a frequency no less than 5 tests per acre or more often as directed by the Owner. All tests will be conducted in the presence of the Owner.

### **3.03 SAND LAYER PLACEMENT**

- A. The Contractor shall construct the sand drainage layer to the grades, slope and depths shown on the Drawings and as specified in this Section.
- B. The sand drainage layer shall be placed directly on top of the HDPE geomembrane liner as shown on the Drawings to a full 12 inch thickness. Thickness verification will be conducted in the presence of the Owner at a minimum frequency of 5 tests/acre or more often as directed by the Owner.
- C. In the event of damage to prior work or work completed as specified in this Section, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.
- D. Sand placement will be performed by the Contractor with extreme caution. Any damages caused to the geomembrane or other appurtenant features will be repaired and retested if necessary to original or better conditions. Repair work will be performed to the satisfaction of the Owner at no additional cost to the Owner.
- E. The integrity of the geomembrane cannot be jeopardized during any part of these operations. Therefore, dump trucks and spreading equipment will not be allowed to operate in direct contact with geomembrane. Placement of the sand will be by such means as to cause no ballooning of the membrane, ahead of the sand placement work.

- E. The placement of the sand drainage layer shall be performed using low ground pressure equipment. The equipment shall exert no more than 5 psi ground pressure.

#### **3.04 SURVEY CONTROL**

- A. The Contractor shall provide survey control necessary for establishing proper grade, slope and thickness when constructing each sand layer.

#### **3.05 PROTECTION OF WORK**

- A. The Contractor shall use all means necessary to protect all prior work, including all materials and completed work specified in this and other Sections.
- B. In the event of damage to prior work or work completed as specified in this Section, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

**END OF SECTION**

## SECTION 02220

### RIPRAP

#### PART 1 - GENERAL

##### 1.01 SCOPE

Furnish all labor, materials, tools, and equipment and perform all operations necessary for the placement of a protective covering of stone of the size, type, and location shown on the Drawings or as directed by the Owner.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork
- B. Section 02596 - Geotextile Fabric

#### PART 2 - PRODUCTS

##### 2.01 STONE

- A. Stone used for riprap shall be hard, durable angular shaped stones which are the product of the primary crushing of a stone crusher. Rounded stone, boulders, sandstone and similar soft stone or relatively thin slabs will not be acceptable.
- B. The quality of the riprap shall be approved by the Owner.
- C. Riprap shall comply with the following gradation criteria:

<u>Size of Stone</u>	<u>Percent of Rock by Mass</u>	<u>Mass (Lbs)</u>
6 to 8 in.	20	22 to 33
5 to 6 in.	30	11 to 22
2 to 5 in.	40	1 to 11
0 to 2 in.	10	0 to 1

#### PART 3 - EXECUTION

##### 3.01 RIPRAP STONES

- A. Riprap stones shall be placed on the prepared area in a manner which will produce a well graded mass with a minimum practical percentage of voids. The riprap stone shall be placed to the minimum thickness as shown on the site plans and detail drawings.
- B. The stone shall be placed to its full thickness in one operation and in such a manner as to avoid displacing the underlying material including the 16 ounce geotextile filter fabric.

- C. The placement of the stone shall produce a compact rip rap protected surface in which all sizes of stone are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to achieve the specified result.

### **3.02 FILTER FABRIC**

- A. A 16 ounce non-woven geotextile shall be placed on top of the prepared embankment slope or surface upon which the rip rap stones will be placed, unless shown otherwise on the Drawings. Refer to SECTION 02596, Geotextile Fabrics.

**END OF SECTION**

## SECTION 02230

### HDPE DRAINAGE PIPE

#### PART 1 - GENERAL

##### 1.01 SCOPE

- A. The Contractor shall furnish all labor, materials, tools, and equipment and perform all operations necessary for drainage pipe construction. Pipe culverts and pipe drains shall consist of sections of pipe of the kinds and sizes shown on the Drawings and as specified, laid on a firm foundation in a trench in accordance with these specifications.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork
- B. Section 02240 - Drainage Structures

##### 1.03 QUALITY ASSURANCE

- A. Pipes shall be laid true to the lines and grades shown on the Drawings or as directed by the Owner. The grades shown on the Drawings are the invert grades to which the work shall conform. A variation of more than 0.02 feet from the true invert grade on drains laid on a one percent or less grade and greater than 0.10 feet on drains laid on grades above one percent will be deemed sufficient reason to cause the work to be rejected. Work so rejected shall be corrected by the Contractor at his own expense in a manner acceptable to the Owner.
- B. The Contractor shall demonstrate his proposed methods of maintaining the grade and alignment of pipe during construction with the Owner before the start of construction.
- C. The Contractor shall furnish all labor, materials, and tools to establish and maintain all lines and grades. Such tools and materials as are required for the work and furnished by the Contractor shall be approved by the Owner. Bench marks and reference points as required for control of the work have been located along the job site. Transferring line and grade from those references shall be the responsibility of the Contractor.
- D. Source Quality Control
  - 1. Contractor shall submit a listing of suppliers of all manufactured products to be used for drains and appurtenances. Inferior performance on prior projects of a similar nature shall be grounds for rejecting a supplier's products.

2. Contractor shall submit for approval shop drawings and technical data on pipe and fittings prior to ordering and receiving these materials.
3. Certificates of compliance with specified standards and tests will be required from the Manufacturer, through the Contractor to the Owner.

#### **1.04 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. When delivered to the site, and prior to unloading, the Contractor shall inspect all pipe, and accessories for loss, damage or lack of specified identification and markings. Any defective or improper material shall be immediately marked and shall not be unloaded.
- B. In shipping, storing and installing, pipe shall be kept in a sound, undamaged condition. It shall at all times be handled with care and shall not be dropped, dumped or bumped against any other object. Any materials damaged shall be marked and immediately removed from the job site.
- C. Pipe shall be stacked with spigot ends projecting from the stack in opposite directions from alternate rows where applicable.
- D. All material found at anytime during the progress of the work to have flaws or other defects will be rejected and marked and the Contractor shall promptly remove such defective material from the work site.

### **PART 2 - PRODUCTS**

#### **2.01 HDPE PIPE**

- A. HPPE Corrugated pipe, fittings and other appurtenances shall be manufactured in accordance with Standard Specification for Corrugated Polyethylene Pipe, AASHTO M-294.
- B. Pipe shall be of the strength and/or class, size and interior and exterior finish indicated on the Drawings and specified under the applicable item of work.
- C. All pipe and fittings shall be produced by a manufacturer approved by the Owner.

#### **2.02 JOINTS**

- A. Joints for all HDPE corrugated pipe and fittings shall be of the bell and spigot type and sealed by an elastomeric rubber gasket meeting ASTM F-477 designed to guard against infiltration of silt at the joint.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. All pipe, fitting and other appurtenances shall be installed true to lines, grades and locations indicated on the plans. Any deviations must be approved by the Owner before installation.

### **3.02 EXCAVATION, BACKFILL AND COMPACTION**

- A. Trenching, Backfill and Compaction shall be as specified in Section 02200 - Earthwork of the Specifications.

### **3.03 PIPE BEDDING CONDITIONS**

- A. All pipes laid in open trench excavations shall be bedded in and uniformly supported over their full length on beddings of the types specified herein and shown on the Drawings. All work shall be performed in a dry trench. Where higher type bedding conditions than those shown on the Drawings are ordered as a result of the Contractor's method of operation, the Contractor shall be due no additional compensation. Where directed by the Owner as a result of unsuitable soil conditions, the Contractor shall be paid for special bedding under appropriate bid items.

### **3.04 GRAVEL PIPE BEDDING**

- A. All pipes shall be supported on gravel pipe bedding, except as otherwise indicated on the Drawings or ordered by the Owner.
- B. The trench shall be excavated to a depth of four inches, below the bottom of the pipe. Gravel pipe bedding shall be furnished and placed in the trench for its full width to uniformly support the pipe at the required line and grade.
- C. Suitable recesses shall be provided in the bedding to permit adequate clearance for couplings or similar projections. The bedding shall extend upward around the pipe barrel to form a positive cradle fitting the bottom quadrant (90 degrees) of the pipe barrel providing uniform support along the length of the pipe section at the required line and grade.
- D. Bedding material shall be spread in four inch layers, and each layer shall be compacted with 20 pound hand tampers or pneumatic tampers until the required total depth of bedding has been built up.
- E. Where a suitable supporting soil or rock stratum occurs at a depth greater than four inches, but less than two feet below the pipe, and where ordered by the Owner, this foundation shall be modified as follows. The trench shall be excavated to the depth necessary to reach the suitable supporting stratum. Screened gravel or crushed stone bedding shall then be spread in four inch layers, and each layer shall be compacted with 20 pound hand or pneumatic tampers. The screened gravel or crushed stone shall carry vertically from the supporting stratum up to an elevation but not less than four inches, below the bottom of the pipe. The gravel pipe bedding shall then be installed as specified above and the additional screened gravel or crushed stone paid for under the over excavation and backfill bid item.

### **3.05 INSPECTION OF PIPE BEFORE INSTALLATION**

- A. All pipe and fittings shall be carefully inspected in the field before lowering into the trench. Damaged, warped, out-of-round or otherwise defective pipe or fittings

as determined by the Contractor or the Owner, shall be pulled and not installed. Such rejected pipe shall be clearly tagged in such a manner as not to deface or damage it, and the pipe shall then be removed from the site by the Contractor at his own expense.

### **3.06 INSTALLATION OF PIPE AND FITTINGS**

- A. After the trench has been brought to the proper grade, as herein before specified, the pipe shall be laid. Unless otherwise approved by the Owner in writing, pipe laying shall be done only in the presence of the Owner and the Contractor shall give ample notice of scheduled pipe laying operations to the Owner. Bedding type shall be as specified in this Section or as directed by the Owner.
- B. All pipe and fittings shall be carefully lowered into the trench with ropes, slings and proper equipment. Pipe becoming damaged during or following installation shall be marked by the Contractor or Owner and removed from the site as required in the preceding clause.
- C. Pipes shall be laid true to grades shown on the Drawings or as directed by the Owner. Each section of pipe shall rest upon the pipe bed for the full length of its barrel, with recesses excavated to accommodate fittings and couplings.
- D. Flexible pipe shall be placed with longitudinal laps and seams at the sides.
- E. Paving or partial lining of pipes shall coincide with the flow line.
- F. Joints between dissimilar pipes shall be made in accordance with the recommendations of the manufacturer of one or the other of the pipes.
- G. If the drain is damaged from any cause, or becomes either partly or completely filled with dirt, stones, sand or other debris, the Contractor shall make all necessary repairs, and remove all such material to the satisfaction of the Owner, without further charge and, upon refusal or failure to do so, it shall be done by the Owner and the cost thereof shall be charged as money paid to the Contractor.
- H. Before machine backfilling shall be done, the Owner shall make tests as may be required, in order to ascertain if the pipe is true to line and grade. In case the test shows poor alignment, misplaced pipe or other defects, such defects shall be remedied by the Contractor, to the satisfaction of the Owner, before the work of backfilling proceeds.

### **3.07 FINAL INSPECTION**

- A. Each section of installed pipe will be visually inspected by the Owner prior to final testing. It shall be true to both line and grade, shall contain no broken pipe, shall show no leaks, shall show no obstructions, and shall contain no debris or other deposits which shall in any way reduce the full cross-sectional area of the pipe.
- B. Any section of pipe which does not comply with these inspection criteria, as determined by the Owner, shall be promptly corrected, replaced or repaired by the

Contractor at his own expense. Such methods as are employed for the correction shall be approved by the Owner.

**END OF SECTION**

**SECTION 02240**  
**DRAINAGE STRUCTURES**

**PART 1 - GENERAL**

**1.01 SCOPE**

- A. Furnish all labor, materials, tools, and equipment to construct drain manholes and furnish and place manhole covers as shown on the Drawings or as directed.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02200 - Earthwork
- B. Section 02230 - Drainage Pipe

**PART 2 - PRODUCTS**

**2.01 CONCRETE**

- A. Cement shall be an approved brand of Portland cement and comply with ASTM C150. Concrete shall be Class A, 3,000 psi.

**2.02 REINFORCING STEEL**

- A. Deformed rods and bars for reinforcing concrete shall be rolled from first quality new billet steel. Rods and bars shall conform to ASTM A615, Grade 60, unless noted otherwise on the Drawings.
- B. All reinforcement shall be accurately cut and bent cold to the dimensions indicated on the Drawings. Bends shall be made in conformance with the Manual of Standard Practice of the Concrete Reinforcing Steel Institute.
- C. Welded wire fabric shall be of cold drawn steel wire of the cross-sectional area indicated on the Drawings conforming to ASTM A185.

**2.03 PRECAST CONCRETE SECTIONS**

- A. Precast concrete barrel sections and transition top sections shall conform to Specifications for Precast Reinforced Concrete Manhole Sections, ASTM C478 and meet the following requirements:
  - 1. The wall thickness shall not be less than 5-in for 48-in and 72-in diameter barrel, if reinforced, and 8-in, if unreinforced.
  - 2. Top sections shall be eccentric except that concentric top sections shall be used where shallow cover requires a top section less 4 feet as shown on the Drawings. Where shallow cover requires a riser section less than 4-feet, use a precast barrel section and precast top slab with a 30-inch opening.

3. Barrel sections shall have tongue and groove joints.
4. All sections shall be cured by an approved method and shall not be shipped nor subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 5 days after fabrication and/or repair, whichever is longer.
5. Precast concrete barrel sections with precast top slabs and precast concrete transition sections shall be designed for a minimum of H-20 loading plus the weight of the soil above.
6. The date of manufacture and the name and trademark of the manufacturer shall be clearly marked on the inside of each precast section.
7. Precast concrete bases shall conform to all the requirements of the Specification on Manhole Barrel Sections ASTM C478. The thickness of the bottom slab of the precast bases shall not be less than the manhole barrel sections or top slab whichever is greater. Tops of manhole bases shall have joints compatible with the precast barrel section.
8. Type II cement shall be used except as otherwise approved.

#### **2.04 BRICK MASONRY**

- A. Bricks for building up and leveling manhole and catch basin frames shall conform to ASTM C62.

#### **2.05 CONCRETE MASONRY UNITS**

- A. Concrete masonry units shall conform to the requirements of ASTM C 139 and shall have a minimum compressive strength of 3,000 psi.

#### **2.06 CEMENT MORTAR**

- A. Use one cement brand for masonry work. Gray and non-staining white Portland cements shall comply with ASTM C150, Type 1. Do not use high early strength or air-entraining cement for masonry mortar.
- B. Sand for mortar shall be natural sand or sand made from stone, gravel, or air-cooled iron blast furnace slag; be clean, well graded, and free of excessive organic and deleterious materials; and comply with ASTM C144.

#### **2.07 CASTINGS**

- A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Their seats shall be machined to a true surface, and shall be true and seat at all points without rocking. Castings shall be thoroughly cleaned and subject to hammer inspection. Before shipment from the foundry, castings shall be given one coat of coal tar pitch varnish which shall present a casting that is smooth and tough, but not brittle. Cast iron shall conform to ASTM A48, Class 30.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. The manholes shall be constructed to the lines, grades, dimensions, and designs shown on the Drawings and as directed by the Owner, with the necessary frames, grating or covers, and steps in accordance with these specifications.

### **3.02 MASONRY JOINTS**

- A. Masonry joints shall be full mortar joint not more than 1/2 inch wide. Exposed joint shall be neatly finished.

### **3.03 FRAMES**

- A. Metal frames shall be set in a full mortar bed, true to line and grade.
- B. When directed by the Owner, the casting shall be temporarily set at such grades as to provide drainage during construction.

### **3.04 GRANULAR BASE**

- A. All drainage structures shall be laid on a granular base. The base shall be of screened gravel or crushed stone, 6 inches deep and in conformance with applicable provisions of Section 02200 - Earthwork.

**END OF SECTION**

## **SECTION 02250**

### **LANDFILL GAS EXTRACTION WELLS**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of landfill gas extraction wells (EW) and condensate traps as specified herein and as shown on the Drawings.

##### **1.02 RELATED SECTIONS**

- A. Section 02200 - Earthwork
- B. Section 02714 - Pipe and Fittings

##### **1.03 CONTRACTOR QUALIFICATIONS**

- A. Contractor shall have completed at least five successful operating landfill gas collection system installations with similar wells, and condensate traps within the last five years.
- B. Submit list of above described collection systems with bids.
- C. All EW extraction wells and condensate traps shall be installed under the direction of a qualified construction superintendent with at least five years of direct experience of conducting landfill gas extraction well boring and construction work. All final EW collection well and condensate trap drilling logs and construction diagrams shall be signed by the construction superintendent.

##### **1.03 SUBMITTALS**

- A. The Contractor is responsible for implementing a Health and Safety Plan for the protection of its employees working at the site. The plan shall be approved by the Owner prior to construction start-up. Refer to Section 01036 – Health and Safety.
- B. Prior to construction, Contractor shall meet with the appropriate representatives of the Police Department and Fire Department to discuss public safety, site access, traffic safety and emergency response requirements.
- C. Prior to construction, the Contractor shall submit to the Owner a detailed Odor Control Plan describing procedures to control odors from the waste excavation and Contractor's procedures for responding to odor complaints.
- D. Prior to construction, the Contractor shall submit to the Owner a detailed Spoils Management Plan for the handling of spoils removed from the borehole and trenches during gas collection system construction.

- E. Prior to construction, the Contractor shall submit to the Owner shop drawings detailing the dimensioning and technical specifications for all the gas collection pipe and fittings. Also, submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM standards specified herein.
- F. The Contractor shall submit testing results of pre-construction quality control tests conducted on representative samples of the Contractor's source of the washed stone. Such test results must document compliance with these specifications.
- G. The Contractor shall submit to the Owner representative samples of washed stone prior to delivery of the washed stone to the project site. Owner may elect to conduct the tests of said sample.
- H. Submit one copy of the following Landfill Gas Extraction Well (EW) Data upon completion of drilling:
  - 1. Daily driller's report. During the drilling of the well, maintain daily driller's report that includes at a minimum, but not limited to:
    - a. Date, Location, Boring identification number, Weather conditions, Daily activities, Equipment used, Drilling crew, Time (rig time, down time, stand-by, etc.), Footage, Materials used, Well construction (materials used, type, quantity, etc.), Relevant notations and Verification of activities.
  - 2. Well Log. During the drilling of the well the Contractor will complete a well log report that includes at a minimum, but not limited to:
    - a. Logger's Name, Date Begun, Date Completed, Location, Boring identification number, Weather conditions, Equipment used, Drilling crew, Time (time to depth, down time, stand-by, etc.), Footage (Total Depth, Well depth), General descriptions of strata encountered, Depth and thickness of intermediate covers/soil layers, General soils descriptions, Estimates of moisture content, Notation of wet or saturated zones, Ambient air monitoring results, Materials used, Well construction (materials used, type, quantity, etc.), Relevant notations and Verification of activities.
  - 3. Well Installation Log. Upon completion of the well the Contractor will complete a well installation report that includes at a minimum, but not limited to:
    - a. Installer's Name, Date Begun, Date Completed, Location, Boring identification number, Equipment used, Installation crew, Time (time to depth, down time, stand-by, etc.), Footage (Total Depth, Well depth), Materials used, Size and depth of pipe, Length of perforated and solid casing, Depth and type of gravel pack, Depth and thickness of bentonite seal(s), Depth and thickness of backfill materials(s), Type and thickness of surface seal, Casing elevation, Relevant notations and Verification of activities.

4. Contractor will provide copies of Driller's Reports, Well Logs and Well Installation Logs for review and approval by the Owner prior to requesting payment for that work.
5. Contractor will provide copies of proposed EW Installation procedures for review and approval by the Owner prior to initiation of well construction.

## **PART 2 - PRODUCTS**

### **2.01 GAS EXTRACTION WELLS (EW) AND CONDENSATE INFILTRATORS**

- A. All pipe and fittings are to be high density polyethylene (HDPE) per Specification Section 02714, and as shown on the Drawings.

### **2.02 WASHED STONE**

- A. Washed stone shall be non-calcareous gravel, 3/4-inch to 1½-inch for gas collection gas wells. Washed stone shall be free of debris, organic matter, vegetation, frozen earth and any other materials considered unsuitable by the Owner. Washed stone shall be clean with no more than 5 percent of the material being finer than a #200 sieve as determined by ASTM D422.

### **2.03 SOIL BACKFILL**

- A. Soil: backfill shall be of a fine material that has good compaction characteristics and shall conform with cover materials on-site or as designated in Section 02200, and as approved by the Owner.

### **2.04 BENTONITE SEALS**

- A. Bentonite shall be medium bentonite chips or 3/8-inch round bentonite pellets.

## **PART 3 - EXECUTION**

### **3.01 GAS EXTRACTION WELLS (EW)**

- A. The Contractor shall install landfill gas extraction wells and piping, associated flexhose, samples ports, valves, gaskets and appurtenances in accordance with the details and at the locations noted on the Drawings and staked in the field, or as approved by the Owner.
- B. The EW well boring will be a minimum 36-inch diameter hole drilled to the bore hole depth listed on the gas extraction well schedule on the Drawings. Wells shall be constructed in accordance with the details shown on the Drawings and as noted in the Specifications.
- C. Contractor shall fabricate the well casings in accordance with Drawings and Specifications. The well casing shall be perforated in accordance with the Drawings and Specifications. All perforations and casing assembly shall be as stipulated in the Drawings and Specifications. The bottom of the casing shall be capped with a fused polyethylene cap of appropriate size and schedule. Slip couplings shall allow for landfill settling, while providing a seal between

changing pipe sizes, as shown on the Drawings. Well casings shall be blind-flanged at the surface connection prior to installation to prevent gas from escaping and backfill material from entering the pipe.

- D. No pressure check is necessary for the extraction wells.
- E. Contractor shall drill the gas extraction well bores using an appropriate truck mounted or Caisson (crane-mounted bucket auger) type drilling unit capable of boring to the depths indicated in the Drawings and Specifications.
- F. Contractor shall perform no boring unless the Owner is present to approve the well location and to witness operations.
- G. Boring depths shall be completed as listed on the gas extraction well schedule shown on the Drawings. Final casing depths shall be adjusted at the completion of drilling to accommodate any deviation from identified depths.
- H. Well casings shall be set and the annular space backfilled in accordance with contract Drawings and Specifications. Well casings shall be installed immediately after completion of the holes by lifting the casing with the drill rig cable hoist, in sections if required, and lower the casing into the hole. The casing shall be installed above the bottom of the boring, as shown on the Drawings. The flanged surface connection shall terminate 5 feet above the final cover system subgrade elevation. The casing shall be suspended at the surface and centered in the boring at all times during backfilling. Suspension and centering equipment shall allow for safe manipulation of the well casing in and over the open boring and provide a stable working surface for personnel completing section couplings and/or final removal of well supporting equipment. Initial washed stone backfilling operations shall be completed while the well casing is suspended at the depth shown on the Drawings above the bottom of the boring hole. When the pipe is "supported" by the washed stone in the hole, and the drill rig can be moved to the next location. Wells shall then be completely backfilled with the designated amounts and levels of materials as shown on the Drawings. Washed stone backfill shall be placed to the depths shown on the Drawings. A minimum two feet thick seal of hydrated bentonite chips shall be installed above the gravel pack and well washer, as shown on the Drawings. This seal will be allowed to hydrate thoroughly prior to addition of clean backfill. Clean backfill shall be installed, as shown on the Drawings.
- I. No well boring shall remain unsecured at the end of the workday. Any well borings not completed by the end of the workday shall be secured in a safe manner that will not allow access to the boring. At no time are open well borings to be left uncovered and/or unattended during the course of the workday.
- J. Contractor shall be responsible for any grading, leveling, towing and/or restoration which may be necessary for movement of the drill rig on the landfill property. No extraction well drilling shall occur on slopes that cannot safely support the drilling operations.
- K. Any settlement shall be backfilled within 3 weeks after placement of backfill from the level of the subsidence to 6 inches above existing grade with the appropriate cover materials.

### **3.02 CONDENSATE INFILTRATORS**

- A. Condensate infiltrators shall be installed as shown on the Drawings.
- B. The infiltrators shall be installed at a depth conditional to vacuum requirements and approved by Owner.
- C. The infiltrators is to be installed plum and in a generally similar manner as the EWs, except as shown on the Drawings.

### **3.03 LANDFILL WELLHEAD ASSEMBLIES**

- A. Landfill wellhead assemblies shall conform to the details and specifications presented in the Landfill Wellhead Assembly detail shown on Drawing No. 8.
- B. The wellhead assemblies shall be constructed with a two (2) inch PVC throttle valve so that landfill gas flow rates can be modulated at each landfill gas extraction well. The landfill gas wellheads shall include sampling ports located on either side of the throttle valve so that landfill gas quality and applied vacuum can be measured and recorded. The landfill gas wellheads shall also have permanently mounted thermometers so that landfill gas temperatures can be read and recorded. The wellheads shall also have fitting and appurtenances necessary for the measurement of landfill gas flow rates from each extraction well.

**END OF SECTION**

## SECTION 02290

### TOPSOIL AND SEED

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION OF WORK

- A. The work covered by this section consists of furnishing all labor, equipment and material as necessary to apply topsoil, seed and fertilizer to the landfill surface and adjacent disturbed areas and to establish a healthy, robust growth of perennial grasses upon these areas.
- B. This section also covers the furnishing and placement of erosion control matting within grass lined diversion berms and swales.

##### 1.02 QUALITY ASSURANCE

- A. The Contractor shall have samples of topsoil tested by an independent testing laboratory for pH, organic concentration and grain size.
- B. The above referenced testing shall be done at a frequency of 1 set of tests for every 1,000 cubic yards of material to be used on this project.
- C. The results of all laboratory testing shall be submitted to the Owner.
- D. Hydraulic conductivity testing: 1 test/3000 cubic yards.

#### PART 2 - PRODUCTS

##### 2.01 TOPSOIL

- A. Topsoil shall be a natural, fertile, friable soil, typical of productive soils in the vicinity, obtained from naturally well-drained areas, neither excessively acid nor alkaline (pH) within 6.5 to 7.5), and containing no substances harmful to grass growth.
- B. Topsoil shall not be delivered to the site in frozen or muddy condition and shall be reasonably free of stumps, roots, heavy or stiff clay, stones larger than 2 inches in diameter, lumps, coarse sand, noxious vegetation, sticks, brush or other litter.
- C. The topsoil shall contain not less than 8 percent nor more than 20 percent organic matter as determined by the loss of weight by ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 230 degrees F  $\pm$ 9 degrees.
- D. Hydraulic conductivity less than or equal to  $1.2 \times 10^{-4}$  cm/sec.

## 2.02 LIME

Lime shall be standard commercial ground limestone containing at least 50 percent total oxides (calcium oxide and magnesium oxide), and 50 percent of the material must pass through a No. 100 mesh sieve with 98 percent passing a No. 20 mesh sieve.

## 2.03 FERTILIZER

Fertilizer shall be commercial fertilizer, 15-30-15 fertilizer mixture. At least 40 percent of the nitrogen content shall be derived from organic material. The fertilizer shall be delivered to the site in the original sealed containers each showing the manufacturer's guaranteed analysis. Store fertilizer so that when used it shall be dry and free flowing.

## 2.04 SEED

- A. Seed shall be of an approved mixture, new crop, clean, high in germinating value, a perennial variety, and low in weed seed. Seed shall be obtained from a reliable seed company and shall be accompanied by certificates relative to mixture purity and germinating value.
- B. The grass seed shall conform to the following requirements:

	<u>Proportion by Weight</u>	<u>Germination Minimum</u>	<u>Purity Minimum</u>
Creeping Red Fescue	50%	85%	95%
K.31 Tall Fescue	30%	85%	95%
Domestic Rye	10%	90%	98%
Red Top	10%	85%	92%
Ladino Clover	5%	85%	96%

## 2.05 MULCH AND STRAW

- A. Mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogenous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content and not contain in excess of 10 percent moisture.
- B. Straw mulch shall consist of cured straw. When air-dried in the loose state, the contents of a representative bale shall lose not more than 15 percent of the resulting air dry weight of the bale. It shall be free from primary noxious weed seed and rough woody materials.

## 2.06 EROSION CONTROL BLANKETS

- A. Erosion control blankets shall be installed to protect grass lined diversion berm swales, as indicated on the Drawings. The erosion control blankets shall consist of a rolled erosion control product manufactured from natural fibers mechanically attached to or woven into two continuous degradable synthetic netting structures. Erosion control blankets shall meet the following minimum standards:
  - 1. Grass Lined Diversion Berm Swales - Double Net Straw/Coconut Fiber Erosion Control Blanket (North American Green SC150 or Approved Equal).
    - (a) Matrix: 70% agricultural wheat straw, 30% coconut fiber, minimum weight (.5 lbs/sy)
    - (b) Netting: Top, UV stabilized polypropylene with .6-inch openings. Bottom, lightweight photodegradable polypropylene with .5-inch openings.
    - (c) Stitching: Degradable thread on 1.5 inch centers
    - (d) Roll Size: 6.5' x 83.5', 60 sy
    - (e) Roll Weight: 30 lbs  $\pm$ 10%
- B. The erosion control material(s) shall be anchored with "U" shaped 11 gauge wire staples or wooden stakes with a minimum top width of one inch and length of six inches. Fastener type (metal or wood) shall be designated by the Owner.

## **PART 3 - EXECUTION**

### **3.01 SURFACE PREPARATION**

- A. Topsoil placement shall not begin until the Owner has approved the placement and grading of the subgrade work performed under other sections. Topsoil placement shall be conducted utilizing equipment and methods that will not cause damage or disruption to the layers below. Unacceptable disruptions include the pushing of sand, tracking through the topsoil into the sand, or causing an intermixing of topsoil and sand. Successful topsoil placement will produce distinct layers.
- B. Topsoil shall be placed and spread to a depth sufficiently greater than the depths required on the Drawings so that after natural settlement and compaction, the completed work will conform to the lines, elevations and grades indicated on the Drawings. Topsoil shall be placed to the limits indicated on the Drawings or as directed by the Owner. After topsoil has been placed and spread, prepare the topsoil's surface by carefully scarifying or harrowing and hand raking. Remove and dispose large stiff clods, brush, roots, litter, stones greater than 2-inch diameter and other foreign material.
- C. Lime shall be applied to bring the pH to 6.5 or, without a soil test, at the rate of 2-3 tons of lime per acre.
- D. When dry fertilizer is used, it shall be applied uniformly to the seeding areas at the time of seeding, at the rate of 1,000 pounds of 15-30-15 fertilizer, or an equivalent quantity of 1-2-1 fertilizer, per acre. The method of application shall be approved by the Owner before fertilizer is applied.

When applied in liquid form or mixed with water, fertilizer shall provide the same value of nutrients per acre as specified for dry fertilizer. Fertilizer applied in liquid form shall be agitated during application.

- E. Seed bed shall be worked up a minimum of 3 inches deep thoroughly incorporating lime and fertilizer in soil. The topsoil shall then be raked until the surface is finely pulverized and smooth and shall be compacted with rollers, weighing not over 100 pounds per linear foot of tread, to even the surface to conform to the prescribed lines and grades.

### **3.02 SEEDING**

- A. Seeding shall be done when weather conditions are approved as suitable, in the periods between April 1 and May 31 or August 15 to October 15, unless otherwise approved.
- B. If there is a delay in seeding, during which weeds grow or soil is washed out, the Contractor shall remove the weeds or replace the soil before sowing the seed, without additional compensation. Immediately before seeding is begun, the soil shall be lightly raked.
- C. Seed shall be applied at the rate of 100 pounds per acre, on a calm day by machine. The preferred method of application is by hydroseeding unless approved otherwise by the Owner.
- D. One-half the seed shall be sown in one direction and other half at right angles. Seed shall be raked into the soil to a depth of 1/4 inch and rolled with a roller weighing not more than 100 lbs. per linear foot of tread.
- E. Hydroseeding equipment shall be designed specifically for this work. Mix seed, fertilizer, wood cellulose fiber mulch and non asphaltic-fiber binder in required amounts of water to produce a homogeneous slurry. Add fiber mulch after seed, water, and fertilizer have been thoroughly mixed and apply at the rate of 200 lbs per acre dry weight. The slurry shall be applied within 30 minutes of mixing to prevent burning of the seed by the fertilizer. Immediately following the application of the slurry mix, make separate application of fiber mulch and fiber binder at the rate of 1,000 lbs, dry weight, per acre except where erosion control blanket is applied immediately. When hydraulically sprayed on the ground, material shall form a blotter-like cover impregnated uniformly with grass seed. Cover shall allow rainfall or applied water to percolate to underlying soil.
- F. The Contractor shall be responsible for maintenance of the grassed area including watering, weeding, fertilization, mowing and replanting as necessary to establish a uniform stand of the specified grasses and until final acceptance. Scattered bare spots, none of which are larger than 72 square inches, will be allowed in seeded areas up to a maximum of 2 percent of any grassed area. After the grass has started, all areas and parts of areas which fail to show a uniform stand of grass, for any reason, shall be reseeded and such areas and parts of areas shall be reseeded repeatedly until all areas are covered with a satisfactory growth of grass. Prior to acceptance, any damage resulting from erosion, gullies, washouts, or other causes shall be repaired by filling with topsoil, tamping, refertilizing, and reseeded.

- G. Grass areas shall be protected against trespassing and damage as required to insure satisfactory growth acceptable to the Owner. Any means of protection shall require the approval of the Owner prior to its erection.

### **3.03 EROSION CONTROL BLANKETS**

A. Channel or Swale Applications:

1. Prepare soil before installing blankets, including application of lime, fertilizer, and seed.
2. Begin at the top of the channel by anchoring the blanket in a 6-inch deep by 6-inch wide trench. Backfill and compact the trench after stapling.
3. Roll center blanket in direction of water flow on bottom of channel.
4. Place blankets end over end (shingle style) with 6-inch overlap. Use a double row of staggered staples 4 inches apart to secure blankets.
5. Full length edge of blankets at top of side slopes must be anchored in a 6-inch deep by 6-inch wide trench. Backfill and compact the trench after stapling.
6. Where necessary, blankets on side slopes must be overlapped 4 inches over the channel blanket and stapled.
7. A staple check slot shall be installed at 30 to 40 foot intervals. Use a row of staples 4 inches apart over entire width of channel. Place a second row 4 inches below the first row in a staggered pattern.

### **3.04 TEMPORARY COVER**

- A. If there is insufficient time in the planting season to complete the fertilizing and seeding, permanent seeding may be left until the following planting season, at the option of the Contractor or on order of the Owner. In that event, a temporary cover crop shall be sown.
- B. This cover crop shall be cut and watered as necessary until the beginning of the following planting season, at which time it shall be plowed or harrowed into the soil, the area shall be fertilized and the permanent seed crop shall be sown as specified.

### **3.05 INSPECTION AND ACCEPTANCE**

- A. At the beginning of the next planting season after that in which the permanent grass crop is sown, the seeded areas will be inspected. Any section not showing dense, vigorous growth at that time shall be promptly reseeded by the Contractor at his own expense. The seeded areas shall be watered, weeded, fertilized, cut and otherwise maintained by the Contractor until the end of that planting season, when they will be accepted if the sections show a dense, vigorous growth.

**END OF SECTION**

## **SECTION 02500**

### **HDPE GEOMEMBRANE**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. The Contractor shall furnish all labor, materials, supervision, and equipment to install the HDPE geomembrane including, but not limited to panel layout, seaming, patching, and testing, and all necessary and incidental items required to complete the Work, in accordance with the Drawings and these Specifications. The Contractor shall also furnish all labor, materials, supervision, and equipment to excavate and backfill the anchor trench for the Geomembrane, as shown on the Drawings.
- B. The Contractor is responsible for conducting compliance testing on representative geomembrane rolls and conducting destructive sample testing from representative field seams. The Contractor shall retain the services of a Geosynthetics Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) certified laboratory to conduct the tests indicated in Parts 2.01 and 3.03 of this Section.
- C. The Contractor shall coordinate geomembrane installation work with the geomembrane sub-grade/gas venting layer placement, sand drainage layer placement and work of others.

##### **1.02 RELATED SECTIONS**

- A. Section 02200 - Earthwork
- B. Section 02210 - Sand
- C. Section 02510 - Geocomposite Gas Venting Layer

##### **1.03 REFERENCES**

- A. Latest version of the American Society for Testing and Materials (ASTM) standards:
  - 1. ASTM D 638, "Standard Test Method for Tensile Properties of Plastics."
  - 2. ASTM D 746, "Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact."
  - 3. ASTM D 751, "Standard Methods for Coated Fabrics."
  - 4. ASTM D 792, "Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement."
  - 5. ASTM D 1004, "Standard Test Method of Initial Tear Resistance of Plastic Film and Sheeting."

6. ASTM D 1204, "Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature."
  7. ASTM D 1238, "Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer."
  8. ASTM D 1505, "Standard Test Methods for Density of Plastics by the Density-Gradient Technique."
  9. ASTM D 1603, "Standard Test Method for Carbon Black in Olefin Plastics."
  10. ASTM D 1693, "Standard Test Method for Environmental Stress Cracking of Ethylene Plastics."
  11. ASTM D 3015, "Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds."
  12. ASTM D 4437, "Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes."
  13. ASTM D 4833, "Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products."
  14. ASTM D 5321, "Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method."
  15. ASTM D 5397, "Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test."
- B. FTMS 101/2065, "Federal Test Method Standard for Puncture Resistance and Elongation Test."
  - C. Daniel, D.E. and R.M. Koerner, (1993), *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93/182.
  - D. U.S.E.P.A., (1991), *Technical Guidance Document: Inspection Techniques for the Fabrication of Geomembrane Field Seams*, EPA/530/SW-91/051.
  - E. NSF Joint Committee on Flexible Membrane Liners, (1993), *Standard 54, Flexible Membrane Liners*, NSF International.
  - F. Geosynthetic Research Institute Test Method GM-5 (b), "Single Point Notched Constant Tensile Load (SP-NCTL) Test for Polyolefin Resin or Geomembranes."
  - G. Geosynthetic Research Institute Test Method GM-6, "Pressurized Air Channel Test for Dual Seamed Geomembranes."

#### **1.04 LINE AND GRADE CONTROL**

- A. Contractor is responsible for line and grade control for all aspects of the work in accordance with the Contract Drawings and these Specifications.

#### **1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store geomembrane rolls and associated materials in such a manner as to ensure a sound, undamaged condition. Procedures shall be in conformance with manufacturer's recommendations.

#### **1.06 QUALIFICATIONS**

- A. The geomembrane manufacturer must have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have produced at least 10 million square feet of similar material.
- B. The geomembrane installer must have at least three years experience in the installation of such geomembrane. Also, the geomembrane installer must have installed at least 10 projects involving a total of 5 million square feet of similar material within the last three years.
- C. The geomembrane installer's supervisor must be on-site and be in responsible charge throughout the geomembrane installation. The supervisor must have supervised the installation of at least 2.5 million square feet of geomembrane.
- D. The geomembrane installer must establish a Quality Control (QC) representative who must be responsible in the field for the quality and integrity of the geomembrane installation, including all testing, inspections and documentation. The QC representative must have performed these duties on at least 2.5 million square feet of geocomposite.

#### **1.07 SUBMITTALS**

- A. The Contractor shall submit to the Owner representative samples of the geomembrane and extrudate rod. The Owner may elect to conduct tests on said samples.
- B. The Contractor shall submit quality control certificates provided by the manufacturer on each roll of the geomembrane barrier to the Owner. Test results must document compliance with the specifications in Part 2.01 of this Section.
- C. The Contractor shall submit testing results of pre-construction tests conducted on representative samples of the geomembrane barriers. Such test results must document compliance with the specifications in Part 2.01 of this Section.
- D. The Contractor shall submit geomembrane panel layout drawings to the Owner at least 10 days prior to beginning the installation. The panel layout drawings shall be prepared at scale not less than 1" = 50'. The drawings shall show the location of

geomembrane roll numbers, geomembrane panels, panel numbers, seam locations, geomembrane penetrations and anchor trench.

- E. The Contractor shall submit an "As-Built" panel layout to the Owner within 10 days of completion of the project.

## **1.08 WARRANTY**

- A. A written Warranty shall be provided to the Owner for materials and workmanship of the HDPE Geomembrane.
- B. The manufacturer shall warrant the membrane against manufacturing defects and material degradation for the design conditions for a period of 20 years. The manufacturer shall provide for the replacement of any material that fails for the above stated reasons.
- C. The installer shall warrant the membrane against any defects in the installation or workmanship for a period of 2 years. The installer shall provide for the replacement of any material that fails for the above stated reasons.

## **PART 2 - PRODUCTS**

### **2.01 HDPE GEOMEMBRANE**

- A. Geomembrane shall be made of textured, 40 mil thick, high density polyethylene (HDPE) as noted and to the limits shown on the Drawings.
- B. Geomembrane used shall meet the minimum standards included in Table 02500-1.
- C. The chemical resistance of the Geomembrane material and seams shall be in keeping with typical properties of high quality polyethylene products currently available through commercial sources.
- D. Geomembrane shall be shipped rolled with no seams in the roll.
- E. Extrudate rod shall be manufactured of the same resin type as the geomembrane and shall have the same properties.
- F. Geomembrane materials shall be manufactured by Serrot International, GSE Lining Technology, Inc., Poly-Flex, Inc. or approved equal and shall be tested to the frequencies and physical properties as specified in this Section.
- G. No reclaimed material (that is, material that has seen previous service) shall be allowed in the Geomembrane sheet.
- H. Regrind material (that is, material that has been previously processed by the same manufacturer but has never seen previous service) shall be allowed in the Geomembrane sheet if approved by the Owner.
- I. The Geomembrane shall be free of pinholes and reasonably free from surface blemishes, scratches and other defects as judged by the Owner.

- J. As part of the Contractor's pre-construction testing, interface shear testing shall be performed on each interface of the cap system in accordance with ASTM D5321 or ASTM D6243 for those interfaces involving Geomembrane. Each test shall determine the interface shear strength at normal stresses of 0.5 psi, 2 psi and 4 psi. The geomembrane interfaces shall have the following shear strengths:
1. Geomembrane and each of the Geocomposite Gas Venting Layer / Sand Drainage Layers (under saturated conditions):  $\geq 27^\circ$  peak and strengths.

## **PART 3 - EXECUTION**

### **3.01 CONSTRUCTION - GENERAL**

- A. The Geomembrane shall be constructed as soon as practical after placement of the geocomposite gas venting layer. No Geomembrane placement shall take place without specific approval from the Owner. Each sequential section of geomembrane shall be secured in an anchor trench or continuously welded to the adjacent sections as shown on the Drawing and detail.
- B. The geomembrane installer shall issue geomembrane subgrade acceptance forms to the Owner prior to the installation of the geomembrane.
- C. All geomembrane compliance testing must be completed and passed before placing the geomembrane barrier.

### **3.02 GEOMEMBRANE INSTALLATION**

- A. Surfaces to receive liner installation shall be smooth and even, and free of ruts, voids, protrusions, and deleterious material. Vehicles leaking contaminants or causing ruts, pumping, cracking or deformation of surface or otherwise unacceptable to the Owner are not permitted on final dressed surfaces unless authorized by the Owner. Any damage to the surface caused by the Contractor's vehicles shall be repaired at the Contractor's expense.
- B. An anchor trench (as illustrated on the Drawings) will be required at locations indicated along the cap perimeter to secure the Geomembrane. The Contractor shall take precautions to minimize loose soil underlying the Geomembrane in the anchor trenches. The time schedule for excavation and backfilling of the anchor trench is to be approved by the Owner so that the anchor trench remains open for the shortest possible time.
- C. Installation of the Geomembrane shall be as follows:
1. Unroll only those sections which are to be seamed together or anchored in one day. Panels should be positioned with the overlap recommended by the manufacturer, but not less than 4 in. (76 mm), after the necessary alignment and cutting. Seams shall run parallel with the slope, not across it, wherever possible. If seams must run across a slope, the edge of the upslope sheet shall be positioned above the edge of the downslope sheet. The Geomembrane sections will be placed in an anchor trench which is then backfilled by the Contractor with suitable excavated materials in accordance with the Drawings.

2. After panels are initially in place, remove as many wrinkles as possible. Unroll several panels and allow the material to relax before beginning field seaming. The purpose of this is to make the edges which are to be bonded as smooth and free of wrinkles as possible.
  3. Once panels are in place and smooth, commence field seaming operations.
  4. At the end of each day or installation segment all unseamed edges shall be anchored by rope, sand bags, or other approved device. Sand bags securing the Geomembrane on the side slopes should be connected by rope fastened at the top of the slope section by a temporary anchor. Staples, U-shaped rods or other penetrating anchors shall not be used to secure the Geomembrane. Any damage to the Geomembrane due to wind, rain, hail, other weather predicaments or negligence shall be the sole responsibility of the Contractor.
- D. Field seaming may be extrusion or fusion welding or a combination of these methods. Solvent welding is not acceptable. The Owner reserves the right to reject any proposed seaming method believed to be unacceptable. Additional requirements of proper field seaming include the following:
1. All foreign matter (dirt, water oil, etc.) shall be removed from the edges to be bonded. For extrusion-type welds, the bonding surfaces must be thoroughly cleaned by mechanical abrasion or alternate methods approved by the Owner to remove surface cure and prepare the surfaces for bonding. All abrasive buffing shall be performed using No. 80 grit or finer sandpaper. The grinding shall be performed so that grind marks are generally perpendicular to the edge of sheet. No solvents shall be used to clean the Geomembrane materials.
  2. As much as practical, field seaming shall start from the top of the slope and proceed down slope. This will minimize the development of wrinkles which may occur due to having people working on the side slopes behind the area being seamed. Tack welds (if used) shall use heat only; no double sided tape, glue or other method will be permitted.
  3. The completed cap shall not exhibit any "trampolining" at the time protective cover or other materials are being placed over the Geomembrane.
  4. The seams should be oriented as shown by the approved panel layout drawing, generally parallel to the line of maximum slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.
  5. No horizontal seams should be within 5 ft (1.5m) of the toe of a slope greater than 5%.
  6. No seaming should be attempted above 104°F (40°C) ambient air temperature.
  7. Below 41°F (5°C) ambient air temperature, preheating of the Geomembrane will be required. Preheating may be achieved by natural and/or artificial means (shelters and heating devices). Ambient temperature is measured 6 in. (150mm) above the liner surface. The membrane installation contractor shall

supply instrumentation for measurement of ambient temperature. Trial welds shall be performed at double the specified frequency. Trial welds shall be made under the same conditions as will be experienced in the work-area. All trial testing will be conducted in a heated area after the samples have been allowed to warm to at least 40°F or more. The lowest temperature at which seaming may take place shall be the lowest temperature at which consistent passing trial seams can be produced under simulated work-area conditions. No seaming will be conducted below 20°F.

8. A moveable protective layer of plastic may be required to be placed directly below each overlap of Geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded. The protective layer must be removed after seaming is complete unless approved by the Owner. It shall be the Contractor's responsibility to determine the need for such a protective layer.
8. Seaming will extend to the outside edge of panels to be placed in anchor trenches.
9. If required, a firm working surface should be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support. The surface must be removed after seaming is complete.
10. No excessive grinding prior to welding shall be permitted. Overground or improperly ground areas shall be replaced at the Contractor's expense.
11. Seams at panel corners of 3 or 4 sheets shall be completed in a fully leak-proof manner. Open ends of all air channels must be welded closed. A patch having a minimum dimension of 24 in. (610mm), extrusion welded to the parent sheet or other approved techniques may be used. The Contractor shall submit a drawing of its proposed seam completion detail and obtain approval from the Owner.

### **3.03 GEOMEMBRANE TESTING**

All Geomembrane sheet and seams will be tested and evaluated prior to acceptance. In general, testing of the sheet will be conducted by the manufacturer. Testing of the seams will be conducted by the Contractor under observation of the Owner. The Owner or a designated, independent geosynthetics laboratory may perform additional testing, as required by these Specifications or as required in the judgement of the Owner to verify that the HDPE sheet and seams meet the specifications. Discretionary testing shall be paid for by the Owner. Testing requirements are detailed in the following subsections:

#### **A. Pre-shipping Sheet Tests**

The Contractor or supplier (manufacturer) will be required to submit his Quality Control program to the Owner for approval prior to the shipment of material to the site. As a minimum, the Contractor shall perform the tests at the frequencies given in Table 02500-2 on the HDPE sheet prior to shipping HDPE material to the site. Test results shall be submitted to the Owner 14 days prior to shipping the HDPE rolls unless otherwise approved by the Owner.

- B. The Owner may, at his discretion, conduct conformance testing on the HDPE sheet in order to verify that it meets the minimum standards specified on Table 02500-1. All conformance tests shall be performed by an independent geosynthetics testing laboratory in accordance with the methods presented on Table 02500-1. All conformance test results shall be reviewed by the Owner and accepted or rejected, prior to the placement of the geomembrane. In case of failing test results, the manufacturer may request that another sample be retested by the independent laboratory with the manufacturer's technical representative present during the testing procedures. This retesting shall be paid for by the manufacturer. The manufacturer may also have the sample retested at two different laboratories approved by the Owner. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, all geomembrane material from the lot representing the failing sample will be considered out of specification and rejected. The manufacturer shall obtain additional samples from rolls immediately before and after the failing roll and test it by the independent laboratory at his/her own expense. If these rolls pass, then only the failing roll will be rejected. If they fail, then the entire lot is rejected. Discretionary testing shall be paid for by the Owner.

C. Trial Test Seams

The Contractor shall maintain and use equipment and personnel at the site to perform testing of test seams. Test seams will be made each day prior to commencing field seaming. These seams will be made on fragment pieces of Geomembrane to verify that seaming conditions are adequate. Such test seams will be made at the beginning of each seaming period; at changes of equipment, equipment settings, weather, or sheet temperature; at the Owner's direction; and at least once every four to six hours during continuous operation of each welding machine. Also, each seamer will make at least one test seam each day. Requirements for test seams are as follows:

1. The test seam sample will be at least 3 ft (0.9m) long by 1 ft (0.3m) wide with the seam centered lengthwise. Ten adjoining specimens 1 in. (25mm) wide each will be die cut from the test seam sample. These specimens will be tested in the field with a tensiometer for both shear (5 specimens) and peel (5 specimens) for single-track fusion welds or extrusion welds. For dual-track fusion welds, the Contractor shall test each track as if it was a single-track weld. Test seams will be tested by the Contractor under observation of the Owner. The specimens should not fail in the weld. The Contractor shall supply qualified personnel and testing equipment. No strain measurements need to be obtained in the field. A passing fusion or extrusion welded test seam will be achieved when the criteria described in Table 02500-1A are satisfied with the exclusion of any strain requirements. If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel.
2. The Owner will observe all test seam procedures. The remainder of the successful test seam sample will be assigned a number and marked accordingly by the Contractor, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail

description. In addition, at least one tested specimen from each test as selected by the Owner will be retained by the Owner.

D. Non-Destructive Testing

Production seams will be tested by the Contractor continuously using non-destructive techniques. Requirements for non-destructive testing are as follows:

1. Single Weld Seams - the Contractor shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams. The system shall be capable of applying a vacuum of at least 4 psi (28 kPa). The vacuum shall be held for a minimum of 10 seconds for each section of seam.
2. Double Weld Seams - The Contractor shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system shall be capable of applying a pressure of at least 30 psi (207 kPa) for not less than 5 minutes. The Contractor shall perform all pressure and vacuum testing under the observation of the Owner. Pressure loss tests shall be conducted in accordance with the procedures outlined in "Pressurized Air Channel Test for Dual Seamed Geomembranes," Geosynthetic Research Institute Test Method GM-6. As outlined by the test method, following a 2 minute pressurized stabilization period pressure losses over a measurement period of 5 minutes shall not exceed 3.0 psi.

E. Destructive Testing

Destructive testing will be performed on an average of every 500 linear ft (150m) of production seam but not less than 2 times per day. The locations will be selected by the Owner. Sufficient samples will be obtained by the Contractor to provide one sample to the archive, one sample to the Owner for discretionary, independent laboratory testing, and one sample to be retained by the Contractor for field or laboratory testing. Testing requirements are as follows: Each sample shall be large enough to test five specimens in peel and five specimens in shear. For the sample to pass, four (4) of the five (5) specimens must meet the minimum test values presented in the project specifications and exhibit a film tear bond and the fifth sample must achieve at least 80% of the required strength. Specimens must fail in film tear bond (FTB) and meet the strain or separation requirements of Table 02500-1A. Samples which do not pass the shear and peel tests will be re-sampled from locations at least 10 ft (3 m) on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined. Requirements for each destructive test are as follows:

1. The Contractor shall test samples in the field or in a laboratory. All tests shall be performed using a calibrated, motor-driven, strain-controlled tensiometer approved by the Owner. The Contractor shall supply certification records demonstrating that the tensiometer has been calibrated by a qualified agency within the past 6 months.

- a. Peel shall be measured for one sample (that is, five specimens). Peel tests will be evaluated for the criteria described in Tables 02500-1 and 02500-1A.
  - b. Shear shall be measured for one sample (that is, five specimens). Strain measurements are required for the shear specimens. Laboratory tests will be evaluated for the criteria described in Table 02500-1 and 02500-1A.
2. The Owner will observe all production seam field test procedures. Testing for both peel and shear will be evaluated in accordance with Tables 02500-1 and 02500-1A.
  3. The Contractor will be responsible for the archive specimen. He will assign a number to the archive sample and mark the sample with the number. He will also log the date, seam number, approximate location in the seam, and field test pass-or-fail description, if applicable. Following completion of the installation of the primary and secondary liners, the archive specimens will be submitted to the Owner.
  4. For double-weld seams, all destructive testing shall be performed for each weld to ensure a continuous good weld.

### **3.04 REPAIR OF DAMAGED GEOMEMBRANE, SAMPLED AND FAILED SEAM AREAS**

- A. Damaged and sample coupon areas of Geomembrane shall be repaired by the Contractor by construction of liner strips. No repairs shall be made to seams by application of an extrusion bead to a seam edge previously welded by fusion or extrusion methods. Repaired areas will be tested for seam integrity. Damaged materials are the property of the Contractor and will be removed from the site at the Contractor's expense. The Contractor will retain all ownership and responsibility for the Geomembrane until acceptance by the Owner.
- B. Once the geomembrane has been deployed, the panels must be examined for flaws, holes, defects and tears. Each location requiring a repair shall be repaired using the following procedures:
 

Patching - A patch shall be used to repair defects in the geomembrane which are 1/8-inch or larger.

Abrading and Re-welding - This procedure may be used to repair seam sections which are less than 10 feet in length.

Spot Welding - Spot welding may be used to repair small tears, pinholes and/or other small defects which are 1/8-inch or smaller.

Capping – Capping shall be used to repair failed seams that are greater than 10 feet in length.
- C. Patches or caps shall extend at least six inches beyond the edge of the defect. The edges of the patch or cap shall be extrusion welded to the in place geomembrane

after both the liners are abraded to remove the surface sheen of the geomembrane and to provide a surface that is more conducive to accepting the weld. Welding of the repair patch or cap shall be completed by extrusion welding the geomembrane. The repairs shall be non-destructive tested using the vacuum-box method as described in this Section.

- D. The Contractor shall not conduct repairs without prior notification of the Owner.

### **3.05 POTENTIALLY DAMAGING ACTIVITIES**

- A. No support equipment shall be allowed on the Geomembrane unless the equipment and protective measures are approved by the Owner. Light-weight portable generators must be placed on protective rub sheets, and stands or supports shall be adequately padded to prevent potential damage to the rub sheet or Geomembrane. All-terrain-vehicles (ATVs) shall not be operated on the Geomembrane. Personnel working on the Geomembrane shall not smoke, wear damaging shoes, or engage in any activity which damages the Geomembrane.

### **3.06 ANCHOR TRENCH BACKFILLING**

- A. The anchor trench will be backfilled and compacted by the Contractor to a dry unit weight not less than 95 percent of standard proctor density determined by ASTM D 698 or 90 percent of the modified proctor density determined by ASTM D 1557. Care should be taken when backfilling the trench to prevent any damage to the Geomembrane. Anchor trench spoil shall be used as backfill material, wherever possible.

### **3.07 HDPE GEOMEMBRANE BOOT SEALS**

- A. HDPE geomembrane boots shall be fabricated around all extraction well piping that penetrates the cap system. The boots shall be constructed in accordance with the Geomembrane Boot detail shown on Drawing No. 8.
- B. All boots shall be extrusion welded to HDPE geomembrane cap. All extrusion welds shall be vacuum-box tested in accordance with the requirements of this Section.
- C. Boots shall be extended to a minimum height of 18 inches above the final landfill surface so that they may be inspected periodically. A neoprene gasket shall be installed between the extraction well and the boot. Boots shall be affixed to extraction well piping with stainless steel clamps so that the connection becomes leak tight. The clamps will allow for the periodic adjustment of the boot, as needed, to accommodate landfill subsidence without causing damage to the membrane cap or the boot.

**TABLE 02500-1  
REQUIRED PHYSICAL PROPERTIES OF HDPE GEOMEMBRANE LINER AND SEAMS**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>40-MIL (0.91mm)</b>
Minimum Thickness, mil.	ASTM D5994	36 (-10%)
Minimum Sheet Density, g/cm <sup>3</sup>	ASTM D792 or D1505	0.940
Minimum Tensile Properties (each direction) Strength at Yield, lb/in. Elongation at Yield, % Strength at Break, lb./in. Elongation at Break, %	ASTM D6693	84 12 60 100
Minimum Tear Resistance, lbs.	ASTM D1004	28
Dimensional Stability, %, maximum	ASTM D1204 (As modified in NSF54 Appendix A)	±2.0
Stress Crack Resistance, hours	ASTM D5397	200
Minimum Puncture Resistance, lbs.	ASTM D4833	60
Carbon Black Content, (Range in %)	ASTM D1603	2.0 - 3.0
Minimum Peel Strength, lb/in., Fusion Extrusion	ASTM D4437	65 52
Minimum Bonded Shear Strength, lb/in.,	ASTM D4437	81
Melt Flow Index (gr. 10 min)	ASTM D1238-E	<1.0
<b>(Continued on Table 02500-1A)</b>		

**TABLE 02500-1A**  
**HDPE WELDED SEAM REQUIREMENTS**  
**(CONTINUED FROM TABLE 02500-1))**

Type of Seam	Peel Requirements	Shear Requirements
Fusion	1) Film Tearing Bond failure, 2) No greater separation than 10% of the width of the track being tested subjected to pressure from the roller, and 3) Achievement of required strength	1) Film Tearing Bond failure, 2) Yield strain is at least 10%, 3) Break strain is at least 50%, and 4) Achievement of required strength
Extrusion	1) Film Tearing Bond failure, 2) No greater than 0.125-inch (3-mm) separation, and 3) Achievement of required strength	1) Film Tearing Bond failure, 2) Yield strain is at least 10%, 3) Break strain is at least 50%, and 4) Achievement of required strength

**FILM TEARING BOND:** A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation of the bonded area.

**STRAIN:** The strain at yield and strain at break are calculated by the following formula: where

$L_w$  is the length of the weld (outside edge to outside edge of area under pressure),  
 $L_0$  is the original measured grip separation, typically 4.0 in. (100mm) plus  $L_w$  and  
 $\Delta L$  is the change in grip separation at yield or break.

**TABLE 02500-2****REQUIRED PRE-SHIPING SHEET TESTING  
OF HDPE GEOMEMBRANE Primary and secondary liners**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>MINIMUM FREQUENCY</b>
Thickness	ASTM D5944	Each Roll
Tensile Properties	ASTM D6693	Each Roll
Sheet Density	ASTM D792 or ASTM D1505	Every Fifth Roll
Carbon Black Content	ASTM D1603	Every Fifth Roll
Carbon Black Dispersion	ASTM D5596	Every Fifth Roll
Tear Resistance	ASTM D1004	Every Roll
Puncture Resistance	ASTM D4833	Every Roll
Dimensional Stability	ASTM D1204 (As modified in NSF54)	Every Tenth Roll
Stress Crack Resistance	ASTM D5397	Every 180,000 lb (81.6 Mg) of Resin*
Melt Flow Index	ASTM D-1238-E	Every 180,000 lb (81.6 Mg) of Resin*
Coefficient of Friction	ASTM D-5321 (Detailed test conditions specified by the Owner)	Once per critical interface

\* Or at least once per railcar for railcars containing less than 180,000 lb (81.6 Mg).

**END OF SECTION**

## **SECTION 02510**

### **GEOCOMPOSITE GAS VENTING LAYER**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. The work in this section includes the furnishing of all materials, tools, supervision, equipment, and labor consisting of but not limited to: transportation, handling, geocomposite layout and placement, seaming, patching, removal of unsuitable materials, protection of installed materials and all work incidental to the proper installation of the Geocomposite Gas Venting Layer, as specified herein and as indicated on the Drawings.
- B. The Contractor shall coordinate installation of Geocomposite Gas Venting Layer with the preparation of landfill surface with the installation of the HDPE Geomembrane.

##### **1.02 RELATED WORK**

- A. Section 02500 – HDPE Geomembrane

##### **1.03 MANUFACTURER'S CONFORMANCE TESTING**

- A. The manufacturer of the Geocomposite Gas Venting Layer shall supply the Contractor with quality control certificates on each roll of geocomposite delivered to the site. The certificates shall be prepared by the geocomposite manufacturer and provide testing frequencies and test results as indicated in Part 2.01 of this Section as available. The results of all testing shall be submitted to the Owner before any geocomposite is incorporated into the work.

##### **1.04 PRE-CONSTRUCTION TESTING REQUIREMENTS**

- A. The Owner shall retain the services of a Geosynthetics Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) certified laboratory for performing pre-construction testing required in this Section. The results of all testing shall be submitted to the Owner before any geocomposite is incorporated into the work.
- B. As part of the pre-construction testing described in Part A of this Section, interface shear tests (ASTM 5321) on the interfaces between the Geocomposite Gas Venting Layer and both the geocomposite subgrade and the HDPE geomembrane material. Each test shall determine interface strength at normal stresses of 0.5 pounds per

square inch (psi), 2 psi and 4 psi. Additional samples shall be collected and tested if the material does not meet specifications of Part 2.01 of this Section. The geocomposite interfaces shall have the following shear strengths:

1. Geocomposite Gas Venting Layer/Intermediate Cover Material under saturated conditions:  $\geq 27^\circ$  peak strength.
  2. Geocomposite Gas Venting Layer/HDPE Geomembrane Material under saturated conditions:  $\geq 27^\circ$  peak strength.
- D. The Owner reserves the right to collect additional samples of Geocomposite Gas Venting Layer material for independent testing by a qualified laboratory chosen by the Owner.

#### **1.05 LINE AND GRADE CONTROL**

- A. The Contractor is responsible for line and grade control for all aspects of the work in accordance with the Contract Drawings and these Specifications.

#### **1.06 SUBMITTALS**

- A. The Contractor shall submit to the Owner representative samples of the Geocomposite Gas Venting Layer. The Owner may elect to conduct tests on said samples.
- B. The Contractor shall submit quality control certificates provided by the manufacturer on each roll of Geocomposite Gas Venting Layer to the Owner. Test results must document compliance with the specifications in Part 2.01 of this Section.
- C. The GAI-LAP certified laboratory retained by the Owner shall submit test results for pre-construction testing requirements that are outlined in Section 1.04. The testing shall be conducted on representative samples of the Geocomposite Gas Venting Layer material. Such test results must document compliance with the specifications in Part 2.01 of this Section.

#### **1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store geocomposite rolls and associated materials in such a manner as to ensure a sound, undamaged condition. Procedures shall be in conformance with manufacturer's recommendations.
- B. Rolls will be stored at the job site away from high-traffic areas but sufficiently close to the active work area to minimize handling. The designated storage area should be flat, dry and stable. Moisture protection of geocomposite rolls should

be provided by its packaging; however, an additional tarpaulin or plastic sheet is recommended to provide extra protection.

## 1.08 QUALIFICATIONS

- A. The geocomposite manufacturer must have at least five years experience in the manufacture of such geocomposite. In addition, the geocomposite manufacturer shall have produced at least 10 million square feet of similar material.
- B. The geocomposite installer must have at least three years experience in the installation of such geocomposite. The geocomposite installer must have installed at least 10 projects, which total 5 million square feet of similar material within the last three years.
- C. The geocomposite installer's supervisor must be on-site and be in responsible charge throughout the geocomposite installation. The supervisor must have supervised the installation of at least 2.5 million square feet of geocomposite.
- D. The geocomposite installer must establish a Quality Control (QC) representative who must be responsible in the field for the quality and integrity of the geocomposite installation, including all testing, inspections and documentation. The QC representative must have performed these duties on at least 2.5 million square feet of geocomposite.

## PART 2 - PRODUCTS

### 2.01 GEOCOMPOSITE

- A. The Geocomposite Gas Venting Layer shall be a biplanar material and shall be comprised of a needle-punched, non-woven, continuous filament polypropylene geotextile fabric of at least 8 ounce which is factory heat-bonded to both sides to an high-density polyethylene (HDPE) geonet.
- B. The heat bonding technique between the geotextile and the geonet should be that of hot air to prevent flattening of the geotextile surface.
- C. Geocomposite Gas Venting Layer material delivered to the site shall be manufactured by Evergreen Technologies, Inc., GSE Lining Technologies, Inc., Fluid Systems, Inc. or approved equal and shall be tested for the frequencies and physical properties as follows:

	<u>Min. Frequency</u>	<u>Min. Value</u>
Ply Adhesion (GRI GC-7)	50,000 SF	1 lb/in.
Transmissivity (ASTM D4716)*	200,000 SF	$5 \times 10^{-4}$ m <sup>2</sup> /sec.

\* Geocomposite at gradient of 0.1, with a normal load of 10,000 psf between two steel plates.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. All work shall be performed in accordance with the Contract Drawings, these Specifications and any pertaining local ordinances.

#### **3.02 PREPARATION**

- A. The Contractor shall conduct all work necessary to ensure that the surface on which the geocomposite gas venting layer is to be placed is free of irregularities, erosion rills, protrusions, loose soil, changes in grade, stones, rocks, sticks, roots, sharp objects, or debris of any kind which may damage the geocomposite.
- B. All geomembrane testing must be completed and passed before placing the geocomposite gas venting layer.

#### **3.03 GEOCOMPOSITE INSTALLATION**

- A. The biplanar geocomposite shall be oriented with its machine direction parallel to the flow direction on the base to cover the entire liner construction area. The biplanar geocomposite shall be installed parallel to the line of maximum slope, (i.e., oriented up and down, not across, the slope). No horizontal seams shall be within five feet of the toe of any steep slope or any anchor trench.
- B. Initially, a geocomposite panel shall be placed over a previously installed geocomposite panels, then manually positioned on the geomembrane. This procedure eliminates the potential for the textured geomembrane to “grip” the bottom geotextile on the geocomposite prior to final placement.
- C. After the geocomposite is positioned and overlapped on a previously placed panel, wrinkles shall be worked out of the geocomposite prior to seaming.
- D. Adjacent panels shall be secured by plastic ties (supplied by the manufacturer) approximately every five (5) feet along the roll length and by sewing the overlapped geotextile. Plastic ties shall be white or other highly visible bright colors for easy inspection. Metallic ties shall not be allowed. Sewing threads shall be of a color that provides contrast to the color of the geotextile.
- E. All deployed panels must be provided with ballast to prevent their movement. The Contractor shall provide ballast, as needed, to prevent the movement of

deployed geocomposite. At a minimum, sand in burlap bags should be placed every 1 to 2 feet along a seam.

- F. The geocomposite shall be covered with the primary liner components, as soon as possible after installation.

### **3.04 PROTECTION OF INSTALLED MATERIALS**

- A. The Contractor shall be responsible for maintaining installed materials and preventing their damage.
- B. The geocomposite drainage layer shall be properly secured and/or ballasted so as to prevent uplift by wind.
- C. Vehicular movement over the geocomposite drainage layer shall not be permitted until the full depth of the drainage soils has been placed.
- D. Damaged geocomposite and scrap material are the property of the Contractor and shall be removed from the site at the Contractor's expense. The Contractor shall retain all Ownership and responsibility for the geocomposite until final acceptance of the entire project by the Owner.
- E. In the event of damage to prior work or work completed as specified in this Section, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Owner, and at no additional cost to the Owner.

### **3.05 WARRANTY**

- A. The geocomposite manufacturer shall warrant that the geocomposite be free from manufacturing defects and that the geocomposite, when properly installed and maintained, shall not suffer significant deterioration due to normal weather aging.
- F. The geocomposite installer shall guarantee the geocomposite installation against defects in the installation and workmanship for one year commencing with the date of final acceptance.

**END OF SECTION**

**SECTION 02596**  
**GEOTEXTILE FABRICS**

**PART 1 - GENERAL**

**1.01 SCOPE**

- A. The Contractor shall furnish all labor, materials, tools, and equipment and perform all operations necessary for the installation of geotextile fabrics, as indicated on the Drawings and as specified herein.
- B. The materials supplied shall be products designed and manufactured specifically for the purpose of this work and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes.
- C. Geotextile filter fabrics shall be used at the locations shown on the Drawings.

**1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 02200 - Earthwork

**1.03 SUBMITTALS**

- A. Shop Drawings shall be submitted in accordance with Section 01340.
- B. Certification test results showing that the fabric meets the specifications shall be submitted to the Owner prior to installation.

**PART 2 - PRODUCTS**

**2.01 GEOTEXTILE FABRICS**

- A. The fabric shall be non-woven consisting of continuous chain polymer filaments or yarns of polyester, formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew and rot resistant, resistant to ultraviolet light exposure, insect and rodent resistant, and conform to the properties specified below.

<u>Physical Properties</u>	<u>Specification</u>
Weight (ounces per square yard)	16
Grab Tensile Strength ASTM D4632 (lbs)	390
Grab Strength Elongation ASTM D4632	50
Puncture Strength ASTM D4833	240
Permittivity ASTM D4491 (sec. <sup>-1</sup> )	0.6
Water Flow Rate ASTM D4991 (gpm/ft <sup>2</sup> )	45
Equivalent Opening Size ASTM D4751 (U.S. Standard Sieve No.)	100
Trapezoid Tear Strength ASTM D4533 (lbs)	150

## **PART 3 - EXECUTION**

### **3.01 SITE PREPARATION**

- A. Site grade preparation shall conform to the requirements of this Section, and Section 02200 - Earthwork.
- B. The surface to receive geotextile shall be cleared of sharp objects, boulders, stumps, or any materials that may contribute to fabric punctures, shearing, rupturing or tearing.

### **3.02 INSTALLATION**

- A. The geotextile shall be placed in the manner and at the locations shown. Geotextile shall be laid smooth and free of tension, stress, folds, wrinkles, or creases.
- B. During the placement of rip rap or other stone materials over the geotextile, care shall be taken so as not to damage the geotextile. Dozer blades shall not be in direct contact with the geotextile.
- C. All materials located on top of geotextiles shall be deployed in such a manner as to ensure:
  - 1. The geotextile materials are not damaged.
  - 2. Minimal slippage of the geotextile on underlying layers occurs.
  - 3. No excess tensile stresses occur in the geotextile.
- D. If geotextile is damaged during any step of installation, a piece of geotextile material shall be cut and placed over the damaged area and overlap the undamaged material a minimum of 3 feet in each direction.

**END OF SECTION**

## SECTION 02714

### HDPE PIPE AND FITTINGS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of all high density polyethylene (HDPE) pipe and other plastic pipe, fittings and appurtenances in conjunction with landfill gas extraction well and collection systems, as specified herein and as shown on the Drawings.

##### 1.02 RELATED SECTIONS

- A. Section 02200 - Earthwork
- B. Section 02250 - Landfill Gas Extraction Wells

##### 1.03 REFERENCES

- A. Latest version of the American Society for Testing and Materials (ASTM) standards:
  - 1. ASTM D 1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
  - 2. ASTM D 1603, Standard Test Method for Carbon Black in Olefin Plastics
  - 3. ASTM D 1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
  - 4. ASTM D2513, Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
  - 5. ASTM D 2657, Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings
  - 6. ASTM D2683, Socket Type Polyethylene Fittings For Outside Diameter Controlled Polyethylene Pipe and Tubing.
  - 7. ASTM D 2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
  - 8. ASTM D3261, Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
  - 9. ASTM D 3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

10. ASTM F 714, Standard Specification for Polyethylene (PE) Plastics Pipe (SDR-PR) Based on Outside Diameter.

#### **1.04 WARRANTY**

- A. The Contractor shall furnish the Owner written warranties obtained from the manufacturer and the installer against defects in materials and workmanship in accordance with ASTM D 3350 and ASTM F 714. Warranty conditions proposed by the manufacturer or installer concerning limits of liability will be evaluated and must be acceptable to the Owner.

#### **1.05 SUBMITTALS**

- A. The Contractor shall submit shop drawings and manufacturers catalog data for all components of a completed service connection in accordance with Section 01340 - Shop Drawings, Samples and Product Data.
- B. The Contractor shall submit to the Owner for approval, a list of materials to be furnished, the names of the suppliers and the proposed dates of delivery of the materials to the site.
- C. The Contractor shall submit to the Owner the pipe Manufacturer's certification of compliance with this Section for all materials delivered to the site, and shall comply with the pipe Manufacturer's recommendations for handling, storing, and installing HDPE pipes and fittings.
- D. The Contractor shall submit to the Owner in writing the following documentation from the HDPE pipe Manufacturer on the raw materials used to manufacture the HDPE pipe and fittings prior to transporting any HDPE pipe or fittings to the site.
  1. Certificate stating the specific resin, its source and the information required by ASTM D 1248.
  2. Certification that no recycled compound has been added to the resin except that generated in the Manufacturer's own plant from resin of the same specification from the same raw material.

### **PART 2 - PRODUCTS**

#### **2.01 HIGH DENSITY POLYETHYLENE (HDPE) COMPOUND**

- A. The HDPE pipe and fittings shall be manufactured from new, high performance, high molecular weight, high density polyethylene resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P 34), ASTM D 3350 (Cell Classification PE 345444C), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. Material specifications for the HDPE pipe and fittings are presented in Table 02714-1.
- B. The resin shall be pre-compounded. In plant blending of non-compounded resins shall not be permitted. The polyethylene compound shall contain a minimum of 2% carbon black.

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

## **2.02 HIGH DENSITY POLYETHYLENE (HDPE) PIPES AND FITTINGS**

- A. All HDPE pipe and fittings shall comply with the ASTM F 714.
- B. All HDPE pipe and fittings shall have a minimum Standard Diameter Ratio (SDR) of 17.
- C. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 feet.
- D. HDPE pipe shall be furnished perforated as indicated on the Drawings. The perforations shall be drilled into the pipe after manufacture, prior to delivery to the site.
- E. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index and other physical properties.
- F. Fittings at the ends of pipes shall consists of HDPE end caps and fused elbows as indicated on the Drawings.
- G. Polyethylene fittings and joints shall be molded by means of thermal butt-fusion. The ends of the fabricated fittings shall be trimmed to match the pipe section to which they are going to be joined. All polyethylene fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications.
- H. Flanges shall be ASTM A 240, Type 304 stainless steel backing flanges with 125-pound, ANSI B16.1 standard drilling. Flanges shall be complete with one-piece, molded polyethylene stub ends. Flanged connections shall have the same pressure rating as the pipe or greater.
- I. Gaskets shall be flat ring, 1/8-inch ethylene propylene rubber (EPR).
- J. Bolting shall be type 304 stainless steel, ASTM A 193, Grade B8 hex head bolts; and ASTM A 194, Grade 8 hex head nuts. Bolts shall be fabricated in accordance with ANSI B18.2 and provided with washers of the same material as the bolts.
- K. The following shall be continuously indent printed 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 dimension ratio (SDR).

4. The letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design basis in 100's of psi (e.g., PE 3408).
5. Manufacturing Standard Reference (e.g., ASTM F-714-1).
6. A production code from which the date and place of manufacture can be determined.

### **2.03 BUTTERFLY VALVES**

- A. Provide butterfly valves at locations shown on Drawings as specified.
- B. Service conditions:
  1. Material handled: Landfill gas (55% CH<sub>4</sub>, 40% CO<sub>2</sub>, 5% other) saturated, corrosive.
  2. Temperature gas: 100 to 150°F.
  3. Average pressure: 1 to 5 inches mercury vacuum.
  4. Location: Outdoor (-20 to 100°F).
- C. Valves
  1. Butterfly valves of indicated sizes are to be installed at each wellhead and at locations within the collection system as shown on the Drawings. Exposed valves are to be hand lever activated with infinite adjustable setting capability.
  2. Valves shall have PVC bodies and polypropylene discs, be flanged, short body type and have stainless steel shafts.
  3. Valve seats shall be of the resilient type, mounted in the body or on the disc. Seats and seals shall be of Teflon® or Viton.

### **2.04 VALVE HEADER BOXES**

- A. Valve header boxes shall be provided for each buried valve. They shall be of steel or HDPE and shall be installed as shown on the Drawings. The bottom of the box section shall enclose the stuffing box and operating nut of the valve but shall not rest upon the valve body or the pipe. Boxes shall have barrels of not less than 5 inches in diameter or greater to allow adequate access to the valve handle.
- B. Valve extension stems shall be pinned to the valve operating nut. Stems shall be of sufficient length to place the valve handle at the grades indicated on the Drawings.

### **2.05 FLEXIBLE HOSE**

- A. Provide flexible hose at locations shown on Drawings and specified.
- B. Specifications - wellhead flexible hoses:

1. Diameter of the hose shall be as shown on the Drawings and shall be constructed airtight by adapters to the HDPE piping system, as approved by the Owner.
  2. Description: PVC suction hose (Kanaflex, Series 101 PS or Equal).
  3. Ratings at 72 F
    - Working Pressure: 30 psig.
    - Vacuum Rating: 28.0 inches of mercury.
  4. Minimum bending radius: 6.5 inches
- C. Service conditions - wellhead flexible coupling:
1. Product flow: Landfill gas (approximately 55% CH<sub>4</sub>, 40% CO<sub>2</sub>, 5% other), saturated, corrosive.
  2. Product temperature: 100 to 150°F.
  3. Product pressure: 1 to 5 inches water vacuum.
  4. Location: Exterior service.
- D. Connections to flanged stub ends shall be by stainless steel hose clamp or manufacturer's standard, as approved by Owner.

## **2.06 TRACER TAPE**

- A. The tracer tape shall be constructed of a metallic core bonded between layers of plastic. The tape shall be a minimum 3 inches wide. The plastic shall be coated with the corrosion-resistant yellow color and the legend shall say "Gas Line Below"

## **PART 3 - EXECUTION**

### **3.01 FAMILIARIZATION**

- A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with all portions of the work falling within this Section.
- B. Prior to implementing any of the work in this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of this section may properly commence without adverse impact.

### **3.02 HANDLING AND PLACEMENT**

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

- B. Ropes, fabric or rubber-protected slings and straps shall be used when handling HDPE pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.
- C. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches, or dragged over sharp and cutting objects.
- D. HDPE pipe shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. The pipes should be stored out of direct sunlight.
- E. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of HDPE pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. Sections of pipe with excessive cuts, gouges or scratches shall be removed and the ends of the pipe rejoined at no cost to the Owner.

### **3.03 INSTALLATION**

- A. General
  - 1. All HDPE pipe and fittings shall be installed in accordance with the manufacturer's instructions.
  - 2. The Contractor shall carefully examine all pipe and fittings for cracks, damage or defects before installation. Defective materials shall be immediately removed from the site and replaced at no cost to the Owner.
  - 3. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.
  - 4. Field-cutting of pipes, where required, shall be made with a machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cutter ends shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed.
- B. Gas Extraction Wells
  - 1. The Contractor shall install vertical sections of perforated piping at each of the well locations shown on the Drawing. This pipe shall be set in a boring into the waste, supported vertically and backfilled as specified.
  - 2. The perforated pipe shall be topped with the 8" x 6" slip coupling and 6" solid wall pipe with blind flange, as indicated on the Drawings. The solid

wall HDPE riser pipe shall extend from the pipe connections to a height of six (6) feet above the existing grade of the landfill.

3. The Contractor shall secure the gas wells with the indicated well washer.

### **3.04 JOINTS AND CONNECTIONS**

- A. HDPE pipe, fittings and flange connections shall be joined with thermal butt-fusion joints. All joints shall be made in strict compliance with ASTM D 2657 and the manufacturer's recommendations, and shall be performed by manufacturer's authorized, trained personnel. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
- B. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections unless noted otherwise, which shall consist of the following:
  1. A polyethylene "stub end" shall be thermally butt-fused to the ends of the pipe.
  2. Provide ASTM A 240, Type 304 stainless steel backing flange, 125-pound, ANSI B16.1 standard. Insulating flanges shall be used where shown.
  3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the manufacturer's standard. Retorque the nuts after 4 hours.
  4. Gaskets as specified.
- C. Butt-fusion of pipes and fittings shall be performed in accordance with the pipe manufacturer's recommendations as to equipment and technique. Depending on site conditions, butt-fusion joining shall be performed in or outside of the excavation at the Contractor's option.
- D. Each joint shall be swabbed and visually inspected inside and outside for damage, dirt, or moisture inside the joint prior to fusing. All open pipe ends will be capped at the end of the work day to prevent foreign material from entering pipe.
- E. Pipe ends shall be wiped clean and ends squared with the facing tool of the fusion machine. Alignment shall be checked to see that the pipe ends meet squarely over the entire surface to be fused. The heater plate shall be applied so as to achieve a melt pattern to a depth of 3/16 inches. The pipe ends shall be carefully removed from the ends. The pipe shall be brought together under sufficient pressure to form a double roll-back bead of 3/16-inch minimum width. After the joint has cooled, the pressure shall be released and the pipe shall be removed from the clamps.

- F. Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between the polyethylene pipe at the flanged joint and the rigid structures is possible.

### **3.05 PRODUCT PROTECTION**

- A. The Contractor shall use all means necessary to protect all prior work and materials and completed work of other Sections.
- B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to Owner.

### **3.06 FIELD QUALITY CONTROL**

- A. General
  1. Upon completion of piping, but prior to covering concealed/buried piping, test all piping systems.
  2. Utilize pressures, media and pressure test durations as specified.
  3. Isolate equipment which may be damaged by the specified pressure test conditions.
  4. Perform pressure test using calibrated pressure gages. Select each gage so that the specified test pressure falls within the upper half of the gage's range. Notify the Owner 24 hours prior to each test.
  5. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.
  6. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.
- B. HDPE Collection System Testing
  1. Backfilling over installed piping shall not be done until a successful pressure test of all piping has been completed to the satisfaction of Owner.
  2. All piping shall be pressure tested to 20 psig (in a complete system) in place in the trench, for a period of 1 hour with no more than a 2.5 psig decrease in pressure. All testing shall be done in the presence of Owner. After test approval by the Owner, the trench will be backfilled.
  3. The pipeline may be tested in sections at the discretion of or with the approval of the Owner.
  4. Contractor shall furnish and install all required vents, purges, plugs and blind flanges and make all necessary connections and all other required preparations required for the tests. Contractor shall provide all

pressurizing equipment, furnish and install temporary piping supports required for the entire length of the pneumatic tests.

5. Contractor shall repair any leaks found in fusion joints which he has made cutting/removing defective joint and fusing pipe ends together using proper polyethylene fusion procedures.
6. No pipe installation will be accepted until it meets all pressure test requirements.
7. No pipe installation will be accepted should there be evidence of exterior surface damage to the pipe, that in the opinion of the Owner, may compromise the integrity of the system, even though it may pass the pressure test requirements.
8. Pipe with exterior surface damage greater than 10 percent of the pipe diameter will not be accepted.
9. All costs associated with the pressure testing of pipe and any repair of damaged pipe shall be borne by the Contractor.

### **3.07 CLEANING**

- A. Clean interior of piping systems thoroughly before installing.
- B. Maintain pipe in clean condition during installation.
- C. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.

### **3.08 LOCATION OF CONSTRUCTED SYSTEM**

- A. The Contractor shall furnish an As-Built Plan showing exact horizontal and vertical locations and description of the constructed facilities. The As-Built Plan shall indicate the location of all wells, tees, connections, valves, header pipe at 50 foot intervals and at elbows and any other pertinent information which will be required by future contractors for replacement servicing, or adjacent construction around any buried facility.

**TABLE 02714-1  
HDPE PIPE AND FITTINGS PROPERTIES**

<b>PROPERTIES</b>	<b>UNITS</b>	<b>SPECIFIED VALUES</b>	<b>TEST METHOD</b>
Density	g/cm <sup>3</sup>	0.941 - 0.955	ASTM D 1505
Melt Flow	g/10 min	< 0.15	ASTM C 1238 Condition E
Flex Modulus	psi	110,000 - 160,000	ASTM D 790
Tensile Strength at Yield	psi	3,000 - 5,000	ASTM D 638
Environmental Stress Cracking	hrs	> 5,000	ASTM D 1693 Condition C
Hydrostatic Design Basis	psi	1,500 @ 23°C	ASTM D 2837

**END OF SECTION**

## SECTION 02715

### CORRUGATED POLYETHYLENE PIPE

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary for the installation of heavy duty corrugated polyethylene tubing, fittings and appurtenances in conjunction with the Drainage Layer Interceptor as specified herein and as shown on the Drawings.

##### 1.02 RELATED SECTIONS

- A. Section 02200 - Earthwork
- B. Section 02210 - Sand

##### 1.03 REFERENCES

- A. Latest version of the American Society for Testing and Materials (ASTM) standards:
  - 1. ASTM D 618 Method for Conditioning Plastics and Electrical Insulating Materials for Testing
  - 2. ASTM D 883 Definition of Terms Relating to Plastics
  - 3. ASTM D 1248 Specifications for Polyethylene Plastics Molding and Extrusion Materials
  - 4. ASTM D 1693 Test Method for Environmental Stress Cracking of Ethylene Plastics
  - 5. ASTM D 2122 Method of Determining Dimensions of Thermoplastics Pipe and Fittings
  - 6. ASTM D 2412 Test Method for External Loading Properties of Plastic Pipe by Parallel-Plate Loading
  - 7. ASTM F 412 D Definitions of Terms Relating to Plastic Piping Systems

##### 1.04 SUBMITTALS

- A. The Contractor shall submit to the Owner for approval, a list of materials to be furnished, the names of the suppliers and the results of physical testing performed by the Manufacturer.
- B. The Contractor shall submit to the Owner the PE pipe Manufacturer's certification of compliance with this Section for all materials delivered to the site, and shall

comply with the pipe Manufacturer's recommendation for handling, storing, and installing PE pipes and fittings.

- C. The Contractor shall submit to the Owner in writing the following documentation from the PE pipe Manufacturer on the raw materials used to manufacture the PE pipe and fittings prior to transporting any PE pipe or fittings to the site.
  - 1. Certificate stating the specific resin, its source and the information required by ASTM D 1248.
  - 2. Certification that no recycled compound has been added to the resin except that generated in the Manufacturer's own plant from resin of the same specification from the same raw material.

## **PART 2 - PRODUCTS**

### **2.01 POLYETHYLENE (PE) COMPOUND**

- A. The PE pipe and fittings shall be made of virgin PE compound which conforms with the requirements of Type III, Category 4 or 5, Grade P33, Class C or Grade P34 Class C as described in ASTM D 1248.

### **2.02 CORRUGATED POLYETHYLENE (PE) PIPE AND FITTINGS**

- A. All corrugated PE pipe and fittings shall comply with ASTM F 405.
- B. All corrugated PE pipe and fittings shall have a nominal inside diameter of four (4) inches and shall be rated for heavy duty commercial use.
- C. Corrugated PE pipe shall be supplied in standard laying lengths which facilitate handling and placement and minimize joint connections.
- D. Corrugated PE pipe shall be furnished in perforated and non-perforated sections.
  - 1. Perforations shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the pipe.
  - 2. Circular perforations shall not exceed 3/16 inch in diameter. Width of slots shall not exceed 1/8 inch. The length of individual slots shall not exceed 10 percent of the pipe inside nominal circumference.
  - 3. Slots shall be centered in the valleys of the corrugation. The water inlet area shall be a minimum of 1 square inch per linear foot of piping.
- E. PE fittings shall not reduce or impair the overall integrity or function of the pipe. All inline fittings, such as couplings shall be "spin-on" type. All other assembly fittings such as tees, wye's and end caps shall be "snap-on" type. All fittings shall provide for a strong connection to the main piping and shall be resistant to pull-out.

### 2.03 PIPING PROTECTIVE WRAP

- A. All corrugated perforated PE piping shall be wrapped with geotextile fabric to prevent the movement of fine soil particles and clogging of the pipe.
- B. Geotextile pipe wrap shall be installed by the pipe manufacturer prior to shipment to the site.
- C. Geotextile pipe wrap shall conform to the following criteria:

<b>Physical Properties</b>	<b>Nominal Values</b>
Weight, Oz. Per Sq. Yd. (ASTM D 3776)	2.5 to 3.5
Fiber Size, Denier Per Filament	100 to 200
Burst Strength, PSI (ASTM D 3786)	100 to 135
Air Permeability CFM Per Sq. Ft. (ASTM D 737)	700
Equivalent Opening Size (EOS) (U.S. Standard Sieve Size)	30 to 40

## PART 3 - EXECUTION

### 3.01 DRAINAGE LAYER SUBDRAIN

- A. Four (4) inch inside diameter, heavy duty, perforated, corrugated polyethylene piping with a geotextile wrap shall be installed around the perimeter of the landfill, beneath stormwater diversion berms and at other locations shown on the drawings. The intent of this piping is to intercept stormwater which has infiltrated the topsoil layer of the landfill cap into the sand drainage layer and to provide discharge of this water to the adjacent drainage channel network.
- B. The perforated interceptor piping shall be fitted with solid wall outlet tees and extension piping at the locations shown on the Drawings.
- C. All piping connections shall be made in accordance with manufacturer's recommendations and shall be secure and resistant to separation.
- D. All piping and appurtenances are intended for placement on top of the impermeable HDPE geomembrane layer of the landfill cap, as shown on the Drawings. The twelve inch (12") sand drainage layer and eight inch (8") topsoil layers will be placed above the impermeable layer.
- E. The Contractor shall protect and maintain the integrity of the impermeable layer during all construction activities.
- F. The Contractor shall be responsible for developing a construction sequence and procedure that will ensure the protection of the lateral drainage interceptor piping system during the placement of subsequent soil layers against pipe crushing or buckling.

- G. The open ends of the interceptor outlet piping shall be fitted with polyethylene mesh screens to prevent rodent access.
- H. Small crushed stone aprons shall be constructed at each outlet pipe for erosion protection.

**END OF SECTION**