



Closure Plan

POND CLOSURE PLAN

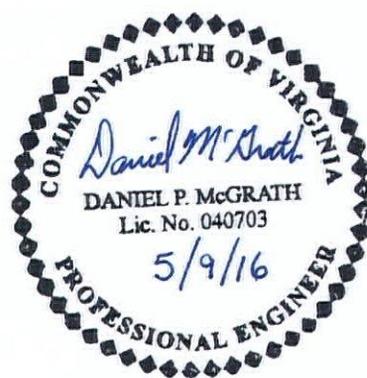
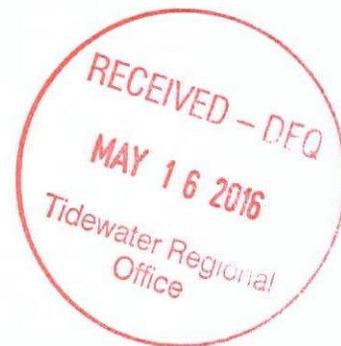
Chesapeake Energy Center
VPDES Permit #VA0004081



Dominion

Submitted To: Dominion – Chesapeake Energy Center
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Chesapeake, Virginia 23323

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Attachments

1. Bearing Capacity of Stabilized Bottom Ash Pond
2. Design Plans
3. CQA Plan and Technical Specifications
4. Stormwater Calculations – SCC-04

1.0 CLOSURE PURPOSE

This Pond Closure Plan (Plan) has been prepared for the Bottom Ash Pond (Pond) at Dominion's Chesapeake Energy Center (CEC), located in Chesapeake, Virginia. The bottom ash pond is a component of the station's wastewater treatment system. Bottom ash from the station historically was sluiced to the bottom ash pond located at the Southern end of the station's landfill. Decant from the bottom ash pond is directed to the facility's sedimentation pond, which receives the bulk of the remaining wastewaters currently generated by the station. As a result of closure of coal-fired operations at the station, the bottom ash pond will be closed and flows from the station into that pond will cease. Golder Associates Inc. of Richmond, Virginia, has prepared this plan for Dominion.

This Plan provides a description of the Pond closure activities; the final grading plan and final cover system design for the Pond and post closure activities that will be undertaken by Dominion. Also included as part of this plan are technical specifications and a construction quality assurance (CQA) plan. The closure construction of the bottom ash pond will be concurrent with the closure of the ash landfill.

1.1 Bottom Ash Pond Information

The current configuration of the bottom ash pond was developed in approximately 1985. The Pond is designated for bottom ash management (separate from the stormwater pond), and is approximately 4.6 acres in plan area. As built drawings for the current configuration indicate that the Pond is approximately 13 feet deep and has varying interior sideslopes. However, because the Pond was constructed on top of the former ash sluice facility for the station, the depth of ash material in the area of the bottom ash pond is uncertain. Over time, during normal operations, the Pond has accumulated material such that now the normal operational depth is approximately 3 to 5 feet and the sideslopes vary. The Pond is not lined.

The Pond received bottom ash sluice from the CEC as part of normal station operations. The sluiced bottom ash entered the Pond on the northeast corner, where it then flowed through a serpentine path to the outlet on the west side. The bottom ash solids dropped out by gravity and the water decanted into the adjacent sedimentation pond for eventual discharge through VPDES Outfall 002. The landfill operations contractor excavated the bottom ash solids periodically and stockpiled them within the bounds of the Pond for further dewatering and then disposal in the landfill.

1.2 Closure Plan Implementation

The goal of the closure plan design is to provide a low maintenance cover system with adequate stormwater run off controls to prevent erosion. The 24" final cover soil layer will have a vigorous stand of vegetation established to minimize soil erosion. A 40-mil HDPE geomembrane liner will serve as the top infiltration barrier to prevent water percolation into any remaining bottom ash. Existing bottom ash in the Pond will be graded and supplemented with clean fill as necessary to create the liner base grades and provide a smooth transition from the landfill cover system. Both the existing, lined retention basin

(Stormwater/Leachate Basin A) and the sedimentation/leachate pond (Stormwater/Leachate Basin B) will remain open following decommissioning activities, and will continue to receive stormwater and leachate flow from the closed landfill. As part of the landfill closure activities, the sedimentation pond will be lined.

2.0 CLOSURE TIMEFRAMES

Bottom ash pond closure construction will be conducted concurrent with the landfill closure construction and upon receipt of all required permits. The Pond will be closed in place under the authority of the VPDES permit. The design of the closure cap is consistent with the requirements of the Virginia Solid Waste Management Regulations and the Disposal of Coal Combustion Residuals from Electric Utilities rule [40 CFR 257.102(d)(3)].

At the time of closure, the bottom ash pond will contain approximately 41,250 cubic yards of bottom ash.

3.0 CLOSURE OF SURFACE IMPOUNDMENTS

The bottom ash pond will be closed concurrent with the landfill. Stormwater/Leachate Basin B will be lined and will remain open to receive stormwater flows and leachate from the closed landfill. Discharges from Stormwater/Leachate Basin B are, and will continue to be, monitored under the Station's VPDES permit through Outfall 002.

Bottom ash in the Pond will remain in place. This material will be supplemented with clean fill for filling and shaping of the bottom ash pond in anticipation of establishing base grades for the final cover system. The final cover system will provide an infiltration barrier for the closed Pond.

The bottom ash is a coarse-grained material and is relatively free draining, with a typical hydraulic conductivity of approximately 1×10^{-2} cm/sec. Remaining surface water in the bottom ash pond will be removed by pumping, and the bottom ash will be dewatered using a system of drainage sumps and pumps. Water removed from the dewatering activities will be managed in accordance with the station's applicable permits and plans. On-site experience shows that the bottom ash drains relatively quickly by gravity and an extensive dewatering system for surface stabilization is not anticipated. Where needed, dewatering may be achieved by excavating trenches (also known as rim ditches) that would drain seepage to strategically located sumps. The sumps would be outfitted with a perforated standpipe, wrapped in geotextile, with a sounding free draining aggregate collar. Centrifugal pumps would be required to continuously pump from the sumps. Depth, width, and spacing of the rim ditches and sumps will depend greatly on the particle size and anisotropic layering of the bottom ash at the time of closure. To achieve a stable surface, it will be necessary to dewater the bottom ash pond by temporarily lowering water table within the impounded bottom ash by approximately 5 feet below the surface.

Dewatering is anticipated to create a stable surface that the final cover system can be constructed upon without further ground improvements to the Pond. During the placement and grading of the bottom ash to achieve the desired base grades, the dry bottom ash will be compacted in lifts with a vibratory drum roller to achieve compaction in accordance with the technical specifications.

The minimum required bearing strength for the stabilized ash pond is 1,500 pounds per square foot (psf), which is approximately 1.5 times greater than the largest expected combination of soil and construction loading (950 psf). Calculations to support this value are included in Attachment 1.

4.0 POND CLOSURE DESIGN

4.1 Final Cover Design

The Pond is being closed under the authority of CEC's VPDES permit. The final cover system will be designed in accordance with 9VAC20-81-160.D.2.e and 40 CFR 257.102(d)(3). This final cover system consists of, from the top down:

- A vegetative support layer consisting of six inches of soil;
- A protective cover layer consisting of a minimum of 18 inches of soil;
- A geosynthetic drainage layer consisting of a 250-mil, double sided geocomposite; and,
- A 40-mil textured HDPE geomembrane barrier layer.

The final cover system will be placed directly on the graded and compacted ash surface. Areas of the pond that have soil cover will be stripped of vegetation, then the ash will be re-graded as needed to achieve the final design grades prior to placement of the capping system. The cover soils of the cap system will have a grass cover established to hold soil and prevent erosion. The Design Plans included in Attachment 2 show the final cover system. Technical Specifications and the CQA plan for the closure system components are included in Attachment 3.

4.1.1 Liner Subgrade

The subgrade for the barrier layer geomembrane will consist of compacted soil or ash material that meets the liner subgrade requirements as specified in Sections 02200 (Earthwork) and 02597 (Polyethylene Geomembrane) of the Technical Specifications. The liner subgrade shall contain particles no larger than 1/2" and will be rolled with a smooth-drum roller to flatten out wheel ruts and protrusions that may damage the overlying geosynthetics. The CQA Plan stipulates that prior to geosynthetic panel deployment, the installer and CQA consultant will inspect the subgrade and provide a written subgrade acceptance indicating that the subgrade is acceptable.

4.1.2 Barrier Layer

The barrier layer is a 40-mil textured HDPE geomembrane. Section 02597 of the Technical Specifications describes the material requirements, installation and seaming procedures, and CQA documentation to be recorded during construction of the barrier layer. HDPE was selected due to its combined physical strength and chemical resistance properties.

4.1.3 Geocomposite Drainage Layer

To provide drainage for the cover soils, a 250-mil geocomposite drainage layer will be placed on top of the geomembrane. The geonet core will be faced on both sides with a nonwoven geotextile to provide filtration and prevent the intrusion of soil into the drainage net. Underneath the channel section (SCC-04), the geocomposite will be a double thickness layer to aid in the subsurface drainage.

4.1.4 Protective Cover Layer

Immediately above the geocomposite drainage layer, an 18-inch thick layer of soil will be placed to serve as the protective cover layer. The soil will be imported into the site from an offsite borrow source. Acceptable soil types for this layer are specified in Section 02200 of the Technical Specifications. The maximum expected frost depth for the Chesapeake, Virginia area is 18 inches; therefore, the thickness of the soil layer is adequate to protect against freeze/thaw effects.

4.1.5 Vegetative Support Layer

The six-inch vegetative support layer will be established immediately following the placement of protective cover soil. This soil will be placed and tracked in, but not compacted. The soil will be seeded with the mix as presented in Section 02936 of the Technical Specifications included in Attachment 3, or with a site-specific mix based on soil testing. Woody vegetation is not allowed on the final cover system.

4.2 Final Slopes

The minimum final slope for the pond closure cap system is 2.0% to promote drainage off the cap and prevent ponding. A stormwater diversion channel is designed as part of the final cover system to convey stormwater from the pond cap to the stormwater basin.

5.0 INSPECTION, MONITORING, AND MAINTENANCE PLAN

5.1 Inspection Schedule

During the post-closure care phase for the adjacent landfill, the cover system of the Pond will also be maintained and inspected at the frequency identified in Table 2 below.

Item	Inspection Items	Frequency of Inspection
Closed Bottom Ash Pond Area	Gate and Fence Erosion of closure cover Settlement and Subsidence Deterioration of vegetative cover Trash, litter Stormwater channel system	Monthly Monthly and after severe storms Monthly Monthly and after severe storms Monthly Monthly and after severe storms
Groundwater Monitoring System	See Groundwater Monitoring Plan	See Groundwater Monitoring Plan

5.2 Run-Off Controls

Sheet flow from the final cover surface will be collected in the stormwater channel crossing the cap (SCC-04). This channel serves the eastern portion of the adjacent landfill and the Pond cap and is sized to convey the runoff from at least the 25-year, 24-hour storm event and prevent overtopping during the 100-year storm event. The stormwater channel will be lined with a non-biodegradable erosion control matting to resist erosion and support vegetative growth. The average longitudinal slope of the channel is 0.3%.

The perimeter channels drain to the existing sedimentation basin for attenuation and eventual discharge through the VPDES permitted outfall point. Calculations for the stormwater channel are included in Attachment 4.

5.3 Erosion and Sediment Control

Control of erosion during construction will take place as part of the overall construction plan of the landfill closure. Initial perimeter controls will be established as the first step in construction. Proper sequencing of the work, minimizing exposure, and structural controls will all be used to reduce erosional runoff. Site flows will be directed towards the stormwater pond at all phases of construction.

5.4 Settlement, Subsidence and Displacement

It is anticipated that the great majority of foundation settlement has already occurred. Localized settlement of the final cover is not anticipated to occur. Global settlement, however small, will cause the

geomembrane liner material to shorten, rather than stretch in tension. Small compressive forces resulting from minor settlement will not affect the integrity or performance of the final cover system.

5.5 Groundwater Monitoring System

The bottom ash pond is located adjacent to the industrial landfill and ancillary activities. The existing groundwater monitoring network for the landfill is capable of detecting a release from the bottom ash pond. Groundwater monitoring will continue as described in the Facility's Groundwater Monitoring Plan. Identified maintenance needs will be repaired as soon as practicable.

6.0 POST CLOSURE LAND USE

Post-closure use shall be in accordance with the provisions of the applicable regulations. Access to the site will be restricted. Possible future uses of the closed Facility include a wildlife management area. At the time of closure, Dominion may explore other safe uses for the Facility under the regulations that will exist at that time. Post-closure activities will be designed and conducted so as to not disturb the integrity of the final cover system, the components of any containment system, or the function of the facility's monitoring system. Any post-closure uses not specifically addressed in the Closure Plan must have prior approval from DEQ.



Project: CEC Ash Landfill - SWP #440

P.N.: 130-0193

Page: 1 of 1

By: DPM

Date: 10/14/13

Checked: *JSD*

Date: 4/15/14

Reviewed:

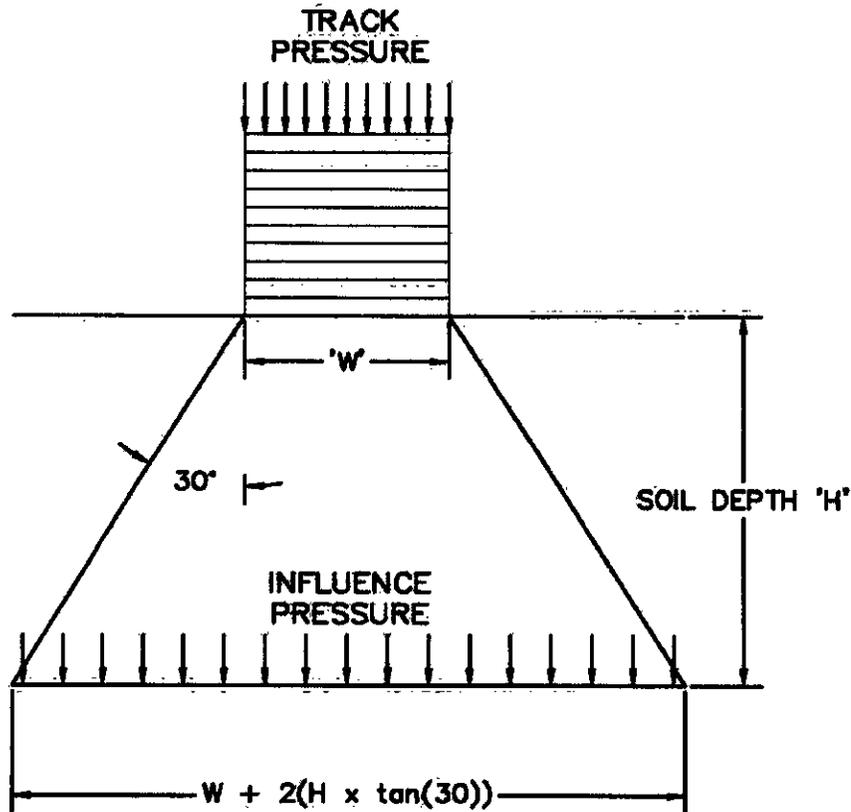
Date:

Subject: Ash Pond Bearing Capacity

Ground Influence Pressure of CAT 320 Hydraulic Excavator

Track Pressure	6.6	PSI
Track Width	2.0	feet
Soil Unit Weight	120.0	lb/ft ³

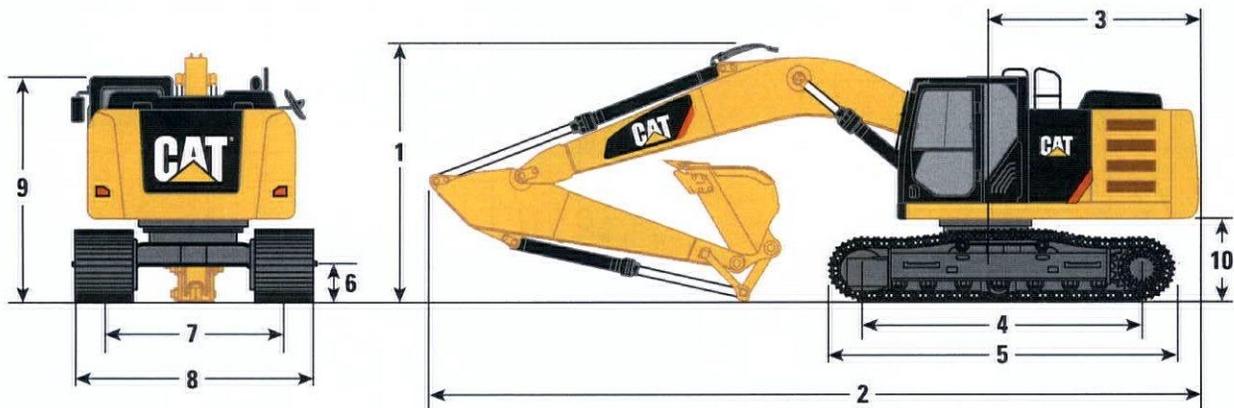
* Per unit length (1') of machine track				
Soil Depth, ft	Soil Pressure, PSF	Track Influence Area, ft ²	Track Pressure, PSF	Total Pressure, PSF
0	0.0	2.00	950.0	950.0
1	120.0	3.15	602.3	722.3
2	240.0	4.31	440.9	680.9
3	360.0	5.46	347.7	707.7
4	480.0	6.62	287.0	767.0
5	600.0	7.77	244.4	844.4
6	720.0	8.93	212.8	932.8



320E L Hydraulic Excavator Specifications

Dimensions

All dimensions are approximate.



Stick	Heavy Duty and Extreme Service Booms 5.7 m (18'8")		Super Long Reach Boom 8.85 m (29'0")
	3.9B1 (12'10")*	2.9B1 (9'6")**	Super Long Reach 6.28 m (20'6")***
	mm (ft)	mm (ft)	mm (ft)
1 Shipping Height†	3740 (12'3")	3130 (10'4")	3180 (10'4")
Shipping Height with Guard Rail	3240 (10'8")	3240 (10'8")	3240 (10'8")
Shipping Height with Top Guard	3150 (10'3")	3150 (10'3")	3150 (10'3")
2 Shipping Length	9340 (30'8")	9540 (31'4")	12 750 (41'10")
3 Tail Swing Radius	2830 (9'3")	2830 (9'3")	2830 (9'3")
4 Length to Center of Rollers	3650 (12'0")	3650 (12'0")	3650 (12'0")
5 Track Length	4460 (14'6")	4460 (14'6")	4460 (14'6")
6 Ground Clearance	450 (1'6")	450 (1'6")	450 (1'6")
7 Track Gauge	2380 (7'10")	2380 (7'10")	2380 (7'10")
8 Transport Width			
600 mm (24") Shoes	2980 (9'9")	2980 (9'9")	2980 (9'9")
790 mm (31") Shoes	3170 (10'5")	3170 (10'5")	3170 (10'5")
9 Cab Height	2960 (9'9")	2960 (9'9")	2960 (9'9")
Cab Height with Top Guard	3150 (10'3")	3150 (10'3")	3150 (10'3")
10 Counterweight Clearance††	1020 (3'4")	1020 (3'4")	1020 (3'4")

*Cat 900 mm (36"), 0.81 m³ (1.06 yd³) GD bucket with 1557 mm (5'1") tip radius.

**Cat 1200 mm (48"), 1.19 m³ (1.56 yd³) HD bucket with 1571 mm (5'2") tip radius.

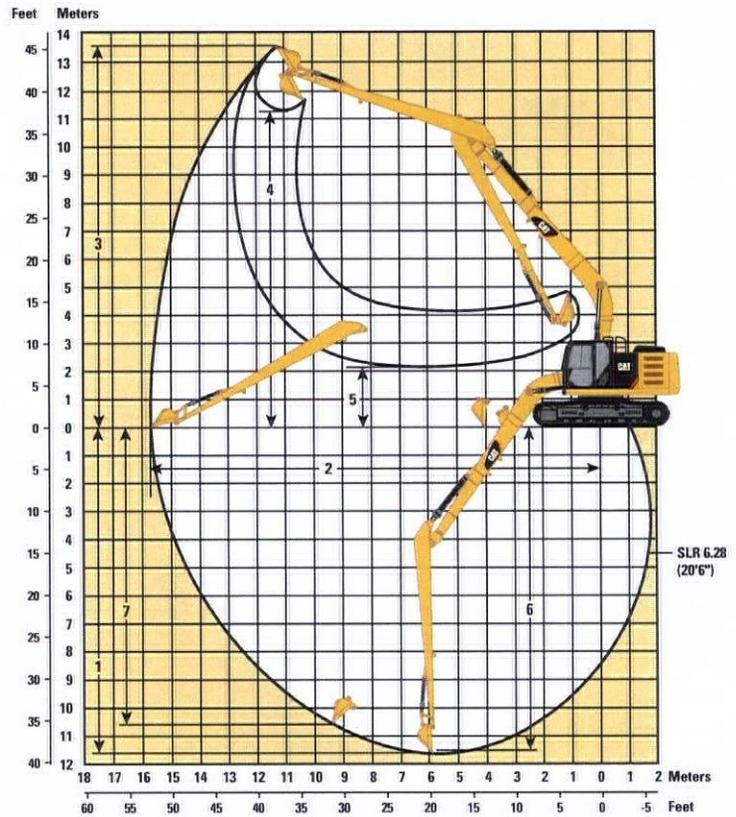
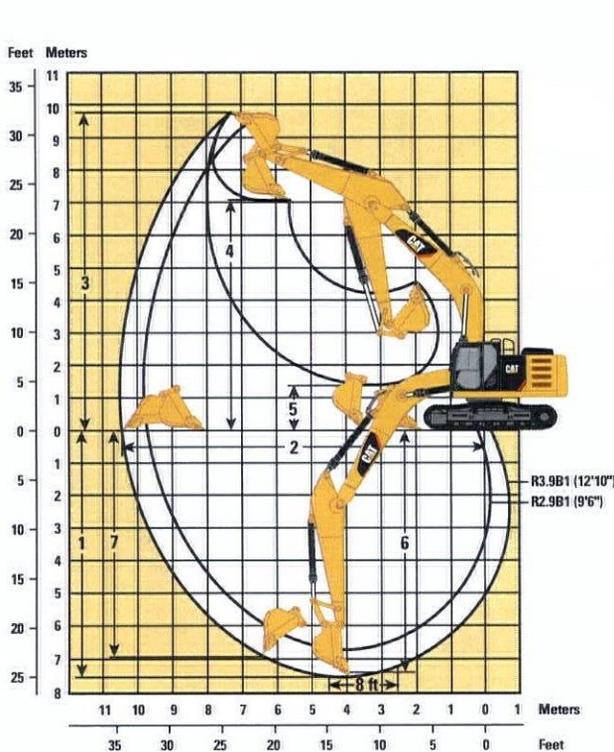
***Cat 1100 mm (44"), 0.61 m³ (0.8 yd³) ditch cleaning bucket with 1092 mm (3'7") tip radius.

†Including shoe lug height without guard rail.

††Without shoe lug height.

Working Ranges

All dimensions are approximate.



Stick	Heavy Duty and Extreme Service Booms 5.7 m (18'8")		Super Long Reach Boom 8.85 m (29'0")
	3.9B1 (12'10")*	2.9B1 (9'6")**	Super Long Reach 6.28 m (20'6")***
	mm (ft)	mm (ft)	mm (ft)
1 Maximum Digging Depth	7580 (24'10")	6720 (22'1")	11 690 (38'4")
2 Maximum Reach at Ground Level	10 680 (35'0")	9860 (30'9")	15 720 (51'6")
3 Maximum Cutting Height	9890 (32'4")	9370 (30'7")	13 590 (44'6")
4 Maximum Loading Height	7030 (23'0")	6490 (21'4")	11 290 (37'0")
5 Minimum Loading Height	1310 (4'4")	2170 (7'1")	2090 (6'9")
6 Maximum Depth Cut for 2440 mm (8'0") Level Bottom	7440 (24'4")	6550 (21'6")	11 590 (38'0")
7 Maximum Vertical Wall Digging Depth	6910 (22'7")	5060 (16'7")	10 670 (35'0")

*Cat 900 mm (36"), 0.81 m³ (1.06 yd³) GD bucket with 1557 mm (5'1") tip radius.

**Cat 1200 mm (48"), 1.19 m³ (1.56 yd³) HD bucket with 1571 mm (5'2") tip radius.

***Cat 1100 mm (44"), 0.61 m³ (0.8 yd³) ditch cleaning bucket with 1092 mm (3'7") tip radius.

320E L Hydraulic Excavator Specifications

Major Component Weights

	kg	lb
Base Machine (with boom cylinder, without counterweight, front linkage and track)	11 300	24,920
Long Undercarriage	7850	17,300
Counterweight		
3.55 mt (3.9 ton) Standard	3550	7,830
4.6 mt (5.1 ton) Super Long Reach	4600	10,140
5.4 mt (5.9 ton) Heavy	5400	11,910
Boom (includes lines, pins and stick cylinder)		
Boom HD – 5.7 m (18'8")	1720	3,790
Boom ES – 5.7 m (18'8")	2010	4,430
Boom HD for CGC – 5.7 m (18'8")	1730	3,810
Boom ES for CGC – 5.7 m (18'8")	2020	4,450
Super Long Reach – 8.85 m (29'0")	2400	5,290
Stick (includes lines, pins and bucket cylinder)		
3.9B1 (12'10") HD	930	2,060
2.9B1 (9'6") HD	680	1,510
2.9B1 (9'6") ES	840	1,850
2.9B1 (9'6") HD for CGC	690	1,530
2.9B1 (9'6") ES for CGC	850	1,870
Super Long Reach	1240	2,740
Track Shoe (Long/per two tracks)		
600 mm (24") Triple Grouser	2700	5,940
790 mm (31") Triple Grouser	3360	7,410
790 mm (31") Triple Grouser HD	3800	8,370
Quick Coupler		
Center-Lock 252	420	920
Buckets		
B1 900 mm (36") GD 347-6707 SAE 0.8 m ³ (1.06 yd ³)	650	1,420
B1 1200 mm (48") HD 347-6731 SAE 1.19 m ³ (1.56 yd ³)	930	2,050

All weights are rounded up to nearest 10 kg and lb except for quick coupler and buckets. Kg and lb were rounded up separately so some of the kg and lb do not match. Base machine includes 75 kg (165 lb) operator weight, 90% fuel weight, and undercarriage with center guard.

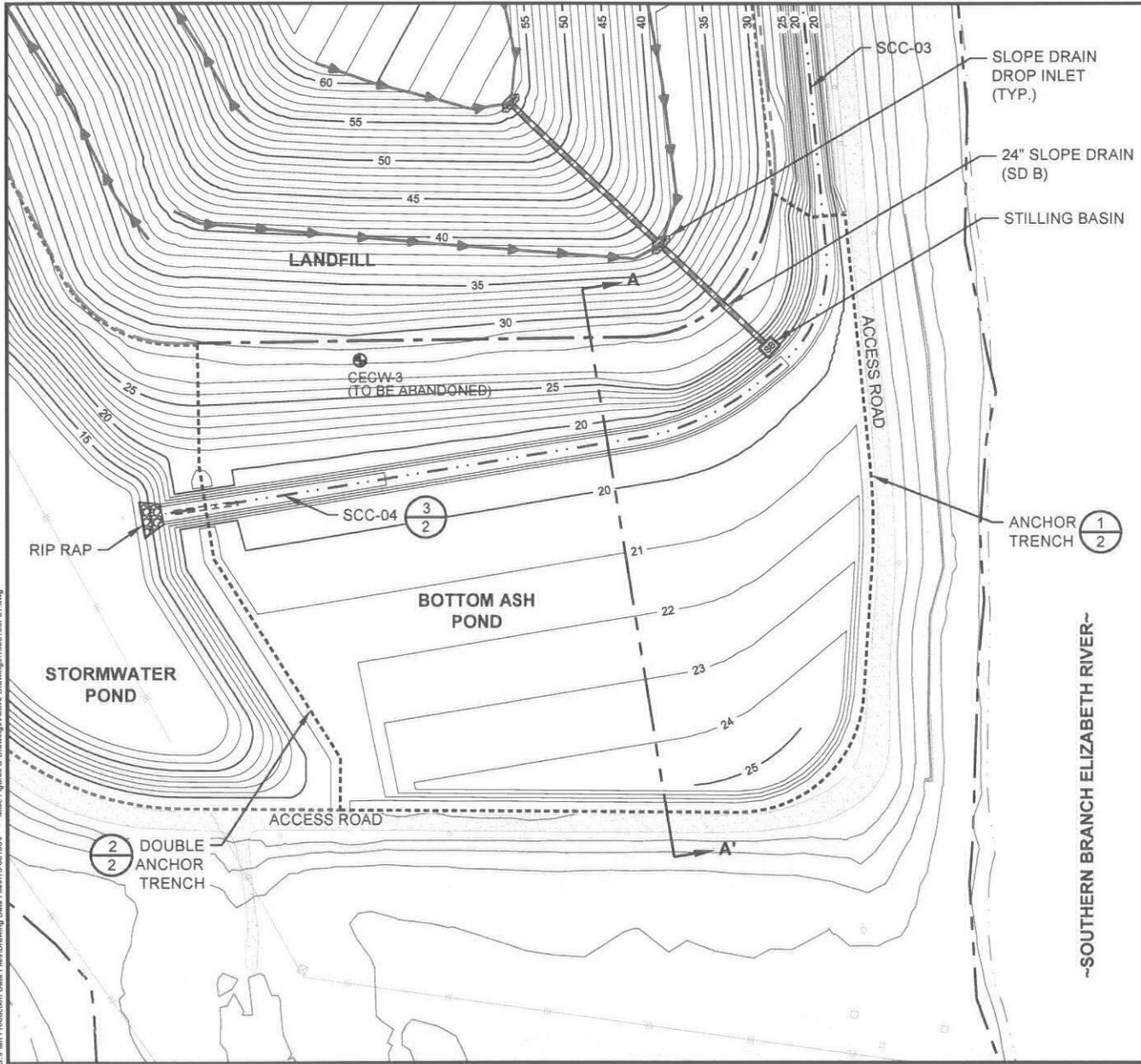
Operating Weight and Ground Pressure

	320E L			
	790 mm (31") Triple Grouser Shoes		600 mm (24") Triple Grouser Shoes	
	kg (lb)	kPa (psi)	kg (lb)	kPa (psi)
Boom HD – 5.7 m (18'8")				
3.9B1 (12'10") HD	22 200 (48,940)	35.0 (5.08)	21 500 (47,400)	44.7 (6.48)
2.9B1 (9'6") HD	22 200 (48,940)	35.1 (5.10)	21 600 (47,620)	44.9 (6.51)
2.9B1 (9'6") ES	22 400 (49,380)	35.4 (5.13)	21 700 (47,840)	45.2 (6.56)
2.9B1 (9'6") ES with Heavy Counterweight	24 700 (54,450)	38.9 (5.64)		
Boom ES – 5.7 m (18'8")				
3.9B1 (12'10") HD	22 500 (49,600)	35.5 (5.15)	21 800 (48,060)	45.4 (6.58)
2.9B1 (9'6") HD	22 600 (49,820)	35.7 (5.18)	21 900 (48,280)	45.6 (6.61)
2.9B1 (9'6") ES	22 700 (50,040)	35.9 (5.21)	22 100 (48,720)	45.9 (6.66)
Super Long Reach Boom – 8.85 m (29'0")				
6.28 m (20'6") SLR	23 500 (51,810)	37.1 (5.38)	22 800 (50,270)	47.4 (6.87)

Bucket and Stick Forces

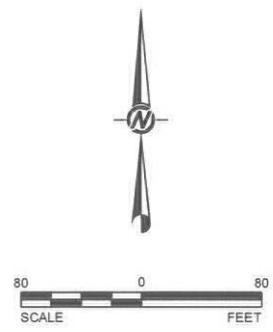
Stick	Heavy Duty and Extreme Service Booms 5.7 m (18'8")		Super Long Reach Boom 8.85 m (29'0")
	3.9B1 (12'10")	2.9B1 (9'6")	Super Long Reach 6.28 m (20'6")
B1 – Family Bucket	kN (lbf)	kN (lbf)	kN (lbf)
General Duty			
Bucket Digging Force (SAE)	125.9 (28,300)	125.9 (28,300)	51.2 (11,500)
Stick Digging Force (SAE)	87.8 (19,700)	103.9 (23,400)	35.8 (8,000)
Heavy Duty			
Bucket Digging Force (SAE)	124.4 (28,000)	133.5 (30,000)	
Stick Digging Force (SAE)	87.6 (19,700)	103.2 (23,200)	
Severe Duty			
Bucket Digging Force (SAE)	124.4 (28,000)	133.5 (30,000)	
Stick Digging Force (SAE)	87.6 (19,700)	103.2 (23,200)	

C:\Plan Production Data Files\Drawings Data Files\13-00193F - Misc Figures & Drawings\Active Drawings\1300193F01.dwg



LEGEND:

	PROPERTY BOUNDARY
	PROPOSED FINAL GRADES (5' CONTOUR)
	PROPOSED FINAL GRADES (1' CONTOUR)
	EXISTING FINAL GRADES (5' CONTOUR)
	EXISTING FINAL GRADES (1' CONTOUR)
	EXISTING SURFACE WATER
	PROPOSED SIDE SLOPE DIVERSION BERM
	CECW-3 EX. MONITORING WELL



- NOTES:**
- EXISTING TOPOGRAPHY SHOWN ON THIS DRAWING IS BASED ON MAP COMPILED BY PHOTO SCIENCE USING PHOTOGRAMMETRIC METHODS. BASED ON AERIAL PHOTOGRAPHY DATED MAY 28, 2013. GROUND CONTROL SURVEY AND EXISTING CULVERT LOCATIONS PREPARED BY D&M SURVEYORS. BORING LOCATIONS AND INFORMATION TAKEN FROM "CHESAPEAKE ENERGY CENTER ASH LANDFILL" VDEQ PERMIT NO. 440, PREPARED BY RESOURCE INTERNATIONAL, LTD. DATED FEBRUARY 29, 200.



Golder Associates
Richmond, Virginia

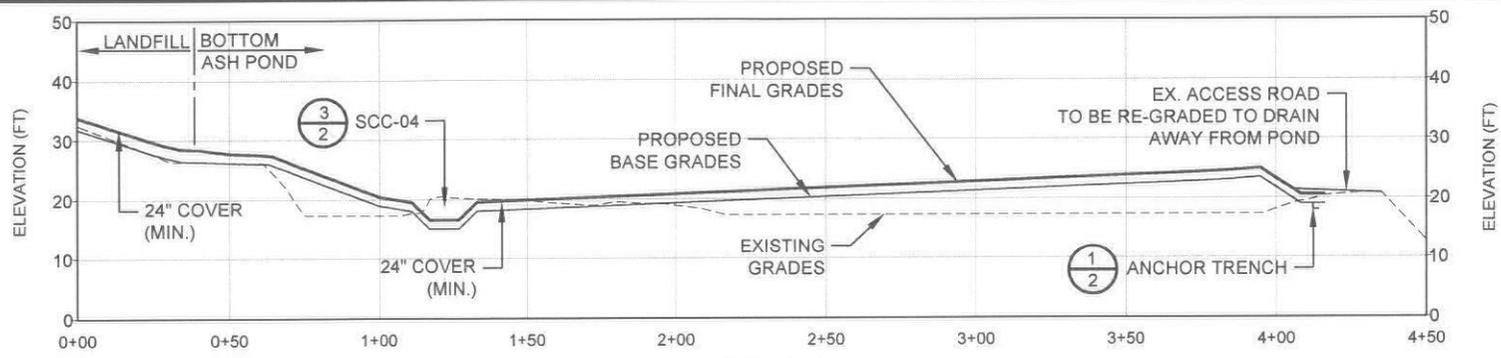
PROJECT
 DOMINION
 CHESAPEAKE ENERGY CENTER
 BOTTOM ASH POND CLOSURE PLAN
 VPDES PERMIT #VA0004081
 CITY OF CHESAPEAKE, VIRGINIA

TITLE
 BOTTOM ASH POND
 FINAL COVER
 GRADING PLAN

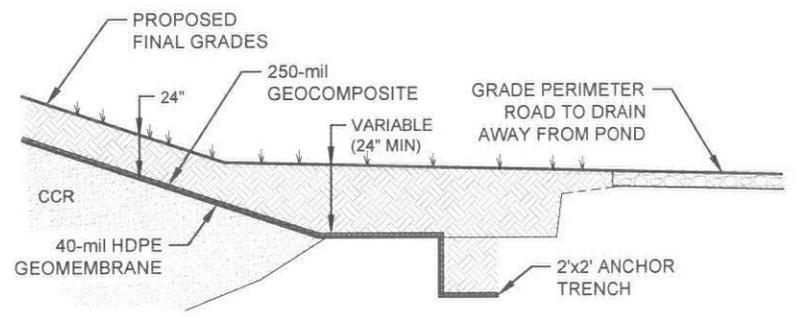
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CADD	ATN 04/17/14
CHECK	ATN 11/26/14
REVIEW	DPM 11/26/14

DRAWING 1

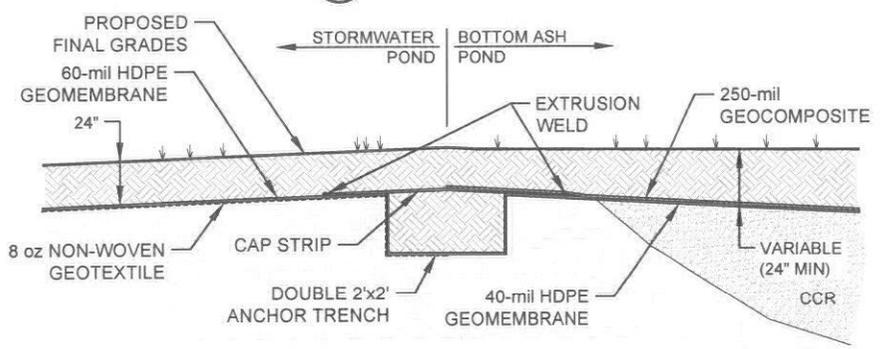
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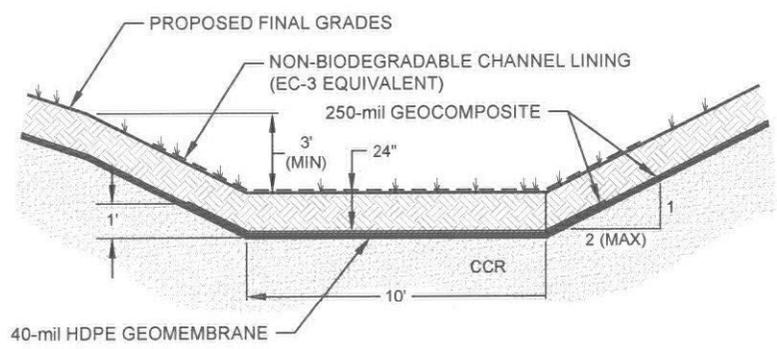
SECTION A-A'



1 ANCHOR TRENCH
NOT TO SCALE



2 DOUBLE ANCHOR TRENCH
NOT TO SCALE



3 SCC-04 DETAIL
NOT TO SCALE



PROJECT
DOMINION
CHESAPEAKE ENERGY CENTER
BOTTOM ASH POND CLOSURE PLAN
VPDES PERMIT #VA0004081
CITY OF CHESAPEAKE, VIRGINIA

TITLE
BOTTOM ASH POND
DETAILS

PROJECT No.	13-00183
FILE No.	1300183P01
REV. 0	SCALE AS SHOWN
DESIGN	DPM 04/17/14
CADD	ATN 04/17/14
CHECK	ATN 11/26/14
REVIEW	DPM 11/26/14

DRAWING 2

**CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN
DOMINION – CHESAPEAKE ENERGY CENTER
INDUSTRIAL SOLID WASTE LANDFILL – PERMIT #440
CHESAPEAKE, VIRGINIA**

Prepared for:



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1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan was prepared by Golder Associates Inc. (Golder) to assist Dominion (OWNER) in performing construction of the landfill components at the Chesapeake Energy Center's Industrial Solid Waste Landfill in Chesapeake, Virginia according to the Construction Drawings and Technical Specifications. This plan is intended to meet the requirements of 9VAC20-81-130.Q.

To implement the construction project, a CONTRACTOR, familiar with earthwork and geosynthetics construction, will serve as a general CONTRACTOR (CONTRACTOR) providing construction services and a CQA Consultant will be retained by the OWNER to ensure project conformance of construction activities to established CQA standards. The CQA Plan provides guidance information and procedures that should be undertaken by all parties so the work will be of the quality necessary to meet the project objectives and will be responsive to the requirements of the OWNER.

This CQA Plan is a supplemental document to the Construction Drawings and Technical Specifications for each project. Where a conflict arises, the contract documents will govern.

1.1 PROJECT DESCRIPTION

The activities addressed under this CQA Plan include the following activities:

- Earthworks;
- Subgrade preparation;
- Polyethylene Geomembrane (HDPE) installation;
- Geonet Composite and Geotextile installation; and,
- HDPE Pipe installation.

1.2 DEFINITIONS

Quality Control: A planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the needs of users. The objective of quality control is to provide a quality product that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification of what is wanted, production to meet the full intent of the specification, inspection to determine whether the resulting material, product, service, etc. is in accordance with the Specifications, and review of usage to determine necessary revisions of Specifications. In practice, Quality Control refers to those procedures, criteria, and tests employed and paid for by the CONTRACTOR(s) to confirm that the work satisfies the CONTRACTOR's standards and is in compliance with the Construction Drawings and Technical Specifications. This CQA plan does not address quality control procedures, criteria, and/or tests employed by the CONTRACTOR.

Quality Assurance: A planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with the ability to have corrective measures initiated where necessary. For a specific material, product, service, etc., this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment. In practice, Quality Assurance refers to those procedures, criteria, and tests required and paid for by the OWNER to confirm that the work performed by the CONTRACTOR(s) is in compliance with the approved Construction Drawings and Technical Specifications and any additional requirements of this plan.

Lot: A quantity of resin (usually the capacity of one rail car) used in the manufacture of geosynthetic material. The finished geosynthetic product (e.g., polyethylene geomembrane roll or geocomposite roll) will be identified by a unique number traceable to the resin lot used.

Geosynthetics: The collective name for polymeric materials used in civil construction. Includes materials such as geomembrane, geotextile, geocomposite, and other like products.

Panel: A unit area of geosynthetic material that will be deployed and used as part of this project. A panel is identified as a roll or portion of a roll that is larger than 100 square feet.

Subgrade Surface: The soil layer surface which immediately underlies the geosynthetic material(s).

1.3 PARTIES

OWNER: The OWNER is the individual, corporation, entity, public body, or authority with whom the CONTRACTOR has entered into the Agreement and for whom the Work is performed. For this project, the OWNER is Dominion.

ENGINEER: The ENGINEER is the official representative of the OWNER. The ENGINEER is responsible for the preparation of the Construction Drawings, Technical Specifications, and the CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for resolution of technical matters that arise during construction.

CONTRACTOR: The CONTRACTOR has the primary responsibility for ensuring that the landfill is constructed in accordance with the Construction Drawings and Technical Specifications developed by the ENGINEER and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, safety, supervision, construction quality control, installation, and subcontracting. The CONTRACTOR is responsible for the protection of completed work until it is accepted by the OWNER. The CONTRACTOR

is also responsible for informing the OWNER and CQA Consultant of the scheduling and occurrence of all construction activities. The CONTRACTOR shall be fully responsible for scheduling and coordinating the work of Subcontractors and for ensuring that the Subcontractor adheres to the requirements of this CQA Plan.

CQA Consultant: The CQA Consultant is an entity, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing and documenting activities related to the quality assurance at the site. The CQA Consultant shall be knowledgeable of soil properties, geosynthetics properties, and the practices typical of the Work. This party will perform field and laboratory testing of soils and other earth materials for evaluation and verification purposes. This party will also observe installation of the geosynthetic liner and coordinate sampling and testing of the geosynthetics with the Geosynthetic CQA Laboratory. The CQA Consultant will be responsible for reviewing the required CONTRACTOR submittals for conformance to the Technical Specifications, Construction Drawings, and this CQA Plan. The CQA Consultant is also responsible for issuing a certification report, sealed by a Professional Engineer licensed in the Commonwealth of Virginia. The OWNER may assign the duties of the ENGINEER to the CQA Consultant provided the CQA Consultant is qualified.

Geosynthetic Manufacturer (Manufacturer): The party responsible for manufacturing the geosynthetic rolls.

Geosynthetic CQA Laboratory (Testing Laboratory): Party, independent from the OWNER or CONTRACTOR, Manufacturer and Installer, responsible for completing laboratory tests on samples of geosynthetics obtained at the site or during manufacturing.

Geosynthetic Installer: The Geosynthetic Installer is responsible for field handling, sorting, placing, seaming, loading (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, geonets, and geonet composites. The Installer is responsible for the protection of the materials once they arrive on site until the work is accepted by the OWNER.

Geotechnical CQA Laboratory: Party, independent from the OWNER or CONTRACTOR, responsible for completing laboratory tests on soil samples obtained at the site or source.

Subcontractor: The Subcontractor is an entity or individual who has a direct contract with the CONTRACTOR for the performance of a part of the Work. The Subcontractor shall communicate with the OWNER or ENGINEER through the CONTRACTOR. The Subcontractor shall adhere to the requirements of the Technical Specifications and this CQA Plan as it relates to the Subcontractor's part of the Work.

2.0 CQA PERSONNEL

The OWNER will retain a CQA Consultant to assure that proper construction techniques and procedures are used and to verify that the materials used meet the Technical Specifications. The CQA Consultant must employ engineer(s) licensed to practice in the Commonwealth of Virginia and personnel experienced in the field of solid waste management and landfill construction. At the completion of the work, the program requires certification reports indicating that the facility has been constructed in accordance with the Technical Specifications and approved permit. It is the responsibility of the CQA Consultant to prepare these reports.

3.0 CQA LABORATORIES

3.1 GEOTECHNICAL CQA LABORATORY

3.1.1 Experience and Qualifications

The Geotechnical CQA Laboratory must have experience in testing soils and aggregates, and be familiar with ASTM International (ASTM) test standards and other applicable test standards as required in the Technical Specifications. The geotechnical laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Technical Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact for reference. The Geotechnical CQA Laboratory must be capable of providing preliminary permeability test results within 48 hours and final permeability test results within 72 hours of receipt of sample. The laboratory must be capable of providing all other test results within five days of receipt of samples.

The Geotechnical CQA Laboratory shall provide a contract administrator/project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

3.1.2 Responsibilities

The Geotechnical CQA Laboratory is responsible for performing all geotechnical laboratory tests and formally submitting results to the ENGINEER as required in the Technical Specification. These tests shall include, but are not limited to, those indicated in the Technical Specifications:

3.2 GEOSYNTHETIC CQA LABORATORY

3.2.1 Experience and Qualifications

The Geosynthetic CQA Laboratory must have experience in testing geosynthetics, and must conform to ASTM, National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other applicable test standards, as required in the Technical Specifications. The geosynthetic laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Technical Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact for reference. The Geosynthetic CQA Laboratory must be capable of providing test results within 48 hours from receipt of samples.

The Geosynthetic CQA Laboratory shall provide a contract administrator/project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

3.2.2 Responsibilities

The Geosynthetic CQA Laboratory is responsible for performing all geosynthetic laboratory tests and formally submitting results to the ENGINEER as required in the Technical Specifications. These tests shall include, but are not limited to, those indicated in the Technical Specifications.

4.0 CQA TESTING AND INSPECTION CRITERIA

This section of the CQA Plan describes the inspection activities (observations and tests) that will be performed during construction to ensure that the facility is constructed to meet or exceed all design criteria, plans, and specifications. The scope of this section addresses the construction, including material installation and the manufacture/fabrication of the following specific components:

- Earthworks;
- Subgrade preparation;
- Polyethylene Geomembrane (HDPE) installation;
- Geonet Composite and Geotextile installation; and,
- HDPE Pipe installation.

4.1 GENERAL PRECONSTRUCTION ACTIVITIES

Prior to the start of construction, a preconstruction meeting shall be held among the OWNER, the ENGINEER, CQA Consultant, Geosynthetic Installer (Installer) and the CONTRACTOR responsible for completing the work. The topics covered at this meeting shall include, but not be limited to:

- CQA documents and supporting information;
- The site-specific CQA plan, its role relative to accomplishing the intent of the design, as well as review of the Construction Drawings and Technical Specifications;
- Responsibilities of each party;
- Lines of authority and communication for each organization;
- Procedures or protocol for construction, change orders, deficiencies, repairs, and retesting;
- Methods of documenting and reporting inspection data;
- Work area security and safety protocol;
- Location and protection of construction materials, and the prevention of damage of the materials from inclement weather or other adverse events;
- Conducting a site walk to review site conditions as well as material staging and storage locations;
- The construction plan, schedule, and procedures; and
- Installation, testing, and acceptance criteria and procedures.

4.2 EARTHWORKS

Structural fill shall be prepared and compacted in accordance with the Technical Specifications and to the grades and lines indicated on the Construction Drawings. Structural fill will also be used for liner subgrade, pipe backfill, and final cover construction. The surface shall be free of vegetation, construction debris, sticks or roots, sharp rocks, void spaces, ice, abrupt elevation changes, standing water,

desiccation cracks, or other puncture hazards. Structural fill shall meet the requirements of Section 02200 of the Technical Specifications:

4.2.1 Material Evaluation

Preconstruction material evaluations shall be performed on samples from proposed sources to ascertain their acceptability as construction materials. Construction testing shall be performed during the course of the Work to verify material compliance with the Technical Specifications.

The criteria determining the acceptability of materials for construction shall be as defined in the Technical Specifications, Virginia Department of Transportation (VDOT) Specifications, and/or as detailed in this CQA Plan. All evaluation tests are to be performed by the Geotechnical CQA Laboratory approved for use by the CQA Consultant. Test reports will state compliance with or deviation from applicable ASTM standards as outlined in the following sections.

4.2.1.1 Preconstruction Material Evaluation

Structural fill shall be sampled and tested prior to use for the project in accordance with Table 1 of Section 02200 to ascertain its conformance to the Technical specifications. Where structural fill soil types vary substantially and are not segregated, representative blends of the soils anticipated for construction use should also be sampled and tested. The material tested shall comply with a maximum particle size of less than 2 inches, except when materials are used for liner subgrade or landfill final protective cover where the maximum particle size shall be 1/2 inch.

As a general rule, a minimum of two series of preconstruction tests should be performed for every source of soil proposed for use as structural fill. Additional preconstruction samples should be taken and tested when the material changes or initial preconstruction test results appear inappropriate or questionable. When the same borrow source is utilized for more than one construction area, results from the previous tests may be used to supplement the preconstruction data.

4.2.2 Construction Observation

Observation of excavation and structural fill placement shall be coordinated with construction testing. Acceptance criteria for construction work shall be as identified in the Technical Specifications. At a minimum, the CQA Consultant shall monitor and record the following during the construction:

- Consistency of the materials during processing and placement; and,
- Deleterious material that may hinder proper soil compaction.

Structural fill grades shall be surveyed by the designated surveyor in accordance with the Technical Specifications.

4.2.3 Construction Testing

CQA testing during construction shall be conducted in accordance with Table 3 of Section 02200 of the Technical Specifications. All field and laboratory tests shall be conducted on samples taken during the course of the construction work. Testing and sampling procedures shall be observed and documented by the CQA Consultant.

Construction Observation: The CQA Consultant will be on-site at all times construction is ongoing, observing and documenting all relevant activities. The ENGINEER will visit the site periodically as construction progress warrants. Such visits will be frequent enough to allow the ENGINEER to be fully knowledgeable of the construction methods and performance. The ENGINEER may then determine if CQA observation and testing activities are adequate to meet the terms and intent of this CQA Plan.

Visual observation shall include, but not be limited to, the following:

- Consistency of materials and
- Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

Construction Testing: During construction, structural fill shall be sampled and tested in accordance with the frequencies and test methods presented in Table 3 of Section 02200.

Structural Fill Field Compaction Verification: Structural fill compaction and moisture content verification shall be determined using the nuclear density test method (ASTM D6938) at a minimum frequency of one per 10,000 square feet per lift and one per lift per 100 L.F. of pipe trench. Structural fill shall be placed in maximum 9-inch compacted layers and shall be compacted to the minimum densities as shown in Table 2 of Section 02200 of the Technical Specifications.

4.2.4 Defects and Repairs

4.2.4.1 Identification

If a defect is identified in the structural fill, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

4.2.4.2 Notification

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the CONTRACTOR and the ENGINEER.

4.2.4.3 Repairs and Retesting

The CONTRACTOR shall correct all deficiencies in accordance with the Technical Specifications. The CQA Consultant shall schedule appropriate retests when the work deficiencies have been corrected. All retests by the CQA Consultant must verify that the deficiencies have been corrected before additional work may be performed by the CONTRACTOR in the area of the deficiency. The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

4.3 HDPE POLYETHYLENE GEOMEMBRANE

Stringent QA and careful documentation are required in the production and installation of all of the High Density Polyethylene (HDPE) geomembrane materials. The work addressed under this section shall facilitate proper construction of all geomembrane components of the landfill final cover system. Work shall be constructed to the lines, grades, and dimensions indicated on the Construction Drawings, in accordance with the Technical Specifications or as required by the OWNER or ENGINEER.

The CQA Consultant shall issue a written daily report of activities. These reports shall include, at a minimum, observations, test results, problems encountered, and resolutions. Construction reports summarizing significant events and addressing problems encountered and their resolutions shall be issued to the ENGINEER. The format of these reports and frequency shall be established at the preconstruction meeting.

4.3.1 Manufacture of Geomembrane

The polyethylene resin used shall be virgin material with no more than 2% rework. If rework is used, it must be a similar formulation of the parent material. No post-consumer resin of any type shall be added to the formulation. Geomembrane shall meet the material requirements in Section 02597 of the Technical Specifications.

Prior to the installation, the Manufacturer will provide the CQA Consultant with the following:

- A properties sheet including all specified properties measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant;
- A list of quantities and descriptions of materials other than the base polymer that comprise the geomembrane;
- The sampling procedure and results of testing; and
- A certification that property values given on the properties sheet are minimum or maximum values and guaranteed by the Manufacturer.

The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Technical Specifications; and
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the geomembrane meets the Manufacturer specifications and the Technical Specifications.

4.3.2 Conformance Testing

Subgrade surfaces to receive geomembrane shall meet the requirements of Section 4.2 and the Technical Specifications. The Installer shall provide written certification that the subgrade surface on which the geomembrane will be installed is acceptable. During placement, the CQA Consultant will verify that:

- Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement;
- Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and free of debris;
- All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, the loading should be continuous along the edges of panels to minimize the risk of wind flow under the panels); and
- Direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected. Portable generators may not be placed directly on the geomembrane, but shall be placed on a rub sheet.

The CQA Consultant will notify the Installer and Contractor if the above conditions are not fulfilled.

After placement and prior to seaming, the CQA Consultant will visually examine each panel for damage. The CQA Consultant will advise the Geomembrane Installer which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked, and their removal from the work area shall be recorded by the CQA Consultant.

Prior to seaming, the CQA Consultant shall verify that the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material. The CQA Consultant shall verify that the bonding surfaces are thoroughly cleaned by mechanical abrasion prior to extrusion welds. QC testing of the seams shall be conducted by the Installer under the observation of the CQA Consultant. The Installer shall supply qualified personnel and testing equipment. The CQA Consultant or Geosynthetic CQA Laboratory may perform additional testing to verify that the seams meet the requirements of the Technical Specifications.

During geosynthetics construction, the CQA consultant shall maintain records on the following items:

The manufacturer and the CQA Consultant will perform MQC and QA verification testing in accordance with Section 02597 of the Technical Specifications. Samples of the geomembrane material shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. QA Samples shall be taken at the factory prior to shipment or upon delivery at the site.

4.3.3 Transportation and Delivery

All on-site storage and handling is the responsibility of the CONTRACTOR or Installer. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.

Upon delivery at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The Installer will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of adverse weather.

4.3.4 Construction

The Installer shall submit proposed panel layouts to the CQA Consultant at least two weeks prior to mobilization of installation crews. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented with, not across, the slope. In corners and other geometrically complex locations, the number of seams should be minimized. No butt seam or tee seam will be less than five feet from the toe of slopes or areas of potential stress concentrations unless otherwise authorized by the CQA Consultant.

Once the panel layout is approved, the Installer may not substantially change the layout without permission of the CQA Consultant, ENGINEER, or OWNER. The Installer shall submit a drawing of proposed seam completion details for intersections of three or more panels to the ENGINEER and the CQA Consultant prior to shipment of the geomembrane.

- Geosynthetic roll inventory (geomembrane, geocomposite, geotextile, etc.)
- Laboratory testing of geosynthetic materials (conformance and seam strength)
- Geosynthetic panel installation logs, including subgrade acceptance
- Seam testing logs, both destructive and nondestructive
- Geomembrane repair logs
- General construction activity logs for daily reports

4.3.4.1 Trial Seams

Trial seams shall be made each day prior to commencing field seaming. The seams shall be made on fragments of geomembrane under the same surface and environmental conditions as the production seams to verify that seaming conditions are adequate. The trial seams shall be made at the beginning of each seaming period; at changes of equipment, equipment settings, operator, weather, or sheet temperature; at the CQA Consultant's discretion; at least once every four to six hours during continuous operation of each welding machine; or at change in geomembrane material type (i.e., smooth-to-smooth seam versus smooth-to-textured seam).

The trial seam sample shall be at least five feet long by one foot wide with the seam centered lengthwise. For dual-track fusion welds, six one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for inside and outside peel adhesion (peel) and three specimens for bonded seam strength (shear). For extrusion welds, six one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for peel and three specimens for bonded seam strength (shear). A trial seam sample shall pass when the values shown below are achieved in both peel and shear testing.

MINIMUM POLYETHYLENE SEAM PROPERTIES (per GRI GM-19)

PROPERTY	METHOD	40 MIL HDPE	60 MIL HDPE
Shear Strength	ASTM D6392	80 ppi	120 ppi
Peel Adhesion:			
Fusion	ASTM D6392	60 ppi	91 ppi
Extrusion	ASTM D6392	52 ppi	78 ppi

The strength of four out of five specimens shall meet or exceed the value shown in this table. The fifth must meet or exceed 80% of the given value in order to be considered a passing test.

Unacceptable break codes are:

- Fusion: AD and AD-Brk > 25%
- Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

Trial seams shall be repeated, in their entirety, when any of the trial seam samples fail in either peel or shear. If additional trial seams fail, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved. No welding equipment or welder shall be allowed to begin production welds until equipment and welders have a successfully completed trial seam. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Installer shall demonstrate that acceptable seaming can be achieved by completing passing trial seams.

The remainder of the successful trial seam shall be assigned a number and marked accordingly by the CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming apparatus, name of seamer, and pass or fail description. The sample itself shall be archived until project completion.

4.3.4.2 Non-Destructive Testing

Production seams shall be continuously tested by the Installer using non-destructive techniques. The Installer shall perform all air pressure (fusion-welded seams) and vacuum testing (extrusion-welded seams) under the observation of the CQA Consultant as follows:

- Extrusion Weld Testing – Non-destructive testing of the extrusion weld shall be conducted with a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom, a valve assembly, and a vacuum gauge. The assembly shall be capable of maintaining at least a three-psi vacuum. A passing extrusion seam shall exhibit at least a three-psi vacuum for a minimum of 10 seconds. The presence of soap bubbles in rapid succession is indicative of a leak. The viewing window should be regularly cleaned to ensure a clear view of the seam section being tested. All areas where soap bubbles appear shall be marked, repaired, and retested.
- Fusion Weld Testing – Non-destructive testing of the fusion weld shall be conducted with an air pump or tank capable of generating and sustaining pressure over 30 psig; a sharp, hollow needle, or other approved pressure-feed device equipped with a pressure gauge; a utility knife with hook blade; a hot air gun or other device, and clamps to seal the ends of the air channel.
 - Seal both ends of the seam to be tested
 - Pressurize the seam to 30 psi, close valve and allow pressure to stabilize for approximately 2 minutes
 - Observe air pressure 5 min after initial 2-min stabilization period ends. If pressure loss exceeds 2 psi or pressure does not stabilize, locate faulty area and repair.
 - Cut opposite end of tested seam area once testing is completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel.
 - A test is considered passing if the pressure loss is less than 2 psi.

4.3.4.3 Destructive Testing

Extrusion- and fusion-welded field seams shall be destructively tested at a minimum frequency of one test per 500 linear feet of seam length per welding machine. Destructive test samples shall be located by the CQA Consultant as seaming progresses and shall be removed by the Installer to obtain laboratory test results before the geomembrane is covered. Samples shall be 12-inches wide by a minimal length (typically 42 inches) with the seam centered lengthwise (a minimum of six inches on either side of the seam). The sample shall be cut into three parts for distribution to the Installer for field testing (12-inches), to the Geosynthetic CQA Laboratory for testing (18 inches), and to the OWNER for archive (remainder).

All passing seams shall meet the requirements in the table below:

MINIMUM POLYETHYLENE SEAM PROPERTIES (per GRI GM-19)

PROPERTY	METHOD	40 MIL HDPE	60 MIL HDPE
Shear Strength	ASTM D6392	80 ppi	120 ppi
Peel Adhesion:			
Fusion	ASTM D6392	60 ppi	91 ppi
Extrusion	ASTM D6392	52 ppi	78 ppi

The strength of four out of five specimens shall meet or exceed the value shown in this table. The fifth must meet or exceed 80% of the given value in order to be considered a passing test.

Unacceptable break codes are:

- Fusion: AD and AD-Brk>25%
- Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

Samples that do not pass the shear and peel tests shall be resampled from locations at least 10 feet on each side of the original location. These two retest samples must pass both shear and peel testing. If these two samples do not pass, then additional sampling shall continue as described in the Technical Specifications until the questionable seam area is defined.

4.3.4.4 Repairs

Any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test shall be repaired. Damaged geomembrane shall be removed and replaced with acceptable geomembrane materials if the damage cannot be satisfactorily repaired. The Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the OWNER, ENGINEER or CQA Consultant, and the Installer. Procedures available include the following:

- Patching - Used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Spot Welding - Used to repair pinholes, other localized flaws (minor), or where geomembrane thickness has been reduced.
- Capping - Used to repair large lengths of failed seams by covering with new material.
- Replacement - Removing the unacceptable seam and replace with new material.

In addition, surfaces of the geomembrane that are to be repaired by extrusion welds shall be lightly abraded with a disc grinder or equivalent to ensure cleanliness. All geomembrane surfaces shall be clean and dry at the time of repair. Patches or caps shall be extended at least six inches beyond the edge of the defect. All corners of patch material shall be rounded. The CQA Consultant shall number and log each patch repair, and the Installer shall non-destructively test each repair using methods specified in this plan.

4.3.4.5 Final Inspection

A final inspection shall be completed by the Installer, ENGINEER, CQA Consultant, and OWNER prior to placement of additional layers of geosynthetic materials or the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant.

4.3.4.6 Survey

As geomembrane installation progresses, identification of all panels, seams, locations of destructive test locations, and anchor trenches shall be made by survey. Survey reporting requirements for geomembrane installation are outlined in Section 5.2.

4.4 GEOTEXTILES

4.4.1 Manufacture of Geotextile

The geotextile Manufacturer shall provide the ENGINEER and the CQA Consultant with a list of guaranteed properties for the type of geotextile to be supplied. The geotextile Manufacturer shall provide the ENGINEER and the CQA Consultant with a Manufacturer's installation guide.

4.4.1.1 Woven Geotextile

- (a) Woven geotextiles used in the perimeter roadways shall be manufactured by Mirafi, Amoco, Nicolon or other approved manufacturers. Woven geotextiles used as roadway stabilization fabric shall meet the requirements of AASHTO M288 Survivability Class 2 or better.
- (b) Woven geotextiles shall be placed at the roadway subgrade elevations as indicated on the Contract Drawings. Woven geotextile shall meet the minimum properties as specified in Section 02595 of the Technical Specifications.
- (c) To keep the number of seams to a minimum, the geotextile shall be provided in rolls not less than 12 feet wide.

4.4.1.2 Nonwoven Geotextile

- (a) The CQA Consultant shall examine all of Manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed those specified.
- (b) The geotextile used for wrapping the leachate collection stone shall be a nonwoven geotextile conforming to AASHTO M288 Survivability Class 2.

4.4.2 Transportation and Delivery

All on-site storage and handling is the responsibility of the CONTRACTOR or Installer as defined in the Technical Specifications. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and other relevant documents to the CQA Consultant.

Upon delivery to the site, the CQA Consultant shall inventory the rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The OWNER will provide storage space in a location (or several locations) that will minimize on-site transportation and handling. The storage space should be protected from theft, vandalism, passage of vehicles, etc. The CQA Consultant will verify that the storage space selected is in a well-drained area

and that cribbing techniques have been used as needed, ensuring that the materials will not be sitting in moisture or mud in the event of adverse weather.

4.4.3 Construction

During deployment, the CQA Consultant shall inspect the geotextile for damage due to equipment, to dragging across the geomembrane, or other potentially damaging activities. The Installer shall handle all geotextiles in such a manner as to ensure they are not damaged and that the following shall be complied with:

- On slopes, the geotextile shall be secured in the anchor trench and rolled down the slope in such a manner as to continually keep the geotextile sheet in tension. If necessary, the geotextile shall be positioned by hand after being unrolled to minimize wrinkles; however, the geotextile shall not be dragged across the geomembrane. Geotextile shall not be placed in the horizontal direction (i.e., across the slope).
- In the presence of excessive wind, geotextile shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Adjacent geotextile shall be joined according to the Manufacturer's recommendations, the Manufacturer's Installation Guide, Construction Drawings, and the Technical Specifications. At a minimum, the following requirements shall be met:

- Adjacent rolls shall be overlapped a minimum of six inches.
- Overlaps shall be secured by continuous sewing, heat bonding, or other means approved by the ENGINEER.
- Where seams do not need to be sewn, a minimum 18-inch overlap shall be maintained.

Holes or tears in the geotextile shall be repaired by placing a patch of geotextile extending a minimum of two feet beyond the edges of the hole or tear and shall be heat bonded. If the hole or tear width across the roll is more than 50 percent the width of the roll, the damaged area shall be cut out and the two portions of the geotextile shall be sewn together.

4.5 GEONET COMPOSITE (GEOCOMPOSITE)

4.5.1 Manufacture of Geonet Composite

The geonet composite manufacturer shall provide the ENGINEER and the CQA Consultant with a list of guaranteed properties for the type of geonet composite to be supplied. The geonet composite manufacturer shall provide the ENGINEER and the CQA Consultant with a Manufacturer's installation guide.

The Manufacturer's quality control (QC) testing shall comply with Tables 02590-1 and 02590-2 of Section 02590 of the Technical Specifications and results of the manufacturer's testing shall be submitted to the CQA Consultant prior to shipment of material to the site. The CQA Consultant shall examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed those specified.

4.5.2 CQA Conformance Testing

The CQA Consultant or a designated independent geosynthetics laboratory will perform additional quality assurance (QA) testing in accordance with Table 02590-3 to verify that the geonet composite meets the requirements of Section 02590 of the Technical Specifications. Samples of the geonet composite shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. Samples shall be taken at the factory prior to shipment or upon delivery at the site.

4.5.3 Transportation and Delivery

All storage and handling on-site is the responsibility of the CONTRACTOR or Installer. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.

Upon delivery to the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water or mud.

4.5.4 Construction

During deployment, the CQA Consultant shall inspect the geonet composite for damage due to equipment, deployment across the geomembrane, or other potentially damaging activities. The Installer shall handle all geonet composite in such a manner as to ensure it is not damaged and the following shall be complied with:

- On slopes, the geonet composites shall be secured in the anchor trench and the rolled down the slope in such a manner as to continually keep the geonet composite sheet in tension. If necessary, the geonet composites shall be positioned by hand after being unrolled to minimize wrinkles. Geonet composite shall not be placed in the horizontal direction (i.e., across the slope).
- In the presence of excessive wind, geonet composite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Adjacent geonet composites shall be joined according to the Manufacturer's recommendations, the Manufacturer's Installation Guide, construction drawings and Specifications. As a minimum, the following requirements shall be met:

- Adjacent rolls shall overlap the geonet component by at least six inches;
- Butt-seams shall overlap one to two feet;
- These overlaps shall be secured by tying;
- Tying can be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed;
- Fasteners shall be spaced a maximum of five feet along downslope roll overlaps, a maximum of two feet along cross-slope roll overlaps, and a maximum of six inches in an anchor trench.
- The edges of the top geotextile component shall be continuously sewn or continuously heat bonded.

Holes or tears in the geonet composite shall be repaired by placing a patch of geonet composite extending a minimum of two feet beyond the edges of the hole or tear. The patch shall be fastened to the original roll with approved fasteners spaced every six inches around the patch. If the hole or tear width across the roll is more than 50 percent the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be overlapped one to two feet and tied together every six inches.

4.7 LEACHATE COLLECTION MATERIAL

The leachate collection material shall consist of clean, subangular, loose non-carbonate gravel used to provide drainage for leachate. The Leachate Collection material shall be placed according to the Technical Specifications and Construction Drawings. The leachate collection material shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge, and other deleterious materials.

4.7.1 Material Evaluation

Preconstruction material evaluations shall be performed on samples from potential sources to ascertain their acceptability as construction materials. Testing shall be performed to verify material compliance with the Technical Specifications.

Criteria to be used for determination of acceptable materials for construction shall be as defined in the Technical Specifications, Virginia Department of Transportation (VDOT) Specifications, and as detailed in this CQA Plan. All evaluation tests are to be performed in the Geotechnical CQA Laboratory approved for use by the CQA Consultant. Test reports will state compliance with or deviation from applicable ASTM standards.

4.7.2 Construction Observation

Observation of the drainage material placement shall be coordinated with construction testing. Acceptance criteria for construction work shall be as identified in the Technical Specifications. At a minimum, the CQA Consultant shall observe and record the following during the placement of the drainage/protection layer:

- Consistency of the materials during processing and placement; and,
- Deleterious material.

4.8 HDPE PIPING

The work addressed under this section shall facilitate proper construction of all HDPE piping for the collection and removal of leachate from the landfill. All work shall be constructed to the lines, grades, and dimensions indicated on the Construction Drawings, in accordance with the Technical Specifications, or as required by the OWNER or ENGINEER.

4.8.1 Manufacture of HDPE Pipe

The CONTRACTOR shall submit manufacturer's data sheets, certification of compliance with specifications for all pipes, fittings and appurtenances. Prior to the installation, the CONTRACTOR shall provide the CQA Consultant with the following:

- A properties sheet including all specified properties measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant; and,
- A certification that property values given in the properties sheet are minimum or maximum values and are guaranteed by the Manufacturer.

The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Technical Specifications; and,
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the HDPE pipe meets the Manufacturer's specifications and the Technical Specifications.

4.8.2 Transportation and Delivery

All storage and handling on-site is the responsibility of the CONTRACTOR. The CONTRACTOR is responsible for the submittal of all other relevant documents to the CQA Consultant.

Upon delivery at the site, the CQA Consultant shall conduct a surface observation of the pipe as is feasible for defects or damage. The inspection will be performed without unstacking pipe unless defects or damage are found or suspected. The CQA Consultant will indicate those pipes with severe flaws that should be removed from the site.

Once on site, the CONTRACTOR will be responsible for the storage of the pipe. The OWNER will provide storage space in a location (or several locations) such that transportation and handling are minimized. The storage space should be protected from theft, vandalism, passage of vehicles, etc.

4.8.3 Construction

4.8.3.1 Pipe Placement

Piping shall be field fit and not cut based on measurements made from the Construction Drawings. Pipe shall be carried manually by using mechanical equipment with flat forks or fabric slings. Pipe shall not be dragged on the ground. The CONTRACTOR shall join pipes using the Manufacturer-recommended fusion methods. The pipe bedding and backfill shall be prepared and the pipe placed and buried as required in the Technical Specifications. During placement, The CQA Consultant will verify that:

- Equipment used does not damage the HDPE pipe by handling, excessive heat, or other means;
- The prepared surface and trench underlying the HDPE pipe has not deteriorated since previous preparation and is still acceptable immediately prior to pipe placement;
- Personnel do not engage in activities that could damage the pipe;
- Methods used to place the pipe do not damage the pipe or supporting soil;
- The pipe is backfilled in a method to completely support the pipe with bedding; and
- Methods used to backfill the pipe do not displace the pipe.

4.8.3.2 Non-destructive Testing

Non-perforated HDPE pipe shall be tested by the CONTRACTOR using non-destructive techniques prior to backfilling the pipe. The Contractor shall perform hydrostatic testing under the observation of the CQA

Consultant according to Section 02651 of the Technical Specifications. Test the electrical integrity of the installed tracer wire prior to backfilling the pipe.

4.8.3.3 Repairs

Any portion of piping failing the pressure test shall be repaired. Damaged pipe shall be removed and replaced when pipe damage cannot be satisfactorily repaired. If the air pressure test fails, the failing section shall be located, removed, and rejoined.

4.8.3.4 Final Inspection

A final inspection shall be completed by the CONTRACTOR and CQA Consultant prior to backfilling the pipe. All identified problem areas shall be repaired by the CONTRACTOR and accepted by the CQA Consultant prior to backfilling.

5.0 RECORDS AND REPORTING

This section of the CQA Plan describes the recordkeeping requirements of the CQA consultant during construction activities and the reporting requirements to document the completion of construction. Following construction, a certification report signed by a Virginia Professional Engineer must be submitted to the DEQ. In the case of closure, a certification signed by a Virginia Professional Engineer verifying closure has been completed will be required.

5.1 RECORDKEEPING DURING CONSTRUCTION

During construction, the CQA consultant shall maintain records on the following items:

- Laboratory testing of soil materials
- Field Soil testing logs (compaction testing)
- Geosynthetic roll inventory (geomembrane, geocomposite, geotextile, etc.)
- Laboratory testing of geosynthetic materials (conformance and seam strength)
- Geosynthetic panel installation logs, including subgrade acceptance
- Seam testing logs, both destructive and nondestructive
- Geomembrane repair logs
- Laboratory testing of drainage material
- General construction activity logs for daily reports

5.2 SURVEYING

As part of the certification report submitted to the DEQ, as-built drawings sealed by a Virginia Licensed Land Surveyor will be included. These drawings must be to scale, have a contour interval of 2 feet or less, and be on a 24"x36" sheet size.

As a minimum, drawings for a Closure Construction Certification Report will include:

1. Existing Conditions
2. Top of Base Grade
3. Geomembrane panel layout and destructive sample locations
4. Geomembrane panel layout including panel numbers, roll numbers and repair locations
5. Top of Final Cover, including thickness verification of layer

5.3 REPORTING

At the completion of construction a report must be submitted to the DEQ documenting the construction activities. The certification report must contain the following sections:

- PE certification as required by the VSWMR
- A site location map and a cross section of constructed layers
- Narrative describing the construction activity, testing performed, and conformance with the permit requirements
- Structural Fill Data, including:
 - Laboratory testing of fill materials
 - Records of field density testing, with location maps of field tests
- Geosynthetic Installation Data, including (as applicable):
 - Material inventory
 - MQC and CQC testing results
 - Subgrade acceptance forms
 - Panel deployment logs
 - Seaming logs
 - Seam defect and repair logs
 - Non-destructive testing logs
 - Destructive testing logs
- Drainage Layer Data (if applicable), including laboratory test results
- Final Cover Soil Data (if applicable), including:
 - Laboratory testing of soil materials
 - Records of field density testing, with location maps of field tests
- Resumes of key personnel
- As-Built drawings as described in Section 5.2

SWP #440 – Technical Specifications

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SECTION 01540

DUST CONTROL

PART 1- GENERAL

1.01 Description of Work

The CONTRACTOR shall employ construction methods and means that keep airborne particulates to the minimum and shall provide for the application of water or employ other appropriate preventive means or methods to maintain dust control, subject to the approval of the OWNER.

Dust control measures shall be compatible with existing on-site materials and proposed materials:

1.02 Related Sections

- A. Section 02100 - Site Preparation
- B. Section 02110 - Site Clearing and Grubbing
- C. Section 02220 - Earthwork

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

- A. During grading activities, soils and CGR material will be treated using wet suppression for dust control. Watering equipment shall be used to minimize airborne concentrations and shall consist of pipelines, tank trucks, or other devices approved by the OWNER, which are capable of applying a uniform spread of water over the ground surface. A suitable device for a positive shut-off and for regulating the flow rate of water shall be located so as to permit positive operator control. Calcium chloride is not allowed for dust control.
- B. Minimize the exposed area of disturbed material.
- C. Depending on the expected weather conditions, exposed disturbed material may only be left exposed over night after wet suppression treatment and sealing with smooth drum roller.
- D. Stabilize exposed subgrade with wet suppression treatment and sealing with smooth drum roller if liner system is not installed in the same day.
- E. Site activities will be suspended if sustained wind speeds exceed 25 mph or during adverse weather conditions.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.
- C. Remove and dispose of all debris, bulky items, waste materials, etc. existing in the area to be constructed and encountered on the surface. All bulky items such as large debris, stumps, cars, old fencing, etc. are to be disposed off-site at CONTRACTOR's expense.
- D. Protect and maintain bench marks, monuments and other reference points. Re-establish, at no cost to the OWNER, any such reference points if disturbed or destroyed. The CONTRACTOR's surveyor shall conduct a survey of all monuments and property markers within proposed cover areas prior to any disturbance such as they can be re-established after completion of the cover by the CONTRACTOR as part of this Contract.
- E. Remove, demolish, excavate, haul and dispose of any on-site structures, pavement, roads, drainage pipes, utilities, etc. per C above.

1.02 Related Sections

- A. Section 01540 – Dust Control
- B. Section 02110 – Site Clearing and Grubbing
- D. Section 02220 - Earthwork

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 02110

SITE CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work as described below. CONTRACTOR shall provide a "Competent Person" to implement and supervise all work.
- B. Site clearing includes, but is not limited to, removing from the limits of work and disposing of trees, stumps, roots, brush, structures (at and below ground), abandoned utilities, trash, asphalt, debris and all other materials found on or near the surface of the ground in the construction area. Precautionary measures that prevent damage to existing features to remain are part of the work.
- C. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.
- D. No clearing and grubbing will be allowed without adequate erosion and sedimentation control measures in place and to the satisfaction of the OWNER or ENGINEER.

1.02 Related Sections

- A. Section 01540 – Dust Control
- B. Section 02125 – Temporary and Permanent Erosion and Sediment Control
- C. Section 02220 - Earthwork

1.03 Job Conditions

Location of the Work: The area to be cleared and grubbed includes all areas designated for closure construction, access road construction, channel construction and required construction access areas.

PART 2 - PRODUCTS

The CONTRACTOR shall furnish equipment of the type normally used in clearing and grubbing operations including, but not limited to, dozers, shears, skidders, loaders, root rakes, chipping equipment and stump grinders.

PART 3 - EXECUTION

3.01 Scheduling Of Clearing

- A. CONTRACTOR shall install all temporary Soil Erosion and Sedimentation Control measures per CONTRACTOR's plan to the acceptance of OWNER and ENGINEER prior to start up of clearing operations.
- B. CONTRACTOR shall maintain all survey controls.

3.02 Construction Area Clearing and Grubbing

- A. Materials to be cleared, grubbed, and removed from the construction areas include, but are not limited to, the following: all trees, stumps, roots, brush, trash, organic matter, miscellaneous structures, debris and abandoned utilities.
- B. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all graded areas so that surface material is free of roots and debris. Surface material is to be left sufficiently clean so that further picking and raking will not be required.
- C. All stumps, roots, foundations and planking embedded in the ground shall be removed and disposed.
- D. Surface rocks and boulders shall be grubbed from the soil and removed to the area on Site as directed by the OWNER.
- E. All construction areas shall be grubbed by tractors with root rakes.
- F. Where tree limbs interfere with utility wires, or where the trees to be felled are in close proximity to utility wires, the tree shall be taken down in sections to eliminate the possibility of damage to the utility. The CONTRACTOR shall be responsible for damages to utilities and shall replace/repair damaged utilities at no cost to OWNER.
- G. Any work pertaining to utility poles and guy wires shall comply with the requirements of the appropriate utility.
- H. Stumps and roots shall be grubbed and removed to a depth not less than two feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to a similar density as the surrounding material.
- I. The CONTRACTOR shall exercise special precautions for the protection and preservation of identified trees and shrubs within the construction area or those situated adjacent to the limits of the construction area. The CONTRACTOR shall be held liable for any damage the CONTRACTOR's operations have inflicted on such property.
- J. The CONTRACTOR shall be responsible for all damages to existing structures and/or improvements resulting from CONTRACTOR's operations.

3.03 Overhead Utility Line Right of Way Clearing

- A. All tree trimming operations within the right of way of overhead utility lines shall be completed in accordance with Dominion Virginia Power Specifications.
- B. Trees at edge of right of way shall be side-walled ground to sky.
- C. Stumps shall be cut to within 3" of ground level.
- D. Brush shall be chipped and windrowed out of right of way, or ground up with a brush hog in the right of way.
- E. No wood shall be left in right of way (stack it out of right of way).

3.04 Disposal of Debris

- A. All wood debris (stumps, roots, branches, and leaves) resulting from the clearing and grubbing operation shall be disposed of as approved by OWNER, in accordance with the Drawings and Specifications.
- B. All large debris, pipe, large metal objects, and bulky items will be removed and hauled to an off-site approved disposal facility.

END OF SECTION

SECTION 02125

TEMPORARY AND PERMANENT EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with all applicable federal, state, and local enforcing agency guidelines and these Specifications. CONTRACTOR shall provide a "Competent Person" to implement and supervise all work who is registered as a Responsible Land Disturber (RLD) with the Commonwealth of Virginia.
- B. The work shown on the Contract Drawings and working drawings shall be considered a minimum requirement. What is shown shall not relieve the CONTRACTOR of the responsibility to actively take all steps necessary to control soil erosion and sedimentation.
- C. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.
- D. CONTRACTOR shall repair any material or existing surface conditions damaged by erosion or covered with sedimentation at the CONTRACTOR's expense.
- E. Erosion Control Measures shall be provided for all construction activities in the landfill area and other related work throughout the site. CONTRACTOR shall maintain at least 20% overstock of erosion control items stockpiled on-site for ease of use to replace installed items as deemed necessary, or provide evidence that necessary amounts of materials are readily available from local suppliers.
- F. The temporary erosion control features installed by the CONTRACTOR shall be maintained by the CONTRACTOR until no longer needed as determined by the OWNER, or permanent erosion control methods are installed.
- G. It shall be the sole responsibility of the CONTRACTOR to properly schedule and coordinate all necessary labor, equipment and materials such that the specified work is performed in accordance with the project schedule and the Contract requirements. At the discretion of the OWNER, the OWNER may reject or direct the CONTRACTOR to repair (at the CONTRACTOR's sole expense) those items which are detrimental to the project or not in compliance with the Contract Documents. Such direction or rejection by the OWNER shall not relieve the CONTRACTOR of his obligation to properly schedule and perform other specified work items in conformance with the Contract Documents.

1.02 Related Sections

- A. Section 01540 - Dust Control
- B. Section 02110 - Site Clearing and Grubbing
- C. Section 02200 - Earthwork
- D. Section 02233 - Coarse Aggregate
- E. Section 02271 - Stone Riprap
- F. Section 02595 - Geotextile
- G. Section 02936 - Seeding

1.03 References

- A. Virginia Erosion & Sediment Control Handbook (VESCH), Third Edition, 1992.

1.04 Submittals

At the preconstruction conference, the CONTRACTOR shall submit for OWNER's approval, a schedule and construction drawing for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, structures at watercourses, and general construction. No work shall be started until the erosion control schedules and methods of operations for each phase of construction have been accepted by the OWNER. This plan will be referred to as the CONTRACTOR's Soil Erosion and Sediment Control Plan.

PART 2 - PRODUCTS

2.01 Silt Fence

Silt fence shall be Filter X, Mirafi 100X, Stabilinka T140N, or approved equal.

2.02 Erosion Wattles

Erosion control wattles shall consist of straw, coconut fiber, shaved wood or other biodegradable filtering medium encased in a photo- or biodegradable netting. Straw fibers shall be certified as weed seed free.

2.03 Seed

Seed type shall meet the requirements of Section 02936 – Seeding.

2.04 Temporary Erosion Control Mat

Temporary Erosion Control Mat shall be BonTerra S2, Erosion Control Systems, Inc.'s High Impact Excelsior Mat, or approved equal, meeting the general requirements of EC-2 matting.

2.05 Permanent Erosion Control Mat

Permanent Erosion Control Mat shall be as specified in the Drawings, or approved equal, meeting the requirements of EC-3 matting.

2.06 Hydraulically Applied Products (Flexible Growth Medium)

Hydraulically applied FGM products such as Flexterra and others, may be used in lieu of temporary erosion control mat (EC-2). FGM with a geofabric backing may be used in lieu of permanent erosion control matting with the approval of the OWNER and ENGINEER. If FGM is used in conjunction with seeding, provide the required soil testing to manufacturer for seed and fertilizer mix design.

PART 3 - EXECUTION

3.01 General

- A. Conduct earthwork and excavation activities in such a manner to fit the topography, soil type and weather conditions.
- B. Minimize the area being disturbed and the duration of exposure to erosion elements.
- C. Stabilize disturbed areas immediately.

- D. Retain on-site, sediment that was generated on-site. Place sediments under cover after dewatering, during construction, and dispose of sediments as cover soil at landfill if not laden with seeps or perched groundwater.
- E. Prevent silt and sediment from entering any watercourse if soil erosion cannot be prevented.
- F. Prevent silt and sediment from migrating downstream in the event it cannot be prevented from entering the watercourse.
- G. Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.
- H. The OWNER has the authority to limit the surface area of erodible material exposed by clearing and grubbing, and to direct the CONTRACTOR to provide immediate temporary or permanent control measures to prevent sediment impact on adjacent watercourses.
- I. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the Project conditions permit; otherwise, erosion control measures may be required between successive construction stages. Under no conditions shall the total aggregate surface area of erodible material (such as exposed soil or erodible material without vegetation or erosion protection) exposed at one time by clearing and grubbing, exceed 250,000 square feet without approval by the OWNER.
- J. The OWNER will limit the area of excavation, and embankment operations in progress commensurate with the CONTRACTOR's capability and progress in keeping the finish grading, mulching, seeding and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measure shall be taken immediately to the extent feasible and justified.
- K. In the event that additional temporary erosion and sedimentation control measures are required due to the CONTRACTOR's negligence, carelessness or failure to install permanent controls as a part of the work schedule, and are ordered by the OWNER, such work shall be performed by the CONTRACTOR at the CONTRACTOR's expense, and no time extension shall be given.

3.02 Temporary Erosion and Sedimentation Control

- A. Temporary erosion control measures shall be used to correct conditions that develop during construction that lead to soil erosion or deposition of waterborne sediments; that are needed prior to installation of permanent erosion control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the Project.
- B. Temporary erosion and sedimentation control devices shall be installed and maintained prior to the initial land disturbance activity until the satisfactory completion and establishment of permanent erosion control measures. At that time, temporary devices shall be removed.
- C. The CONTRACTOR shall coordinate the installation of temporary erosion and sedimentation control provisions contained herein with the permanent erosion control features, to ensure economical, effective and continuous erosion control throughout the construction and post-construction period.
- D. Temporary erosion and sedimentation control procedures should be initially directed toward preventing silt and sediment from entering the watercourses. The preferred method is to provide an undisturbed natural buffer, extending a minimal 5 feet from the top of the bank, to filter the run-off.

- E. Silt fences, barriers, temporary sedimentation basins and other temporary measures and devices shall be installed, and shall be maintained until no longer needed, as determined by the OWNER. At that time, the items shall be removed by the CONTRACTOR. All temporary items and devices must be removed with the OWNER's approval prior to final demobilization from the Site.
- F. Where permanent vegetation is not appropriate, and where the CONTRACTOR's temporary erosion and sedimentation control practices are inadequate, the CONTRACTOR shall provide temporary vegetative cover. Such temporary vegetative cover shall be provided by the CONTRACTOR in compliance with Section 02936 "Seeding" of these specifications.
- G. All erosion and sedimentation control devices shall be inspected by the CONTRACTOR at least weekly and after each rainfall occurrence, and cleaned out and repaired by the CONTRACTOR as necessary.

3.03 Temporary Erosion and Sediment Control Techniques

A. Temporary Diversion Berms

- (1) A temporary diversion berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes.
- (2) These diversion berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.
- (3) A temporary diversion berm shall be constructed of compacted soil, with a minimum width of 24-inches at the top and a minimum height of 12-inches with or without a shallow ditch. Side slopes shall be three horizontal to one vertical (3H:1V) or flatter.

B. Temporary Slope Drains

- (1) A temporary slope drain may consist of stone downchutes, fiber mats, plastic sheets, half-round pipe, metal pipe, plastic pipe, sod or other material acceptable to the OWNER that may be used to carry water down slopes to reduce erosion prior to installation of permanent facilities or growth of adequate ground cover on slopes.
- (2) Fiber matting and plastic sheeting shall not be used on slopes steeper than 4H:1V except for short distances of 20 feet or less.
- (3) All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base of temporary slope drains shall be compacted and concavely formed to channel water or hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain.
- (4) Energy dissipators, sediment basins or other approved devices shall be constructed at the outlet end of the slope drains to reduce erosion downstream.

C. Sediment Control Structures

- (1) Sediment basins, ponds and traps, are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect stream channels below the construction areas from excessive siltation.
- (2) When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural or intended condition.

D. Riprap

Unless shown otherwise on the Contract Drawings, riprap shall be placed where ordered by the OWNER and at all points where banks of streams or drainage ditches are disturbed by excavation. Fill or backfill shall be carefully compacted and riprap placed to prevent subsequent settlement and erosion. This requirement applies equally to construction along side a stream or drainage ditch as well as crossing a stream or drainage ditch.

E. Straw Bales

- (1) Straw bales are temporary measures to control erosion and retain the suspended silt particles in the runoff water leaving disturbed areas. Bales shall contain five cubic feet or more of material.
- (2) Straw bales shall be embedded in the ground 4 to 6-inches to prevent water flowing under them. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales shall be removed after they have served their purpose, as determined by the OWNER.
- (3) The CONTRACTOR shall keep the bales in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris clean-out will be considered routine maintenance.
- (4) Straw bales shall be used at the toe of fill slopes, in ditches, or other areas where siltation, erosion or water run-off is a problem.

F. Silt Fences / Wattles / Terra Tubes, etc.

- (1) Silt fences and wattles are temporary measures utilizing geofabrics or other approved materials attached to posts with filter cloth attached to the upstream side of the fence to retain the suspended silt particles in the runoff water.
- (2) Temporary silt fences and wattles shall be placed on the natural ground, at the toe of fill slopes, in ditches or other areas where siltation is a problem. Materials shall be anchored per VESCH or manufacturer specifications.
- (3) The CONTRACTOR shall be required to maintain the silt fence or wattle in a satisfactory condition for the duration of the Project or until its removal is requested by the OWNER. The silt accumulation at the control must be removed and placed on Site as directed by the OWNER.

G. Temporary Vegetation

- (1) Temporary vegetation are measures consisting of seeding, mulching, fertilizing and matting utilized to reduce erosion. All cut and fill slopes shall be seeded when and where necessary to eliminate erosion. Disturbed or bare soil areas shall not be left without stabilization for more than 7 days.
- (2) Seeding, mulching and fertilizing shall be performed in accordance with Section 02936 "Seeding" of these Specifications.
- (3) If late fall completion prevents germination. Disturbed areas shall be protected by mulching without application of seed as a minimum.

3.04 Permanent Erosion and Sediment Control

- A. The CONTRACTOR shall incorporate all permanent erosion control features into the Project at the earliest practicable time as outlined in the CONTRACTOR's Soil Erosion and Sediment Control Plan accepted schedule or as land disturbance for each segment of the Project has been completed.
- B. Restore the work site to its original contours, unless shown otherwise on the Drawings or directed by the OWNER.
- C. All references to permanent vegetation, unless noted otherwise, shall relate to establishing permanent vegetative cover and be in accordance with Section 02936 "Seeding" of these specifications.
- D. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched in an effort to restore to a protected condition. Areas that are not stabilized with seed and mulch shall be sodded as approved or directed by the OWNER.
- E. Specified permanent vegetation shall be established at the first appropriate season following establishment of final grading in each section of the Site.
- F. Where sod is removed or damaged, such areas shall be replanted using sod of the same species of grass at the first appropriate season.
- G. Permanent vegetative cover activities shall comply with local soil and water conservation guidelines.
- H. Where permanent vegetative cover cannot be immediately established (due to season or other circumstances) the CONTRACTOR shall provide temporary vegetative cover.

3.05 Permanent Erosion and Sediment Control Techniques

A. Permanent Vegetation

All references to permanent vegetation, unless noted otherwise, shall relate to establishing permanent vegetative cover and be in accordance with Section 02936 "Seeding" of these specifications.

B. Riprap

- (1) Riprap used for permanent stabilization of channels, slopes and culvert outlets shall be installed in accordance with the Contract Drawings and Section 02271 "Stone Riprap" of these specifications.
- (2) Placing of riprap at locations other than those specified on the Contract Drawings shall be done only with approval or by the direction of the OWNER.
- (3) The ground surface around which the riprap is to be placed shall be brought in reasonably close conformity to the correct lines and grades before placement is commenced.
- (4) Geotextile shall be placed in all areas to receive riprap, unless otherwise specified. The surface to receive geotextile shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. Geotextile shall be overlapped at least three feet between panels or the geotextile seams shall be continuously sewn or thermally bonded. The geotextile shall be anchored in place with securing pins of the type recommended by the geotextile manufacturer, or anchored at the edges in an anchor trench. The geotextile shall be placed loosely so as to avoid stretching

and tearing during placement of riprap. Riprap shall be dropped no more than three feet during construction. The geotextile shall be protected at all times during construction from runoff containing clay, silts, chemicals or other substances. Any geotextile damaged during its installation or during placement of riprap shall be removed and replaced with undamaged geotextile at no expense to OWNER.

END OF SECTION

SECTION 02140

CONSTRUCTION DEWATERING

PART 1 - GENERAL

1.01 Description of Work

- A. This section specifies the requirements for handling and management of dewatering activities.
- B. CONTRACTOR shall design, construct and maintain all dikes, sumps, and diversion and drainage channels as necessary to complete the construction and to protect the areas to be occupied by permanent work from water damage. CONTRACTOR shall remove temporary works after they have served their purpose.
- C. CONTRACTOR shall be responsible for the stability of all temporary and permanent slopes, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and subsurface, to the lines, grades and conditions existing prior to the damage, at no additional cost to OWNER.
- D. CONTRACTOR shall provide a Competent Person to implement and supervise all Work.
- E. The CONTRACTOR shall submit a description of its methods for accomplishing construction dewatering to OWNER and ENGINEER for approval.
- F. CONTRACTOR shall provide measures to minimize accumulation of surface water in the work area.
- G. CONTRACTOR will segregate all surface runoff and waters from perched groundwater and seeps encountered by CONTRACTOR during excavation or filling operations. Perched groundwater and seeps encountered by CONTRACTOR will be collected, pumped, transferred and hauled to an on-site discharge point as directed by OWNER.

1.02 Related Sections

- A. Section 02125 – Temporary and Permanent Erosion and Sediment Control
- B. Section 02150 – Shoring and Bracing
- C. Section 02220 – Earthwork

PART 2 - PRODUCTS

Piping, pumping equipment, and all other equipment and materials required for dewatering shall be suitable for the intended purpose. Standby pumping units shall be maintained at the Site to be used in case of failure of the normal pumping units.

PART 3 - EXECUTION

3.01 Determination of Water Source

- A. Water originating from within the landfill or bottom ash pond shall be treated as leachate unless otherwise definitively determined to not be leachate.
- B. Water to be treated as leachate shall be pumped to the location directed by the OWNER. If the water contains sediment, it shall be filtered by a dewatering structure or method to

SECTION 02150

SHORING AND BRACING

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of shoring, bracing, and sheeting or sheet piling, necessary to complete the construction, protect structures, and prevent the loss of ground or caving of embankments, excavations, or cut slopes, as shown, specified or required, and shall meet all applicable building and safety codes. The CONTRACTOR shall provide a "Competent Person" as defined to implement, supervise, and inspect all shoring and bracing.
- B. CONTRACTOR shall be solely responsible for proper excavation procedures including, but not limited to, safe slope angles and the design and use of properly designed and installed shoring and bracing systems in accordance with OSHA and other applicable standards and requirements. As required, shoring and bracing shall be designed by the CONTRACTOR's engineer who is a registered Professional Engineer in the Commonwealth of Virginia. Remove all shoring and bracing without disturbing backfill, bedding, haunching, pipes or structures. The presence of the CQA Consultant or the ENGINEER shall not relieve the CONTRACTOR of his responsibility to properly design, install and maintain shoring and bracing. The OWNER or ENGINEER shall not be the "Competent Person" on the Site.
- C. Pressures on sheeting and the stability of the sheeting and bottom of the excavation are dependent not only on soil conditions but upon many procedures and options available to the CONTRACTOR, such as dewatering, staging of excavation and installation of bracing, flexibility of sheeting, construction equipment used, and time of completing the work. All such factors shall be considered and investigated as necessary in the design of the sheeting and bracing.
- D. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related References

- A. Recommended Technical Provisions for Shoring and Sloping of Trenches and Excavations, U.S. Department of Commerce.
- B. Construction Safety and Health Regulations, U.S. Department of Labor, Occupational Safety and Health Administration.
- C. Occupational Safety and Health Regulations- Excavations, U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR Part 1926.

1.03 Related Sections

Section 02200 -- Earthwork

1.04 Submittals

- A. In cases where the excavation cannot be open cut to a safe working angle in accordance with applicable requirements or where excavation may jeopardize adjacent site areas or the stability of nearby structures or facilities, the CONTRACTOR shall submit drawings, computations and substantiating data, prepared, signed, and sealed by a Professional Engineer licensed in the Commonwealth of Virginia, showing the proposed shoring and bracing design and method of construction for the information of the OWNER prior to the start of such construction.

remove sediment prior to discharge by means of a filter box, sediment tank, Dirtbag®, or other means compliant with Std. & Spec 3.26 of the Virginia Erosion and Sediment Control Handbook.

3.02 Handling of Water

- A. Design, furnish, install, maintain, monitor, operate and remove necessary pumping and other equipment for dewatering the various parts of the Work and for maintaining the work areas free from water as required for constructing each part of Work.
- B. Install all drainage ditches, sumps, and pumps to control excessive seepage on excavated slopes, to drain isolated zones with perched water tables and to drain impervious surfaces at final excavation elevation.
- C. Water shall be filtered by a dewatering structure to remove sediment prior to discharge by means of a filter box, sediment tank, Dirtbag®, or other means compliant with Std. & Spec 3.26 of the Virginia Erosion and Sediment Control Handbook, Third Edition. Do not allow filtered water to leave site except through an approved stormwater outfall point.
- D. Dewater by means which will enable completion of the Work and preserve final lines and grades. Do not disturb or displace adjacent soil.
- E. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the Work of other contractors, and in accordance with all Federal, State, and local laws, ordinances and regulations.
- F. Do not overload or obstruct existing drainage facilities.
- G. After they have served their purpose, remove all temporary protective work at a time and in a manner approved by the OWNER. All temporary diversion channels and other temporary excavations in areas where the compacted fill or other structures will be constructed shall be cleaned out, backfilled and processed under the same specifications as those governing the compacted fill (Section 02200).
- H. When the temporary works will not adversely affect any item of permanent work on the planned usage of the project, CONTRACTOR may be permitted to leave such temporary works in place. In such instances, breaching of dikes and other temporary works may be required.
- I. By the use of pumps, siphons, tile drains or other approved methods, CONTRACTOR shall control the flow and accumulation of water in excavated areas to prevent excessive softening and disturbance of exposed soils in excavations as necessary for completion of the Work.
- J. The system used shall not cause settlement damage to adjacent structures. The CONTRACTOR shall carry out the Work by the use of other methods which will not endanger adjacent structures; all such Work shall be done at the CONTRACTOR's expense.

END OF SECTION

- B. Shoring and bracing systems shall be designed such that removal shall not jeopardize work already performed. Shoring and bracing systems shall not remain permanently in place without the written approval of the OWNER.
- C. Any review or comments by the OWNER shall not relieve the CONTRACTOR of his responsibility for sheeting and bracing.
- D. In trenches, the sheeting shall be designed so that the lowest brace is no closer than 12 inches above the base of the structure to be installed.

1.05 Quality Control

During the installation of the sheeting and bracing and as long as the excavation is open, the CONTRACTOR's "Competent Person" shall monitor the work to ensure that it is carried out in accordance with his design and procedures.

PART 2 - PRODUCTS

All materials shall meet, or exceed, the minimum requirements of the applicable codes and those assumed in the design submitted by the CONTRACTOR.

PART 3 - EXECUTION

3.01 Verifying Existing Conditions

Before commencing work, the CONTRACTOR shall check and verify all governing dimensions and elevations, including field measurements of existing and adjoining work on which his work is dependent, to assure proper fit and clearance of each part of the work to the new and existing structures.

3.02 Coordination With Other Operations

The schedule and progress of the shoring, bracing, and sheeting work shall be coordinated with the excavation and backfilling work. If, during the progress of the excavation, lateral movement of the surrounding soils, or any other evidence of instability is discovered, further excavation or backfilling work in the excavation shall cease and corrective measures shall be taken immediately to prevent further movement.

3.03 Removal of Shoring and Bracing Materials

- A. Where the CONTRACTOR elects and is permitted not to remove shoring and bracing material, all such material shall be removed to the extent that the top of the material shall be a minimum of 5 feet below the proposed finished grade. No shoring or bracing may remain in place within the limits of the proposed geomembrane liner placement.
- B. Removal of shoring and bracing shall be carried out in a manner such that no structure shall be disturbed or damaged during or after removal. Protection of structures during the removal of shoring and bracing shall be the sole responsibility of the CONTRACTOR, and any disturbance or damage shall be rectified at no expense to the OWNER.

3.04 Safety

Installation and removal methods of shoring and bracing shall meet, or exceed, the minimum requirements of the applicable codes and safety precautions as outlined in such codes, and shall be enforced by the CONTRACTOR.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The work under this section includes the furnishing of all labor, equipment and materials, and completing all operations in connection with excavating, backfilling, compacting, grading, and placing soil materials and all other incidental work necessary for construction according to Drawings and Technical Specifications.
- B. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.
- C. The CONTRACTOR shall locate all existing active and abandoned utilities and structures in work areas prior to commencing any excavation activities and shall protect from damage those utilities and structures which are to remain in place

1.02 RELATED WORK

- A. Other specification sections containing requirements relating to this section include, but are not limited to, the following:
 - 1. Section 02140 – Construction Dewatering
 - 2. Section 02125 – Temporary and Permanent Erosion and Sediment Control
 - 3. Section 02235 – Vegetative Support Layer
 - 4. Section 02233 – Coarse Aggregate

1.03 DEFINITIONS

- A. Excavation shall mean the removal from place of all materials and shall include soil, facilities, structures above and below ground, rock, pavements, topsoil, boggy waste, rubbish, tree stumps, boulders, logs, ashes, cinders, organic material such as peat, humus or organic silt, softened or disturbed soils or other unsuitable bearing materials determined in the field by the ENGINEER.
- B. Mucking or mucking-out shall mean excavation, as defined herein before, without prior dewatering.

1.04 PROTECTION OF PEOPLE AND PROPERTY

- A. The CONTRACTOR shall plan and conduct operations in accordance with OSHA and local codes and ordinances so as to prevent damage to existing structures, safeguard people and property, minimize traffic inconvenience, protect the structures to be installed, and provide safe working conditions.
- B. The CONTRACTOR shall control stormwater such that run-on and run-off do not affect the quality of receiving wetlands, brooks, streams, or rivers. The CONTRACTOR shall be responsible for cleaning (removal of silt) stormwater structures (swales, culverts, basins) as

needed during construction, after stabilization of project areas, and at the conclusion of work prior to demobilization.

- C. The CONTRACTOR shall be responsible for protecting existing environmental monitoring devices such as groundwater monitoring wells within the limits of work. Any damage to existing environmental monitoring devices resulting from construction activities shall be the responsibility of the CONTRACTOR to correct at no additional cost to the OWNER.
- D. Excavations, except as specified, shall be adequately shored and braced. Where the installation of shoring is impractical or might cause damage, as a result of, but not limited to, vibration, settlement or lateral movement, the CONTRACTOR shall utilize other methods.
- E. CONTRACTOR shall be solely responsible for proper excavation procedures including, but not limited to, safe slope angles and the design and use of properly designed and installed shoring and bracing systems in accordance with OSHA and other applicable standards and requirements. As required, shoring and bracing shall be designed by the CONTRACTOR's engineer who is a licensed Professional Engineer in the Commonwealth of Virginia. Remove all shoring and bracing without disturbing backfill, bedding, haunching, pipes or structures. The presence of the ENGINEER shall not relieve the CONTRACTOR of his responsibility to properly design, install and maintain shoring and bracing. The OWNER shall not be the competent person on the Site.
- F. In cases where excavation without shoring and bracing is not permissible solely because of protection of workers, trench boxes may be used.
- G. The CONTRACTOR shall not stockpile any excavated material without OWNER approval. Stockpile location shall be approved by the ENGINEER or OWNER.

1.05 REFERENCES

- A. ASTM D6913 Grain-Size Analysis of Soils
- B. ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Compaction Effort
- C. ASTM D2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D. ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- E. ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.06 SUBMITTALS

- A. Shoring and Bracing
 - 1. In cases where the excavation cannot be open cut to a safe working angle in accordance with applicable requirements or where excavation may jeopardize adjacent site areas or the stability of nearby structures or facilities, the CONTRACTOR shall submit drawings, computations and substantiating data, prepared, signed, and sealed by a Professional Engineer licensed in the Commonwealth of Virginia, showing his/her proposed shoring and bracing design and method of construction for the information of the OWNER prior to the start of such construction.

2. Shoring and bracing systems shall be designed such that removal shall not jeopardize work already performed. Shoring and bracing systems shall not remain permanently in place without the written approval of the OWNER.
 3. Any review or comments by the OWNER shall not relieve the CONTRACTOR of his responsibility for sheeting and bracing.
 4. In trenches, the sheeting shall be designed so that the lowest brace is no closer than 12 inches above the base of the structure to be installed.
- B. The CONTRACTOR shall submit the technical data sheet for the proposed compaction equipment to the OWNER or ENGINEER for review and approval.
- C. The CONTRACTOR shall provide the OWNER or ENGINEER samples from each borrow source to be used as structural fill. From each borrow source, two representative composite sample(s) shall be tested for the following:
1. Soil Classification (ASTM D2487, which includes Grain Size Analysis - ASTM D6913 and Atterberg Limits - ASTM D4318); two per source or material type
 2. Compaction Testing (Proctor) (ASTM D698); two per source or material type
- If the OWNER or ENGINEER determines that the source contains more than one soil type, as determined by the Unified Soil Classification System (USCS), the tests listed shall be completed for each soil type.

1.07 TOLERANCES

Grading tolerance for all fill and backfill shall be -0.0 to +0.2 feet.

1.08 QUALITY ASSURANCE

- A. The CONTRACTOR shall be an experienced earthwork CONTRACTOR who has at least five years experience. The CONTRACTOR shall have completed at least three projects with similar materials and of similar scope as that indicated for this project with a successful installation and maintenance record of in-service performance.
- B. The CONTRACTOR is required to demonstrate compliance to the above requirements to the satisfaction of the ENGINEER and OWNER.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. All backfill and fill materials, unless otherwise specified, shall consist of suitable, selected, and approved (by the OWNER) soil from borrow areas.
- B. Maximum particle size, unless otherwise specified or approved by the ENGINEER, shall be as given in Paragraph 2.02.
- C. Structural Fill shall be placed and compacted in accordance with Table 2 in Paragraph 3.06.B.
- D. No frozen earth shall be used for backfill and fill, and no fill or backfill shall be placed over frozen surfaces. All backfill and fill materials shall be free from all perishable and

objectionable (as described below) materials. All fill shall be protected from frost if the ENGINEER judges frost will prevent the material from performing as required.

- E. All required fill materials shall be free from organic materials, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. It shall not contain rock fragments, broken concrete, masonry rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted to the specified density. Snow, ice, and frozen soil shall be removed from fill material prior to placement.
- F. Preconstruction material testing of proposed structural fill materials shall be performed for each source of material. Samples shall be tested as per Table 1.

Table 1 - Structural Fill Preconstruction Testing Schedule

TEST	METHOD	FREQUENCY
Sieve Analysis	ASTM D6913	2 per source/type
Standard Proctor Compaction	ASTM D698	2 per source/type
Atterberg Limits	ASTM D4318	2 per source/type
USCS Classification	ASTM D2487	2 per source/type

2.02 STRUCTURAL FILL

- A. Structural fill materials shall be used as subgrade to the bottom of the liner grades, clean backfill, pipe bedding and as other material as shown on the Drawings. Structural fill shall be free of rubble, wood, stumps, brush, metal, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge and other deleterious materials. The maximum stone size shall be two inches in any dimension and shall not comprise more than five percent of the total soil mass. Structural fill materials shall be classified according to the USCS as GM, GC, SM, SC, ML, CH, CL or MH (ASTM D2487). Structural fill shall be approved by the ENGINEER for each application.
- B. Structural fill materials to be used for embankment construction of basins or ponds shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge and other deleterious materials. The maximum stone size shall be two inches in any dimension and shall not comprise more than five percent of the total soil mass. Structural fill materials shall be classified according to the USCS as SM, SC, ML, CH, CL or MH (ASTM D2487) and have a Plasticity Index (PI) of at least 7. Structural fill for embankment use shall be approved by the ENGINEER for each application.
- C. The Liner Subgrade fill shall consist of the top six inches of soil material underlying a geosynthetic liner. It shall contain particles no larger than 1/2" in their greatest dimension and be free of organic materials. Coal Combustion Residuals (CCR) or soil mixed with CCR may be used as liner subgrade in areas that will be covered by a geomembrane liner, subject to preparation in accordance with Paragraph 3.06.C.

2.03 SAND AND AGGREGATE

Sand and Aggregate shall conform to the requirements of the Virginia Department of Transportation (VDOT) Road and Bridge Specifications, latest edition.

2.04 LANDFILL FINAL PROTECTIVE COVER

Fill for the Final Protective Cover layer shall consist of Structural Fill material that is void of deleterious materials, has no particles over 1/2" in their greatest dimension and meets the requirements of Paragraph 2.02 of this specification. Soil containing or mixed with CCR shall not be used.

2.05 VEGETATIVE SUPPORT LAYER

Fill for the Vegetative Support Layer shall consist of soil material that is void of deleterious materials, has no particles over 1/2" in their greatest dimension and meets the requirements of Section 02235 of the Technical Specifications. Soil containing or mixed with CCR shall not be used.

PART 3 – EXECUTION

3.01 PREPARATION

- A. The CONTRACTOR shall establish and identify required lines and levels.
- B. The CONTRACTOR shall maintain benchmarks, monuments, and other reference points and reestablish them if disturbed or destroyed, at no cost to OWNER.
- C. Before start of grading, the CONTRACTOR shall establish the location and extent of utilities in the work areas. The CONTRACTOR shall notify utilities to remove and relocate lines that are in the way of construction and are not to be relocated as a part of the work covered by these specifications.
- D. The CONTRACTOR shall maintain, protect, reroute, or extend as required existing utilities to remain in place that pass through the work area.
- E. The CONTRACTOR shall develop access to the construction area in accordance with the requirements of the drawings.
- F. The CONTRACTOR shall install sediment controls as needed to prevent erosion immediately downslope of each area to be disturbed prior to the beginning of work in that area. The CONTRACTOR shall maintain the sediment controls for the duration of construction. Accumulated sediment behind the sediment controls shall be disposed of on-site by the CONTRACTOR in a manner approved by the OWNER.
- G. Diversion ditches, either permanent or temporary, shall be constructed in accordance with the drawings and as necessary to control surface water. The CONTRACTOR shall be responsible for constructing diversion ditches as required to divert run-on around the construction area and maintain the diversions until approved by the OWNER or ENGINEER.
- H. The CONTRACTOR shall install barriers and other devices to protect areas adjacent to construction.

3.02 STOCKPILING

- A. All soil stockpiles shall have adequate protections for Erosion and Sediment Control (including dust control) in accordance with the Contract Drawings, the Virginia Erosion and Sediment Control Handbook (VESCH), and to the satisfaction of the OWNER.
- B. Excavated materials classified suitable for use as structural fill shall be stockpiled in designated areas free of incompatible soil, clearing debris, or other objectionable materials. Stockpile areas shall be approved by the OWNER.
- C. Excavated material classified as topsoil shall be segregated from fill and stockpiled in the manner shown on the Drawings or as specified by the OWNER.
- D. Stockpiles of fill or topsoil shall be no steeper than 3:1 (horizontal:vertical), graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the ENGINEER, and dressed daily during periods when fill is taken from the stockpile.

3.03 EXCAVATION - GENERAL

- A. Excavation shall be performed, at a minimum, to the lines and grades indicated on the Drawings. Additional excavation shall only be performed to achieve a stable working base or to "bridge" over weak subgrade materials if approved by the ENGINEER. The limits of additional excavation shall be determined by the ENGINEER.
- B. Excavated materials shall be transported to stockpile or placement locations, as indicated on the Drawings or as directed by the OWNER.
- C. In areas where the subgrade is to be reached by excavation, the area shall be excavated to the design grades, then proofrolled in the presence of the CQA Consultant who will make a review of conditions.
 - (1) If the excavated subgrade is found to be suitable for liner installation, no further excavation is required.
 - (2) If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations to develop suitable bearing and replace excavated material as directed by the ENGINEER. At least 12 inches of the unsuitable bearing material shall be removed and replaced with Structural Fill suitable for Liner Subgrade (Paragraph 2.02.B).
 - (3) Further removal of unsuitable material and its replacement as directed will be made based on results of proofrolling and as directed by the OWNER and ENGINEER.

3.04 GRADING - GENERAL

- A. Uniformly grade areas to a smooth surface, free of irregular surface changes, to the lines and grades indicated on the Drawings. Provide a smooth transition between existing grades and new grades.
- B. Unless otherwise specified, place borrow fill and trench backfill material in lifts of not more than nine inches in compacted thickness for material compacted by heavy construction equipment, and not more than four inches in loose depth for material compacted by hand-operated tampers. Compact borrow fill and trench backfill material as specified in Paragraph 3.06.B.

3.05 TRENCH EXCAVATION AND BACKFILL

- A. Excavation for all drainage, piping, and other structures shall conform to the lines and grades shown on the Construction Drawings. Excess or unsuitable material removed from the excavations shall be replaced with approved material. The CONTRACTOR will be responsible for all shoring, bracing, trench boxes, etc., necessary to complete the excavation and pipe installation in a safe manner.
- B. Stability of Excavations: Slope sides of excavations shall comply with OSHA and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Comply with all OSHA and other applicable safety requirements.
- C. Unless directed otherwise by the OWNER or ENGINEER, excavations shall not be backfilled until the work as installed conforms to all requirements specified in these Technical Specifications. Each lift of trench backfill material shall be moistened as necessary and compacted in such a manner as to permit the proper and desired compaction of the filled excavation to provide the necessary support and protection for the pipe.
- D. Placement of pipe bedding shall be done in accordance with the following procedures.
 - 1. The bottoms of excavations shall be thoroughly compacted and in an approved condition prior to placing pipe bedding. Pipe bedding shall be placed in layers not exceeding four inches in loose depth. Each layer shall be compacted by at least two passes of an approved plate-type vibratory compactor.
 - 2. Pipe bedding shall be graded, compacted, and shaped so that the full length of pipe barrel has complete and uniform bearing for the bottom quadrant of each pipe.
 - 3. The CONTRACTOR shall exercise care in all operations to prevent disturbing joints, displacement of or damage to the pipes already installed, and tearing of geotextile. As the work progresses, the pipelines will be checked by the OWNER or ENGINEER to determine whether any disturbance, displacement, or damage has occurred. If inspection shows poor alignment, displaced or damaged pipe, disturbed joints, or any other defects, all defects designated by the OWNER or ENGINEER shall be remedied in a satisfactory manner by the CONTRACTOR, at no additional expense to the OWNER.
- E. The balance of backfill, as shown on the Drawings and specified in this section, shall be structural fill or other compactable materials as approved by the OWNER or ENGINEER and as detailed. All trench backfilling shall be carefully placed to avoid disturbance of new work.
- F. Backfill trench with clean backfill in accordance with the details shown on the Drawings. The moisture content of backfill shall be such that proper compaction will be obtained. Backfill shall be compacted to the minimum requirements specified. It is the responsibility of the CONTRACTOR to ensure that the minimum specified densities are obtained. Puddling or jetting of backfill with water will not be permitted.
- G. Compact soil materials using equipment suitable for materials to be compacted and work area locations. Hand-operated plate type vibratory or other suitable equipment may be used in areas not accessible to larger rollers or compactors, and to avoid damaging pipes or structures. Any pipe that is damaged shall be replaced at the CONTRACTOR's expense.

- H. Backfill material shall be compacted to achieve the compaction specified in Paragraph 3.06.B.
- I. During filling and backfilling operations, pipelines will be checked by the OWNER or ENGINEER to determine whether any displacement of the pipe has occurred. If the inspection of the pipelines shows poor alignment, displaced pipe or any other defects, the defects designated by the OWNER or ENGINEER shall be remedied in a satisfactory manner by the CONTRACTOR at no additional expense to the OWNER.
- J. Any backfill that fails to comply with the minimum compaction requirements specified shall be recompacted or, if necessary, removed to the limits directed by the OWNER or ENGINEER. The trench shall then be refilled with approved materials and by approved methods. The backfill shall be compacted by approved methods to the minimum requirements specified. All of this work shall be completed by the CONTRACTOR at no additional expense to the OWNER.
- K. After backfilling, the CONTRACTOR shall maintain the filled surfaces in good condition with a smooth surface level with adjacent undisturbed surfaces. Any subsequent settling shall be immediately repaired by the CONTRACTOR in a manner satisfactory to the OWNER or ENGINEER. Such maintenance shall be provided by the CONTRACTOR for the remainder of this contract at no additional expense to the OWNER.

3.06 STRUCTURAL FILL

A. Surface Preparation

- 1. Prepare areas to receive structural fill by:
 - a. Clearing and grading areas required for access to site and execution of the work. Clearing shall be limited to areas within the limits of construction that need to be cleared in order to execute the work.
 - b. Grubbing areas within a 10-foot zone bordering all proposed structures and pipelines.
 - c. In areas to be cleared, removing all stumps, roots ½-inch or larger, organic material, and debris to a depth of approximately one foot below existing grade, or one foot below the proposed subgrade elevation, whichever is lower.
 - d. Stockpiling topsoil material on site in areas designated by the ENGINEER or facility personnel.
 - e. Burning will be permitted when allowed by local ordinance. No burning will be allowed within 100 feet of waste disposal areas or site access roads.
 - f. At the end of the construction period, the CONTRACTOR shall restore to existing grade those areas disturbed by construction activities that lie beyond the limits of construction shown on the drawings and that are outside the borrow area. Areas to be filled shall be nominally compacted as may be achieved with construction equipment, and permanently seeded in accordance with the requirements of Section 02936.
- 2. Grade areas to receive fill to a uniform surface. Scarify surface if directed by the ENGINEER.
- 3. Dry or wet subgrade at the discretion of the ENGINEER to establish subgrade with acceptable moisture content.

4. Do not construct structural fill layer until the subgrade has been approved by the ENGINEER.

B. Construction

1. Construct project features to the lines and grades shown on the drawings.
2. Place fill material in lifts no greater than nine inches compacted depth.
3. Compact fill material to a minimum percentage of the maximum dry density as determined by a standard Proctor (ASTM D698) as shown in Table 2 below:

Table 2 - Minimum Compaction Requirements for Structural Fill

Material Type / Use	Compaction Requirement
Structural Fill / Liner Subgrade	95%
Structural Fill / Road Subgrade	98%
Structural Fill / Trench Backfill & Stockpile	90% **
Structural Fill / Final Cover	90%
Structural Fill / Embankments	95%
Structural Fill / Foundations	95%
Structural Fill / All other uses	95%
Vegetative Soil / Final Cover	Do not compact.

** 95% when under road or structure

4. Fill material which does not meet the density requirements shall be recompacted or removed and reworked to meet density objectives.
5. Do not place or compact fill material during sustained period of temperatures below 32° F.
6. Employ a professional land surveyor licensed in Virginia to conduct a topographic survey of the top of the structural fill layer, and prepare a survey drawing showing contours at maximum two-foot intervals.
7. Furnish the ENGINEER with three copies of the topographic survey drawing. This drawing shall become part of the record drawings required by this contract.

C. Geosynthetic Liner Subgrade

1. The surface for geosynthetic liner shall be graded to remove all vegetation and to fill in all voids and cracks. The surface shall then be compacted with a smooth-drum roller to provide the best practicable surface for the geosynthetic liner. At the completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade.
2. All protrusions extending more than 1/2" from the surface shall be removed, crushed or pushed into the surface with a smooth-drum compactor.

3.07 PROTECTION AND ACCEPTANCE

- A. Protect the finished surface from erosion, desiccation, or other damage.
- B. Develop a contingency plan for responding to construction deficiencies due to inclement weather, defective materials, and construction inconsistent with the Technical

Specifications. The plan shall provide a methodology for selecting and implementing corrective action.

- C. Portions of the work damaged due to exposure shall be reworked to meet the Technical Specifications or, at the discretion of the ENGINEER, removed and replaced with conforming material at no additional cost to the OWNER.

3.08 REMOVAL OF SHORING AND BRACING MATERIALS

- A. Where the CONTRACTOR elects and is permitted not to remove shoring and bracing material, all such material shall be removed to the extent that the top of the material shall be a minimum of 5 feet below the proposed finished grade. No shoring or bracing may remain in place within the limits of the proposed geomembrane liner placement.
- B. Removal of shoring and bracing shall be carried out in a manner such that no structure shall be disturbed or damaged during or after removal. Protection of structures during the removal of shoring and bracing shall be the sole responsibility of the CONTRACTOR, and any disturbance or damage shall be rectified at no expense to the OWNER.

3.09 QUALITY ASSURANCE

- A. Under the supervision of the ENGINEER, a soils technician from a commercial geotechnical testing company approved by the ENGINEER shall perform soil tests described herein and in the Construction Quality Assurance (CQA) Plan. Samples shall be collected by field testing personnel at the minimum frequencies presented below.
- B. Structural fill shall be tested during construction to verify material compliance and proper installation in accordance with Table 3.

Table 3 - Structural Fill Construction Testing Schedule

TEST	METHOD	MINIMUM FREQUENCY
Sieve Analysis	ASTM D6913	one test per 5,000 cubic yards in place
Atterberg Limits	ASTM D4318	one test per 5,000 cubic yards in place
USCS Classification	ASTM D2487	one test per 5,000 cubic yards in place
Standard Proctor Compaction	ASTM D698	one test per 10,000 cubic yards of material in place
Nuclear Field Density and Moisture	ASTM D6938	one test per 10,000 square feet per lift and one per lift per 100 L.F of pipe trench
Drive Cylinder	ASTM D2937	1 test per 20 nuclear density tests

- D. The CONTRACTOR shall cooperate with the ENGINEER and his representative in obtaining samples for testing and conducting in-situ tests during the construction period. The CONTRACTOR shall provide all necessary labor, equipment, and material to refill sample locations as directed.
- E. If the tests conducted on a particular lift and section do not meet required specifications, the CONTRACTOR shall be responsible for any expenses incurred performing additional tests following recompaction of the material until passing test results are achieved.

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

SECTION 02233

COARSE AGGREGATE

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, placing and compacting the stone as shown, specified or required. CONTRACTOR shall provide a "Competent Person" to implement and supervise all work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02200 – Earthwork
- B. Section 02595 – Geotextile

PART 2 - PRODUCTS

2.01 Material

- A. The material shall be clean, sound, tough, durable, angular, subangular, subrounded or round stone, not lumpy, and free from slag, cinders, ashes, rubbish, or other deleterious material. Subangular, angular, subrounded, and round shall be as defined in ASTM D2488 entitled "Standard Practice for Description and Identification of Soils [Visual-Manual Procedure].
- B. The CONTRACTOR shall maintain a uniform gradation of coarse aggregate.
- C. Aggregate shall be stored in designated areas approved by the OWNER. The CONTRACTOR is responsible for maintaining the stone free of contamination, and any stone determined by the OWNER to be contaminated shall not be incorporated into the work.
- D. Coarse Aggregate for access road and drainage pipe bedding shall meet the gradation requirements for VDOT No. 57 coarse aggregate.

2.02 Testing

- A. The CONTRACTOR shall submit to the ENGINEER and OWNER for approval, certification that the materials proposed for use as coarse aggregate comply with specification for the proposed application. The certification shall include, but not necessarily be limited to testing or certification of testing provided by the supplier.
- B. Additional confirmatory testing may be required by the QAC to confirm compliance with the specifications.
- C. No material shall be placed unless approved by the QAC.

PART 3 - EXECUTION

3.01 Placement

- A. A uniform layer of coarse aggregate shall be placed to the lines, depths and grades as shown on the Drawings.
- B. Backfilling of coarse aggregate shall be performed by the CONTRACTOR in a manner such that the material is kept clean and free of foreign materials.
- C. For pipe bedding, the bedding and backfill shall be compacted with the compaction effort acceptable to the QAC. The compaction effort shall be applied to both the bedding and the backfill around the pipes. The method of compaction shall not damage the pipe, geotextile or the flexible membrane liner.
- D. The QAC will at any time inspect the stone in the trenches or in stockpile on-Site for contamination and, if necessary, reject all or portions of the stone.
- E. The CONTRACTOR shall use extreme care in the placing of the material over geosynthetics. The material shall be placed in a manner to maintain a minimum thickness of 1 foot between the geosynthetics and the spreading equipment. All coarse aggregate, placed within the limits of the geosynthetics, shall be placed by low pressure equipment. Equipment with ground pressure less than 5 psi may travel on a minimum 12-inch thick leachate collection layer. Equipment with a ground pressure equal to or greater than 5 psi must travel on a minimum 36-inch thick layer.

END OF SECTION

SECTION 02235
VEGETATIVE LAYER

PART 1 - GENERAL

1.01 Description of Work

- A. Furnish all labor, materials, equipment and incidentals necessary to perform all fill and grading required to complete the placement of vegetative support soil as shown on the Construction Plans and specified herein. The work shall include, but not necessarily be limited to, the earthwork required for vegetative layer placement and all related work. CONTRACTOR shall provide a "Competent Person" to implement and supervise all work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02200 - Earthwork
- B. Section 02936 - Seeding

1.03 Tolerances

The minimum thickness of soil is as shown on the Contract Drawings. Tolerance for the thickness of vegetative layer is -0.0 to +0.2 feet.

PART 2 - PRODUCTS

2.01 Materials

- A. Soil material used as topsoil shall be loamy fine sand, loamy sand, sandy clay, sandy clay loam, fine sandy loam, clay loam, silty clay, or sandy loam as defined by the U.S. Department of Agriculture textural classification chart, and shall be suitable to support vegetative growth.
- B. The vegetative layer shall not contain trash, debris, stones, lumps, roots, or similar objects larger than 1-½ inches in any dimension.
- C. Soil material used as the vegetative layer must be capable of sustaining vegetation as specified in Section 02936 - Seeding.

2.02 Testing

- A. The CONTRACTOR shall submit, to the OWNER for approval, evidence that the material proposed for use as topsoil meets the requirements of Section 2.01.
- B. No material shall be placed unless approved by the OWNER and ENGINEER.

PART 3 - EXECUTION

3.01 Installation

- A. This item shall consist of the placement of the vegetative layer in all areas disturbed during the course of construction.

- B. The CONTRACTOR shall provide all the required materials, labor, and equipment to perform the Work in accordance with these Specifications.
- C. No vegetative layer soils shall be placed until soil placement (backfill, fill, etc.) is complete and approved by the OWNER.
- D. The vegetative layer shall be installed in a single, 6-inch thick lift without additional compactive effort.
- E. The CONTRACTOR shall take care to ensure that underlying soil remains intact and does not become mixed with the vegetative layer during installation.

END OF SECTION

SECTION 02271

STONE RIPRAP AND GROUTED RIPRAP

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall provide all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing and placing stone riprap, as shown, specified or required. CONTRACTOR shall provide a "Competent Person" to implement and supervise all work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02125 – Temporary and Permanent Erosion and Sedimentation Control
- B. Section 02595 – Geotextile

PART 2 - PRODUCTS

2.01 Material

- A. Stone riprap shall consist of hard, durable, subangular material. It shall be free from any considerable amount of flat, laminated or elongated particles; and shall be free from cracks, overburden shells, clay, organic matter, or other deleterious matter.
- B. The riprap shall be composed of an evenly distributed mixture such that 50 percent of the mixture by weight shall be larger than the d_{50} size as indicated on the Contract Drawings. The diameter of the largest stone size in such a mixture shall be at least 2.0 times the d_{50} size. The diameter of the smallest stone size in such a mixture shall be greater than 0.5 times the d_{50} size.
- C. The breadth or thickness of a single stone shall not be less than 1/3 its length.
- D. Cement grout for grouted riprap shall consist of one part cement and three parts VDOT A, B, or C sand, thoroughly mixed with water to produce grout having a thick, creamy consistency.

2.02 Submittals

Submit manufacturer's certification of material properties as outlined in Part 2.01 to the ENGINEER.

PART 3 - EXECUTION

3.01 Installation – loose riprap

- A. Stone riprap shall be placed to thicknesses as indicated on Contract Drawings.
- B. With the exception of grouted riprap, all riprap shall be placed on a nonwoven geotextile underlayment of at least 8oz per square yard. The edges of the geotextile shall be sufficiently anchored to prevent movement during rock placement.
- C. Stone riprap shall be placed in a manner that will not damage geotextile, synthetics, utilities or other facilities. Riprap shall not be dropped from a height exceeding three feet.

- D. The tolerance in riprap thickness in place shall be -0 to +0.3 feet.
- E. No material shall be placed unless approved by the OWNER.

3.02 Installation – grouted riprap

- A. Grout shall consist of 1 part hydraulic cement and 3 parts sand, thoroughly mixed with water to produce grout having a thick, creamy consistency.
- B. Stones shall be of the same sizes and placed in the same manner as specified for dry riprap, Class I. Care shall be taken during placing to keep earth or sand from filling spaces between stones. After stones are in place, spaces between them shall be filled with grout from bottom to top and the surface swept with a stiff broom.
- C. Riprap shall not be grouted in freezing weather. In hot, dry weather, the work shall be protected from sunlight and kept moist for at least 3 days after grouting by the use of saturated burlap or other suitable method.

END OF SECTION

SECTION 02286

GEOMEMBRANE PIPE BOOTS AND SLEEVES

PART 1 GENERAL

1.01 Description

Furnish and install HDPE or LLDPE pipe boot or pipe sleeve for use in areas where the geomembrane liner must be penetrated by leachate conveyance system as shown on plans or as directed by the ENGINEER and in accordance with these specifications.

1.02 Quality Assurance

The CONTRACTOR shall assist the QAC in all testing required; the CONTRACTOR will supply any laborers and equipment necessary for assistance in the testing at no additional cost. This work may include, but is not limited to providing material, samples and revising work to meet the intent of the plans and specifications.

1.03 Submittals

- A. The CONTRACTOR shall supply material certificates for the boots, sleeves and stainless steel straps.
- B. If the boot or sleeve is fabricated by the manufacturer, shop drawings must be submitted for approval by the ENGINEER. The boot or sleeve shall not be shipped until the shop drawings are approved.

1.04 Related Work

- A. Section 02597 – Polyethylene Geomembrane
- B. Section 02650 – Leachate Collection and Conveyance Pipe

PART 2 - PRODUCTS

2.01 HDPE or LLDPE Pipe Boots and Pipe Sleeves

The pipe boot or sleeve shall be constructed or manufactured with smooth sheet HDPE or LLDPE to match the geomembrane being used.

PART 3 - EXECUTION

3.01 Construction Methods

- A. The pipe boot and sleeve shall be installed in areas where the geomembrane liner must be penetrated as shown on the Contract Drawings or as directed by the ENGINEER.
- B. Prior to constructing the boot or sleeve, the CONTRACTOR shall assure that the material in the area of the penetration is properly compacted and that the area is clean. The CONTRACTOR shall take extreme care in work to assure the geomembrane liner is not damaged.
- C. The size of the boot or sleeve shall be adequate to provide 6" overlap of the geomembrane liner.
- D. Extrusion welding shall be as shown on the Contract Drawings.

- E. When tightening the stainless steel adjustment bands, the CONTRACTOR shall be careful not to over tighten the bands, thereby causing damage to the boot or sleeve.

3.02 Inspection and Testing

- A. The CONTRACTOR shall employ non-destructive testing of all welds to the geomembrane liner. A vacuum box test or spark test would provide adequate testing.
- B. The CONTRACTOR is responsible for providing all necessary test equipment and shall conduct the test. The testing of welds shall be observed by the QAC.

END OF SECTION

SECTION 02590

GEOCOMPOSITE

PART 1 - GENERAL

1.01 Description of Work

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary for the installation of geocomposite as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance Program.
- B. The Contractor shall be prepared to install the geocomposite drainage layer in conjunction with earthworks and other components of the liner system.

1.02 Related Sections

- A. Section 02200 - Earthwork
- B. Section 02597 - Polyethylene Geomembrane

1.03 Qualifications

- A. The Contractor shall provide the services of a Geocomposite Manufacturer and Installer, who shall meet the following qualifications. The Contractor shall, however, accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the completed system.
 - 1. Manufacturer
 - a. The Geocomposite Manufacturer shall be responsible for the production and delivery of geocomposite rolls and shall be a well-established firm with more than one year of experience in the manufacture of geocomposite. The Manufacturer shall submit a statement to the QA Consultant listing:
 - 1) Certified minimum property values of the proposed geocomposite and the tests used to determine those properties.
 - 2) Production capacity available and projected delivery dates for this project.
 - 2. Installer
 - a. The Installer shall be responsible for field handling, storing, deploying, seaming or joining, temporary restraining (against wind), anchoring systems, and other site aspects of the geocomposite drainage layers.
 - b. The Installer shall be trained and qualified to install geocomposite. The installer's qualifications will require the QA Consultant approval.
- B. Prior to confirmation of any contractual agreements, the potential installer shall provide the QA Consultant with the written information that corresponds to the information required in this Part.

1.04 Submittals

- A. The Contractor shall submit to the QA Consultant in writing the following documentation on the raw materials used to manufacture the geocomposite prior to transporting any geocomposite to the site:
1. Copies of quality control certificates issued by the resin supplier including production dates of the resin.
 2. Results of tests conducted to verify the quality of the resin used to manufacture the geonet and geotextile material assigned to the project.
 3. Certification that no reclaimed polymer is added to the resin during the manufacture of the geonet and geotextile material to be used in this project.
- B. The Contractor shall submit to the QA Consultant the following information on the geotextile:
1. Copies of quality control certificates issued by the geotextile manufacturer. The certificate should include roll number and identification.
 2. The quality control certificate shall include:
 - a. roll numbers lot or batch numbers and identification;
 - b. sampling procedures; and
 - c. results of quality control tests, including descriptions of test methods used.
 3. The geotextile shall meet the requirements of Table 02590-1. Quality Control Testing of the geotextile shall be in conformance with the frequencies specified in Table 02590-2.
- C. The Contractor shall submit to the QA Consultant the following information on geocomposite production:
1. Manufacturing quality control certificates for each shift's production, signed by responsible parties employed by the Manufacturer (such as the production manager), and notarized.
 2. The quality control certificate shall include:
 - a. roll numbers and identification;
 - b. sampling procedures; and
 - c. results of quality control tests, including descriptions of test methods used.
 3. The quality control testing to be performed by the manufacturer is presented in Part 2.03 of this Section.

1.05 Construction Quality Assurance

- A. The installation of the geocomposite shall be monitored as outlined in the CQA Plan.
- B. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

PART 2 - PRODUCTS

2.01 Geocomposite

- A. The Manufacturer shall furnish geocomposite having properties that comply with the required property values shown in Table 02590-1. The Manufacturer shall provide test results for these procedures, as well as certification that the materials meet or exceed the specified values.
- B. In addition to the property values listed in Table 02590-1, the geocomposite shall:
 - 1. Retain its structure during handling, placement, and long-term service.
 - 2. Be capable of withstanding outdoor exposure for a minimum of 30 days with no measurable deterioration.
 - 3. Be chemically inert when immersed in the leachate from a typical landfill.

2.03 Manufacturing Quality Control

- A. The geocomposite shall be manufactured with quality control procedures that meet generally accepted industry standards.
- B. The Contractor shall require that the Geocomposite Manufacturer sample and test the geocomposite to demonstrate that the material conforms to the requirements of this Section.
- C. Any geocomposite sample that does not comply with this Section shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to The Owner.
- D. Additional sample testing may be performed, at the Geocomposite Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.
- E. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required. The Contractor shall require that the Geocomposite Manufacturer sample and test the geocomposite at the frequencies presented in the Geocomposite Manufacturer's Quality Control Plan.
- F. The manufacturer shall test the materials at the frequencies shown in Table 02590-2 to demonstrate that its properties conform to the values specified in Table 02590-1.
- G. The Contractor shall require that the Geocomposite Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.04 Labeling

- A. Geocomposite shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.
- B. Geocomposite rolls shall be labeled with the following information:
 - 1. manufacturer's name;
 - 2. product identification;
 - 3. lot or batch number;
 - 4. roll number; and
 - 5. roll dimensions.
- C. If any special installation is required, it shall be so marked on the geotextile component e.g., "This Side Up" or "This Side Against Soil".

2.05 Handling and Storage

- A. Handling, storage, and care of the geocomposite prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the lining system by the Owner.
- B. The Contractor shall be responsible for storage of the geocomposite at the site. The geocomposite shall be stored off the ground and out of direct sunlight, and shall be protected from excessive heat or cold, mud, dirt, and dust. Any additional storage procedures required by the manufacturer shall be the Contractor's responsibility.

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 and the CQA Plan.
- B. Inspection
 - 1. Prior to implementing any of the work in this Section, the Contractor shall carefully inspect the installed earthwork, liner and other related Sections and verify that all work is complete to the point where the installation of this Section may properly commence without adverse impact.
 - 2. If the Contractor has any concerns regarding the installed work of other Sections, he/she shall notify the QA Consultant in writing within 48 hours of his site inspection. Failure to inform the QA Consultant in writing or installation of the geocomposite will be construed as Contractor's acceptance of the related work of all other Sections.

3.02 CQA Conformance Testing

- A. Upon delivery to the site or at the location of the manufacturer, samples of the geocomposite shall be removed by the QA Consultant and sent to the laboratory selected by the QA Consultant for testing to ensure conformance to this Section.
- B. Geocomposite samples and tests shall be selected by the QA Consultant in accordance with this Section and the procedures outlined in the CQA Plan.
- C. Geocomposite samples shall be taken at the rate of one sample per 200,000 square feet with a minimum of one sample per lot. Samples shall be tested for the properties presented in Table 02590-3.
- D. The QA Consultant may increase the frequency of sampling in the event that test results do not comply with Part 2.01 of this Section. This additional testing shall be performed at the expense of the Contractor.
- E. Any geocomposites that are not certified in accordance with Part 1.03 and 1.04 of this Section, or that conformance testing indicates do not comply with Part 2.01 of this Section shall be rejected and replaced with new material by the Contractor at no additional cost to the Owner.

3.03 Handling and Placement

- A. The Contractor shall handle the geocomposite in such a manner as to ensure the geocomposite drainage layers are not damaged in any way.
- B. The Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- C. In the presence of wind, the geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.
- D. On side slopes, the geocomposite shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite in tension.
- E. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.
- F. Care shall be taken during placement of geocomposite not to entrap dirt or excessive dust in the geonet core that could cause clogging of the drainage system, and/or stones that could damage the adjacent liner. If dirt or excessive dust is trapped in the geocomposite, it should be cleaned prior to placement of the next material on top of it.
- G. Geocomposite shall only be cut using Manufacturer's recommended procedures.
- H. Unless otherwise specified, geocomposite shall not be welded to liners.
- I. Tools shall not be left on, in, or under the geocomposite.
- J. After unwrapping the geocomposite from its opaque cover, the geocomposite shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the ENGINEER, based on a formal demonstration from the Contractor that the geotextile component of the geocomposite is stabilized against U.V. degradation for a period in excess of 30 days.
- K. If white colored geotextile is used in the geocomposite, precautions shall be taken against "snowblindness" of personnel.

3.04 Installation

- A. Each component of the geocomposite (i.e., geotextile(s) and geonet) will be secured or seamed to the like component at overlaps.
- B. Geonet Components
 - 1. Adjacent edges of geonet shall be overlapped at least 4 inches. These overlaps shall be secured by tying with white nylon ties at 5 foot intervals in the direction of the roll length.
 - 2. Geonet roll ends (butt seams) shall be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width. White nylon ties shall be applied at 6 inch intervals.
 - 3. Geonet shall be tied at 6 inch intervals with white nylon ties in the anchor trench.
- C. Geotextile Components
 - 1. The bottom layer of geotextile shall be overlapped. The top layer of geotextile shall be continuously sewn with contrasting color thread or continuously heat bonded in the direction of the roll length. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming.

2. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The thread shall be a contrasting color (white or other light color) to facilitate seam inspection. The seams shall be sewn to provide a flat (prayer) seam, "J" seam, or "butterfly-folded" seam and shall be a two-thread, double-lock stitch or a double row of single-thread, chain stitch.

3.05 Repair

- A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending 2 feet beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet on the slope. The patch shall secure every 6 inches with approved tying devices. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.04 above.

3.06 Placement of Soil Materials

- A. The Contractor shall place the soil materials in such a manner as to ensure that:
 1. no construction equipment operates directly on the geocomposite;
 2. the geocomposite and underlying lining materials are not damaged;
 3. minimal slippage occurs between the geocomposite and underlying layers; and
 4. excess tensile stresses are not produced in the geocomposite.

3.07 Product Protection

- A. The Contractor shall use all means necessary to protect all prior work, and the 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 QA Consultant and at no additional cost to the Owner.

TABLE 02590-1 GEOCOMPOSITE PROPERTY VALUES (MARY)				
PROPERTIES AND REQUIREMENTS	QUALIFIER	UNITS	SPECIFIED VALUES	TEST METHOD
HDPE GEONET CORE				
Thickness	Minimum	mil	250	ASTM D 5199
Geonet Density	Minimum	g/cm ³	0.94	ASTM D 1505
Carbon Black Content	Range	%	2 - 3.5	ASTM D 1603
GEOTEXTILE COMPONENT				
Mass Per Unit Area	Minimum	oz/yd ²	8	ASTM D 3776
Apparent Opening Size	Maximum	Std sieve	80	ASTM D 4751
Permittivity	Minimum	sec ⁻¹	1.0	ASTM D 4491
Grab Tensile Strength	Minimum	lb	200	ASTM D 4632
Puncture Strength	Minimum	lb	400	ASTM D 6241
UV Resistance	Minimum	%@hr	70@500	ASTM D 4355
GEOCOMPOSITE				
Transmissivity(1)	Minimum	m ² /s	5.0 x 10 ⁻⁴	ASTM D 4716
Ply Adhesion	Minimum	lb/in	1.0	ASTM F 904 or ASTM D 7005

NOTES:

- (1) The design transmissivity is the transmissivity of the geocomposite drainage layer measured using water at 70°F with a gradient of 0.1, under a compressive stress of 10,000 psf.

TABLE 02590-2 REQUIRED MANUFACTURER QUALITY CONTROL TEST FREQUENCIES		
PROPERTY	TEST METHOD	FREQUENCY
GEONET CORE		
Geonet Density	ASTM D 1505	Every 100,000 ft ²
Geonet Carbon Black Content	ASTM D 1603	Every 100,000 ft ²
Geonet Thickness	ASTM D 5199	Every 100,000 ft ²
GEOTEXTILE COMPONENT		
Mass Per Unit Area	ASTM D 3776	Every 100,000 ft ²
Grab Tensile	ASTM D 4632	Every 100,000 ft ²
Apparent Opening Size	ASTM D 4571	Every 540,000 ft ²
Permittivity	ASTM D 4491	Every 540,000 ft ²
Puncture Strength	ASTM D 6241	Every 100,000 ft ²
GEOCOMPOSITE		
Transmissivity	ASTM D 4716	One per production lot
Ply Adhesion	ASTM F 904	Every 200,000 ft ²

TABLE 02590-3 REQUIRED CGA QUALITY CONTROL TEST FREQUENCIES		
PROPERTY	TEST METHOD	FREQUENCY
GEOCOMPOSITE		
Transmissivity	ASTM D 4716	One per production lot
Ply Adhesion	ASTM F 904	Every 200,000 ft ²

END OF SECTION

SECTION 02595

GEOTEXTILE

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, and placing geotextile, complete with appurtenances, as shown, specified or required. CONTRACTOR shall provide a "Competent Person" to implement, supervise, and inspect all work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02200 = Earthwork
- B. Section 02233 – Coarse Aggregate

1.03 Submittals

- A. The CONTRACTOR shall furnish a mill certificate from the company manufacturing the woven and non-woven geotextile attesting that the geotextile meets the chemical, physical, and manufacturing requirements specified. Geotextiles shall be rejected by the ENGINEER and replaced by the CONTRACTOR if they are found to have defects, rips, holes, flaws, deterioration or other damage.

1.04 Product Handling

- A. The CONTRACTOR shall protect the work described in this Section before, during, and after installation, and shall protect the installed work covered by other Sections.
- B. The CONTRACTOR shall, during all periods of shipment and storage, protect the geotextile from direct sunlight, ultraviolet light, temperatures greater than 120 degrees F, mud, dirt, dust, debris and other deleterious sources. Geotextiles shall be maintained, wrapped in a heavy-duty protective covering until it is installed.
- C. If the QAC determines material is damaged or has excessive sunlight exposure, the CONTRACTOR shall immediately make all repairs and replacements, at no additional cost to the OWNER.

1.05 Definitions

On the Drawings and in the Specifications, the word geotextile is used and refers to either a woven or non-woven geotextile as described in Section 2.01.

PART 2 - MATERIALS

2.01 Woven Geotextile

- A. Woven geotextiles shall be manufactured by Mirafi, Amoco, Nicolon or other approved manufacturers.
- B. Woven geotextiles shall be placed at the subgrade elevations as indicated on the Contract Drawings. Woven geotextile shall meet the following MARV minimum properties:

Property	Test Method	Value
Polymer Composition	-	95% polypropylene or polyester by weight
Grab Tensile Strength	ASTM D4632	200 lbs
Grab Tensile Elongation	ASTM D4632	10% - 15%
Apparent Opening Size	ASTM D4751	40 Sieve

- C. To keep the number of seams to a minimum, the geotextile shall be provided in sections not less than 12 feet wide.

2.02. Nonwoven Filter Geotextile

Nonwoven filter geotextile shall be used for wrapping the leachate collection stone, pipe construction or cushioning as indicated on the Contract Drawings. The nonwoven geotextile shall meet the following MARV minimum properties:

Property	Test Method	Value
Polymer Composition	-	95% polypropylene or polyester by weight
Grab Tensile Strength	ASTM D4632	300 lbs
Grab Tensile Elongation	ASTM D4632	50 %
Trapezoidal Tear Strength	ASTM D4533	115 lbs
CBR Puncture Strength	ASTM D6241	800 lbs
Apparent Opening Size	ASTM D4751	100 sieve
Permittivity	ASTM D4491	0.8 sec ⁻¹
UV Resistance	ASTM D4355	70 %

PART 3 - EXECUTION

3.01 Site Preparation

- A. Site subgrade 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 to the satisfaction of the ENGINEER.
- C. The base surface or surface of embankments shall be graded as smooth as possible. The subgrade shall be inspected for unstable areas or soft spots, before the geotextile is placed and additional fill shall be placed and compacted to eliminate those unstable areas.

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. Woven geotextile will be overlapped a minimum of 2 feet, with the upgradient rolled lapped over the downgradient roll. Anchor edges as indicated in the Contract Drawings.
- C. All nonwoven geotextile seams shall be continuously sewn or heat bonded. Nonwoven geotextiles will be overlapped a minimum of 6 inches prior to seaming.
- 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.

- E. Geotextile placed on side slopes shall be positioned by hand after being unrolled to minimize wrinkles. The geotextile shall not be placed in the horizontal direction (i.e. across the slope) on slopes steeper than 10 (horizontal): 1 (vertical), except as part of a patch.

3.03 Protection

- A. After installation, the geotextile should be visually inspected to assure that no objects are present that could potentially harm the geotextile.
- B. Any geotextile damaged during its installation or during placement of cover material, as deemed by the QAC, shall be replaced by the CONTRACTOR at no additional cost to the OWNER.
- C. The work shall be scheduled so that the covering of the geotextile with the material to be placed over it is accomplished within 30 days after placement of the geotextile. Failure to comply with this requirement shall require replacement of an additional geotextile at no additional cost to the owner.
- D. When spot-repairing geotextile with patches, a 3-foot lystered overlap will be used or by a means approved by the ENGINEER.

END OF SECTION

SECTION 02597

POLYETHYLENE GEOMEMBRANE

PART 1 - GENERAL

1.01 Submittals

A. Pre-installation: Submit prior to geomembrane deployment:

- (1) Origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture geomembrane.
- (2) Copies of dated quality control certificates issued by resin supplier.
- (3) Results of tests conducted by geomembrane manufacturer to verify that resin used to manufacture geomembrane meets Specifications.
- (4) Statement that amount of reclaimed polymer added to resin during manufacturing did not exceed 2% by weight.
- (5) List of materials that comprise geomembrane, expressed in following categories as percent by weight: polyethylene, carbon black, and other additives.
- (6) Manufacturer's specification for geomembrane that includes properties listed and measured using appropriate test methods.
- (7) Written certification that minimum values given in manufacturer's specification are guaranteed by geomembrane manufacturer.
- (8) Quality control certificates provided by geomembrane manufacturer. Each quality control certificate shall include applicable roll identification numbers, testing procedures, and results of quality control tests.
- (9) Field panel layout and identification code including dimensions and details.
- (10) Resumes of Geomembrane superintendent and master seamer including dates and duration of employment.
- (11) Installation schedule.
- (12) List of personnel performing seaming operations including experience information.
- (13) Certificate that extrudate to be used is comprised of same resin as geomembrane to be used.

B. Installation: Submit as installation proceeds.

- (1) Quality control documentation recorded during installation.
- (2) Subbase surface acceptance certificates signed by LINER INSTALLER for each area that will be covered directly by geomembrane.
- (3) Deployment of geomembrane will be considered acceptance of subgrade if certificate is not submitted.
- (4) Material and Installation Warranty from manufacturer.

1.02 Prequalifications

A. Manufacturer:

- (1) Manufacturer shall have minimum 5 yrs continuous experience in manufacture of HDPE geomembrane or experience totaling 10,000,000 sq ft of manufactured HDPE geomembrane for minimum of 10 completed facilities.

B. Fabricator (if applicable):

- (1) Fabricator shall have minimum 5 yrs continuous experience in fabrication of HDPE geomembrane or experience totaling 2,000,000 sq ft of fabricated HDPE geomembrane for minimum of 10 completed facilities.

C. Installer:

- (1) Installer shall have minimum 5 yrs continuous experience in installation of HDPE geomembrane or experience totaling 2,000,000 sq ft of installed HDPE geomembrane for minimum of 10 completed facilities.
- (2) Personnel performing seaming operations shall be qualified by experience or successfully passing seaming tests. Minimum of one seamer shall have experience seaming minimum 2,000,000 sq ft of HDPE geomembrane using same type of seaming apparatus in use at site. Most experienced seamer, "master seamer," shall provide direct supervision over less experienced seamers.

1.03 Quality Assurance Program

- A. Manufacturer, fabricator, and installer shall participate in and conform to items and requirements of a quality assurance program as outlined in this section.

1.04 Delivery, Storage, and Handling

A. Packing and Shipping:

- (1) Manufacturer shall identify each roll delivered to site with following:
 - a. Manufacturer's name.
 - b. Product identification.
 - c. Thickness.
 - d. Roll number.
 - e. Roll dimensions.
- (2) Protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions during loading, transport, and unloading at site.

B. Acceptance at Site:

- (1) Conduct surface observations of each roll for defects and damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected.
- (2) Defected or damaged rolls or portions of rolls will be rejected and shall be removed from site and replaced with new rolls.
- (3) Rolls or portions of rolls without proper identification or labeling will be rejected and shall be removed from site.

C. Storage and Protection:

- (1) OWNER will provide on-site storage area for geomembrane rolls from time of delivery until deployment.
- (2) INSTALLER shall protect geomembrane from dirt, water, and other sources of damage.
- (3) Preserve integrity and readability of geomembrane roll labels.
- (4) Rolls which do not have proper identification at delivery will not be accepted.

PART 2 - PRODUCTS

2.01 Materials

A. Textured HDPE Geomembrane Properties:

Testing Properties	Testing Method	40 mil HDPE Value	60 mil HDPE Value
Thickness mils (min ave.) • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values	ASTM D 5994	38 mils 36 mils 34 mils	57 mils 54 mils 51 mils
Density g/cc	ASTM D1505 or ASTM D792	0.940 (min ave) (either method)	0.940 (min ave) (either method)
Asperity Height (min ave.) (1) (2)	ASTM D7466	10 mils	10 mils
Tensile Properties (min. ave.) (3) • Break strength - lb/in • Break elongation - %	ASTM D638 Type IV	60 100	90 100
Tear Resistance - lb (min. ave.)	ASTM D1004	28	42
Puncture Resistance - lb (min. ave.)	ASTM D4833	60	90
Stress Crack Resistance (11)	ASTM D5397	300 hr	300 hr
Carbon Black Content - %	ASTM D1603 (4)	2.0 to 3.0	2.0 to 3.0
Carbon Black Dispersion	ASTM D 5596	Note (5)	Note (5)
Oxidative Induction Time (OIT) (min ave.) (6) • Standard OIT, or • High Pressure OIT	ASTM D3895 ASTM D5885	100 400	100 400
Oven Aging at 85°C (7) • Std. OIT (min. ave.), % retained after 90 days or • High Pressure OIT (min. ave.), % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	55 80	55 80
UV Resistance (8) • Std. OIT (min. ave.), or • High Pressure OIT (min ave.) % retained after 1600 hrs	ASTM D3895 ASTM D5885	N.R. (9) 50	N.R. (9) 50

- (1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
- (2) Alternate the measurement side for double sided textured sheet.
- (3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3
- (6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane
- (7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
- (8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (9) Not recommended since high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
- (10) UV resistance is based on percent retained value regardless of the original HP-OIT value.
- (11) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheet made from the same formulation as being used for the textured sheet materials.

B. Geomembrane shall be manufactured from new polyethylene resin, except as noted below:

- (1) Use of geomembrane recycled during manufacturing process shall be permitted with written approval from OWNER and if recycled geomembrane does not exceed 2% by weight.
- (2) Geomembrane manufactured from non-complying resin shall be rejected.

2.02 Contractor-Provided Seaming and Testing Equipment

A. Welding:

- (1) Maintain on-site minimum of 2 spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.
- (2) Seaming equipment shall not damage geomembrane.
- (3) Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus, or utilize hand-held gauges to measure extrudate temperatures.
- (4) Use fusion-welding apparatus that are self-propelled devices equipped with gauges indicating temperature of the heating element and speed of travel.
- (5) Place electric generator on smooth base with rub sheet such that no damage occurs to geomembrane.

B. Vacuum Testing Equipment:

- (1) Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing, porthole or valve assembly, and vacuum gauge.
- (2) Pump assembly equipped with pressure controller and pipe connections.
- (3) Pressure/vacuum rubber hose with fittings and connections.
- (4) Soapy solution to wet test area.
- (5) Means of applying soapy solution.

C. Air Pressure Testing Equipment:

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

D. Tensiometer Testing Equipment:

- (1) Tensiometer shall be capable of maintaining constant jaw separation rate of 2 in. per minute, and shall be calibrated, with certificate of calibration less than 1 yr old kept with tensiometer.

2.03 Source Quality Control

(a) Tests, Inspections shall be performed by geomembrane manufacturer as follows:

- (1) Test geomembranes to demonstrate that resin meets this Specification.
- (2) Continuously monitor geomembrane during manufacturing process for inclusions, bubbles, or other defects. Geomembranes which exhibit defects shall not be acceptable for installation.

- (3) Monitor thickness continuously during manufacturing process.
- (4) Tests shall be conducted for following properties in accordance with test methods specified in the following table. Samples not complying with Specifications shall result in rejection of rolls. At geomembrane manufacturer's discretion and expense, additional testing of individual rolls may be performed to identify and reject non-complying rolls and to approve individual rolls.

Required Manufacturer Testing Frequency

Testing Properties	Testing Method	Manufacturer QC Testing Frequency
Thickness	ASTM D 5994	1 per Roll;
Density	ASTM D1505 or ASTM D792	1 per 200,000 lb
Asperity Height (1) (2)	GM-12	Every 2 nd roll
Tensile Properties (3)	ASTM D638 Type IV	1 per 20,000 lb
Tear Resistance	ASTM D1004	1 per 45,000 lb
Puncture Resistance	ASTM D4833	1 per 45,000 lb
Stress Crack Resistance (9)	ASTM D5397	per GRI GM10
Carbon Black Content - %	ASTM D1603 (4)	1 per 20,000 lb
Carbon Black Dispersion (5)	ASTM D 5596	1 per 45,000 lb
Oxidative Induction Time (OIT) (6) <ul style="list-style-type: none"> • Standard OIT, or • High Pressure OIT 	ASTM D3895 ASTM D5885	(9)
Oven Aging at 85°C (7) <ul style="list-style-type: none"> • Std. OIT, % retained after 90 days or <ul style="list-style-type: none"> • High Pressure OIT, % retained after 90 days 	ASTM D5721 ASTM D3895 ASTM D5885	(9)
UV Resistance (8) <ul style="list-style-type: none"> • Std. OIT, or • High Pressure OIT % retained after 1600 hrs 	ASTM D3895 ASTM D5885	(9)

- (1) Of 10 readings, 8 out of 10 must be ≥7 mils, and lowest individual reading must be ≥ 5 mils
- (2) Alternate the measurement side for double sided textured sheet.
- (3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
 - Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 in Categories 1 or 2 and 1 in Category 3
- (6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
- (7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
- (8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (9) Manufacturer may provide a certification letter

PART 3 - EXECUTION

3.01 QUALITY ASSURANCE SAMPLING

- A. INSTALLER or MANUFACTURER shall make rolls available and assist the QAC in obtaining material inventory and material samples. Samples shall be tested in accordance with the test methods specified in the following table:

Required Quality Assurance Testing Frequency

Testing Properties	Testing Method	Conformance QA Testing Frequency
Thickness	ASTM D 5994	1 per 200,000 sf
Density	ASTM D1505 or ASTM D792	1 per 200,000 sf
Asperity Height (1) (2)	GM-12	1 per 200,000 sf
Tensile Properties (3)	ASTM D638 Type IV	1 per 200,000 sf
Tear Resistance	ASTM D1004	1 per 200,000 sf
Puncture Resistance	ASTM D4833	1 per 200,000 sf
Carbon Black Content - %	ASTM D1603 (4)	1 per 200,000 sf
Carbon Black Dispersion (5)	ASTM D 5596	1 per 200,000 sf

- (1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
(2) Alternate the measurement side for double sided textured sheet.
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
 - Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.(4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 in Categories 1 or 2 and 1 in Category 3

- B. Rolls represented by quality assurance testing shall be rejected if test failure occurs. INSTALLER may at their expense request additional testing to validate individual rolls. Rolls bracketed by passing tests will be allowed to be deployed and seamed.

3.02 Preparation

A. Surface Preparation:

- (1) EARTHWORK CONTRACTOR is responsible for preparing supporting surface for geomembrane placement.
- (2) After prepared surface has been accepted in accordance with Quality Assurance Plan, report to OWNER any change in supporting surface condition that may require repair work. Maintain prepared surface.
- (3) Do not place geomembrane onto an area that has become softened by precipitation or cracked due to desiccation. Observe and report surface condition daily to evaluate degree of softening and desiccation cracking.
- (4) Repair damage to prepared surface caused by installation activities at INSTALLER'S expense.

3.03 Geomembrane Installation

A. Panel Nomenclature:

- (1) Field panel is defined as a roll or portion of roll cut and seamed in field, excluding patches and cap strips.
- (2) Identify each field panel with identification code (number or letter-number) consistent with INSTALLER'S layout plan. This identification code shall be agreed upon by OWNER, INSTALLER, and QAC.
- (3) Writing on liner with colored markers or paint shall be as agreed upon in the Pre-Construction Meeting. Only authorized personnel shall be permitted to write on liner.

B. Protection:

- (1) Do not use equipment that damages geomembrane.
- (2) Ensure prepared surface underlying geomembrane has not deteriorated since previous acceptance, and remains acceptable immediately prior to geomembrane deployment.
- (3) Keep geosynthetic elements immediately underlying geomembrane clean and free of debris.
- (4) Do not permit personnel to smoke or wear shoes that can damage geomembrane while working on geomembrane. Personnel shall not bring glass bottles on geomembrane.
- (5) Unroll panels in manner that does not cause excessive scratches or crimps in geomembrane and does not damage supporting soil.
- (6) Place panels in manner that minimizes wrinkles (especially differential wrinkles between adjacent panels).
- (7) Prevent wind uplift by providing adequate temporary loading and/or anchoring (e.g., sandbags) that shall not damage geomembrane. In case of high winds, continuous loading is recommended along panel edges.
- (8) Protect geomembrane in areas where excessive traffic is expected with geotextiles, extra geomembrane, or other suitable materials.

C. Field Panel Deployment:

- (1) Install field panels at locations indicated on INSTALLER'S layout plan.
- (2) Replace seriously damaged (torn, twisted or crimped) field panels, or portions thereof, at no cost to OWNER. Repair less serious damage as specified herein. QAC shall determine if material shall be repaired or replaced.
- (3) Remove damaged panels or portions of damaged panels that have been rejected from work area.
- (4) Do not proceed with deployment at ambient temperature below 32 F or above 104 F unless otherwise authorized in writing by OWNER.
- (5) Do not deploy during precipitation, in presence of excessive moisture, (fog, dew), in areas of ponded water or in presence of excessive winds.
- (6) Do not undertake deployment if weather conditions will preclude material seaming on same day as deployment.
- (7) Do not deploy more geomembrane field panels in one day than can be seamed during that day.

D. Seam Layout:

- (1) When possible, orient seams parallel to line of maximum slope, i.e., oriented along, not across, slope.

- (2) When possible, no horizontal seam shall be closer than 5 ft from toe of slope.
- (3) In general, maximize lengths of field panels and minimize number of field seams.
- (4) Align geomembrane panels to have nominal overlap of 3 in. for extrusion welding and 4 to 6 in. for fusion welding. Final overlap shall be sufficient to allow peel tests to be performed on seam.

E. Temporary Bonding:

- (1) Hot air device (Liestar) may be used to temporarily bond geomembrane panels to be extrusion welded.
- (2) Do not damage geomembrane when temporarily bonding adjacent panels. Apply minimal amount of heat to lightly tack geomembrane panels together. Control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.
- (3) Do not use solvent or adhesive.

F. Seaming Methods:

- (1) Approved processes for field seaming are extrusion fillet welding and fusion welding. Proposed alternate processes shall be documented and submitted to OWNER for approval. Alternate procedures shall be used only after being approved in writing by OWNER.
- (2) Seams shall meet following requirements:

MINIMUM POLYETHYLENE SEAM PROPERTIES (per GRI GM-19)

PROPERTY	METHOD	40 MIL HDPE	60 MIL HDPE
Shear Strength	ASTM D6392	80 ppi	120 ppi
Peel Adhesion:			
Fusion	ASTM D6392	60 ppi	91 ppi
Extrusion	ASTM D6392	52 ppi	78 ppi

- The strength of four out of five specimens shall meet or exceed the value shown in this table. The fifth must meet or exceed 80% of the given value in order to be considered a passing test.
- Unacceptable break codes are:
 - Fusion: AD and AD-Brk > 25%
 - Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

- (3) Use fusion welding as primary method of seaming adjacent field panels.
 - a. For cross seam tees, associated with fusion welding or extrusion welding, shall be patched to a minimum distance of 6-in. on each side of tee.
 - b. Place welder on protective pad to prevent geomembrane damage between seaming.
 - c. When subgrade conditions dictate, use movable protective layer (e.g. extra piece of geomembrane) directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers.
- (4) Use extrusion fillet welding as secondary method for seaming between adjacent panels and as primary method of welding for detail and repair work.
 - a. Purge heat-degraded extrudate from barrel of extruder under following conditions:

- 1) Prior to beginning seam.
 - 2) Wherever extruder has been inactive.
- a. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.
 - b. Use clean and dry welding rods or extrudate pellets.
 - c. Complete grinding process without damaging geomembrane within 1 hr of seaming operation.
 - d. Minimize exposed grinding marks adjacent to extrusion weld. Do not allow exposed grinding marks to extend more than 1/4 in. outside finished seam area and grind perpendicular to seam.

G. Seaming Procedures:

(1) General Seaming Procedures: (Ambient temperature between 32°F and 104°F).

- a. Do not field seam without master seamer being present.
- b. Dry conditions, i.e., no precipitation nor other excessive moisture, such as fog or dew.
- c. No excessive winds.
- d. If required, provide firm substrate by using extra piece of geomembrane, or similar hard surface directly under seam overlap to achieve proper support for seaming apparatus.
- e. Align seams with fewest possible number of wrinkles and fishmouths.
- f. Extend seams to outside edge of panels placed in anchor trench.
- g. Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris or foreign material.
- h. Fishmouths or wrinkles at seam overlaps shall be cut along ridge of wrinkle in order to achieve flat overlap. Cut fishmouths or wrinkles shall be seamed and any portion where overlap is inadequate shall be patched with an oval or round patch of same geomembrane extending minimum of 6-in. beyond cut in each direction.

(2) Cold Weather Seaming Procedures (ambient temperature is below 32° F).

- a. QAC shall determine geomembrane surface temperatures at intervals of at least once per 100 ft of seam length to determine if preheating is required. For extrusion welding, preheating required if surface temperature of geomembrane is below 32° F.
- b. Preheating may be waived by OWNER based on recommendation from QAC, if demonstrated to QAC'S satisfaction that welds of equivalent quality may be obtained without preheating at expected temperature of installation.
- c. If preheating is required, QAC shall observe areas of geomembrane that have been preheated by hot air device prior to seaming, to ensure they have not been subjected to excessive melting.
- d. QAC shall confirm that surface temperatures have not lowered below minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for seam area.
- e. Preheating devices used shall be pre-approved by OWNER prior to use.
- f. Additional destructive seam tests shall be taken at interval between 500 ft and 250 ft of seam length, at QAC'S discretion.
- g. Sheet grinding may be performed before preheating, if applicable.
- h. Trial seaming shall be conducted under same ambient temperature and preheating conditions as actual seams. New trial seams shall be conducted if ambient temperature drops by more than 10° F from initial trial seam test

conditions. New trial seams shall be conducted upon completion of seams in progress during temperature drop.

- (3) Warm Weather Procedures (ambient temperature is above 104° F).
 - a. No seaming of geomembrane is permitted unless demonstrated to QAC that geomembrane seam quality will not be compromised.
 - b. Trial seaming shall be conducted under same ambient temperature conditions as actual seams. New trial seams shall be conducted if ambient temperature rises by more than 5° F from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature rise.
 - c. At option of QAC, additional destructive seam tests may be required for any suspect areas.

H. Repair Procedures:

- (1) Repair portions of geomembrane exhibiting flaw, or failing destructive or nondestructive test.
- (2) Final decision as to repair procedure shall be agreed upon between OWNER, INSTALLER, and QAC.
- (3) Acceptable repair procedures include following:
 - a. Patching: Piece of same geomembrane material extrusion welded into place. Use to repair large holes, tears, nondispersed raw materials, and contamination by foreign matter. All panel intersections shall be patched.
 - b. Spot welding or seaming: Bead of molten extrudate placed on flaw. Use to repair small tears, pinholes, or other minor, localized flaws.
 - c. Capping: Strip of same geomembrane material extrusion welded into place over inadequate seam. Use to repair large lengths of failed seams.
 - d. Removal and replacement: Remove bad seam and replace with strip of same geomembrane material welded into place. Use to repair large lengths of failed seams.
 - e. Extrusion welding flap: Repairs of this type shall not be used unless approved by QAC and shall not exceed 100 ft in length.
- (4) For each repair method:
 - a. Ensure surfaces are clean, dry, and prepared in accordance with specified seaming process.
 - b. Ensure seaming equipment used in repairing procedures meet requirements of this Specification.
 - c. Extend patches or caps at least 6 in. beyond edge of defect. Round corners of patches with radius of approximately 6 in.
- (5) Do not place overlying layers over locations, which have been repaired until appropriate acceptable nondestructive and destructive (laboratory) test results are obtained.

I. Anchor Trench:

- (1) EARTHWORK CONTRACTOR shall excavate anchor trenches, unless otherwise specified, to lines and grades shown on design construction drawings, prior to geomembrane placement. Anchor trench shall be drained to prevent ponding or softening of adjacent soils while trench is open.

- (2) Slightly rounded corners shall be provided in anchor trench to avoid sharp bends in geomembrane.
- (3) If anchor trench is excavated in clay material susceptible to desiccation, amount of trench open at any time should be minimized.
- (4) Remove construction-related debris from anchor trench.
- (5) Earthwork Contractor shall backfill and compact anchor trench as soon as practical after geomembrane installation is completed. Take care when backfilling trenches to prevent damage to geosynthetics.

3.04 Field Quality Control

A. Visual Inspection:

- (1) QAC will examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, nondispersed raw materials, and any sign of contamination by foreign matter.
- (2) Clean and wash geomembrane surface if QAC determines that amount of dust or mud inhibits examination.
- (3) Do not seam any geomembrane panels that have not been examined for flaws by QAC.
- (4) Nondestructively test seams and any non-seam areas identified by QAC.

B. Trial Seams:

- (1) Make trial seams on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming.
- (2) Make trial seams at beginning of each seaming period, following restart of welding equipment, upon change of seamers, and at least once each 5 hrs, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day.
- (3) Make trial seams under same conditions as actual seams.
- (4) Make trial seams only under observation of QAC.
- (5) Seam overlap shall be as indicated for finished seam.
- (6) Make trial seam sample shall be at least 5 ft long by 1 ft wide (after seaming) with seam centered lengthwise.
- (7) Cut 6 specimens from sample with 1 in. wide die. These specimen locations shall be selected randomly along trial seam sample by QAC. Test 3 specimens in peel and 3 specimens in shear using field tensiometer. Samples shall fail in sheet or exceed the specified peel and shear criteria stated in this Specification.
- (8) If specimen fails, entire trial seam operation shall be repeated. If additional specimen fails, do not use seaming apparatus and seamer until deficiencies are corrected and two (2) consecutive successful trial welds are achieved.
- (9) Cut remainder of successful trial seam into three pieces; one to be retained in OWNER'S archives, one to be retained by INSTALLER, and one to be retained by QAC for possible laboratory destructive seam testing. If required by OWNER, remaining portion of trial seam sample may be subjected to destructive testing.

C. Nondestructive Seam Testing:

(1) General:

- a. Purpose of nondestructive tests is to check continuity of seams. It will not provide quantitative information on seam strength.

- b. Nondestructively test field seams over their full length using vacuum test for extrusion seams, air pressure for double-fusion seams or other OWNER approved method. Document results.
- c. Perform nondestructive testing as seaming work progresses.

(2) Vacuum Testing for extrusion seam:

- a. Energize vacuum pump and reduce tank pressure to approximately 5 psi gauge pressure.
- b. Wet strip of geomembrane approximately 12 in. by 48 in. with soapy solution.
- c. Place box over wetted area.
- d. Close bleed valve and open vacuum valve.
- e. Ensure that leak-tight seal is created.
- f. For minimum of 10 sec, apply vacuum and examine geomembrane through viewing window for presence of soap bubbles.
- g. If no bubbles appear within 10 sec, close vacuum valve and open bleed valve, move box over to next adjoining area with minimum 3 in. overlap and repeat process.
- h. Mark and repair areas where soap bubbles appear.

(3) Air Pressure Testing for double-fusion seam:

- a. Seal both ends of seam to be tested.
- b. Insert needle or other approved pressure feed device into air channel created by fusion weld.
- c. Insert protective cushion between air pump and geomembrane.
- d. Pressurize air channel to 30 psi. Close valve and allow pressure to stabilize for approximately 2 minutes.
- e. Observe air pressure 5 min after initial 2-min stabilization period ends. If pressure loss exceeds 2 psi or pressure does not stabilize, locate faulty area and repair.
- f. Cut opposite end of tested seam area once testing is completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel.
- g. Remove needle or other approved pressure feed device and repair hole in geomembrane.

(4) Inaccessible Seams:

- a. Cap-strip seams that cannot be nondestructively tested.
- b. Cap-strip material shall be composed of same type and thickness geomembrane as geomembrane to be capped.
- c. Examine cap-stripping operations with QAC for uniformity and completeness. Document observations.

D. Destructive Seam Testing:

(1) General:

- a. Perform destructive seam test as seaming progresses.
- b. The destructive seam sample shall fail if the grips of testing machine cannot be closed on sample test flap (available flap is 1/2 in. long or less) due to excessive temporary welding.

- (2) Location and frequency:
- a. Test at minimum frequency of one test location per 500 ft of welding length performed by each fusion welding machine, and one test per 150 ft of extrusion welding.
 - b. Test locations shall be determined during seaming, at QAC'S discretion.
 - c. INSTALLER will not be informed in advance of locations where seam samples will be taken.
 - d. OWNER reserves right to increase frequency of testing in accordance with performance results of samples previously tested.
- (3) Sampling Procedures:
- a. Cut samples at locations chosen by QAC.
 - b. QAC shall number each sample and record sample number and location in panel layout drawing.
 - c. Repair holes in geomembrane resulting from destructive seam sampling immediately in accordance with repair procedures described in this Specification.
 - d. Continuity of repair and seams shall be tested in accordance with vacuum testing requirements.
- (4) Sample Dimensions: Take two 1-in. wide samples for field testing prior to cutting full laboratory sample.
- a. Field Testing: Cut 1 in. wide samples, 8 inches long with seam centered parallel to width. Distance between these 2 samples shall be 42 in. Test both samples on field tensiometer in peel. If both samples pass field test, take sample for laboratory testing.
 - b. Laboratory Testing: Take laboratory test sample from between samples taken for field testing. Cut sample for laboratory testing 12 in. wide by a minimum 42 in. long with seam centered lengthwise. Cut this sample into three parts. QAC shall distribute parts as follows:
 - 1) One part to INSTALLER for optional laboratory testing, a minimum 12 in. by 12 in.
 - 2) One part to Geosynthetic Quality Assurance Laboratory (QAL) for testing, a minimum 12 in. by 18 in.
 - 3) One part to OWNER for archive storage, a minimum 12 in. by 12 in.
 - c. Final determination of sample sizes shall be agreed upon at pre-construction meeting.
 - d. Submit laboratory sample for quantitative testing
- (5) Destructive Test Failure Procedures:

When sample fails destructive testing, whether test is conducted by Geosynthetic QAL or by field tensiometer, CONTRACTOR has following options:

- a. Repair seam between any 2 passing destructive test locations.
- b. Trace welding path to intermediate point (10 ft minimum from point of failed test in each direction) and take small sample with 1 in. wide die for an additional field test at each location. If these additional samples pass test, then take full laboratory samples. If these laboratory samples pass tests, repair seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.

- c. Acceptable repaired seams shall be bound by 2 locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 ft of repaired seam, QAC may have INSTALLER destructive test repair seam.
- d. When sample fails, OWNER may require additional testing of seams that were welded by same welder and/or welding apparatus during same time shift.

E. Repair Verification:

- (1) QAC shall observe number and log each repair.
- (2) Nondestructively test each repair.
- (3) Nondestructive test results that pass shall indicate adequate repair.
- (4) Repairs more than 150 ft long require destructive test sampling.
- (5) Failed destructive or nondestructive tests indicate that repair shall be redone and retested until passing test results.

F. Large Wrinkles: Wrinkle is considered to be large when geomembrane can be folded over onto itself.

- (1) When seaming of geomembrane is completed, and prior to placing overlying materials, QAC shall identify all excessive geomembrane wrinkles, which should be cut and resealed.
- (2) Cut and reseam all wrinkles identified by QAC. Seams produced while repairing wrinkles shall be nondestructively tested.
- (3) Repair wrinkles identified by QAC. Repair during coldest part of installation period.

END OF SECTION

SECTION 02650

LEACHATE COLLECTION AND CONVEYANCE PIPE

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, placing and compacting the drainage conveyance pipe as shown, specified or required. CONTRACTOR shall provide a "Competent Person" to implement and supervise all work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02651 – HDPE Pipe and Manhole Leak Testing

1.03 Submittals

The CONTRACTOR shall submit manufacturer's data sheets, certification of compliance with specifications for all pipes, fittings and appurtenances and leak testing requirements.

1.03 Quality Assurance

- A. Pipe installation shall be performed by skilled workers. Each pipe laying crew shall have a pipe laying foreman.
- B. Pipe shall be accurately installed to the lines and grades shown on the Construction Drawings, or as approved by the ENGINEER, so that inverts are smooth.
- C. Deflections in horizontal alignment at joints are not permitted without the written consent of the OWNER. If so approved, the deflections shall not exceed one-half the manufacturer's recommendation.
- D. The OWNER shall be notified in advance whenever an existing pipeline location conflicts with the proposed locations of the Work.
- E. Pipe and fittings of the same type shall be the products of a single manufacturer.
- F. All piping shall be of the type and size as shown on the Construction Drawings and described in this Section of the Specifications.

1.04 Delivery, Storage, and Handling

- A. All pipes and fittings shall be carefully handled when loading and unloading. Lift by hoists or lower on skidways in a manner to avoid shock.
- B. Where required, due to weight of material and for the safety and protection of workmen, materials, equipment, property, and the work, use derricks, ropes, or other suitable equipment for lowering pipe into trenches. Take particular care to avoid damaging the pipe.
- C. Pipe and fittings shall be protected against the damaging ultraviolet rays of the sun when stored for any period. Such protection shall consist of canvas covering, or other material as recommended by the manufacturer. Plastic sheets shall not be used which may allow excessive temperatures to develop where pipe is stored. All pipe which has been distorted

or otherwise negatively affected by high temperatures shall be rejected, regardless of the pipe's appearance after return to ambient temperatures. Rejected pipe shall be marked by the QAC and removed from the site of the work at the sole expense the CONTRACTOR.

- D. The manufacturer's recommended procedures for pipe stacking shall be followed. When pipe is stacked for storage, the heaviest series of pipe shall be placed at the bottom.
- E. Pipe and fittings shall be protected from damage by sharp objects through all phases of work.
- F. If any defective pipe is discovered after being laid or placed, removal and replacement with a sound pipe will be required without cost to the OWNER.

PART 2 - MATERIALS

2.01 Pipe and Fittings

- A. Piping resins shall be high performance, high molecular weight, high density polyethylene conforming to ASTM D1248 (Type III, Class C, Category 5, Grade P34), and ASTM D3350 (Cell Classification PE345434C). The pipe and fittings shall be manufactured from pre-compounded resin manufactured by the pipe manufacturer, with a minimum of two percent carbon black to withstand outdoor exposure without loss of properties. In-plant blending of non-compounded resins is not acceptable. All polyethylene pipe shall meet the requirements of ASTM F714 for SDR-11, SDR-17, or SDR-21 pipe. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code, and standard dimension ratio.
- B. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes (other than those manufactured), foreign inclusions, or other deleterious defects, and shall be identifiable in color, density, melt index, and other physical properties.
- C. The manufacturer shall provide a product supplying a minimum hydrostatic design basis (HDB) of 1,600 psi at 63.4 degrees F, as determined in accordance with ASTM D2837.

2.02 Tracer Wire

- A. For open cut pipe installations, tracer wire shall be #12 AWG solid copper with 30 mil HMWPE or 60 mil PVC insulation, green in color.
- B. For trenchless pipe installations, tracer wire shall be #12 AWG solid copper clad steel core with 45 mil HMWPE insulation, green in color. Wire shall be expressly specified for use in trenchless tracer wire applications.

PART 3 - EXECUTION

3.01 Inspection - General

- A. Each length of pipe and each fitting shall be carefully inspected prior to placement. All materials not meeting the requirements of these Specifications, or otherwise found defective or unsatisfactory by the QAC, shall be rejected and immediately marked and removed from the job site by the CONTRACTOR.
- B. Bedding, sub-bedding, and other trench conditions shall be carefully inspected prior to laying pipe in each stretch of open trench. All conditions shall be made available to the QAC for inspection purposes, and the QAC shall be further advised where, in the CONTRACTOR's opinion, unstable or otherwise deleterious conditions exist.

- C. Each stretch of completed pipeline shall be inspected prior to backfilling. Backfilling operations shall not be initiated prior to inspection by the QAC.

3.02 Preparation

Pipe and fitting interiors and joint surfaces, shall be thoroughly cleaned prior to installation. Pipe and fittings shall be maintained clean.

3.03 Pipe Installation

- A. Pipes and fittings shall be carefully lowered into place.
- B. Pipe and fittings shall be installed so that there will be no deviation at the joints and so that inverts present a smooth surface. Pipe and fittings which do not fit together to form a tight fitting joint are not permitted.
- C. All HDPE joints shall be welded.
- D. Pipes shall be installed in the locations and to the required lines and grades as shown on the Construction Drawings and provided in these Specifications, using an approved method of control. The OWNER has the authority to order the removal or relaying of all pipe laid contrary to the specifications, his instructions, or during his absence.
- E. Excavations shall be maintained free of water during the progress of the Work. No pipes shall be laid in water nor shall there be any joints made up in water. All slides or cave-ins of the trenches or cuts shall be remedied to the satisfaction of the OWNER.
- F. Cleanliness of installed pipe and fitting interiors shall be maintained throughout the Work.
- G. All adjustments to the line and grade of pipe shall be done by scraping away or compacted filling of the bedding stone under the barrel of the pipe, and not by blocking or wedging.
- H. Fittings shall be installed as required and in accordance with the Construction Drawings and Specifications. The installation of fittings after the pipeline has been laid will not be permitted without the written approval of the OWNER. In such cases, complete details pertaining to the proposed type of fittings and the installation procedure shall be submitted by the CONTRACTOR to the ENGINEER for review and approval before such work can be performed.
- I. Approval by the OWNER is required prior to changing the location of any of the Work due to field conditions. Changes in pipe sizes are prohibited without prior written consent from the OWNER.
- J. All installed piping shall form completely connected systems including connections to and appurtenances specified in other sections to result in a satisfactorily operating installation.
- K. All pipe shall be so laid that after the line is completed, the interior surface thereof shall conform accurately to the established grade and alignment. No deflections shall be allowed at joints.
- L. Pipe lengths of at least 20 feet shall be utilized, except that shorter random lengths may be utilized where wyes and tees, and similar circumstances are present, only inasmuch as is necessary to properly effect the joint(s) in the desired location. In all cases, the number of pipe joints shall be minimized. In the case of random lengths of pipe, the CONTRACTOR shall provide proper smooth and square ends prior to assembling.
- M. All pipe ends not terminated by another specific fitting shall be capped with a slip cap. Caps shall not be bonded to the pipe unless otherwise specifically noted on the Construction Drawings.

3.04 Tracer Wire

- A. Install tracer wire for all non-perforated, non-metallic underground piping installations where indicated on the Contract Drawings and where allowed by code. Use on other perforated pipes (e.g. toe drain) where shown on the Contract Drawings.
- B. Do not install tracer wire on the perforated leachate collection pipes or sideslope risers within the landfill lined area.
- C. Secure wire to top of pipe at maximum 8-foot intervals using plastic tape or cable ties. Run wire to the side of fittings and valves where required.
- D. Provide terminal access to each end of tracer wire at convenient locations (e.g. cleanouts, pump vaults, etc.).
- E. After installation of pipe with tracer wire, verify the electrical continuity of the installed wire run.

END OF SECTION

SECTION 02651

HDPE PIPE & MANHOLE LEAK TESTING

PART 1 - GENERAL

1.01 Scope of Work

- A. CONTRACTOR shall furnish all labor, material, equipment, tools, and appurtenances required to setup and pressure test non-perforated HDPE pipe.
- B. CONTRACTOR shall conduct all pressure testing using water as the testing method. The piping manufacturer and the ENGINEER shall be consulted before using pressure testing methods other than those presented here. Other pressure testing procedures may or may not be applicable, depending upon piping products and/or piping applications.
- C. CONTRACTOR shall comply with all applicable codes, ordinances, rules, regulations and laws of local, municipal, State, or Federal authorities having jurisdiction. CONTRACTOR shall also comply with all applicable health and safety regulations as required by OSHA and in accordance with the CONTRACTOR's Health and Safety Plan.
- D. CONTRACTOR shall conduct all tests in a manner to minimize as much as possible any interference with the day-to-day operations of existing facilities or other contractors working on site.

1.02 Related Sections

- A. Section 02650— Leachate Collection and Conveyance Pipe

1.03 Submittals

- A. Testing Report

Prior to placing the leachate conveyance system into service, submit for review and approval a detailed report summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based. The report shall include, at a minimum, the following information:

- (1) The length and diameter of the section of line tested.
- (2) A complete description of test procedures and methods, including:
 - a. Trench backfilling and pipe cleaning status
 - b. Types of plugs used and where
 - c. Stabilization time period and water pressure
 - d. The allowed time by specifications
 - e. The actual test time
 - f. The water pressure at the beginning and end of the test.
- (3) The name of the inspector / tester and the date and time of all testing, including any retesting
- (4) A description of any repairs made.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 Leakage Testing for Pipes

A. General

All new non-perforated leachate conveyance pipe installed shall be tested for leakage. The test used will be hydrostatic testing. Pressure testing with air is not allowed. Testing to be performed will be indicated by the ENGINEER and witnessed by the ENGINEER and the OWNER's representative.

B. Flushing

All pipe shall be flushed to remove all sand and other foreign matter. The velocity of the flushing water shall be at least 4 fps. Flushing shall be terminated at the direction of the ENGINEER. Dispose of the flushing water in accordance with the site-specific SWPPP.

C. Test Preparation and Inspection

- (1) Perform hydrostatic testing of the system as set forth in the following, and perform such testing in the presence of the ENGINEER and the OWNER's representative. Give 48 hours notice of planned testing.
- (2) Piping and appurtenances to be tested shall be sections of at least 250 feet in length, unless unavoidable. All piping shall be thoroughly cleaned and flushed prior to testing to clear the lines of foreign matter. While the piping is being filled with water, care shall be exercised to permit the escape of air from the extremities of the test section, with additional release cocks (provided by the CONTRACTOR) if required. Venting may be provided by loosening flanges. Re-tighten any loosened flanges before applying test pressure.
- (3) Test equipment and the pipeline should be examined before pressure is applied to ensure that connections are tight, necessary restraints are in place and secure, and components that should be isolated or disconnected are isolated or disconnected. All low pressure filling lines and other items not subject to the test pressure should be disconnected or isolated.
- (4) If a lower pressure rated component the system cannot be removed or isolated, then the maximum allowable test pressure is the allowable pressure of the component.

D. Monitored Make-Up Water Test

- (1) The test procedure consists of initial expansion and test phases. During the initial expansion phase, the test section is pressurized to the test pressure, and sufficient make-up water is added each hour for three (3) hours to return to test pressure.
- (2) After the initial expansion phase, the test phase begins. The test phase may be one (1), two (2), or three (3) hours, after which a measured amount of water is added to return to test pressure. If the amount of water does not exceed the amount shown in Table 1, leakage is not indicated.
- (3) The testing procedure shall consist of the continued application of the specified pressure to the test system for the duration of the test period, by way of a pump taking supply from a container suitable for measuring water loss. The amount of

loss shall be determined by measuring the volume of water taken from said container.

- (4) Hydrostatic testing shall be performed with a sustained pressure after the expansion phase for a minimum of one (1) hour at 1-1/2 times the working pressure of the pipe, unless otherwise approved by the OWNER. The allowable leakage shall be less than the number of gallons per hour determined from the following table:

Table 1 - Test Phase Make-Up Amount

Nominal Pipe Size, in.	Make-Up Water Allowance (U.S. Gallons per 100 ft of Pipe)		
	1 Hour Test	2 Hour Test	3 Hour Test
2	0.07	0.11	0.19
3	0.10	0.18	0.29
4	0.13	0.25	0.4
6	0.3	0.6	0.9
8	0.5	1.0	1.5
10	0.8	1.3	2.1
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.0	4.3	6.5

- (5) The testing duration, including initial pressurization, initial expansion and time at test pressure must not exceed eight (8) hours. If the pressure test is not completed due to leakage, equipment failure, etc. the test section shall be depressurized and allowed to "relax" for eight (8) hours before bringing the test section up to test pressure again.

3.01 Leakage Testing for HDPE Structures

- (a) Perform leakage testing for vaults, wet wells and manholes prior to backfilling by filling the structure with water to the overflow level and observing the water level for the following 24 hours.
- (b) Make an inspection for leakage of the exterior surface of the structure, especially in areas around construction joints.
- (c) Leakage will be accepted as within allowable limits for structures from which there are no visible leaks and the leakage rate does not exceed 0.02 gallon per 100 gallons of computed capacity per hour. Method for testing leakage shall be submitted to the ENGINEER prior to testing.
- (d) If visible leaks appear, repair the structure by removing and replacing the leaking portions of the structure, waterproofing the inside, or by other methods approved.
- (e) Water for testing will be provided by the OWNER at the CONTRACTOR's expense.
- (f) Submit a report describing the manhole description, duration of test, results of testing, and any repairs made.

END OF SECTION

1.07 WARRANTY

- A. CONTRACTOR shall provide a one-year warranty on all permanent seeding. If after a one-year period, a mature stand of grass vegetation is not established to the satisfaction of the OWNER, the CONTRACTOR shall be responsible for re-top soiling, fertilizing, seeding, and mulching any denuded areas. At which time, another one-year warranty shall be provided to the OWNER by the CONTRACTOR on the repaired areas. Retainage, if specified in the contract and withheld on seeding, shall not be released until the warranty period is over and the OWNER is satisfied with the final stand of vegetation.

PART 2 - PRODUCTS

2.01 Fertilizer

The fertilizer shall consist of 12-12-12 commercial grade fertilizer, unless otherwise needed based on fertility test of topsoil.

2.02 Seed

- A. Seed shall be brought on site unmixed unless the mixture is certified and stated on the package as to the quality and mixture. Mixing shall be done at the project site from the original unopened packages. Unless otherwise indicated from soil-specific analysis, seed mixtures and application rates shall be as follows:

<u>Common Name</u>	<u>Total Lbs per Acre</u>
Kentucky 31 Fescue	128 lbs
Red Top Grass	2 lbs
Season Nurse Crop *	20 lbs

- * Use seasonal nurse crop in accordance with seeding dates as stated below:

February through April	Annual Rye
May 1 st through August	Foxtail Millet
September through November 15 th	Annual Rye
November 16 th through January	Winter Rye

Weeping Lovegrass may be added to the seeding mix during the warmer seeding periods; add 10-20 lbs./acre in mixes.

- B. Labels and contents shall conform to all State and Federal regulations.

2.03 Agricultural Ground Dolomitic Limestone

- A. Agricultural ground dolomitic limestone shall conform to the standards of the Association of Official Agricultural Chemists, and must comply with all existing State and Federal regulations.

- B. The material must comply with the following gradation:

<u>Square Mesh Sieves</u>	<u>Percent Passing by Weight</u>
Pass # 10	100
Pass # 20	90
Pass #100	40

- C. The minimum calcium carbonate equivalent shall be 90.
- D. The OWNER reserves the right to draw such samples and perform such tests as he deems necessary to assure that these Specifications are met.

SECTION 02936

SEEDING

PART 1 - GENERAL

1.01 Description

- A. Supply all material, labor, equipment required for soil preparations and placement of lawn seeding in location as directed by the OWNER or as shown on the plans. This work shall include maintenance of established lawns until final acceptance. The CONTRACTOR shall be expected to provide and place all topsoil necessary to complete the work.
- B. Apply lime, fertilizer, seed and seed mulch to all topsoiled areas disturbed by the work not receiving a specific surfacing.

1.02 Requirements of Regulatory Agencies

Pesticides, herbicides and fungicides shall be used in accordance with the specifications of the prevailing Public Health Authority or Agricultural Extension Service.

1.03 Related Work

- A. Section 01540 – Dust Control
- B. Section 02125 – Temporary and Permanent Erosion and Sedimentation Control
- C. Section 02235 – Vegetative Layer

1.04 Submittals

- A. Submit full and complete information on topsoil sampling and fertility testing results prior to amending topsoil with lime and fertilizer.
- B. Submit to the ENGINEER affidavits certifying that seed comply with the specifications.
- C. Submit Flexible Growth Medium (FGM) or hydroseed procedure and application rates for approval by ENGINEER.
- D. Submit full and complete written maintenance instructions for proper care and development of seeded areas to OWNER prior to substantial completion.
- E. Submit material certification for seed mulch to the ENGINEER.

1.05 Product Handling

Deliver seed, lime and fertilizer in new, clean, sealed containers.

1.06 Scheduling

- A. Schedule planting of seeding areas for optimum germination as follows:
 - (1) Spring planting schedule is March 15th to June 15th
 - (2) Fall planting schedule is August 15th to October 15th
- B. Seeding dates other than listed above are to be approved by the OWNER.

2.04 Seed Mulch

- A. Provide erosion control or hydromulch as required in areas to be seeded.
- B. Seeding mulch shall be wood fiber, straw or non-woven fibers free from weeds and coarse matter.

PART 3 - EXECUTION

3.01 General

Construction methods shall be those established as agronomically acceptable and feasible and which are approved by the OWNER.

3.02 Seed Bed Preparation

- A. The areas shall be made friable and receptive to seeding by approved methods, which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.
- B. Fine grade areas to a firm even surface, free from lumps or stones 1 inch or more in any dimension. Installation of grass areas may be done immediately after finish grading provided the seeding bed is in a good condition and not muddy or hard. If it is hard, till to a friable condition again.

3.03 Seeding Operations

- A. Seed areas within the areas disturbed by CONTRACTOR as directed by the OWNER and Contract Drawings. After cleaning the seeding area of coarse material, maintain finish grades as shown on the Contract Drawings and spread fertilizer and lime uniformly over the areas using an approved mechanical spreader. The rate of application of fertilizer shall be commercial fertilizer as required to provide 1 lb. of nitrogen per 1,000 square feet or as indicated by soil test results.
- B. The lime application rate will be based on fertility test results and will be broadcasted prior to harrowing and raking of topsoil prior to fertilizing to achieve a minimum soil pH of 6.5. The maximum application rate allowed is 100 lbs per 1,000 square feet.
- C. Do not undertake seeding in windy or unfavorable weather or when the ground is too wet to rake easily, frozen, or too dry. Uniformly sow seed at a rate specified, using drills or seeders or hydroseeding. If hydroseeded, add 10 percent to seeding mixture requirement.
- D. Drill in the specified seed mixture uniformly at the rate specified, using a press drill equipped with individually mounted, adjustable spring load, double disk furrow openers fitted with depth control banks or drums. Make two passes at right angles to one another.

3.04 Replanting

- A. The CONTRACTOR shall be required to replant areas damaged by water, wind, fire, equipment or pedestrian traffic as necessary or when ordered by the OWNER at no cost to the OWNER.
- B. All areas and spots that do not show a prompt catch of vegetation shall be reseeded at fifteen day intervals until a growth of grass is established. Contractor shall reseed as required to establish a minimum of 95% vegetation coverage within 1 year of initial planting. Remedial seeding, fertilizer and lime will be applied at no additional cost to the OWNER.

3.05 Compaction

The CONTRACTOR shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the CONTRACTOR shall rework the soil to make a suitable seedbed; then reseed and reblanket such areas with the full amounts of the specified materials, at no extra expense to the OWNER.

3.06 Mulching

- A. If seeding is done with hydromulching, then seeding mixture shall be increased 10 percent.
- B. Hydromulching of seeding areas shall have approved mulch applied at a rate as recommended by the manufacturer for tackling agent.
- C. Other methods of mulching shall not be applied prior to approval by the ENGINEER.

3.07 Maintenance of Grass Areas

- A. Water, weed, and reseed throughout the construction contract and/or acceptance by the OWNER after seeding areas are substantially established turf areas.
- B. Install and maintain temporary protection fences, barriers, and signs where deemed necessary.

END OF SECTION

Date: April 18, 2014

Made by: DPM

Project No.: 130-0193

Checked by: JTB

Subject: Capacity of Channel SCC-04

Reviewed by:
Project: CEC BOTTOM ASH POND CLOSURE CAP

This purpose of this evaluation is to verify the design and performance of the proposed stormwater channel SCC-04 crossing the final cap of the bottom ash pond. SCC-04 is part of the perimeter channel system for the adjacent ash landfill.

1.0 DESIGN STANDARDS

For this project, two standards cover the design of the stormwater channels. The first are the Virginia Erosion and Sediment Control Minimum Standards (9VAC24-840-40). Minimum Standard 19 (MS-19) states that the design of man-made channels shall be verified so that stormwater will not overtop the channel banks during the 10-year storm event and that stormwater will not cause erosion during the 2-year storm event. The second standard is from the Virginia Solid Waste Management Regulations (VSWMR), section 9VAC20-81-130, which requires surface water systems to control the runoff volume from at least the 25-year storm event.

2.0 CALCULATIONS

2.1 Channel Flow

The computed flows in SCC-04 were made using the US Army Corps of Engineers Hydrologic Engineering Center's Hydraulic Modeling System (HEC-HMS) software package as part of the overall stormwater control system for the landfill. SCC-04 has a total contributing drainage area of 20.89 acres. The channel is a trapezoidal shape with a 10-foot wide bottom, 2:1 sideslopes and has a constructed depth of 3 feet. Computed flows, and the resulting depths and velocities (Table 1) were computed using the Manning's equation for open channel flow.

Table 1: SCC-04 Computed Stormwater Flows

Storm, yr	Flow, CFS	Flow Depth, ft	Freeboard, ft	Velocity, ft/s
2	34.4	1.21	1.79	2.29
10	79.7	1.93	1.07	2.97
25	112.4	2.34	0.66	3.29
100	173.1	2.95	0.05	3.73

The computed velocity at the 2-year event is 2.29 ft/s. This is within the recommended limits for a grass-lined channel; however, this channel will be lined with a non-biodegradable lining and seeded to provide for good grass establishment and erosion resistance for larger flow events. The channel has adequate conveyance capacity for the 25-year event.

3.0 CONCLUSIONS

Based on the calculations presented herein, the channel size and lining is adequate to handle the runoff from the 2-year and 25-year storm events.



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