

Mathews, Barbara

From: King, Jonathan B. <Jonathan.King@terracon.com>
Sent: Wednesday, April 20, 2016 4:56 PM
To: Leamons, Bryan; Matoska, Maria; Mathews, Barbara
Cc: keith.byerly@ashgrove.com; charles.beauvais@ashgrove.com; Carpenter, Owen
Subject: Notification of Construction Ash Grove Cement Company AFIN: 41-00230

Mr. Leamons,

Please see below a Sharefile download link containing the Notification of Construction in regard to the 7.5 Acre Partial Closure Project located at the Ash Grove Cement Company-Foreman site. Attached to the Notification of Construction are updated facility plans along with the construction drawings and technical specifications as requested in the March 13, 2015 meeting between the ADEQ and Terracon. If you have any trouble accessing the electronic data please let me know. Also if you have questions or need additional information feel free to contact me at your earliest convenience.

<https://terracon.sharefile.com/d-s6096042ea2341fe9>

Thank You
Jonathan

Jonathan King
Staff Engineer I Solid Waste Services

Terracon

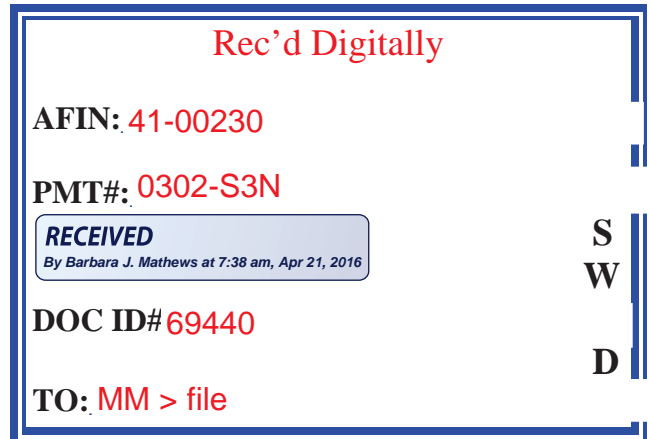
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Terracon provides environmental, facilities, geotechnical, and materials consulting engineering services delivered with responsiveness, resourcefulness, and reliability.

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April 20, 2016

Solid Waste Division
Arkansas Department Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317

Attention: Mr. Bryan Leamons, P.E., Engineer Supervisor
P: (501) 682-0601
E: leamons@adeq.state.ar.us

**Subject: Notification of Construction – Module A Partial Closure
Ash Grove Cement Company Class 3N Landfill
Permit No. 0302-S3N; AFIN: 41-00230**

Dear Mr. Leamons:

Terracon Consultants, Inc. (Terracon) is providing this notification of construction on behalf of the Ash Grove Cement Company Class 3N Landfill (Facility), located near Foreman, Arkansas. The Facility is partially closing Module A at the existing Class 3N Landfill. Terracon and the Facility are notifying the Arkansas Department of Environmental Quality (ADEQ) of the proposed construction schedule in accordance with **Reg.22.428(f)** of Regulation 22. The earthwork contractor anticipates beginning construction on April 19, 2016. Below is the proposed schedule of construction events.

RESPONSIBLE PARTIES	DATES
Earthwork Contractor (James Construction Group, LLC)	4/18/16 – 8/4/16
CQA Services (Terracon Consultants, Inc.)	4/18/16 – 8/4/16
Surveying (Mason Surveying and Consulting, Inc.)	4/18/16 – 8/4/16
Geosynthetics Installer (Environmental Specialties International, ESI)	5/28/16 – 6/20/16

Note: This schedule is tentative and may change due to weather delays.

The earthwork contractor has completed over 500,000 square feet of clay liner during the last three years. Therefore, Terracon requests that the ADEQ waive the test fill requirements of Reg.22.428(c)(11). A construction certification report documenting construction activities will be submitted to the ADEQ upon completion of construction.



Notification of Construction ■ Proposed 7.5 Acre Partial Closure

Ash Grove Cement Company ■ Class 3N Landfill

April 20, 2016 ■ Terracon Project No. 35147187



Attached to this notification of construction are updated facility plans along with the construction drawings and technical specifications as stated in the March 13, 2015 meeting between Terracon and the ADEQ. The updated items include the Construction Quality Assurance (CQA – submitted previously), Closure and Post-Closure Care, and Operating plans. Ash Grove and Terracon would like to thank the ADEQ for the rapid approval and response to the previous submittal of the CQA Plan (ADEQ Doc Id. 69374).

If you have any questions or comments regarding this notification, please feel free to contact me at jbking@terracon.com or 501-847-9292 at your convenience.

Sincerely,

Terracon Consultants, Inc.


Jonathan King
Staff Engineer


F. Owen Carpenter, P.E., P.G.
Engineering Department Manager

Attachments: Closure and post-closure care plan with updated financial assurance costs, construction quality assurance plan, operating plan and narrative, & closure construction drawings and technical specifications.

Cc: Keith Byerly, Environmental Manager

N:\Projects\2014\35147187\Working Files\ADEQ Notification of Construction.doc\

Attachment A

Closure and Post-Closure Care Plan

Closure & Post-Closure Care Plan

Ash Grove Cement Company
Class 3N Landfill
Permit No. 0302-S3N
AFIN: 41-00230

April 2016
Project No. 35147187



Prepared for:

Ash Grove Cement Company
4343 Highway 108
Foreman, AR 71836
(870) 542-3000

Prepared by:

Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022
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PROFESSIONAL ENGINEER'S CERTIFICATION

"I certify to the best of my professional judgment that this document and all attachments properly adhere to established, sound engineering practices. This certification is contingent on the fact that all information supplied to the signatory authority, up to the date of this certification, is unquestionably accurate and was provided in good faith."

F. Owen Carpenter, P.E., P.G.
Arkansas Professional Engineer No. 8653

April 18, 2016

Date



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Closure & Post-closure Care Plan

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TABLES

Table 1 Estimated Closure Schedule

FIGURES

Figure 1 Site Location Map

APPENDICES

Attachment A Closure and Post-closure Cost Estimates

Attachment B Financial Assurance Mechanism

Attachment C Closure Phasing Drawings

2.0 CLOSURE PLAN

The following sections describe the general layout, design, and operations of the Landfill. This Closure and Post-closure Plan has been developed for the Class 3N Landfill, and addresses all waste management and disposal areas at the landfill.

2.1 GENERAL SITE LAYOUT

The landfill site consists of approximately 91 acres with approximately 41 acres permitted for solid waste disposal. Various support facilities including entrance roads, vehicle/equipment facilities, groundwater monitoring facilities, wastewater treatment facilities, other Class 3N Landfill facilities and surface water drainage systems are located adjacent to the Ash Grove Cement Company Class 3N Landfill.

2.2 INDUSTRIAL SOLID WASTE DISPOSAL AREA

The CKD landfill has an irregular shape consisting of approximately 41 acres. The landfill is configured to be developed in four modules starting with Module A at the west end and progressing eastward through B, C, and D as shown in the Permit Drawings found in Attachment D of the FPA. The Landfill is being developed from Module A to Module D as described in the Permit Design Narrative Section of the FPA. As of April 2015, Module A and Module B have been prepared for waste, and waste has been placed in approximately 42% of the available airspace in Module A and Module B, collectively. The Landfill progression is generally from the west to the east in the prepared areas. Ash Grove began filling Module A at the west side of the Landfill on June 15, 2003. The Landfill will be closed as it is developed, the closure sequence will progress from west to east.

2.3 CLOSURE REQUIREMENTS

The closure plan for the facility includes all of the information required by **Reg.22.1301** as presented in the sections that follow. The steps that are necessary to close all of the landfill units at any point during its active life, in accordance with the proposed cover design, are presented.

2.3.1 Description of Final Cover System (Reg.22.1301(c)(1))

This section describes the configuration of the landfill at final closure. It includes a description of the various components that will have been completed at the time of closure. Information incorporated in this section includes excerpts from the effective closure plan submitted within the FPA as prepared by CH2M HILL.

The final grading plan is shown in Attachment D of the FPA. This plan provides for a final landfill volume of about 2,874,000 cubic yards, which based on current utilization rates, would be projected to be filled in greater than 100 years.

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The outer slopes of the perimeter dike are shaped to a slope of approximately 2H:1V. The landfill will be graded to provide 3H:1V outer slopes with benches. The benches will be approximately 15 feet in width and will be constructed every 20 feet vertically on the sideslopes. It provides an effective slope of about 3.5H:1V, which is stable and readily accessible for maintenance. The benches break up the drainage length along the slope and help to control surface water velocities and erosion. According to the FPA, the estimated long-term erosion potential is estimated to be approximately 2 tons per acre per year once the slopes have been fully vegetated. This value conforms with U.S. Environmental Protection Agency (EPA) guidance for landfill closure design and will comply with the conformance standards of **Reg.22.1301(h)**.

The closure cost estimates for the Facility will be adjusted yearly to account for any partial closures or modified permit conditions. Closure construction will be monitored and documented in accordance with the facility Construction Quality Assurance Plan. Documents related to final cover system construction activities will be placed in the POR and the ADEQ will be notified of such activities.

The final cover system details are shown in Attachment D of the FPA. The final cover system consists of the following from bottom to top:

- A 6-inch bedding layer consisting of compacted CKD materials
- A 40-mil (0.040-inch) linear low density polyethylene (LLDPE) flexible membrane liner (FML), or an equivalent liner that is compatible with CKD
- A geocomposite drainage layer (GC)
- An 18-inch erosion/vegetative layer

The cover system described above is an alternative cover design to both the minimum Class 3N cover requirement specified in Arkansas Regulation 22 Section 1301(b), and the minimum CKD Landfill cover system specified in EPA's 1999 Proposed Rule for CKD Management. In Regulation 22, Section 1301(b), a cover system is specified that consists of at least an 18-inch infiltration layer and a 6-inch erosion layer. The infiltration layer must have a hydraulic conductivity of no more than 1×10^{-5} centimeters per second (cm/s), or the hydraulic conductivity of the formation below the landfill, whichever is less. The minimum cover requirement under EPA's Proposed Rule is similar, except that the erosion layer must have sufficient thickness to sustain vegetation. Both allow for alternative designs of equal or better performance.

Previous Hydraulic Evaluation of Landfill Performance (HELP) simulations were conducted by CH2M HILL (ADEQ Doc # 15635 and ADEQ Doc # 15430) to evaluate the infiltration reduction potential of the proposed alternative cover system with that of the Regulation 22 cover system (*Plans for Closure and Post-closure Care, Existing Cement Kiln Dust Landfill, Ash Grove Cement, Foreman, Arkansas*). The infiltration layer for the Regulation 22 cover system was assumed to have a maximum hydraulic conductivity of 3×10^{-6} cm/s to conform to the average measured hydraulic conductivity of the formation of the landfill. Both simulations included the following assumptions:

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- Surface slopes vary from 4 percent at the top of the landfill to 33 percent on the sideslopes of the landfill
- The average hydraulic conductivity of landfilled CKD is 2×10^{-5} cm/s for CKD materials taken from the Foreman Plant and compacted to at least 85 percent of relative compaction based on Standard Proctor maximum dry density.

The results of the HELP model simulations indicated that up to 15 percent of the annual rainfall could infiltrate to the base of the landfill with the Regulation 22 cover system, but less than 1 percent of annual rainfall could infiltrate to the base of the landfill with the alternative cover design proposed in this closure plan.

The erosion layer and vegetative cover system were designed to conform to the provisions of the EPA Proposed Rule requiring a soil thickness capable of sustaining vegetation with minimal irrigation or maintenance. The erosion layer and vegetative cover system design consists of the following:

- A 12-inch compacted soil base layer installed in a single lift and compacted only to the degree necessary to remain stable on the slope, yet loose enough to allow root penetration
- A 6-inch vegetative support (topsoil) layer lightly compacted and then cultivated to form a suitable seed bed
- Nutrient augmentation, as necessary, and heavy seeding with bahia or bermuda grass

Materials for both the 12-inch base and 6-inch vegetative support layers will come from surface soil deposits stripped from the site and stockpiled. If there is a shortage of these surface soil materials, it is expected stockpiles of soils stripped during the quarry operations.

Common bahia or bermuda grass was recommended by the University of Arkansas Cooperative Extension Service Office in Little Rock. According to Extensive Service personnel, these grasses are relatively drought resistant, hard to eradicate, and require only 6 to 12 inches of soil beneath them. They typically become dormant during sustained dry weather periods and actively grow when moisture is again present.

To confirm that the design provides a reasonable level of water storage for vegetative growth, HELP model results performed for the *Plans for Closure and Post-closure Care, Existing Cement Kiln Dust Landfill, Ash Grove Cement, Foreman, Arkansas*, were reviewed to determine the potential frequency and duration of drought conditions that may have to be sustained by vegetative cover system. It was found that there is essentially no difference in the number of days that the moisture content in the erosion layer is less than the wilting point with either an 18- or a 24-inch thick erosion layer.

In summary, the evaluations described above confirm that the alternative cover system proposed for the existing CKD Landfill meets or exceeds the minimum requirements of both Regulation 22 and the EPA Proposed Rule for CKD Management.

2.3.2 Estimate of Largest Area (Reg.22.1301(c)(2))

The estimated largest area of the landfill unit ever requiring closure at any time during the active life of the Landfill is noted on the financial assurance cost estimates in **ATTACHMENT A**.

2.3.3 Maximum Inventory (Reg.22.1301(c)(3))

The estimated maximum inventory of waste ever on-site over the active life of the landfill is 2,874,000 cubic yards according to the FPA. The maximum inventory of waste that may be accumulated at the site and would still need to be processed in some way (for example, would still require placement within the landfill or would require load-out from the collection hopper into a haul vehicle and transportation to the landfill followed by placement within the landfill) is approximately 5,000 cubic yards.

2.3.4 Schedule for Closure (Reg.22.1301(c)(4))

Final closure of the landfill will begin once the permitted capacity has been reached. In accordance with the closure phasing diagrams depicted in **Attachment C**, routine closure will be completed as planned and scheduled by Ash Grove, depending on the economic and other factors considered at the time of closure. If there is a need to close the facility prematurely, construction plans for the closure will be developed at the time of closure. An estimated schedule, based on the largest area of the landfill requiring a final cover at any time during the active life, for completing all activities necessary for a premature closure is presented in **TABLE 1**. Attachment A Closure Cost Estimate indicates the largest area of the landfill requiring a final cover at any time during the active life.

**TABLE 1
ESTIMATED CLOSURE SCHEDULE**

Closure Activity/Task	Number of Days to Complete
Notify the ADEQ of intent to perform closure	1
Begin closure activities	20
Perform grading of waste	10
Install final cover system	120
Seed and mulch	10
Installation of erosion and sediment control structures	10
Complete certification report	10
Estimated Total time to Complete Closure	180

Reg.22.1301(g) requires that the facility complete the closure activities in a timely manner. It is estimated that closure of the facility will be completed no later than 180 days following the beginning of closure activities. If necessary, due to inclement weather or other circumstances (**Reg.22.1301(g)**), a request to extend this schedule may be made to the Director of the ADEQ.

Closure & Post-closure Care Plan

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2.3.5 Closure Plan Approval (Reg.22.1301(d))

The facility will submit the prepared closure plan, including any revisions that may be necessary to the ADEQ for approval, prior to beginning any closure activities. It is anticipated that this revised closure plan will be submitted to the ADEQ for their approval in conjunction with the construction notification provided prior to construction of the first partial closure area in Module A.

2.3.6 Notification Requirements (Reg.22.1301(e))

The ADEQ will be notified when the facility stops receiving waste for disposal. The Director of the ADEQ will be notified, prior to the beginning of closure of the landfill, that the intent to close the landfill has been placed in the POR.

2.3.7 Estimated Closure Costs (Reg.22.1402)

In accordance with **Reg.22.1402**, estimated costs for closing the facility will be developed based on hiring a third party to close the largest area requiring final cover at any given time during the operation of the Class 3N facility. **ATTACHMENT A** presents the estimated closure cost for closing the largest area potentially requiring closure at the facility.

2.3.8 Facility Recordkeeping and Report Requirements (Reg.22.520(a)(6))

A copy of the approved closure and post-closure plan will be kept in the POR (**Reg.22.520(a)(6)**). The Director of the ADEQ will be notified that closure and post-closure plans have been prepared and placed in the POR (**Reg.22.1302(e)**). The records will be permanently maintained in the facility permanent operating record unless destruction of the records is authorized by the Director of the ADEQ following the completion of the post-closure monitoring period (**Reg.22.1301(d)**). The Director of the ADEQ will be provided with updated closure and post-closure cost estimates for the landfill each year with the Annual Engineering Inspection Report. These estimates will also be placed within the POR (**Reg.22.1301(d)**).

2.3.9 Financial Assurance

Evidence of a financial assurance mechanism for closure and post-closure care will be placed in the POR and provided to the ADEQ annually. **ATTACHMENT B** presents the financial assurance instrument for the closure and post-closure care of the facility.

2.3.10 Site Survey (Reg.22.1301(i))

Before Installation of the final cover, the site will be graded to prevent stormwater from running onto the landfill (**Reg.22.1301(h)**). Upon completion of the installation of the final cover system for each phase, the site will be surveyed by a registered professional engineer or surveyor to document the final elevations of the Class 3N facility, the location of the surface improvements, site boundaries, and areas that received waste. Final closure of the site will be achieved when

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all permitted cells/modules have been filled and have the final cover system installed. Closure will be considered complete after the final cover has been inspected and approved by the ADEQ. The final cover plan and typical final cover details for the facility are included in the permit drawings provided in the FPA.

2.4 CLOSURE DOCUMENTATION

2.4.1 Land Use Restrictions (Reg.22.1301(j) and (k)).

Following placement of final cover over the landfill, a notation will be recorded on the deed to the property. The Director of the ADEQ will be notified that the notation has been recorded and a copy has been placed in the POR. The notation on the deed must inform any potential purchaser of the property of the following:

- The past use of the land was as a solid waste disposal facility;
- Future use shall comply with the ADEQ regulations and shall not disturb the integrity of the final cover system or any other components of the containment or monitoring system; and,
- It shall be unlawful for any person, partnership, company, corporation or other entity to build, erect, or construct any house, home, or building to be used for residential purposes.

The restriction of residential construction applies only to the areas actually used for solid waste disposal. The owner may request permission from the Director of the ADEQ to remove the notation from the deed if all wastes are removed from the facility.

2.4.2 Closure Certification (Reg.22.1301(l)).

Following closure of the facility, the Director of the ADEQ will be provided a certification, signed by a registered professional engineer, verifying that closure has been completed in accordance with the closure plan, and that this certification has been placed in the POR. A final closure report shall accompany the certification that includes:

- The final survey, in accordance with **Reg.22.1301(i)**;
- Quality control and quality assurance data documenting proper construction and installation of the cover system;
- A copy of the deed notation required under **Reg.22.1301(j)**; and,

Other information that the ADEQ may deem necessary to making the certification described in **Reg.22.1302(h)**.

3.0 POST-CLOSURE CARE PLAN

The post-closure period shall be two years following the date of written confirmation by the ADEQ that the facility has been closed in accordance with the approved closure plan, unless the period is decreased or increased by the Director of the ADEQ (**Reg.22.1302(c)(4)**). The period may be decreased if the facility demonstrates that the reduced period is sufficient to protect human health and the environment and this demonstration is approved by the Director of the ADEQ (**Reg.22.1302(c)(4)(i)**). The period may be increased if the Director determines that the lengthened period is necessary to protect human health and the environment (**Reg.22.1302(c)(4)(ii)**). During the post-closure care period, the closure cover shall be maintained and monitoring activities will be performed as described in the following subsections.

3.1 POST-CLOSURE MONITORING AND MAINTENANCE (**Reg.22.1302(b)**)

Access to the site after closure will be controlled through maintenance of existing fencing and signs, and all access gates will be locked to discourage unauthorized entry.

The integrity of the final cover shall be maintained, including the repair of the cover, as necessary to correct the effects of settlement, subsidence, and erosion, and prevent runoff and run-on from damaging the cover. Vegetation shall be mowed at least annually to control the growth of unwanted vegetation that may interfere with integrity of the final cover. All cracked, eroded and uneven areas must be filled and reseeded and ditches maintained (**Reg.22.1302(b)(1)**).

If applicable, any leachate collection system will be maintained and properly operated during the post-closure period in accordance with the requirements of **Reg.22.429 (Reg.22.1302(b)(2))**. However, the landfill has demonstrated in Attachment G of the FPA that leachate collection is not necessary at the CKD landfill.

During the post-closure period, the facility will continue to monitor the ground water in accordance with the requirements of Regulation 22, Chapter 12, and maintain the groundwater monitoring system (**Reg.22.1302(b)(3)**).

If applicable during the post-closure period, the facility will maintain and operate a gas monitoring system in accordance with the requirements of (**Reg.22.1302(b)(4)**). The facility will also maintain and properly operate the gas collection and processing system, if applicable (**Reg.22.1302(b)(5)**), during the post-closure period. However, neither a gas monitoring system nor a landfill gas collection and processing system is required at the landfill at this time.

The surface water control systems will be operated and maintained in accordance with **Reg.22.419** and **Reg.22.1302(b)(1)** or until such time as a permanent erosion control measures have been established at the site.

Closure & Post-closure Care Plan

Ash Grove Cement Company ■ Class 3N Landfill

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3.2 CONTACT PERSONS (Reg.22.1402(d))

The name, address, and telephone number of the person to contact about the facility during the post-closure period will be provided upon notice of closure.

3.3 POST-CLOSURE COST ESTIMATE (Reg.22.1402)

An estimate of the cost of performing post-closure activities is based on the estimated cost of hiring a third party to conduct the activities. The cost estimate is based on the most expensive costs of post-closure care during the post-closure care period. **ATTACHMENT A** presents the estimated post-closure cost for the facility. The post-closure cost estimate will be revised annually during the life of the facility to account for inflation.

3.4 CERTIFICATION OF COMPLETION (Reg.22.1302(f))

Following the completion of the post-closure care period for the facility, the Director of the ADEQ will be notified that a certification has been placed in the POR. The certification, signed by an independent registered engineer and approved by the Director of the ADEQ, will verify that post-closure care has been completed in accordance with the post-closure plan.

3.5 SITE MANAGEMENT AND USE (Reg.22.1302(h))

It is anticipated that upon completion of post-closure care, that the site of the facility will become open grassland. The actual long-term use of the land will be determined upon notice of closure. The final facility cover will not be disturbed without prior approval from the Director of the ADEQ.

Closure & Post-closure Care Plan

Ash Grove Cement Company ■ Class 3N Landfill

April 2016 ■ Terracon Project No. 35147187



ATTACHMENT A
Closure and Post-closure Cost Estimates

Ash Grove Cement Company Class 3N Landfill

LANDFILL CLOSURE - COST ESTIMATE WORKSHEET (2016 DOLLARS)

OWNER: <u>Ash Grove Cement Company</u>	PERMIT No. <u>0302-S3N</u>	AFIN No.: <u>41-00230</u>
OPERATOR: <u>Ash Grove</u>	ESTIMATOR: <u>F. Owen Carpenter</u> (Ark. Licensed P.E. #: <u>8653</u>)	DATE: <u>April 18, 2016</u>
TOTAL PERMITTED WASTE DISPOSAL ACRES: <u>41</u>		
TOTAL PERMITTED ACRES CERTIFIED CLOSED: <u>0</u>	ACRES CURRENTLY OPEN: <u>16.2</u> (i.e., "open" means areas subject to regulation and have not been certified closed)	
LARGEST ACREAGE EVER REQUIRING FINAL COVER OVER ACTIVE LANDFILL LIFE: <u>13.4</u> (i.e., largest acreage ever open at any one time; NOTE: if approved Closure Plan does not include phased closure then largest area is the total permitted disposal acres)		

ITEM No.	ITEM	QUANTITY	UNITS	UNIT COST	COST	SUBTOTALS	SOURCE OF UNIT COST INFO
1.0.0	PROFESSIONAL SERVICES						
1.1.0	Engineering (Design, Bid Documents, Procurement, Construction Contract Mangement)	1	Lump Sum	\$ 30,000.00	\$ 30,000.00		Terracon Estimate
1.2.0	Topographic and Boundary Survey	1	Lump Sum	\$ 17,000.00	\$ 17,000.00		Terracon Estimate
1.3.0	Engineering Services (Construction Oversight, Testing, Reporting, Certification)	1	Lump Sum	\$ 237,120.00	\$ 237,120.00		Terracon Estimate
	Professional Services Subtotal					\$ 284,120	
2.0.0	FINAL COVER						
2.1.0	Low Permeability Soil Layer						
2.1.1	Preparation of landfill to receive cover (final grading)	13.4	ACRE	\$ 1,500.00	\$ 20,100.00		Terracon Estimate
2.1.2	Clay and CKD, On-Site (excavate, transport, place, compact) (Quantity must match earthwork balance and must be guaranteed for future availability)	32,428	CU. YD.	\$ 3.50	\$ 113,498.00		AEP ash landfill 2015 intermediate liner project
2.1.3	Clay, Off-site (excavate, transport, place, compact) (Quantity must match earthwork balance)		CU. YD.		\$ -		
	Low Permeability Soil Layer Subtotal					\$ 133,598	
2.2.0	Geomembrane and Drainage Layer						
2.2.1	Liner tie-in preparation	3,363	Lin. FT.	\$ 9.00	\$ 30,267		Jefferson County LF Closure Bid
2.2.2	Drainage material--geocomposite	583,704	SQ. FT.	\$ 0.66	\$ 385,245		AEP ash landfill 2015 intermediate liner project
2.2.3	Geomembrane	583,704	SQ. FT.	\$ 0.50	\$ 291,852		AEP ash landfill 2015 intermediate liner project
	Geomembrane and Drainage Layer Subtotal					\$ 707,364	
2.3.0	Protective Soil and Vegetative Layer						
2.3.1	Protective Soil, On-site (excavate, transport, place, compact) (Quantity must match earthwork balance and must be guaranteed for future availability)		CU. YD.		\$ -		
2.3.2	Protective Soil, Off-site (excavate, transport, place, compact) (Quantity must match earthwork balance)		CU. YD.		\$ -		
2.3.3	Vegetative Soil (Topsoil), On-site (excavate, transport, place) (Quantity must match earthwork balance and must be guaranteed for future availability)	10,809	CU. YD.	\$ 3.50	\$ 37,833		AEP ash landfill 2015 intermediate liner project
2.3.4	Vegetative Soil (Topsoil), Off-site (excavate, transport, place) (Quantity must match earthwork balance)		CU. YD.		\$ -		
2.3.5	Seeding and mulching (incl. fertilizer)	0.0	ACRE	\$ 2,460.00	\$ -		Model Fill 38 acre closure
2.3.6	Fertilizer		ACRE		\$ -		
	Protective Soil and Vegetative Layer Subtotal					\$ 37,832.67	

Ash Grove Cement Company Class 3N Landfill

ITEM No.	ITEM	QUANTITY	UNITS	UNIT COST	COST	SUBTOTALS	SOURCE OF UNIT COST INFO
3.0.0	EROSION CONTROL						
3.1.0	Letdown structures	291	Lin. FT.	\$ 86.00	\$ 25,026.00		Extrapolated from Jefferson County rip-rap/geotextile @ \$43.00/LF
3.2.0	Letdown / drainage bench intersection	4	EACH	\$ 2,500.00	\$ 10,000.00		Terracon Estimate
3.3.0	Stormwater control during construction	1	EACH	\$ 7,500.00	\$ 7,500.00		Terracon Estimate
3.4.0	Silt fencing, rolled EC products and miscellaneous	1	EACH	\$ 19,500.00	\$ 19,500.00		Jefferson County Class 1 LF closure bid for similar items
	Erosion Control Subtotal					\$ 62,026.00	
4.0.0	CONTRACTOR MOBILIZATION AND MISC.						
4.1.0	Mobilization/General Conditions for final closure	1	EACH	\$ 100,000.00	\$ 100,000.00		AEP ash landfill 2015 intermediate liner project
4.2.0							
4.2.1	Road Construction with aggregate	1	EACH	\$ 40,000.00	\$ 40,000.00		Terracon Estimate
4.3.0							
4.3.1	Bench and Toe Drains including piping and aggregate where applicable	1	EACH	\$ 30,000.00	\$ 30,000.00		Jefferson County Class 1 LF closure bid for similar items
4.3.2	Edge treatments including anchor trenching, termination berms, etc.	1	EACH	20000	\$ 20,000		AEP ash landfill 2015 intermediate liner project
4.3.4			Lump Sum		\$ -		
	Subtotal					\$ 190,000	
5.0.0	GROUNDWATER MONITORING SYSTEM						
5.1.0	Well installation		EACH		\$ -		
5.2.0	Upgrade existing wells		EACH		\$ -		
5.3.0	Dedicated pump/sampling system installation/upgrade		EACH		\$ -		
5.4.0	Baseline sample collection (4 events per first year, ____ samples per event)	4	EVENT		\$ -		
5.5.0	Baseline sample analysis and reporting (4 events per first year, ____ samples per event))	4	EVENT		\$ -		
	Groundwater Monitoring System Subtotal					\$ -	
6.0.0	LEACHATE COLLECTION SYSTEM						
6.1.0	Additional/upgrades for collection piping		Lin. FT		\$ -		
6.2.0	Additonal/upgrades to pumps		EACH		\$ -		
6.3.0	Additional/upgrades to storage containers		EACH		\$ -		
6.4.0	Baseline sample collection		EACH		\$ -		
6.5.0	Baseline sample analysis and reporting		EACH		\$ -		
	Leachate Collection System Subtotal					\$ -	
7.0.0	OPERATIONS AND INVENTORY REMOVAL						
7.1.0	Excess solid waste	5000	CU. YD.	\$ 3.50	\$ 17,500		Terracon Estimate
7.2.0	Mobile equipment/machinery (e.g., containers, tanks, etc...)		Lump Sum		\$ -		
7.3.0	Stored leachate		GAL.		\$ -		
7.4.0	Contaminated soils		CU. YD.		\$ -		
	Operations and Inventory Removal Subtotal					\$ 17,500	
8.0.0	DEMOLITION/REMOVAL SITE IMPROVEMENTS						
8.1.0	Office/shop/maintenace and other ancillary buildings		Lump Sum		\$ -		
8.2.0	Equipment to be decommissioned (e.g., weigh scales, bulking/solidification pits, collection pits/sumps, piping, etc...)		Lump Sum		\$ -		
8.3.0	Site Utilities		Lump Sum		\$ -		
	Demolition/Removal Site Improvements Subtotal					\$ -	
9.0.0	REPLACE/REBUILD SITE ACCESS CONTROLS						
9.1.0	Fencing		Lin. FT.		\$ -		
9.2.0	Gates		EACH		\$ -		

Ash Grove Cement Company Class 3N Landfill

ITEM No.	ITEM	QUANTITY	UNITS	UNIT COST	COST	SUBTOTALS	SOURCE OF UNIT COST INFO
9.3.0	Access barriers		EACH		\$ -		
9.4.0	Lump sum replace/rebuild	1	Lump Sum	20000	\$ 20,000		
Replace/Rebuild Site Access Controls Subtotal						\$ 20,000	
10.0.0	BORROW AREA RECLAMATION						
10.1.0	Regrade and site prep		ACRE		\$ -		
10.2.0	Soil, On-site (excavate, transport, place, compact)		CU.YD.		\$ -		
10.3.0	Soil, Off-site (excavate, transport, place, compact)		CU. YD.		\$ -		
10.4.0	Seeding and mulching		ACRE		\$ -		
10.5.0	Fertilizer		ACRE		\$ -		
Borrow Area Reclamation Subtotal						\$ -	
Total Closure Cost Subtotal						\$ 1,452,440	
11.0.0	MISCELLANEOUS						
11.1.0	10% Administration and Contingency (Total Closure Cost Subtotal x 10%)				\$ 145,244		
	10% Construction cost Contingency (Total Closure Cost Subtotal x 10%)				\$ 145,244		
Misc. Subtotal						\$ 290,488	
TOTAL CURRENT CLOSURE COST						\$ 1,742,928	

Ash Grove Cement Company Class 3N Landfill

LANDFILL POST CLOSURE CARE - ANNUAL COST ESTIMATE WORKSHEET

OWNER: <u>Ash Grove Cement Company</u>	PERMIT NO. <u>0302-S3N</u>	AFIN No.: <u>41-00230</u>
OPERATOR: <u>Ash Grove</u>	ESTIMATOR: <u>F. Owen Carpenter</u>	(Ark. Licensed P.E. #: <u>8653</u>)
TOTAL PERMITTED WASTE DISPOSAL ACRES: <u>41</u>		DATE: <u>April 18, 2016</u>
TOTAL PERMITTED ACRES CERTIFIED CLOSED: <u>0</u>		

ITEM No.	ITEM	QUANTITY	UNITS	UNIT COST	COST	SUBTOTALS	SOURCE OF UNIT COST INFO
1.0.0	PROFESSIONAL SERVICES						
1.1.0	Engineering (Annual inspection and reporting, corrective action design and bid, contract management)	1	Lump Sum	\$ 5,000.00	\$ 5,000.00		Terracon estimate
1.2.0	Topographic and Boundary Survey (annual, final, and corrective action, if required)		Lump Sum		\$		
1.3.0	Corrective Action Engineering Services (Construction Oversight, Testing, Reporting, Certification)		Lump Sum				
	Professional Services Annual Subtotal					\$ 5,000.00	
2.0.0	FINAL COVER ROUTINE MAINTENANCE						
2.1.0	Inspect soil cover, vents, flares, drainage letdowns and outfalls, etc...	2	Event	\$1,500.00	\$ 3,000.00		Site specific cost
2.2.0	Mowing/Trimming (<u>41</u> acres twice per year)	82	ACRE	\$90.00	\$ 7,380.00		Site specific cost
2.3.0	Clean Drain/Vent Openings	2	Event	\$200.00	\$ 400.00		Site specific cost
	Final Cover Routine Maintenance Annual Subtotal					\$ 10,780.00	
3.0.0	FINAL COVER REPAIRS						
3.1.0	Remove/incorporate unacceptable materials (e.g., dead vegetation, solid waste)		ACRE		\$ -		
3.2.0	Scarify and prepare surface		ACRE		\$ -		
3.3.0	Soil, On-Site (excavate, transport, place, compact)	100	CU. YD.	\$3.50	\$ 350.00		Terracon Estimate
3.4.0	Soil, Off-site (excavate, transport, place, compact)		CU. YD.		\$ -		
3.5.0	Seeding and mulching (5% of total acreage annually)	2.1	ACRE	\$2,460.00	\$ 5,166.00		Model Fill 38 acre closure
3.6.0	Fertilizer	2.1	ACRE	\$150.00	\$ 315.00		Model Fill 38 acre closure
	Final Cover Repairs Annual Subtotal					\$ 5,831.00	
4.0.0	ACCESS ROADS REPAIRS						
4.1.0	Reshape/regrade subgrade		SQ. YD.		\$		
4.2.0	Gravel (transport, place, compact)		TON		\$		
4.3.0	Drainage Structures (e.g., culverts,		Lin. FT.		\$		
4.4.0	Riprap ditching/channels		Lin. FT.		\$		
	Access Roads Repair Annual Subtotal					\$ -	
5.0.0	SURFACE WATER MANAGEMENT OPERATION AND MAINTENANCE (O&M)						
5.1.0	Collection system operation and maintenance (ditches, piping conveyances, outfalls, sampling points repair/replace)	1	Lump Sum	\$ 1,500.00	\$ 1,500.00		Site specific cost
5.2.0	Stormwater storage (sediment pond) operation/repairs		Lump Sum		\$		
5.3.0	Sample collection (___ events per year)		Event		\$		
5.4.0	Sample analysis and reporting (___ events per year)		Event		\$		

Ash Grove Cement Company Class 3N Landfill

ITEM No.	ITEM	QUANTITY	UNITS	UNIT COST	COST	SUBTOTALS	SOURCE OF UNIT COST INFO
	Surface Water Management O&M Annual Subtotal					\$ 1,500.00	
6.0.0	LEACHATE COLLECTION SYSTEM O&M						
	Generation Rate = _____ gal./ac./yr.						
6.1.0	Collection operation/maintenance (pump, piping, storage...operation/repair/replace)	12	Months		\$		
6.2.0	Leachate loading, off-loading and off-site transportation		Event		\$		
6.3.0	Leachate Treatment/Disposal		Gal.		\$		
6.4.0	Additional/upgrades for piping, pumps and storage		Lump Sum		\$		
6.5.0	Leachate sample collection		EACH		\$		
6.6.0	Leachate sample analysis and reporting		EACH		\$		
	Leachate Collection System O&M Annual Subtotal					\$ -	
7.0.0	GROUNDWATER MONITORING SYSTEM O&M						
	Number of Wells in Approved System = <u>4</u>						
7.1.0	Well maintenance (e.g., protective casing (lock & hinges) repair/replacement, well pad repair/replace, etc...)	4	EACH	\$ 25.00	\$ 100.00		
7.2.0	Upgrade/redevelop existing wells		EACH		\$		
7.3.0	Well Replacement (assume one well)	110	Lin. FT.	\$ 25.00	\$ 2,750.00		
7.4.0	Sample collection (2 events per year)	2	Event	\$ 2,500.00	\$ 5,000.00		Site specific cost
7.5.0	Sample analysis and reporting (2 events per year)	2	Event	\$ 12,000.00	\$ 24,000.00		Site specific cost
	Groundwater Monitoring System O&M Annual Subtotal					\$ 31,850.00	
8.0.0	GAS MONITORING SYSTEM O&M						
8.1.0	Number of Gas Monitoring Probes/Wells = _____						
8.2.0	Methane monitoring of probes/wells (4 per year)	4	Event		\$		
8.3.0	Methane monitoring at site boundary and structures (4 per year)	4	Event		\$		
8.4.0	Sample analysis and reporting	4	Event		\$		
	Gas Monitoring System O&M Annual Subtotal					\$ -	
9.0.0	GAS EXTRACTION SYSTEM O&M						
	Gas vents, _____ # of vents, _____ average depth						
9.1.0	Passive System						
9.1.1	Passive well head flare maintenance		EACH		\$		
9.2.0	Active System						
9.2.1	Flare, _____ BTU/hour		EACH		\$		
9.2.2	Additional Well Installation/Upgrades		EACH		\$		
9.2.3	Ancillary gas equipment repair/replacement (piping, blowers, condensate collection)		Lump Sum		\$		
	Gas Extraction System O&M Annual Subtotal					\$ -	
10.0.0	CORRECTIVE ACTION EVALUATION AND IMPLEMENTATION						
10.1.0	Resurvey monitoring well reference points and site benchmarks (prorate for annual expenses)		EACH		\$		
10.2.0	Remove sediments from stormwater basin(s) (prorate for annual expenses)		EACH		\$		
10.3.0	Groundwater exceedances statistical evaluation (EACH		\$		
10.4.0	Groundwater alternate source determination) (prorate for annual expenses)		EACH		\$		

Ash Grove Cement Company Class 3N Landfill

ITEM No.	ITEM	QUANTITY	UNITS	UNIT COST	COST	SUBTOTALS	SOURCE OF UNIT COST INFO
10.5.0	Groundwater compliance monitoring (prorate for annual expense)		EACH		\$		
10.6.0	Other: _____		EACH		\$		
	Corrective Action Evaluation and Implementation Annual Subtotal					\$ -	
	Total Post Closure Care Annual Cost Subtotal					\$ 54,961.00	
11.0.0	MISCELLANEOUS						
11.1.0	10% Administration and Contingency (Total Closure Cost Subtotal x 10%)				\$ 5,496.10		
					\$		
					\$		
	Misc. Subtotal					\$ 5,496.10	
	TOTAL ESTIMATED ANNUAL POST CLOSURE CARE COST					\$ 60,457.10	
	ESTIMATED 2 YEAR POST CLOSURE CARE PERIOD		2 x "Total Estimated Annual Post Closure Care Cost".			\$ 120,914.20	

Closure & Post-closure Care Plan

Ash Grove Cement Company ■ Class 3N Landfill

April 2016 ■ Terracon Project No. 35147187



ATTACHMENT B

Financial Assurance Mechanism

ASH GROVE CEMENT COMPANY



11011 CODY STREET
OVERLAND PARK, KANSAS 66210
PHONE 913/451-8900

L. JOHN NELSON, IV
ASSISTANT SECRETARY AND
ASSISTANT GENERAL COUNSEL

FAX 913/451-8924
DIRECT LINE 913/319-6003
E-MAIL john.nelson@ashgrove.com

March 27, 2015

Mr. Benjamin Jones
Chief of Solid Waste Management Division
Arkansas Department of Environmental Quality

Re: 2015 Financial Assurance Demonstration
Ash Grove Cement Company
Foreman, AR

AFIN: 41-00230
PMT#: 030-53N RECD SCAN

MAR 30 2015


DOC ID: 7350
TO: SS file SWMD

Dear Mr. Jones:

Enclosed please find the updated Surety Bonds in the amounts of \$1,763,094.00 and \$131,776.00.

Please contact me if you have any questions regarding our submission.

Sincerely,


Leonard John Nelson IV

INCREASE/DECREASE RIDER

To be attached to and form a part of Bond Number 106078267 in the amount of One Million Seven Hundred Thirty Eight Thousand, Sixty Six and No/100 Dollars (\$1,738,066.00) Dollars issued by Travelers Casualty and Surety Company of America on behalf of Ash Grove Cement Company, in favor of Arkansas Department of Environmental Quality.

It is understood and agreed that the bond described above is hereby modified to Increase bond amount:

FROM: One Million Seven Hundred Thirty Eight Thousand, Sixty Six and No/100 Dollars (\$1,738,066.00)


TO: One Million Seven Hundred Sixty Three Thousand, Ninety Four and No/100 Dollars (\$1,763,094.00)

It is further expressly understood and agreed that the aggregate liability of the company under said bond to the obligee herein mentioned shall not exceed the amount stated above. Nothing herein contained shall be held to vary, alter, waive, or extend any of the terms, agreements, conditions or limitations of the above mentioned bond, other than as above stated.

To be effective this 28th day of March, 2015 .

Signed, Sealed, and dated this 26th day of March, 2015 .

ATTEST:

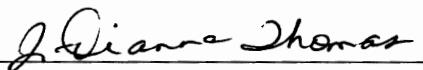


Ash Grove Cement Company

Principal

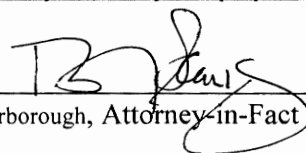


ATTEST:



Travelers Casualty and Surety Company of America

Surety


Debra J. Scarborough, Attorney-in-Fact

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company, which resolutions are now in full force and effect, reading as follows:

RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

FURTHER RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

FURTHER RESOLVED, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

FURTHER RESOLVED, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, Kevin E. Hughes, the undersigned, Assistant Secretary, of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this _____ day of _____, 20 _____.

MAR 26 2015

WARNING: THIS POWER OF ATTORNEY IS INVALID WITHOUT THE RED BORDER

Kevin E. Hughes
Kevin E. Hughes, Assistant Secretary



To verify the authenticity of this Power of Attorney, call 1-800-421-3880 or contact us at www.travelersbond.com. Please refer to the Attorney-In-Fact number, the above-named individuals and the details of the bond to which the power is attached.



POWER OF ATTORNEY

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company

Attorney-In Fact No. 229029

Certificate No. 006263724

KNOW ALL MEN BY THESE PRESENTS: That Farmington Casualty Company, St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company are corporations duly organized under the laws of the State of Connecticut, that Fidelity and Guaranty Insurance Company is a corporation duly organized under the laws of the State of Iowa, and that Fidelity and Guaranty Insurance Underwriters, Inc., is a corporation duly organized under the laws of the State of Wisconsin (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint

Patrick T. Pribyl, Debra J. Scarborough, Christy M. Braile, Mary T. Flanigan, Jeffrey C. Carey, Charles R. Teter III, Laura M. Buhmester, Charissa D. Lecuyer, Evan D. Sizemore, Rebecca S. Gross, Larissa Smith, Wendy A. Casey, C. Stephens Griggs, Rebecca A. Lilley, and Tahitia M. Fry

of the City of Kansas City, State of Missouri, their true and lawful Attorney(s)-in-Fact, each in their separate capacity if more than one is named above, to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

IN WITNESS WHEREOF, the Companies have caused this instrument to be signed and their corporate seals to be hereto affixed, this 13th day of February, 2015

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company



State of Connecticut
City of Hartford ss.

By: [Signature]
Robert L. Raney, Senior Vice President

On this the 13th day of February, 2015, before me personally appeared Robert L. Raney, who acknowledged himself to be the Senior Vice President of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

In Witness Whereof, I hereunto set my hand and official seal. My Commission expires the 30th day of June, 2016.



[Signature]
Marie C. Tetreault, Notary Public



POWER OF ATTORNEY

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company

Attorney-In Fact No. 229029

Certificate No. 006263725

KNOW ALL MEN BY THESE PRESENTS: That Farmington Casualty Company, St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company are corporations duly organized under the laws of the State of Connecticut, that Fidelity and Guaranty Insurance Company is a corporation duly organized under the laws of the State of Iowa, and that Fidelity and Guaranty Insurance Underwriters, Inc., is a corporation duly organized under the laws of the State of Wisconsin (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint

Patrick T. Pribyl, Debra J. Scarborough, Christy M. Braile, Mary T. Flanigan, Jeffrey C. Carey, Charles R. Teter III, Laura M. Buhmester, Charissa D. Lecuyer, Evan D. Sizemore, Rebecca S. Gross, Larissa Smith, Wendy A. Casey, C. Stephens Griggs, Rebecca A. Lilley, and Tahitia M. Fry

of the City of Kansas City, State of Missouri, their true and lawful Attorney(s)-in-Fact, each in their separate capacity if more than one is named above, to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

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Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
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State of Connecticut
City of Hartford ss.

By: [Signature]
Robert L. Raney, Senior Vice President

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In Witness Whereof, I hereunto set my hand and official seal.
My Commission expires the 30th day of June, 2016.



[Signature]
Marie C. Tetreault, Notary Public

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RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

FURTHER RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

FURTHER RESOLVED, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

FURTHER RESOLVED, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, Kevin E. Hughes, the undersigned, Assistant Secretary, of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this _____ day of MAR 26 2015, 20 ____.

WARNING: THIS POWER OF ATTORNEY IS INVALID WITHOUT THE RED BORDER

Kevin E. Hughes
Kevin E. Hughes, Assistant Secretary



To verify the authenticity of this Power of Attorney, call 1-800-421-3880 or contact us at www.travelersbond.com. Please refer to the Attorney-In-Fact number, the above-named individuals and the details of the bond to which the power is attached.

Closure & Post-closure Care Plan

Ash Grove Cement Company ■ Class 3N Landfill












April 2016 ■ Terracon Project No. 35147187



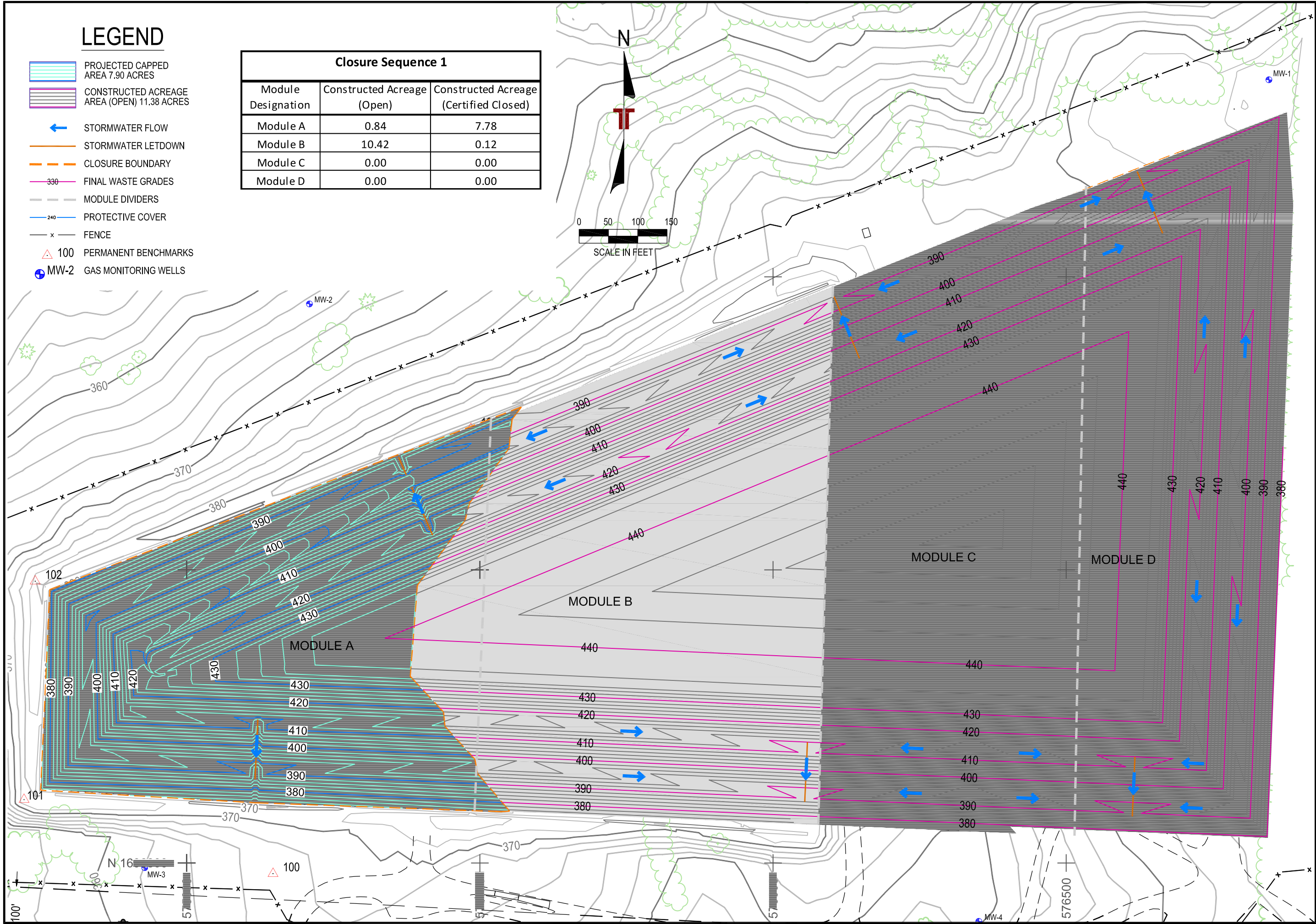
ATTACHMENT C

Closure Phasing Diagrams

LEGEND

-  PROJECTED CAPPED AREA 7.90 ACRES
-  CONSTRUCTED ACREAGE AREA (OPEN) 11.38 ACRES
-  STORMWATER FLOW
-  STORMWATER LETDOWN
-  CLOSURE BOUNDARY
-  330 FINAL WASTE GRADES
-  MODULE DIVIDERS
-  240 PROTECTIVE COVER
-  FENCE
-  100 PERMANENT BENCHMARKS
-  MW-2 GAS MONITORING WELLS

Closure Sequence 1		
Module Designation	Constructed Acreage (Open)	Constructed Acreage (Certified Closed)
Module A	0.84	7.78
Module B	10.42	0.12
Module C	0.00	0.00
Module D	0.00	0.00



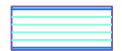
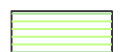










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APPROVED BY: FOC	SCALE: 1" = 150'
JOB NO. 03312016	DATE: 03/31/2016
ACAD NO. 002	005-001-35147187
SHEET NO.: 2	OF 5

CLOSURE SEQUENCE 1
 CLOSURE PHASING
ASH GROVE CEMENT COMPANY
 CEMENT KILN DUST LANDFILL
 ARKANSAS
 FOREMAN

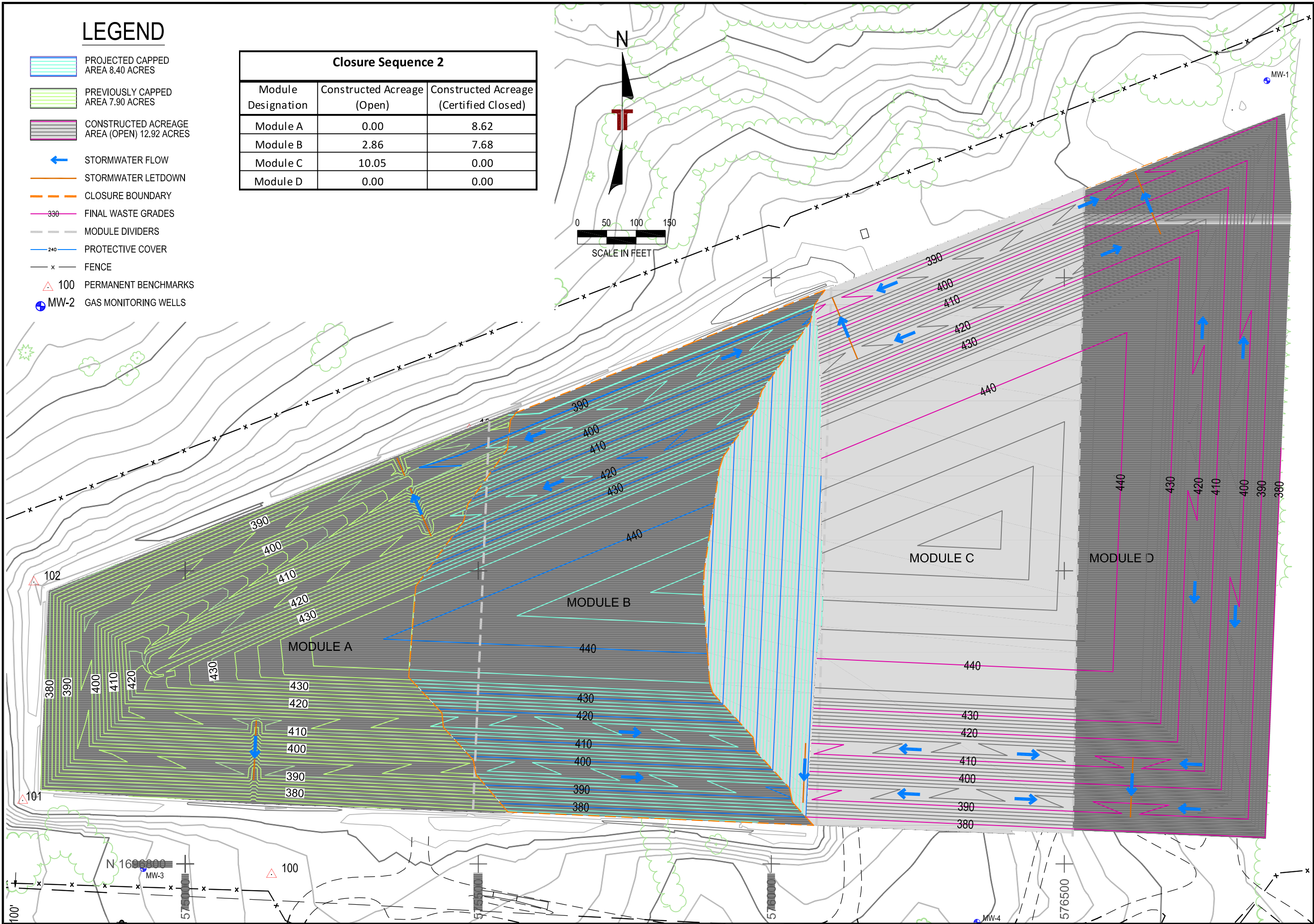

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REV.	DATE	BY	DESCRIPTION

LEGEND

-  PROJECTED CAPPED AREA 8.40 ACRES
-  PREVIOUSLY CAPPED AREA 7.90 ACRES
-  CONSTRUCTED ACREAGE AREA (OPEN) 12.92 ACRES
-  STORMWATER FLOW
-  STORMWATER LETDOWN
-  CLOSURE BOUNDARY
-  390 FINAL WASTE GRADES
-  MODULE DIVIDERS
-  240 PROTECTIVE COVER
-  FENCE
-  100 PERMANENT BENCHMARKS
-  MW-2 GAS MONITORING WELLS

Closure Sequence 2		
Module Designation	Constructed Acreage (Open)	Constructed Acreage (Certified Closed)
Module A	0.00	8.62
Module B	2.86	7.68
Module C	10.05	0.00
Module D	0.00	0.00



DRAWING 3

DESIGNED BY: FOC	DRAWN BY: SRE	APP'D BY: FOC	SCALE: 1" = 150'	JOB NO.: 03/312016	ACAD NO.: 003	SHEET NO.: 3 OF 5
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CLOSURE SEQUENCE 2

CLOSURE PHASING
ASH GROVE CEMENT COMPANY
 CEMENT KILN DUST LANDFILL
 ARKANSAS
 FOREMAN

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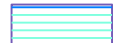




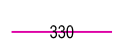

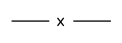




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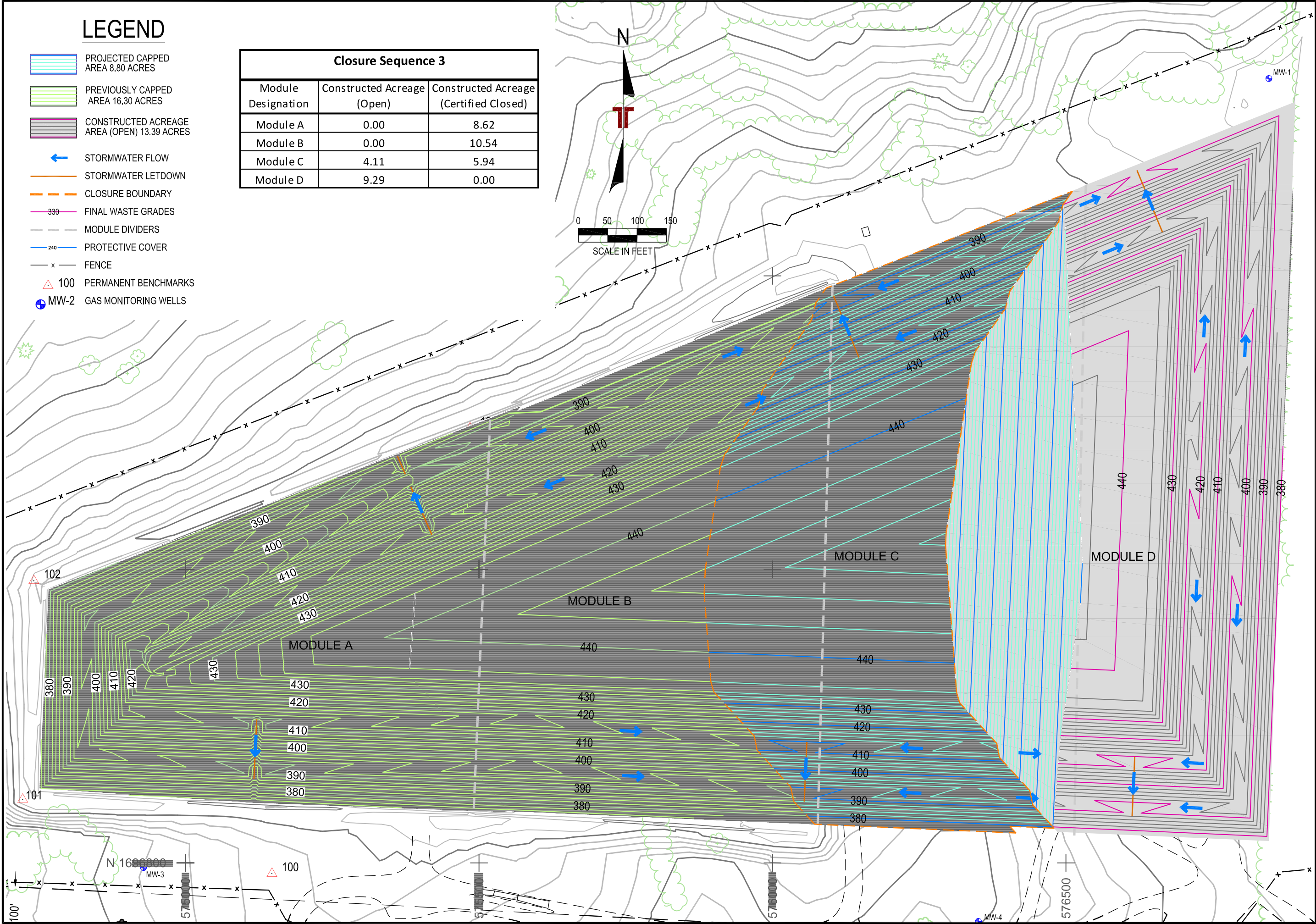
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REV.	DATE	BY	DESCRIPTION

LEGEND

-  PROJECTED CAPPED AREA 8.80 ACRES
-  PREVIOUSLY CAPPED AREA 16.30 ACRES
-  CONSTRUCTED ACREAGE AREA (OPEN) 13.39 ACRES
-  STORMWATER FLOW
-  STORMWATER LETDOWN
-  CLOSURE BOUNDARY
-  390 FINAL WASTE GRADES
-  MODULE DIVIDERS
-  240 PROTECTIVE COVER
-  FENCE
-  100 PERMANENT BENCHMARKS
-  MW-2 GAS MONITORING WELLS

Closure Sequence 3		
Module Designation	Constructed Acreage (Open)	Constructed Acreage (Certified Closed)
Module A	0.00	8.62
Module B	0.00	10.54
Module C	4.11	5.94
Module D	9.29	0.00



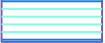










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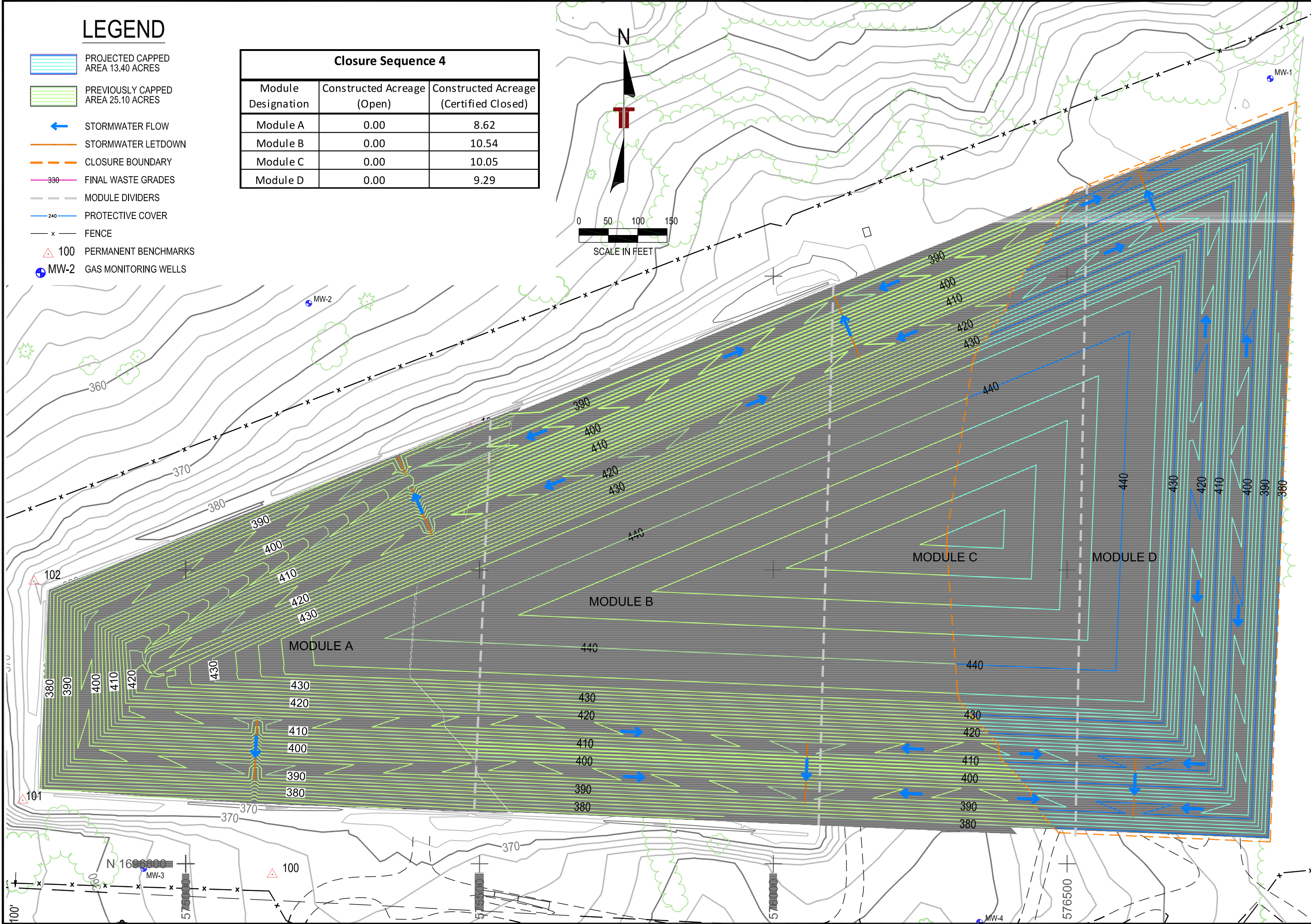

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REV.	DATE	BY	DESCRIPTION

LEGEND

-  PROJECTED CAPPED AREA 13.40 ACRES
-  PREVIOUSLY CAPPED AREA 25.10 ACRES
-  STORMWATER FLOW
-  STORMWATER LETDOWN
-  CLOSURE BOUNDARY
-  390 FINAL WASTE GRADES
-  MODULE DIVIDERS
-  240 PROTECTIVE COVER
-  FENCE
-  100 PERMANENT BENCHMARKS
-  MW-2 GAS MONITORING WELLS

Closure Sequence 4		
Module Designation	Constructed Acreage (Open)	Constructed Acreage (Certified Closed)
Module A	0.00	8.62
Module B	0.00	10.54
Module C	0.00	10.05
Module D	0.00	9.29



DRAWING 5

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REV.	DATE	BY	DESCRIPTION

Attachment B

Construction Quality Assurance Plan

Construction Quality Assurance Plan

Ash Grove Cement Company
Class 3N Landfill
Permit No. 0302-S3N
AFIN: 41-00230

February 2016
Project No. 35147187



Prepared for:

Ash Grove Cement Company
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Prepared by:

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FIGURES

FIGURE 1 CQA ORGANIZATIONAL STRUCTURE

ATTACHMENTS

ATTACHMENT A DEFINITIONS

SECTION 1

GENERAL

1.0 INTRODUCTION

Arkansas Regulation Reg.22.528 requires all Class 3N landfills to conform to the requirements of Arkansas Regulation Reg.22.428. Arkansas Regulation Reg.22.428 requires landfills in Arkansas to develop a written Construction Quality Assurance (CQA) Plan associated with the installation of liner systems and final cover systems. The plan is to be made a part of the Facility Permanent Operating Record and detail quality assurance methods for all aspects of liner and final cover system construction. In accordance with *Arkansas Regulation Reg.22.428*, this document incorporates the minimum standards set forth in Regulation 22 and the *Generic Construction Quality Assurance Plan for the Lining and Cover Systems Guidance (Geosyntec, 1992)*. The Ash Grove Class 3N Landfill facility has adopted the following CQA standards as the facility CQA Plan to be used as a reference and directive associated with all future liner and cover system construction.

CQA of the selection, evaluation, treatment, placement, and compaction of soils and CKD for earthwork, low-permeability soil liners, granular drainage systems, and final cover layers is included in the scope of this plan. CQA applicable to manufacturing, fabricating, shipping, handling, and installing of all geosynthetics is also included. This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geomembranes, and other geosynthetics (which include chemical compatibility between geosynthetics and contained material). In particular, this document addresses the requirements for CQA monitoring, testing and documentation of activities related to the production, construction, and installation of landfill lining systems, leachate collection systems, and cover systems. When applicable and deemed appropriate by the Arkansas Department of Environmental Quality (ADEQ), deviations from this plan must be consistent with changes in applicable State and Federal Regulations, Facility Permit Conditions, and/or accepted practices in the field of Engineering.

The CQA Plan includes references to test procedures and standards of the American Society for Testing and Materials (ASTM), Corps of Engineers (COE), the Federal Test Method Standards (FTMS), the Geosynthetic Research Institute (GRI), and current industry practice.

1. Generic Construction Quality Assurance Plan for the Lining and Cover Systems; Geosyntec Consultants; September 1992;
2. ASTM Standards and Other Specifications and Test Methods on the Quality Assurance of Landfill Liner Systems; ASTM; 1916 Race Street; Philadelphia, PA 19103; 1994;
3. "Arkansas Regulation No. 22 Solid Waste Management Rules"; Arkansas Department of Pollution Control and Ecology (ADPC&E); Effective April 26, 2008;
4. Waste Containment Facilities-Guidance for Construction, Quality Assurance and Quality Control of Liner and Cover Systems; David E. Daniel and Robert M. Koerner; 1995.

5. Geosynthetic Research Institute Test Methods and Standards; Latest versions as of the date of this CQA Plan.

2.0 DEFINITIONS RELATED TO CQA

This section describes CQA associated with the construction of liner and cover systems and defines terminology used throughout this document. **ATTACHMENT A** provides detailed definitions for common quality assurance and landfill terminology used in this document.

2.1 Construction Quality Assurance and Construction Quality Control

This CQA Plan is devoted to Construction Quality Assurance and Construction Quality Control. In the context of this CQA Plan, Construction Quality Assurance and Construction Quality Control are defined as follows:

Construction Quality Assurance (CQA) - A planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC) - Those actions which provide a means to measure and control the characteristics of an item or service to contractual and regulatory requirements.

2.2 Use of the Terms in This Plan

In the context of this plan:

1. CQA refers to means and actions employed by the CQA Consultant to assure conformity of the lining and cover system component production and installation with this CQA Plan, the Project Plans, and the Project Specifications. CQA is provided by a party independent from production and installation.
2. CQC refers to those actions taken by Manufacturers, Fabricators, Installers, or the CQC Firm to insure that the materials and the workmanship meet the requirements of the Project Plans and Specifications.

3.0 CQA AND CQC PARTIES

This section summarizes the CQA parties that will be involved in any liner/cover system installation corresponding to the Ash Grove Class 3N Landfill. **FIGURE 1** illustrates the general “CQA Organizational Structure” that will be utilized associated with construction projects of this type.

3.1 Description of CQA Parties

The following section summarizes the CQA Parties who will be either directly or indirectly involved in the construction/installation associated with the bottom liner or final cover system corresponding to the Ash Grove Landfill. Where applicable, the Ash Grove Landfill will be responsible for insuring that each of the Parties selected have the necessary experience and qualifications associated with bottom liner and final cover system installations. In addition, each party should be aware of its obligations and responsibilities as defined in this plan. Depending on the size and/or scope of the project, a person or firm may act as more than one of the parties listed below, as long as third party and conflict of interest matters are addressed.

3.1.1 Owner

The Owner owns, and/or is responsible for, the facility, including components constructed and governed by the scope of this document. The Owner is responsible for managing all aspects of the project including planning, cost control, design, permitting, regulatory liaison, contract acquisitions, construction oversight, quality control, and certification. Unless otherwise noted, the Ash Grove Landfill will be the owner of any liner/final cover system constructed in association with the Landfill. The Ash Grove Landfill will be responsible for negotiating contracts between other CQA Parties, and for insuring that qualified agencies, firms, contractors, etc. are selected who will satisfy the requirements of this CQA Plan and who will be responsible for insuring that the project is completed in accordance with applicable Project Plans, Specifications, Regulations, and within established cost constraints.

3.1.2 Project Manager

The Project Manager is the official representative of the Owner. As indicated in **FIGURE 1**, the Project Manager, along with the Design Engineer will be the central point of contact for the Owner and CQA Consultant. Depending on the size or scope of the Project, the Project Manager may be a 3rd Party Firm or Agency contracted directly with the Owner to oversee the Project. In some situations, the Project Manager may act jointly as the Project Manager and Design Engineer. The Owner and/or Project Manager shall carefully consider the size and scope of the project when determining whether it is necessary to have separate individuals to fill the role of Design Engineer and Project Manager. It should be noted, that *Arkansas Regulation 22* requires that the Design Engineer and/or CQA Manager be represented as a firm/agency independent of the Owner (i.e., 3rd Party). While considering this, the Design Engineer and/or CQA Manager will have no corporate ties, which could be construed as a conflict of interest in relation to this *Arkansas Regulation 22* requirement.

3.1.3 Design Engineer

The Design Engineer is responsible for the design of the liner and/or cover systems, and for the preparation of the Project Plans and Specifications. The Design Engineer may be an employee of the Owner/Operator or a 3rd Party firm or agency hired by the Owner/Operator.

3.1.4 CQA Consultant

The CQA Consultant is directly responsible for verifying that construction materials, practices, and procedures, are consistent with the requirements of this plan, the project specifications, plans, and applicable regulations. The CQA Consultant will work directly with the CQC Firm and/or labs in order to efficiently manage all aspects of project quality assurance. The CQA Consultant shall be an independent third Party firm or agency with no direct corporate ties to the Owner, which may be construed as a conflict of interest.

3.1.4.1 CQA Certifying Engineer

The CQA Certifying Engineer is a party, independent from the Owner, Manufacturer, Fabricator, and Installer, that is responsible for the overall observation, testing and documentation activities related to the CQA of the earthwork at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geotextiles and geocomposite on this facility. The CQA Certifying Engineer also is responsible for issuing a certification report, sealed by a Registered Professional Engineer associated with the installation of the clay liner and collection system. Depending on the size and/or scope of the Project, the CQA Certifying Engineer may also serve as the CQA Consultant, and/or CQA Manager.

3.1.4.2 CQA Manager

The CQA Manager reports to the Certifying Engineer and is responsible for observing, testing and documenting activities related to the CQA of the earthwork at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geotextiles and geocomposites on this facility.

3.1.4.3 CQA Monitor

The CQA Monitor reports to the CQA Manager and/or the Certifying Engineer and is responsible for observing, testing and documenting activities related to the CQA of the earthwork at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geotextiles and geocomposites on this facility.

3.1.4.4 Soils Testing Laboratory

The Soils CQC Firm is responsible for conducting tests in the field and in the laboratory on samples of soils associated with liner and cover system installations. The Owner or the General Contractor may retain the third party CQA Firm.

3.1.4.5 Geosynthetics Laboratory

The Geosynthetics Laboratory is a party, independent from the Owner, Manufacturer, Fabricator, and Installer, that is responsible for conducting tests on samples of geosynthetics taken from the site. The Geosynthetics Laboratory testing services cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The geosynthetics installer, if deemed acceptable by the CQA consultant, may

perform the CQC field-testing. The CQA consultant shall be present during all such testing. In no case shall the geosynthetics installer or subcontractor conduct laboratory testing for conformance or destructive analysis. A firm independent of the geosynthetics installer shall conduct this analysis.

3.1.4.6 CQA Surveyor

The CQA Surveyor is a party that is independent from the Contractor that is responsible for surveying the subgrade and liner during construction.

3.1.5 General Contractor

The General Contractor is responsible for construction of the bottom liner and final cover systems. The General Contractor may perform directly or subcontract out various elements of the construction, including subgrade preparation, geosynthetics, and soil placement. The General Contractor may also be responsible for other construction at the Facility either directly or indirectly related to the waste disposal area.

3.1.6 Soils Contractor

The Soils Contractor excavates and/or delivers soil material to the General Contractor and/or project site. Depending on the size and/or scope of the Project, the General Contractor may also serve as the Soils Contractor.

3.1.7 Geosynthetics Manufacturer

The Geosynthetics (Geomembrane, Geotextile, Geosynthetic Clay, Geonets or Geogrids) Manufacturer (Manufacturer) is responsible for the production of geomembranes, geonet or geogrid rolls from resin. The geosynthetics manufacturer may also produce geosynthetic clay liners from bentonite and/or geotextile rolls from resin fibers. This Class 3N landfill will only require geomembrane, geotextile and geocomposite drainage materials for geosynthetic production.

3.1.8 Geosynthetics Installer

The Geosynthetics Installer (Installer) is responsible for field handling, storing, placing, seaming, loading, and other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials to the site and for construction of the anchor trenches if so defined in the project specifications.

3.1.9 Geosynthetics Transporter

The Transporter transports the geosynthetics, including rolls of geotextiles, geocomposites, and geonets between the Manufacturer and the site; or between the Manufacturer and the Fabricator, and/or between the Fabricator and the site.

3.2 Qualifications of the Parties

The following qualifications shall be required of all parties involved with the design, manufacture, fabrication, installation, transportation, and CQA of all lining and cover system materials to be utilized at the Landfill.

3.2.1 Project Manager

The selection of the Project Manager is the responsibility of the Owner. Qualifications for this position are determined by the Owner independently of the CQA Plan and will be based on the objectives and constraints of the Project as determined by the Owner.

3.2.2 Design Engineer

The Design Engineer shall be a qualified professional engineer with registration in the State of Arkansas. The Design Engineer shall have demonstrated experience associated with previous similar solid waste/hazardous waste projects. In particular, the Design Engineer shall have a history which demonstrates familiarity with geosynthetics and/or soils, as appropriate, including detailed design and construction methods commonly used in the field of Civil and/or Sanitary Engineering.

3.2.3 CQA Consultant

The CQA Consultant shall be a designated firm or agency independent of the Owner with demonstrated knowledge and experience with geosynthetics and soil liner/cover systems. The CQA Consultant is responsible for the CQA Manager, CQA Monitors, Soils Testing Laboratory, Geosynthetics Laboratory, and CQA Surveyor.

The CQA Consultant shall be a well-established engineering firm incorporated (or otherwise registered) in the United States. The CQA Consultant shall be experienced in providing CQA services for soils, including low-permeability and high-permeability soils and aggregates. The CQA Consultant shall be experienced in the preparation of quality assurance documentation including quality assurance forms, reports, certifications, and manuals.

In addition, the CQA Consultant shall provide the following in writing, if required, to the Owner before entering into contractual agreements with the Owner:

1. Corporate background and information; and
2. Quality assurance capabilities:
 - a summary of the firm's experience with soils;
 - a summary of the firm's experience in quality assurance, including installation quality assurance of soils;
 - a summary of the CQA documentation and methods used by the firm, including sample CQA forms, reports, certifications, and manuals prepared by the firm;
 - a summary of the firm's experience with geosynthetics, including geocomposites, geonets, and geotextiles;

- a summary of the firm's experience in quality assurance, including installation quality assurance of geocomposites, geonets, and geotextiles; and
- a summary of CQA documentation and methods used by the firm, including sample CQA forms, reports, certifications, and manuals prepared by the firm.

In addition, the CQA Consultant shall provide the following in writing, if required, to the Owner before beginning work on this project:

1. Resumes of personnel to be involved in the project including the CQA Certifying Engineer, CQA Manager, and CQA Monitors;
2. Proof of Professional Engineering registration in the project state of the engineer to be designated the CQA Certifying Engineer; and
3. Proof of quality assurance experience of the CQA personnel with emphasis on geocomposites, geonets, and geotextiles.

3.2.3.1 CQA Certifying Engineer

The CQA Certifying Engineer shall represent a designated firm or agency, independent of the Owner, with demonstrated knowledge and experience with geosynthetics and soil liner/cover systems. The CQA Certifying Engineer shall be an Arkansas Registered Professional Engineer who will be responsible for preparing and sealing a certification report upon the successful completion of the project.

Third Party CQA Firm – An independent third party shall provide Construction quality assurance (CQA). If the certifying firm or individuals have any relationship with the owner or operator of the facility, which could be interpreted as a conflict (such as belonging to a firm under the same corporate umbrella), these should be disclosed in advance of the construction.

Required Presence – A qualified member of the CQA firm should be present at the site continuously during liner or final cover barrier construction. The professional certifying the construction shall at a minimum visit the site at least once prior to construction, once during construction and once after construction is substantially completed unless such visits are not practical. Additional visits by the professional certifying the construction shall be required if additional visits are prescribed in the approved Quality Assurance Plan or if site conditions warrant.

3.2.3.2 Soils Testing Laboratory

The Soils Testing Laboratory shall have experience in soils testing, meet all regulatory requirements, and have demonstrated experience utilizing the standards specified in this Plan. The Soils Testing Laboratory shall be capable of providing test results in accordance with the test methods described in the specifications. **The Soils Testing Laboratory shall be capable**

of providing a minimum of ten flexible wall permeability test results in six (6) days or less.

3.2.3.3 Geosynthetics Laboratory

The Geosynthetics Laboratory shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), National Sanitation Foundation (NSF), and Geosynthetic Research Institute (GRI) test methods and standards. The Geosynthetics CQC Firm shall be capable of providing destructive test results within 24 hours of receipt of samples and shall maintain that standard throughout the installation.

3.2.4 Soils Supplier

Qualifications of the soils supplier are specific to the construction contract. The soils supplier shall have a demonstrated history of providing soils with consistent properties (when applicable).

3.2.5 Earthwork Contractor

Qualifications of the Earthwork Contractor are specific to the construction contract. The Earthwork Contractor shall have a demonstrated history of successful earthwork construction. In particular, the Contractor shall have successfully completed clay liner/cover systems for solid waste, hazardous waste, or surface water containment. Documentation of this experience shall be submitted with the Contractor's Bid to the Owner or Project Manager.

3.2.6 Geosynthetics Installer

The Geosynthetics Installer shall be trained and qualified to install geosynthetics. Prior to confirmation of any contractual agreements, the Geosynthetic Installer shall provide the Project Manager with the following written information:

1. Corporate background and information;
2. Installation capabilities;
3. Equipment and personnel;
4. Daily anticipated production;
5. Quality control manual for installation;

3.2.7 Transporter

All personnel responsible for the loading, transport and unloading of the geosynthetics must be aware of the consequences of damage to the geosynthetics, and be familiar with the handling and transport constraints required by the Manufacturer and/or Fabricator.

3.3 Duties of the CQA Personnel

In this CQA Plan, the roles of the CQA Certifying Engineer, CQA Manager, Soils CQA Monitor, and Geosynthetics CQA Monitor are described separately. Individuals or consultants may be responsible for each particular aspect of the liner/cover system construction.

1. The CQA Manager, who depending on the size and/or scope of the project may direct CQA activities from the offices of the CQA Consultant's firm and visit the site periodically; The CQA Manager may designate CQA Monitors depending on the size and/or scope of the project to oversee certain aspects of the project. The CQA Monitors will report directly to the CQA Manager.
2. The CQA Monitors will be on site during all aspects of construction pertaining to the liner/cover system installation.

As described in earlier sections, the CQA Manager may also serve as the Soils CQA Monitor and the Geosynthetics CQA Monitor depending on the size and/or scope of the project. It is likely that a CQA Manager will be designated for both the Soils and Geosynthetics components of the liner/cover system installation on large projects.

3.3.1 CQA Certifying Engineer

The CQA Certifying Engineer will be responsible for:

1. Review of all project related designs, plans, and specifications;
2. Reviews all other site-specific documentation, including bid documents, proposed layouts, soils and groundwater investigation reports, and for geosynthetics, the manufacturer's and installer's literature;
3. Attends the resolution meetings;
4. Administers the CQA program (i.e., assigns and manages all CQA personnel, reviews all field reports, and provides engineering review of all CQA related issues);
5. Provides quality control of the CQA personnel, including site visits;
6. Reviews all changes to the design, plans, and specifications; and
7. Prepares/approves the final certification report, including a review of the Record Drawing(s).

3.3.2 CQA Manager

The CQA Manager may also be the CQA Monitor depending on the size and/or scope of the project and will be responsible for:

1. Familiarizes self and/or all CQA Monitors with the site and the project requirements;
2. Manages the daily activities of the CQA Monitors;
3. Attending CQA-related meetings (resolution, pre-construction, daily, weekly, etc.);

4. Prepares or oversees the ongoing preparation of the Record Drawings(s);
5. Assigns locations for testing and sampling;
6. Reviews results of laboratory testing and makes appropriate recommendations;
7. Reviews all CQA Monitors' daily reports and logs;
8. Reports to the Project Manager, and logs in his daily field report any relevant observations reported by the CQA Monitors;
9. Prepares weekly summary of CQA activities; and
10. Delegate's responsibilities to a senior CQA Monitor whenever absent from the site while operations are ongoing.

In addition, the CQA Manager shall be responsible for insuring:

1. Periodically checks stockpile or borrow pit sources for variability of the soils, and insures that conformance testing is carried out;
2. Reviews the qualifications of the Contractor's equipment operators, to insure that care is taken to protect other portions of the work;
3. Establishes additional test requirements beyond those in the specifications, where necessary to confirm permeability or density requirements;
4. Performs site visit and review of manufacturing plant facilities (when possible), methods, and quality control;
5. Reviews all Supplier, Manufacturer, and Installer certifications and documentation and makes appropriate recommendations;
6. Reviews the Installer's personnel qualifications for conformance with those pre-approved for work on site; and
7. Notes any on-site activities that could result in damage to the geosynthetics.

3.3.3 CQA Monitors

The duties of the CQA Monitors include, as assigned by the CQA Certifying Engineer and/or CQA Manager: monitoring, logging, and/or documenting all appropriate operations. The duties to be performed, and operations to be monitored by the Soils CQA Monitors include:

1. Soils delivery, dumping, and placement;
2. Soils moisture content, and moisture conditioning, if required;
3. Compaction of soils, and in situ testing of compacted density and moisture content;
4. Collection of samples for laboratory testing for moisture/density relationships, permeability; and other testing as outlined in the specifications;

5. Operations to protect completed areas before the covering materials are placed;
6. Measurement of loose and compacted lift thickness;
7. Verification of bonding between lifts;
8. Observation of equipment type, number of passes and equipment contact pressure;
9. Examination of the soil surface for signs of excessive wetting, desiccation, or other disturbance prior to placement of any cover materials; and
10. Scarification, rewetting, recompaction, or proof rolling required to repair deteriorated areas; and
11. Reports any unresolved deviations from the CQA Plan to the CQA Manager.

The operations to be monitored by the Geosynthetics CQA Monitors, for all geosynthetics include:

1. Material delivery and "spotting";
2. Unloading and on-site transport and storage;
3. Marking samples for conformance testing;
4. Sampling for conformance testing by the Geosynthetics CQC Firm;
5. All placement operations;
6. Condition of panels as placed;
7. All joining and/or seaming operations; and
8. Repair operations.

All CQA Monitors shall take note of on-site activities that could result in damage to the soils or geosynthetics components of the lining system. Any observations so noted shall be reported as soon as possible to the CQA Manager.

4.0 SITE AND PROJECT CONTROL

In order to coordinate various aspects of the construction project and develop time frames for completion of the project, various project coordination meetings will be required associated with all liner/cover system installations. The Owner will be responsible for organizing or selecting a representative to organize the various project coordination meetings. A person shall be designated at the beginning of all meetings to document and transmit the minutes to all parties.

4.1 Resolution Meeting

Following the completion of the design, plans, and specifications for the project, a Resolution Meeting shall be held. This meeting shall include all parties then involved, including the Owner,

Project Manager, and Design Engineer. This meeting may be combined with the pre-construction meeting depending on the size and scope of the project.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems, which might cause difficulties and delays in construction, and present the CQA Plan to all the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all. The first part of the Resolution Meeting may be devoted to a review of the design drawings and specifications for completeness and clarity. This is different from the peer review of the design, including design calculations, which shall have been carried out previously. This meeting should include all of the following activities:

1. Communicate to all parties any relevant documents;
2. Review critical design details of the project;
3. Review the seam layout drawing provided by the Designer, the Fabricator, or the Installer;
4. Review the project-specific CQA Plan;
5. Make any appropriate modifications to the CQA Plan to insure that it specifies all CQA activities that are necessary (within the context of the regulatory agency approval if necessary);
6. Make any appropriate modifications to the design criteria, plans, and specifications so that the fulfillment of all design specifications or performance standards can be determined through the implementation of the site-specific CQA Plan;
7. Reach a consensus on the CQA Plan and quality control procedures, especially on methods of determining the acceptability of the soils and geosynthetics comprising the lining system;
8. Assign the responsibilities of each party;
9. Decide the number of soil density testing units to be maintained on site;
10. Establish work area security and safety protocol;
11. Select testing equipment and review protocols for testing and placement of soil materials;
12. Confirm the methods for documenting and reporting, and for distributing documents and reports; and
13. Confirm the lines of authority and communication.

4.2 Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. At a minimum, the Owner, Project Manager, Design Engineer, CQA Manager, Earthwork Contractor, and Geosynthetics Installer

shall attend the meeting. If deemed appropriate by the Project Manager, the Pre-Construction Meeting may be separated into two separate meetings; one for the Earthwork Contractor and one for the Geosynthetics Installer.

Specific topics considered for this meeting include:

1. Make any appropriate modifications to the CQA Plan (within the context of regulatory agency approval as necessary);
2. Review the responsibilities of each party;
3. Review lines of authority and communication;
4. Review methods for documenting and reporting, and for distributing documents and reports;
5. Establish protocols for testing;
6. Establish protocols for handling deficiencies, repairs, and retesting;
7. Review the time schedule for all operations;
8. Conduct a site walk-around to verify that earthwork construction is proceeding on schedule, and to review material storage locations;
9. Establish soil stockpiling locations; and
10. Review precautions to be taken against clay deterioration, due to wetting or desiccation.

4.3 Progress Meetings

Periodic progress meetings shall be held between the Soils and Geosynthetics CQA Monitors, the Installer's superintendent, the Project Manager, and any other concerned parties. These meetings shall discuss current progress, planned activities for the next period, and any new business or revisions to the work. The CQA Monitors shall log any problems, decisions, or questions arising at this meeting in their daily reports. Any matter requiring action, which is raised in this meeting, shall be reported to the appropriate parties. The CQA Monitor's logs shall be submitted to the CQA Manager for inclusion in the Certification Report if deemed pertinent and appropriate.

4.4 Problem or Work Deficiency Meetings

A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the affected contractor, the Project Manager, and the appropriate CQA Manager(s) shall attend the meeting. If the problem requires a design modification, the Design Engineer should also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

1. Define and discuss the problem or deficiency;

2. Review alternative solutions; and
3. Implement an action plan to resolve the problem or deficiency.

4.5 Project Control Visits

4.5.1 Periodic Visits

Periodically, the CQA Manager, and/or the Certifying Engineer(s) shall visit the construction site. This visit should be coordinated with a similar visit by the Design Engineer when appropriate. The professional certifying the construction shall at a minimum visit the site at least once prior to construction, once during construction and once after construction is substantially completed, unless such visits are not practical. Additional visits by the professional certifying the construction shall be required if additional visits are prescribed in the approved Quality Assurance Plan or if site conditions warrant. The Project Manager and/or Owner may also inform state regulatory officials of these designated inspection dates if deemed appropriate.

4.5.2 Manufacturing Plant Visits

A representative of the Owner, Project Manager, Design Engineer, or CQA Manager may carry out a geosynthetic manufacturing plant visit in order to verify manufacturing practices or quality control procedures. These visits be arranged on an “as needed” basis if deemed appropriate by the Project Manager. Project specific plant visits for the manufacture and fabrication of the geosynthetics (geotextiles, geocomposites, and geonets) are optional. This project will be utilizing geomembrane, geotextile and drainage geocomposite. These plant visits shall be carried out at the discretion of the Owner, by the Owner, or his designated alternate.

SECTION 2

SURVEYING CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

Surveying of lines and reference elevations is conducted on an ongoing basis during the construction of the compacted soil liner materials, synthetic layers, and leachate collection system components. Accurate surveying is essential to insure that the liner/cover and hydraulic transport systems function as designed. The Contractor will be responsible for establishing grade control and the preparation of accurate record drawings (as built). The CQA Consultant will be responsible for reviewing all surveying activity performed by the Contractor to insure that construction adheres to the Project Plans and Specifications.

2.0 SURVEY CONTROL

At least one permanent elevation benchmark and at least two horizontal control benchmarks will be established for the project in a location convenient for reference during construction. The reference control points will be consistent with State Plane Coordinates and the established facility grid/survey coordinate system. The vertical and horizontal control for the benchmarks shall be established within normal land surveying standards. All initial survey controls either are in place as of the date of this writing, or will be established by the Design Engineer prior to execution of the Project.

3.0 LINES AND GRADES

The following surfaces shall be surveyed by the Contractor and verified by the CQA Consultant to document the lines and grades achieved during placement and compaction.

1. For the berms and other earthworks:
 - original grade surface;
 - compacted surface of cut slopes; and
 - finished grade surface.
2. For the compacted soil liners:
 - original contours;
 - prepared subgrade surface; and
 - finished compacted soil liner surface.
3. For the soil cover materials:
 - prepared surface; and
 - finished soil cover surface.

In addition, the lateral and vertical extent of all synthetic components as well as critical leachate collection system components shall be provided on the record drawings for future reference (if necessary).

4.0 FREQUENCY AND SPACING

All surveying should be carried out immediately upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. Any surveying conducted by the CQA team, is to be conducted as a check on the Contractor, but is not intended to alleviate the Contractor from his/her responsibilities for insuring that all construction is within the required grades and lines shown in the project plans and specifications.

The following minimum spacing's and locations should be provided for survey points:

1. All "flat" surfaces, such as the base of the landfill, with gradients less than 10 percent, should be surveyed on a square grid not wider spaced than 50 feet;
2. On all slopes greater than 10 percent, a square grid not wider than 50 feet should be used, but in any case, a line at the crest, midpoint, and toe of the slope should be taken;
3. A line of survey points no further than 50 feet apart must be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope);
4. A line of survey points no further than 50 feet apart must be taken at the invert of any pipes or other appurtenances to the liner;
5. At the corners and midpoints of the top and bottom of all sumps; and
6. At the midpoint of the crest of the outside berms.

5.0 DOCUMENTATION

The Surveying CQA Managing Engineer should retain copies of all field survey notes. The findings from the field surveys should be documented on a set of Survey Record (As Built) Drawings.

The Record Drawings should include the following information when applicable:

1. Site Layout Drawing showing:
 - a. Layout of Prepared Area in Relation to Permitted Boundaries;
 - b. Property boundaries and/or corners;
 - c. Monitoring wells and piezometers (if scale permits);

- d. Leachate risers, manholes and collection piping related to the specific cell and/or construction;
 - e. Limits of existing/future refuse disposal areas and limits of liner or final cover barrier;
 - f. Labeling and Miscellaneous Information:
 - Descriptions of what each line style represents;
 - Drawing scale;
 - Legend; and
 - North Arrow.
 - g. Existing Contours (prior to construction activity corresponding to this project);
 - h. A key map showing the location of the construction related to the permitted design, along with an identification of areas previously constructed and areas yet to be constructed;
 - i. If necessary to document leachate head level compliance, the report should also indicate the lowest point of the liner constructed not including leachate trenches and sumps;
 - j. In addition, the certifying professional shall make a statement that the cell was constructed in accordance with the permit drawings and narrative. The report should also include a list of any deviations from the permitted drawings, if they exist, and any reasons for the deviations; and
 - k. Any other features deemed significant.
2. Subgrade Drawing showing:
 - a. Prepared Subgrade Surface (Plan View);
 - b. The limits of excavation including all slopes;
 - c. The location of slope breaks, leachate sump and trenches, berms; and
 - d. Any other features deemed significant.
3. Top of Compacted Clay Liner or CKD Bedding Layer (or GCL, if approved) showing:
 - a. The top and bottom of liner or final cover elevations referenced to the site grid coordinate system at 50' intervals;
 - b. The location and elevation of slope breaks, leachate piping, leachate sump and trenches, berms; and any other features which are material to the disposal area construction; and
 - c. Any other features deemed significant.
4. Top of Drainage Layers or Liner Protection Layers showing:
 - a. If a granular blanket is utilized in the design, top of blanket elevation should be identified at 50' intervals;

- b. The location of slope breaks, leachate sump and trenches, berms; and any other features which are material to the disposal area construction; and
 - c. Any other features deemed significant.
5. Top of Waste
- a. Verify top of waste elevations are at or below permitted elevations prior to placing final cover. The elevations shall be referenced to the site grid coordinate system at 50' intervals.
6. Final Cover Compacted Clay System showing:
- a. The top and bottom of final cover elevations referenced to the site grid coordinate system at 50' intervals;
 - b. The location and elevation of slope breaks, trenches, berms and any other features which are material to the final cover construction; and
 - c. Any other features deemed significant.
 - d. ***NOTE: Depth verification may be required in lieu of survey elevations for landfills with compressible wastes due to possible settlement of waste during construction of the final cover system.***
7. Top of Final Cover Layers showing:
- a. The top and bottom of the vegetative support/topsoil layer plus base layer referenced to the site grid coordinate system at 50' intervals;
 - b. The location of slope breaks, trenches, berms; and trenches, berms; and any other features which are material to the disposal area construction; and
 - c. Any other features deemed significant.
 - d. ***NOTE: Depth verification may be required due to possible settlement of waste during construction of the final cover system.***

The Contractor will be responsible for submitting these record drawings (as-builts) if applicable to the CQA Consultant for review. The applicable record drawings are to be included in the Certification Report along with the CQA Consultant's Certifying Engineer's seal. The report shall then be submitted to the Design Engineer and Owner for review prior to being submitted to the ADEQ.

SECTION 3

CONSTRUCTION QUALITY ASSURANCE INVOLVING SOILS AND CKD

1.0 INTRODUCTION

This CQA document covers five types of soil (and CKD) that are used in the construction of the industrial landfill liner and/or cover system. The following types of soil layers will be used in some form in the construction of liner and cover systems corresponding to the Ash Grove Landfill.

1. Subgrade Surface;
2. Compacted Clay Liners and/or Compacted Clay Barrier Layers and/or CKD Bedding Layers (low permeability);
3. Drainage layers or media (free-draining, high-permeability soils, usually clean sand or gravel);
4. Liner Protective Cover Layers; and
5. Cover Base Layer and Topsoil (soil demonstrating the ability to support plant growth).

2.0 SOIL MATERIALS SPECIFICATIONS

Except when otherwise noted in the Project Specifications or Plans, soil materials to be utilized in each component of the liner and/or final cover system shall conform to the following minimum materials specifications.

2.1 Subgrade Surface

The subgrade soils prepared for bottom liner installation require treatment in the form of compaction or recompaction, prior to the placement of any of the lining system materials. This supporting layer is comprised of natural in-place materials, so this document will only address the compaction criteria. If the subgrade is disturbed, through undercutting of unsuitable material etc.; the subgrade is to be replaced, moisture conditioned, and compacted to the standards established in the Project Specifications. When possible, the subgrade surface should be relatively smooth and free of large rocks, sticks, or other debris which could compromise the liner system.

The upper portion of the subgrade can be damaged by excess moisture (causing softening) and insufficient moisture (causing desiccation and shrinkage), or by freezing. These conditions are normally not discovered until after the design phase of the project. At a minimum, the Soils CQA Monitor shall determine the suitability of the subgrade for fill placement by one or more of the following methods:

1. Continuous visual inspection during proof-rolling;
2. Pocket penetrometer or Torvane shear tests in suspect soil areas; and

3. Other tests identified in **TABLES 1** and **2**.

The main requirement for the subgrade is it must have sufficient compaction and strength to enable the placement and compaction of the clay bottom liner. The subgrade also must be stable to prevent large differential settlements that would be conducive to damage of the liner system. If the specifications require a minimum compaction and moisture standard, the frequency for testing using a nuclear density gauge shall be at least one test per 10,000 square feet of prepared subgrade.

The “subgrade” prepared for covers systems coincides with the top of waste and consists generally of CKD waste. At a minimum, the Soils CQA Monitor shall determine the suitability of the top of waste subgrade for fill placement by proof-rolling. If the specifications require a minimum compaction and moisture standard, the frequency for testing using a nuclear density gauge shall be at least one test per 10,000 square feet of prepared subgrade for the top 6-inches of top of waste subgrade.

2.2 Compacted Clay Liners

The soil component of the liner system shall comply with the following specifications. This includes compacted clay liners for bottom liner systems and compacted CKD bedding layers for final cover systems. The values and numbers presented herein are to be considered the minimum criteria for all materials utilized in the construction of compacted clay liner systems:

1. Requirements for fines content of soil shall be greater than 30 percent (material passing a #200 sieve). There is no fines content requirement for CKD;
2. The soil must be classified as either CL, CH or SC and should have a Plasticity Index (PI) greater than 10 percent. There is no classification requirement for CKD;
3. Material greater than #4 sieve must compose less than twenty percent (20%) of soil by weight with no particle sizes greater than 1.0 inch in diameter. There is no sieve requirement for CKD;
4. Soil or CKD clod size must be less than four (4) inches in diameter;
5. The soil component of the bottom liner system must have a hydraulic conductivity (k) of 1×10^{-7} cm/sec or less measured by hydraulic conductivity testing of undisturbed specimens. The CKD material for the final cover bedding (barrier) layer must have a hydraulic conductivity (k) of 5×10^{-6} cm/sec or less measured by hydraulic conductivity testing of undisturbed specimens. The soils and CKD shall be installed and compacted at a minimum of 95% Standard Proctor maximum dry density at a moisture content 1 to 3 percent above optimum as determined by ASTM D698, or equivalent Modified Proctor or other demonstration of adequate shear strength and compressibility using geotechnical laboratory testing methods;

6. Pre-construction testing shall be conducted at the rate of one test per every 20,000 cubic yards of liner or final cover barrier material, or more frequently if visual observation indicates a change in material characteristics. Tests shall be conducted in a manner to correlate compaction effort to permeability. Tests shall include:
 - Soil Classification (ASTM D2487);
 - Moisture Content (ASTM D2216);
 - Particle Size (ASTM D1140, D422);
 - Atterberg Limits (ASTM D4318);
 - Laboratory Compaction (ASTM D698); and
 - Laboratory Hydraulic Conductivity at a specified compaction (ASTM D5084).
7. Construction testing on soil or CKD hauled for liner or final cover placement shall be conducted at a rate of one test set per every 5,000 cubic yards of material used in the construction of the liner or cover, or more frequently if visual observation indicates a change in material, or if otherwise indicated herein. In addition to the tests shown below, the liner shall be monitored to insure bonding between lifts and that the specified lift thickness is being achieved. Tests shall include:
 - Soil Classification (ASTM D2487);
 - Moisture Content (ASTM D2216);
 - Particle Size (ASTM D1140, D422);
 - Atterberg Limits (ASTM D4318);
 - Laboratory Compaction (ASTM D698); and
 - Laboratory Hydraulic Conductivity at a specified compaction (ASTM D5084).
8. Field testing of the completed liner or final cover barrier shall be conducted at the rate of one test set every 10,000 ft² of liner constructed per compacted lift and shall include:
 - In-place field density/moisture (ASTM D6938).
9. Performance testing on undisturbed field samples shall be conducted at the rate of one test per 40,000 square feet of liner or final cover barrier constructed per compacted lift and shall include:
 - Laboratory Hydraulic Conductivity at a specified compaction (ASTM D5084).
10. Liner or final cover barrier penetrations resulting from performance testing will be repaired using bentonite clay or other manner approved by the certifying professional. Constructed liner should be rolled, wetted or protected in order to prevent desiccation and freeze/thaw damage;
11. Test fills (Section II, subsection 3 of the generic plan) will be required prior to the construction of the clay-lined area at a facility meeting the requirements of this section. Where the facility or an earth work contractor has successfully completed

- and documented a minimum of 500,000 square feet of clay liner or final cover barrier construction consistent with the requirements of this section during the last three (3) years, the owner or operator may submit a written request to the Department to waive the test fill requirements of this section;
12. The soil must consist of relatively homogeneous, fine grained soils which are free of debris, foreign objects, excess silt/sand, and organic substances;
 13. The hydraulic conductivity of the clay liner and/or CKD barrier layers shall not exceed 1.0×10^{-7} cm/s or 5.0×10^{-6} cm/s respectively;
 14. The soil must be compacted to the appropriate density and moisture content as per the Specifications and as compared with specimens tested in the laboratory by ASTM D698. Also, the contractor is required to use a sheep foot compactor with penetrating teeth;
 15. Maximum soil clod size, soil classifications, Atterberg Limits, and other physical properties shall be as specified; and
 16. Any moisture conditioning that is required shall be conducted in such a manner as to preserve the homogeneity of the soil or CKD and insure that moisture content throughout the soil or CKD mass is relatively uniform.

Acceptable hydraulic conductivity shall be verified by sampling and laboratory testing the soil materials comprising the soil component of the clay liner and cover barrier layers, regardless of the material properties. The clay liner or CKD bedding layers shall not be considered acceptable under any circumstances before this criterion is met.

2.3 Drainage Layers

Materials to be utilized in the construction of lateral drainage layers, particularly in leachate collection systems shall be comprised of clean washed river sand or gravel with a minimum hydraulic conductivity as specified and as determined utilizing the Hydrologic Evaluation of Landfill Performance (HELP, Version 3.0) Model. The hydraulic conductivity value shall be determined by the Design Engineer and made a part of the Project Specifications. Drainage nets may be utilized in place of a soil drainage layer as long as the material and installation requirements of Section 5 are adhered to.

The installer shall insure that all soil materials such as sand and gravel are placed in such a manner as to insure that no damage occurs to the geomembrane liner and that no excess tensile stresses occur in the geomembrane. The following details will be followed during construction of the drainage media system.

1. A geotextile or other cushion approved by the designer will be installed between the drainage media and the geomembrane if any of the following conditions are met:

- The drainage layer material contains angular aggregate; and/or
 - The drainage layer contains aggregate over 1 inch in nominal size as determined by a gradation test (ASTM D422);
2. A minimum of 12 inches of drainage media will be maintained between the dozer and the geomembrane at all times and thicker layers are required for heavier dozers (Larger than a D6). Typical minimum thickness' used for the ground pressure exerted by the equipment is described below.
 3. In areas of heavy traffic such as access ramps, the thickness should be at least 2 to 3 feet. This material can be common protective cover or the material used for the drainage media.

Equipment Ground Pressure (psi)	Minimum Loose Lift Thickness (inches)
< 9	9
9-12	12
9-16	18
>16	24

2.4 Protective Cover Layers

The protective cover materials above the bottom liner system and primary drainage system components (if applicable) are addressed herein. The protective cover materials will be comprised of one, or a combination, of the following:

- 1) 12-inch layer of compacted native soil,
- 2) 6-inch layer of compacted CKD overlain by 6-inch layer of compacted native soil,
- 3) Or a 12-inch layer of compacted cement kiln dust overlain by a protective plastic (w/ballast)

The protective cover materials above the cover geosynthetic liner and the primary drainage system geocomposite (also the vegetative support layers) will be comprised of the following:

- 1) 12-inch layer of soil base placed in a single lift and compacted only to the degree necessary to remain stable on the slope and loose enough to allow root penetration, and
- 2) 6-inch vegetative support (topsoil) layer lightly compacted and then cultivated to form a suitable seed bed.

2.5 Soils Testing

2.5.1 Test Methods

All testing used to evaluate the suitability or conformance of soils and CKD materials shall be carried out in accordance with the current versions of the corresponding American Society for Testing and Materials (ASTM) test procedures. The test methods indicated in **TABLES 1, 2, 3, and 4** are to be utilized for evaluating soil and CKD materials (when applicable) for adherence to the project specifications and the materials standards specified in this CQA Plan. All pre-construction and construction testing shall be performed at the frequency given in the tables below.

**TABLE 1
 TEST REQUIREMENTS FOR PRE-CONSTRUCTION TESTING OF CLAY LINER AND/OR CKD
 COVER BARRIER MATERIALS**

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Soil Classification	ASTM D2487	1 test per 20,000 yd ³ or change of material or borrow area
Moisture Content	ASTM D2216	1 test per 20,000 yd ³ or change of material or borrow area
Particle-size Analysis	ASTM D1140, D422	1 test per 10,000 yd ³ or change of material or borrow area
Atterberg Limits	ASTM D4318	1 test per 20,000 yd ³ or change of material or borrow area
Standard Proctor	ASTM D698	1 test per 20,000 yd ³ or change of material or borrow area
Hydraulic Conductivity	ASTM D5084	1 test per 20,000 yd ³ or change of material or borrow area

**TABLE 2
 TEST REQUIREMENTS FOR CONSTRUCTION TESTING OF CLAY LINER AND/OR CKD
 COVER BARRIER MATERIALS**

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Field Density/ Moisture (Subgrade)	ASTM D6938	1 test per 10,000 ft ²
In-Place Field Density/ Moisture (Clay Liner)	ASTM D6938	1 test per 10,000 ft ²
Soil Classification	ASTM D2487	1 test per 5,000 yd ³ or change of material or borrow area
Moisture Content	ASTM D2216	1 test per 5,000 yd ³ or change of material or borrow area
Particle-size Analysis	ASTM D1140, D422	1 test per 5,000 yd ³ or change of material or borrow area
Atterberg Limits	ASTM D4318	1 test per 5,000 yd ³ or change of material or borrow area

Standard Proctor	ASTM D698	1 test per 5,000 yd ³ or change of material or borrow area
Hydraulic Conductivity	ASTM D5084	1 test per 40,000 ft ² or change of material or borrow area

**TABLE 3
 TEST REQUIREMENTS FOR PRE-CONSTRUCTION TESTING OF SAND AND GRAVEL**

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Particle-size Analysis	ASTM D1140	1 test per source or change in material
Hydraulic Conductivity	ASTM D2434	1 test per source or change in material
Carbonate Content (gravels)	ASTM D4373	1 test per source or change in material

**TABLE 4
 TEST REQUIREMENTS FOR CONSTRUCTION TESTING OF SAND AND GRAVEL**

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Particle-size Analysis	ASTM D1140	1 test per source or change in material
Hydraulic Conductivity	ASTM D2434	1 test per source or change in material

2.5.2 Soils Testing Requirements

All soils testing shall be conducted under the direct supervision of the Soils CQA Consultant and/or qualified Soils CQC Firm. Nuclear densometer methods shall be used for field density testing in all cases. The drive cylinder (ASTM D2937) tests shall be used in cases of uncertainty, or as a check of the machine calibration, if applicable during the early stages of construction. The Soils CQA Consultant and/or CQA Manager shall resolve any conflict over the results.

The test frequencies presented in **TABLES 1, 2, 3, and 4** are specified as minimum test frequencies. The CQA Manager or Soils CQA Consultant can increase the actual frequency of testing required as necessary in order to insure adequate quality control associated with all soil liner/cover systems. For example, the actual test frequencies may be increased in order to consider local soil variability (if applicable).

3.0 TEST PAD

The Contractor must prepare a test pad in accordance with this section unless it can be demonstrated that the **Contractor successfully constructed a minimum of 500,000 square feet of compacted clay liner systems in the past three years** for the containment of waste or water systems using similar soils, equipment, and installation methods and that an exemption has been granted by the ADEQ. Demonstrations of Earthworks Qualification shall be made to the Project Manager and/or Design Engineer prior to mobilization. The Contractor must prepare a Clay Liner Test Pad for determining the necessary compactive effort and procedures necessary for achieving the desired consistency associated with the compacted clay liner and/or clay cover system.

The Project Manager, CQA Manager, or Regulatory Official may request that the compacted clay liner test pad be constructed to provide on-site verification of the moisture, density and permeability relationships for the clay liner or CKD barrier materials, as determined in the laboratory testing carried out in conjunction with the design of the facilities. The Test Pad shall utilize materials from the same source intended for use in construction. This test shall be used to evaluate the following:

1. Sampling procedures for laboratory testing;
2. Materials handling and placement procedures;
3. Compaction equipment effectiveness;
4. Permeability of the compacted clay; and
5. Data relating the compaction characteristics of the soil.

The Test Pad shall be constructed using the actual conditions and equipment to be utilized during the construction of the clay liner. The width of the Test Pad should be at least four times wider than the largest piece of construction equipment. The Test Pad should also be long enough to allow the construction equipment to achieve normal operating speed before reaching the area within the Test Pad that will be used for testing. All activities relating to the Test Pad shall be fully monitored and documented by the Soils CQA Consultant. The following sections outline the necessary steps associated with the construction of the Test Pad.

3.1 Purpose and Scope

The purpose of the Test Pad is to analyze the procedures utilized in the placement and compaction of the compacted clay liner system. The Test Pad also allows all the parties involved in the construction of the liner system the opportunity to become familiar with the soils properties; develop a correlation between the number of passes and density, moisture content and moisture conditioning requirements; and establish the relationship between density and permeability at different moisture contents, for given levels of compactive effort. The Test Pad program shall include:

1. Preparation of the subgrade;
2. Construction of a Test Pad;
3. Monitoring and CQA testing of the soil materials; and
4. Sampling and laboratory testing of the soil materials.

All the conditions of the actual construction of the clay liner system will be simulated as closely as possible during the construction of the Test Pad. The Test Pad program is not intended to replace the proper engineering design of the compacted clay liners based on the soil properties. The Test Pad program is intended to establish correct methods and procedures for attaining the correct specifications.

3.2 Test Pad Materials

The fill materials to be used for the construction of the test pad shall be from the same borrow source as the material to be utilized for the construction of the clay liner. All the pre-construction testing must be performed to determine if the material meets the specifications necessary for the proper construction of the clay liner and/or compacted CKD barrier layer.

3.3 Test Pad Construction

If the subgrade has already been excavated and is properly prepared the test pad may be constructed in the actual construction area and utilized as the liner once all the test results are accepted as passing. The area within the limits of the Test Pad shall be prepared as follows:

1. Cleared and grubbed of all trees, debris, stumps, and any other vegetation;
2. Stripping of topsoil and/or organic materials;
3. Proof-rolling to eliminate soft zones, irregularities, and abrupt changes in grade;
4. Finished subgrade surface shall be sloped at a grade of 2 percent or specified for the actual construction criteria; and
5. No standing water or excessive moisture shall be allowed to accumulate on the surface.

The Soils CQA Consultant shall properly document that all specifications are met for the Test Pad. The Soils CQA Consultant shall document the condition of the subgrade. The Test Pad width will be at least four times wider than the widest piece of construction equipment and the length will allow the equipment to obtain the normal operating speed before reaching the area within the Test Pad that will be used for testing. The lifts and overall thickness of the Test Pad should be as similar to the actual construction of the clay liner as possible.

Each lift of the soil will be constructed to meet the criteria as outlined below. The following criteria for each lift are designed to allow the determination of the relationships between fill

compaction criteria (which include density and moisture content), permeability, and compaction method parameters. The same criteria for the preparation of the actual clay liner and/or clay barrier layer will be followed for the compaction of the Test Pad.

3.3.1 Initial Lift

The placement, compaction, and testing of the soils in the first lift of the Test Pad shall be in accordance with the following requirements:

1. The first lift shall be installed such that the compacted lift will be no more than six inches thick;
2. The soil moisture content shall be adjusted until the moisture content is within the correct range (refer to Project Specifications);
3. The soil shall be compacted by the contractor, using the same compaction equipment intended for the construction of the landfill;
4. The Soils CQA Consultant shall collect samples and perform in-situ density tests using the nuclear densometer;
5. When compaction and the moisture requirements are met, Shelby tube samples are to be taken for permeability testing; if the moisture or density requirements fail then the Contractor must recompact the Test Pad until passing results are obtained; and
6. All holes resulting from the collection of samples shall be repaired.

3.3.2 Subsequent Lifts

The placement, compaction, and testing of the soils in the second and subsequent lifts of the Test Pad shall be in accordance with the following requirements:

1. The lift shall be installed such that the compacted lift will be no more than six inches thick or as thick as the actual lifts shall be utilized during the construction of the clay liner;
2. The Soils CQA Consultant shall verify that the two lifts are intermixed (this can be checked by digging test pits) to insure a good bond exists between two consecutive lifts;
3. The soil shall be compacted as under the actual conditions for the construction of the liner; and
4. Tests shall be performed to confirm that compaction, moisture, and hydraulic conductivity specifications are achieved.

3.3.3 Finished Surface Preparation

The surface of the Test Pad shall be smooth rolled and prepared as the actual clay liner and/or clay barrier layer will be prepared. This will include but is not limited to the following:

1. Rolling until all irregularities, loose soil, and abrupt changes in grade are removed; and
2. All stones larger than 0.25 inches shall be removed.

One-half of the prepared soil surface will be left exposed to the environment. The other half will be immediately protected against drying. Monitoring and documentation of the condition of the surface (e.g., desiccation cracking) shall be performed by the Soils CQA Consultant on the uncovered section of the Test Pad. This will aid in the knowledge of how often the final surface needs to be watered and rolled until the drainage layer is placed on the clay liner and/or compacted clay barrier layer. The CQA Consultant will also monitor desiccation cracking during the construction of the clay liner due to variances in environmental conditions during the construction process.

3.4 Test Pad CQA Requirements

The testing requirements for the Test Pad will be as follows:

During the first two lifts, the Soils CQA Consultant shall perform the following:

1. Estimate the thickness of the loose lifts;
2. Count and record the numbers of compaction equipment passes and monitor the coverage of the Test Pad;
3. After every two passes, perform a minimum of five (5) in-situ moisture and density tests using the nuclear densometer;
4. Compute the degree of compaction and collect an additional three (3) samples for laboratory moisture content determination;
5. Monitor the repair of holes left in the soil lift as a result of density testing and soil sample collection; and
6. Continue in-situ density testing and moisture content determination to enable the development of a dry density versus number of passes relationship for a given lift thickness.

During each remaining lift, the Soils CQA Consultant shall:

1. Verify that the thickness of the loose lift does not exceed the loose thickness determined from the testing of the second lift;
2. Count the number of compaction equipment passes, determined from testing of the second lift, which are necessary to achieve the specified density and monitor coverage of the Test Pad; and

3. Perform the same number of nuclear density tests as under actual construction conditions to verify the adequacy of the construction procedures.

The Soils CQA Consultant shall collect a minimum of two (2) undisturbed Shelby tube samples from various depths in the completed Test Pad. These samples shall be sealed or otherwise protected to retain their natural moisture, and shipped to the laboratory for testing. The soil Test Pad will be monitored by the Soils CQA Consultant to verify bonding between adjacent lifts. Such observation shall be exercised on the portion of the Test Pad which has been excavated to permit removal of undisturbed soil samples.

3.5 Permeability Testing

A minimum of six (6) Shelby tube samples shall be obtained from the completed test pad (at various depths) and delivered to the Soils CQC Firm for permeability testing in accordance with ASTM D5084. If required, the procedures for evaluating the field hydraulic conductivity of the Test Pad shall utilize the principle of a "sealed double-ring infiltrometer", as described in the latest version of ASTM D5093 "Standard Test for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring". The use of the infiltrometer for field-testing will be at the discretion of the Project Manager and/or CQA Manager.

3.6 Documentation

The Soils CQA Consultant shall monitor and document activities associated with the construction, monitoring, testing, and repair of the Test Pad. This documentation shall include daily reports of construction activities and oral communications with the Contractor. The following additional documentation shall be submitted to the CQA Manager and/or CQA Certifying Engineer:

1. A moisture/density relationship for the Test Pad materials and other test results as required for the compacted clay liners; and
2. A Test Pad summary report, which shall include, at least:
 - record of the compaction equipment type, configuration (e.g., drum diameter and length), and weight;
 - procedures used to bond lifts;
 - results of all field testing;
 - record drawing of the Test Pad and locations of all test samples for each lift;
 - description of the actual construction procedures utilized in association with the test pad;
 - results of all preconstruction, construction, and post-construction quality assurance inspections and testing performed;

- summary of material specifications and construction specifications, methodology, and equipment necessary to construct a full-scale compacted clay liner or cover achieving a field hydraulic conductivity of 1.0×10^{-7} cm/sec or less; and
- complete documentation, including a summary of raw data, detailing how the field hydraulic conductivity of the compacted clay liner (and/or clay barrier layer) was measured and calculated.

4.0 CLAY LINER SYSTEM CQA

Clay liner system CQA shall consist of the following procedures:

1. Visual observations made by the field CQA Monitor;
2. Investigations into the adequacy of layer bonding;
3. Field and laboratory testing; and
4. Surveying.

All field and laboratory tests shall be conducted on samples taken from material during the course of work. A more detailed explanation of these procedures is provided below.

4.1 Visual Observations

Monitoring construction associated with the installation of the low permeability, soil barrier liner shall include the following:

1. Monitoring the thickness of each lift;
2. Observations of the action of the compaction and heavy hauling equipment on the construction surface (sheep foot penetration, pumping, cracking, etc.); and
3. Noting the liner material for any change in soil properties (including soil consistency, color, layers of silt or sand, etc.).

4.2 Evaluation of Layer Bonding

The Soils CQA Monitor shall check for layer bonding as needed. This can be checked through excavation of backhoe test pits. The pits should penetrate the layer below adequately to determine if the two layers are bonding together properly. These pits shall be excavated, backfilled and compacted according to all the specifications required for the placement of the original clay liner material. This can be accomplished through the use of mechanical equipment or other methods approved by the CQA Soils monitor.

4.3 Field and Laboratory Tests

The field and laboratory test methods and testing frequencies presented in **TABLES 1** and **2** shall apply to all clay liner and CKD barrier layer systems constructed in association with Ash Grove's CKD Landfill. All test methods will adhere to ASTM Standards and other applicable regulations.

The construction area will be divided into a grid so the approximate location of the sampling or testing area can be determined. All the sampling and testing locations should be determined at random or in areas where the CQA Soils Monitor determines that there is a possibility of inadequate compaction, material, thickness, etc. At locations where the field testing indicates densities below the requirements of the specification, the failing area or grid shall be reworked and retested. The size of the area to be reworked is determined by the closest edge of the area with passing results. The Soils CQA Monitor determines this area. For clay liners where the field testing indicates the moisture content is below the requirements, the area shall be scarified, moisture-conditioned, and recompacted. For areas where the compaction is inadequate, the area will be compacted further until a passing result is obtained.

4.4 Construction Testing Frequency

All pre-construction testing shall be conducted in accordance with the project specifications and as directed by the Project Manager and/or CQA Manager. The Soils CQA Monitor shall observe testing methods, as previously identified. Pre-construction testing shall be conducted on material samples obtained from the designated borrow location and/or from the stockpile(s) of the materials to be utilized in the construction of the clay liner system. The required frequency of pre-construction testing is presented in **TABLE 1**.

The Soils CQA Consultant shall select sampling locations. If necessary, the location of routine in-place density tests shall be determined using a non-biased sampling plan. A special testing frequency shall be used at the discretion of the Owner and/or his Soils CQA representative when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas shall be considered when:

1. Rollers slip during rolling operation;
2. Lift thickness is greater than specified;
3. Earthfill is at improper and/or variable moisture content;
4. Less than specified number of roller passes are made;
5. Dirt-clogged rollers are used to compact the material;
6. Rollers may not have used optimum ballast;
7. Fill materials differ substantially from those specified;
8. The degree of compaction is doubtful; and
9. As directed by the Owner or the Soils CQA Monitor.

During construction, the frequency of testing may also be increased in the following situations:

1. Adverse weather conditions;
2. Breakdown of equipment;
3. At the start and finish of grading;
4. Material fails to meet specifications; and
5. The work area is reduced.

4.5 Clay Liner Perforations

Perforations that must be filled shall include, but not be limited to, the following:

1. Nuclear density test probe locations;
2. Permeability sampling locations; and
3. Test pit locations.

Samples that will be collected to confirm the in-place hydraulic conductivity shall be taken such that the sample tube is inserted into the liner normal (perpendicular) to the plane of the constructed surface. Unless otherwise noted in the project specifications, or as directed by the Owner or his representative, all perforations of the clay liner by probe or sample tube shall be backfilled with a soil having similar index properties and moisture content as the extruded sample or with bentonite clay. The soil shall be compacted in-place with a tamping rod, Modified or Standard Proctor hammer as specified, or hand tamper, depending on the size of the perforation. Test pit excavations shall be backfilled with the same material being tested or examined.

4.6 Deficiencies

If a defect is discovered in the earthwork product, the Soils CQA Monitor shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the Soils CQA Monitor shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the Soils CQA Monitor deems appropriate and as indicated in the project specifications. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the Soils CQA Monitor shall define the limits and nature of the defect.

4.6.1 Notification

After determining the extent and nature of a defect, the Soils CQA Monitor shall notify the Project Manager and/or CQA Manager and schedule appropriate retests when the work deficiency is corrected.

4.6.2 Repairs and Retesting

The Contractor shall correct the deficiency to the satisfaction of the Soils CQA Monitor. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soils CQA Monitor shall develop and present to the Soils CQA Manager suggested solutions for approval. All retests recommended by the Soils CQA Monitor must verify that the defect has been corrected before the Contractor, in the area of the deficiency, performs any additional work. The Soils CQA Monitor shall also verify that all installation requirements are met and that all submittals are provided.

5.0 DOCUMENTATION

The CQA Manager shall document that quality assurance requirements have been addressed and satisfied. The CQA Manager shall provide the Project Manager with signed descriptive remarks, data sheets, and logs to verify that all monitoring activities have been carried out. The CQA Manager shall also maintain at the job site a complete file of plans and specifications, a CQA plan, checklists, test procedures, daily logs, and other pertinent documents.

5.1 Daily Recordkeeping

Standard reporting procedures shall include preparation of a daily report, which at a minimum, will consist of: (a) field notes, including memoranda of meetings and/or discussions with the Contractor; (b) observation logs and testing data sheets; and (c) construction problems and solution data sheets. This information will be regularly submitted to and reviewed by the Project Manager.

5.1.1 Memorandum of Discussion with Earthwork Contractor or Subcontractors

A memorandum will be prepared each day, if required to summarize discussions between the Soils CQA Monitor and Contractor. At a minimum, the memoranda will include the following information:

1. Date, project name, location, and other identification;
2. Name of parties to discussion;
3. Relevant subject matter or issues;
4. Activities planned;
5. Constraints or suggestions;
6. Schedule; and

7. Signature of the CQA Monitor and/or CQA Manager.

5.1.2 Observation Logs and Testing Data Sheets

Observation and testing data sheets shall be prepared daily. At a minimum, these data sheets shall include or reference the following information if applicable:

1. An identifying sheet number for cross referencing and document control;
2. Date, project name, location, and other identification;
3. Data on weather conditions;
4. A scaled Site Plan showing all proposed work areas and test locations;
5. Descriptions and locations of ongoing construction;
6. Equipment and personnel in each work area, including subcontractors;
7. Descriptions and specific locations of areas of work being tested and/or observed and documented (identified by lift and location);
8. Locations where tests and samples were taken;
9. A summary of test results;
10. Calibration or recalibrations or test equipment, and actions taken as result of recalibration;
11. Off-site materials received, including quality verification documentation;
12. Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and
13. The CQA Monitor signature.

In any case, all logs must be completely filled out with no items left blank.

5.2 Construction Problems and Solution Data Sheets

When a construction problem arises, sheets describing the special construction situation shall be cross-referenced with specific observation logs and testing data sheets, and may include the following information, where available:

1. An identifying sheet number for cross-referencing and document control;
2. A detailed description of the situation or deficiency;
3. The location and probable cause of the situation or deficiency;
4. How and when the situation or deficiency was found or located;
5. Documentation of the response to the situation or deficiency;
6. Final results of any responses;
7. Any measures taken to prevent a similar situation from occurring in the future; and
8. The signature of the CQA Monitor and signature indicating concurrence from the Project Manager.

The Project Manager shall be made aware of any significant recurring non-conformance with specifications. The Project Manager shall then determine the cause of the non-conformance and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results must be documented, and the Owner and the Design Engineer shall approve any revision to procedures or specifications.

A summary of all supporting data sheets, along with final testing results and the CQA Manager's approval of the work, shall be required upon completion of construction.

5.3 Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, may be cross-referenced with observation and testing data sheet(s), and/or construction problems and solution data sheet(s) where appropriate. These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. Digital photos will be stored on appropriate media. These records shall be presented to the Project Manager upon completion of the project or upon request.

5.4 Design and/or Specification Changes

Design and/or specification changes may be required during construction. In such cases, the CQA Manager shall notify the Project Manager and the Design Engineer. Design and/or specification changes shall be made only with written agreement from the Project Manager and the Design Engineer, and shall take the form of an addendum to the specifications.

5.5 Progress Reports

The CQA Manager shall prepare a summary progress report biweekly, or at time intervals established at the pre-construction meeting. As a minimum, this report shall include the following information based on the CQA Monitor's daily logs and other accessible information:

1. A unique identifying sheet number for cross-referencing and document control;
2. The date, project name, location, and other information;
3. A summary of work activities during progress reporting period;
4. A summary of construction situations, deficiencies, and/or defects occurring during progress reporting period;
5. A summary of test results, failures and retests; and
6. The signature of the CQA Manager.

5.6 Signatures and Final Report

At the completion of the work, the CQA Engineer shall submit to the Project Manager and/or Design Engineer a signed final Report. This report shall certify that the work has been performed in compliance with the plans and specifications except as properly authorized and implemented, and that the summary document provides the necessary supporting information.

At a minimum, this report shall include: (a) summaries of all construction activities; (b) observation logs and testing data sheets including sample location plans; (c) construction problems and solutions data sheets; (d) changes from design and material specifications; (e) Record Drawings; and (f) a summary statement sealed and signed by a registered Professional Engineer. The Record Drawings shall include scaled drawings depicting the location of the construction details pertaining to the extent of construction (depths, plan dimensions, elevations, soil component thickness, etc.). This document shall be prepared by the CQA Consultant and included as part of the CQA documentation.

SECTION 4

GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE

1.0 GEOMEMBRANE MANUFACTURING, SHIPPING, & CONFORMANCE TESTING

1.1 Manufacturing

1.1.1 Raw Material

The raw material to be utilized in the manufacturing of the geomembrane shall be first quality polyethylene resin. The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE or LDPE as the parent material. The base polyethylene resin shall be mixed with carbon black and a proprietary additive package of heat stabilizers and anti-oxidants. The percent distribution of these components including recycled polymer shall be as per the project specifications.

The raw material shall be first quality polyethylene resin and shall be tested by the Manufacturer for the following specifications:

TABLE 5 TESTING REQUIREMENTS FOR POLYETHYLENE GEOMEMBRANE RAW MATERIALS		
TEST NAME	TEST METHOD ¹	MINIMUM FREQUENCY OF TESTING ²
Specific Gravity	ASTM D1505/D792	per 200,000 lb
Melt Flow Index	ASTM D1238 Condition 190°C / 2.16 kg	per batch

1 Tests shall be performed in accordance with the minimum requirements in the most recent GRI Test Method GM13 or GM17, provided by the Geosynthetic Research Institute.

2 Or as dictated by the project plans and project specifications.

Raw materials (resin, carbon black, and additive package) may be mixed during the production stage using a “masterbatch” carrier resin containing the carbon black and other additives or during a compounding process prior to production.

Conformance testing shall be carried out by the Manufacturer to demonstrate that the product meets this specification. At the Owner's discretion, additional testing may be carried out for purposes of conformance by the Geosynthetics CQC Firm, and paid for by the Owner. If the results of the Manufacturer's and the Geosynthetics CQC Firm's testing differ, the testing shall be repeated by the Geosynthetics CQC Firm, and the Manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, if the applicable test methods have been followed.

Prior to the installation of any geomembrane material, the Manufacturer shall provide the Project Manager and the Geosynthetics CQA Monitor with the following information:

1. The origin (Resin Supplier's name and resin production plant), identification (brand name, number) and production date of the resin;
2. A copy of the quality control certificates issued by the Resin Supplier to include specific gravity (ASTM D1505) and melt index (ASTM D1238 Condition, 190°C/2.16 kg); and
3. A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed percentage required in the project specifications).

The CQA Monitor shall review these documents and shall report any discrepancies to the Project Manager.

1.1.2 Geomembrane Manufacturing

The Project Manager shall provide to the CQA Monitor the plans, specifications and drawings for the lining system prepared by the Design Engineer. **TABLES 5** and **6** provide the frequency of testing for the geomembrane. The CQA Monitor shall verify that the specifications include at least all properties listed in **TABLES 5** and **6**, measured with the same methods or equivalent.

If the specifications do not fulfill the above conditions, the Design Engineer shall complete the required alterations of the specifications. The Geomembrane Manufacturer shall provide the Project Manager and the CQA Monitor with the following:

1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications, or equivalent;
2. A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane;
3. The sampling procedures and results of testing; and
4. A certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

TABLE 6
CONFORMANCE TESTING REQUIREMENTS FOR POLYETHYLENE GEOMEMBRANES

TEST NAME	TEST METHOD ¹	MINIMUM FREQUENCY OF TESTING ²
Density	ASTM D1505 / D792	1 test per 100,000 ft ²
Tensile Strength at Yield	ASTM D6693 /Type IV	1 test per 100,000 ft ²
Tensile Strength at Break	ASTM D6693/Type IV	1 test per 100,000 ft ²
Elongation at Yield	ASTM D6693/Type IV	1 test per 100,000 ft ²
Elongation at Break	ASTM D6693/Type IV	1 test per 100,000 ft ²
Melt Flow Index	ASTM D1238	1 test per 100,000 ft ²
Tear Resistance	ASTM D1004	1 test per 100,000 ft ²
Carbon Black Content	ASTM D1603	1 test per 100,000 ft ²
Carbon Black Dispersion	ASTM D5596	1 test per 100,000 ft ²
Average Thickness	ASTM D5199 ³ / D5994 ⁴	1 test per 100,000 ft ²

1. Reference the most recent version of GRI Test Method GM13 or GM17 for updated test methods required.
2. Manufacturer's quality control testing shall be completed at a frequency of one test per roll or as dictated by the project plans and project specifications.
3. To be used for smooth geomembrane.
4. To be used for textured geomembrane.

The CQA Monitor shall verify that:

1. the property values certified by the Geomembrane Manufacturer meet all of the specifications; and
2. the measurements of properties by the Geomembrane Manufacturer are properly documented and that the test methods used are acceptable.

In addition, the Geosynthetics CQA Monitor may, at the request of the owner, undertake a manufacturing plant visit, preferably during the production of the particular geomembrane for this project, in order to evaluate the Manufacturer's quality control procedures.

1.1.3 Rolls

Prior to shipment, the Geomembrane Manufacturer shall provide the Project Manager and the CQA Consultant with a quality control certificate for every roll of geomembrane to be provided for the particular project. A responsible party employed by the Geomembrane Manufacturer,

such as the production manager, shall sign the quality control certificate. The quality control certificate shall include:

1. Roll numbers and identification; and
2. Sampling procedures and results of quality control tests - as a minimum, results shall be given for thickness, tensile strength, and tear resistance, evaluated in accordance with the methods indicated in the specifications or equivalent methods approved by the Designer.

The CQA Monitor shall:

1. Verify that the quality control certificates have been provided at the specified frequency, and that each certificate identifies the rolls related to it; and
2. Review the quality control certificates and verify that the certified roll properties meet the specifications.

1.2 Roll Label Requirements

All rolls delivered to the site must be labeled containing the following information:

1. Roll Number;
2. Material Type;
3. Nominal Thickness; and
4. Batch Number.

The geomembrane rolls are to be packaged with a label placed on the outside of the roll and one within the roll core. If both of these labels are missing or illegible, the roll will be rejected.

1.3 Shipping, Handling, and Storage Requirements

1.3.1 Shipping

Shipping of the geomembrane is the responsibility of the Geomembrane Manufacturer, Fabricator, Installer, or other party as agreed upon. All handling on site is the responsibility of the Installer.

Upon delivery at the site, the Installer and the Geosynthetics CQA Consultant shall conduct a surface observation of all rolls or factory panels for defects and for damage. This inspection shall be conducted without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The Geosynthetics CQA Consultant shall indicate to the Project Manager:

1. Rolls, factory panels, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and

2. Rolls or factory panels that include minor repairable flaws.

1.3.2 Handling

The geomembrane temporary tagging area on site should be coordinated with the on-site CQA Manager and the Installer to insure ease of transportation and placement in an area where the geomembrane will not be damaged or in the way of daily operations of the landfill. Two high strength-carrying straps must be placed around the outside of the roll to assist in transportation and handling of the material on the construction site.

1.3.3 Storage Requirements

The Installer shall be responsible for the storage of the geomembrane on site. The Project Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are optimized if possible. Storage space should be protected from theft, vandalism, passage of vehicles, etc. If the geomembrane is to be exposed to the weather for an extended period of time it should be covered until installed. The designated storage area should be a firm, smooth surface free of large and/or sharp stones or any other sharp objects that could damage the liner. If the area is sloped or the rolls are stacked precautions should be taken to insure that the rolls will not shift or move causing possible damage to the rolls or injuring workers.

1.4 Conformance Testing of Geomembrane

1.4.1 Tests and Procedures

Upon or prior to delivery of the rolls of geomembrane, the CQA Monitor shall insure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQC Firm for testing to insure conformance to both the design specifications and the list of guaranteed properties. The test procedures shall be as indicated in **TABLE 6** or as specified in the project plans. Additionally the Geomembrane shall meet or exceed the following specifications:

1. Conformance testing (1 test set every lot or every 100,000 ft² whichever is greater). Material lots found not in conformance will be rejected.
 - a. Density (ASTM D1505);
 - b. Carbon Black Content (ASTM D1603);
 - c. Carbon Black Dispersion (ASTM D5596);
 - d. Thickness (ASTM D5994);
 - e. Tensile Properties (ASTM D6693/Type IV); and
 - f. Tear Resistance (ASTM D1004, Die C).
2. Seam Testing:
 - a. Trial seams tested in field tensiometer or at testing laboratory at the beginning of everyday and every four working hours; and

- b. Air pressure and vacuum testing of all field seam lengths (ASTM D5820 and ASTM D5641, respectively).

1.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three linear feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the machine direction on the samples with an arrow. The required minimum sampling frequencies are provided in **TABLE 6**.

1.4.3 Test Results

The CQA Monitor shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager.

2.0 Installation of Geomembrane

2.1 Earthwork

2.1.1 Subgrade Preparation

The CQA Monitor shall verify that:

1. A qualified land surveyor has verified all lines and grades;
2. A qualified geotechnical engineer, normally the Soils CQA Consultant, has verified that the supporting soil or CKD meets the density specification;
3. The surface to be lined has been rolled and compacted so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade;
4. The surface of the supporting soil or CKD does not contain stones which may be damaging to the geomembrane; and
5. There is no area excessively softened by high water content.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given by the Installer to the Project Manager prior to commencement of geomembrane installation in the area under consideration. The CQA Consultant shall be given a copy of this certificate by the Project Manager.

After the supporting soil or CKD has been accepted by the Installer, it shall be the Installer's responsibility to indicate to the Project Manager any change in the supporting soil or CKD condition that may require repair work. If the Geosynthetics CQA Monitor concurs with the Installer, then the Project Manager shall insure that the supporting soil or CKD is repaired.

At any time before and during the geomembrane installation, the Geosynthetics CQA Monitor shall indicate to the Project Manager locations that may not provide adequate support to the geomembrane.

2.1.2 Anchor Trench System

All anchor trench systems will be excavated in accordance with the lines and widths as shown on the contract drawings, before geosynthetics placements. The CQA Consultant shall verify that the anchor trench has been constructed according to design drawings.

If the anchor trench is excavated in a clay liner susceptible to desiccation, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated (unless otherwise specified) to minimize desiccation potential of the anchor trench clay soils. The corners of the anchor trench where geosynthetic enters the trench should be slightly rounded to avoid sharp bends in the geosynthetics. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. No large rocks or clay lumps will be allowed to underlie the geomembrane in the anchor trench.

Backfilling of the anchor trench shall be conducted utilizing suitable backfill materials as deemed appropriate by the CQA Manager. All anchor trenches shall be backfilled in 6" compacted lifts. If a compaction standard is included in the Project Specifications, the anchor trenches shall be tested at a frequency of one test per 100 feet of trench (each lift).

2.2 Geosynthetic Placement

2.2.1 Installation Schedule

Field panels may be installed using any one of the following schedules:

1. All field panels are placed prior to field seaming (in order to protect the subgrade from erosion by rain);
2. Field panels are placed one at a time and each field panel is seamed immediately after its placement (in order to minimize the number of unseamed filed panels exposed to wind), and
3. Any combination of the above.

If a decision is reached to place all field panels prior to field seaming, installation normally should begin at the high point area and proceed toward the low point with "shingle" overlaps to facilitate drainage in the event of precipitation. It is also usually beneficial to proceed in the direction of prevailing winds. Accordingly, an early decision regarding installation scheduling should be made if, and only if, weather conditions can be predicated with certainty. Otherwise, scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the Installer is fully responsible for the decision made regarding placement procedures.

The CQA Monitor shall evaluate changes in the schedule proposed by the Installer and advise the Project Manager on the acceptability of that change. The CQA Monitor shall verify that the condition of the supporting soil has not changed detrimentally during installation. The CQA Monitor shall record the identification code, location, and date of installation of each field panel.

2.2.2 Field Panel Location and Identification

Field panels are to be located by the CQA Monitor in a manner consistent with the specifications and in a manner best suited to existing site conditions (i.e., a field panel is a roll or a portion of roll cut in the field).

A field panel is the unit area of geomembrane which is to be seamed in the field. Two cases can be considered:

1. If the geomembrane is fabricated into panels in a factory, a field panel is a factory panel or a portion of factory panel cut in the field.
2. If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the CQA Monitor to insure that each field panel is given an "identification code" (number or letter-number) consistent with the layout plan. The Project Manager, Installer and CQA Monitor shall agree upon this identification code. This field panel identification code shall be as simple and logical as possible. (Note that roll numbers established in the manufacturing plant must be traceable to the field panel identification code.)

The CQA Consultant shall establish documentation showing correspondence between roll numbers, factory panels, and field panel identification codes. The Field panel identification code shall be used for all quality assurance records. The CQA Consultant shall verify that field panels are installed at the location indicated in the Designer's layout plan, as approved or modified.

2.2.3 Weather Conditions

Geomembrane placement shall not proceed at an ambient temperature below 5°C (40°F) unless otherwise authorized. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponding water, or in the presence of excessive winds.

The CQA Monitor shall verify that the above conditions are fulfilled. Additionally, the CQA Consultant shall verify that the supporting soil has not been damaged by weather conditions. The Geosynthetics CQA Monitor shall inform the Project Manager if the above conditions are not fulfilled.

2.2.4 Method of Placement

The Geosynthetics CQA Monitor shall verify the following:

1. Construction equipment used to deploy geomembranes should not create excessive rutting in the subgrade;
2. If the substrata is a geosynthetic material, deployment may be by hand, by use of small jack lifts on pneumatic tires having low ground contact pressure, or by use of all-terrain vehicles (ATVs) having low ground contact pressure;
3. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
4. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;
5. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris;
6. All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
7. The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
8. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
9. 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, continuous loading, e.g., adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels);
10. Direct contact 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;
11. No bridging or stressed conditions in the material; and
12. Pipes or other objects that penetrate the liner are connected to the liner material in a way that prevents leakage and unnecessary stresses.

The Geosynthetics CQA Monitor shall inform the Project Manager if the above conditions are not fulfilled.

2.2.5 Damage

The Geosynthetics CQA Monitor shall inspect each panel, after placement and prior to seaming, for damage. The Geosynthetics CQA Manager shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetics CQA Consultant. Repairs shall be made according to procedures described in Section 2.4.

2.3 Seaming and Joining

2.3.1 Seam Layout

The Installer shall provide the Project Manager and the Geosynthetics CQA Monitor with a seam layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The Geosynthetics CQA Monitor shall review the seam layout drawing and verify that it is consistent with accepted industry practice. No panels may be seamed in the field without the Project Manager's approval. In addition, no panels not specifically shown on the seam layout drawing may be used without the Project Manager's prior approval.

Seams will be made by overlapping sheets approximately three inches (3") for extrusion welding and approximately four inches (4") for hot wedge welding. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet from the toe of the slope, or areas of potential stress concentrates, unless otherwise authorized.

A seam numbering system compatible with the panel numbering system shall be agreed upon at the Resolution and/or Pre-Construction Meeting.

2.3.2 Requirements of Personnel

All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 5,000,000 ft² of polyethylene geomembrane using the same type of seaming apparatus to be used to fabricate the site-specific geomembrane. The most experienced seamer, the "master seamer", shall provide direct supervision over less experienced seamers.

The Installer shall provide the Project Manager and the Geosynthetics CQA Consultant with a list of proposed seaming personnel and their experience records. The Project Manager and the Geosynthetic CQA Monitor shall review this document.

2.3.3 Seaming Equipment and Products

The approved processes for field seaming are extrusion welding and hot wedge (fusion) welding. Proposed alternate processes will be documented and submitted to the owner or his representative for approval. The hot wedge welding system is generally the primary system for geomembrane installation and the extrusion welding system is utilized for repairs and detail work. Only apparatus, which have been specifically approved by make and model, shall be used. The Project Manager and the Geosynthetics CQA Monitor shall approve all seaming processes and apparatus.

The Installer will verify the following general conditions during the seaming of the liner:

1. Equipment used for seaming is not likely to damage the geomembrane;
2. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
3. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
4. The geomembrane is protected from damage in heavily trafficked areas.

2.3.3.1 Hot Wedge Welding/Fusion System

The hot wedge welding apparatus (typically called a fusion welder) is self-propelled and produces a double seam with an enclosed air channel for testing. The fusion welding consists of placing two heated wedge mounted self-propelled unit, between two overlapped sheets of polyethylene liner. The heated plate heats and fuses the two sheets together. The fusion welder must meet the following requirements:

1. A temperature readout device that continuously monitors the temperature of the wedge;
2. For cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to welding;
3. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
4. The geomembrane is protected from damage in heavily trafficked areas.

2.3.3.2 Extrusion (Fillet) Welding System

The extrusion-welding apparatus shall be equipped with gauges giving the extrudate temperature in the apparatus and at the nozzle. The Installer shall provide documentation regarding the extrudate to the Project Manager and the Geosynthetics CQA Monitor, and shall

certify that the extrudate is compatible with the specifications, and in any event is comprised of the same resin as the geomembrane sheeting.

The Geosynthetics CQA Monitor and the Installer shall log apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals. The Geosynthetics CQA Monitor shall verify that the extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. The welder also must be equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

2.3.4 Seam Preparation

The Installer shall insure that:

1. Before seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
2. If seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions, within one hour of the seaming operation and in a way that does not damage the geomembrane; and
3. Seams are aligned with the fewest possible number of wrinkles and "fish mouths".

2.3.5 Seaming in Various Weather Conditions

The high temperature limit for welding is based on two factors:

1. The well-being of the crew. Black lining material will get very hot when exposed to sunlight. It is possible that the elevated sheet temperature in conjunction with immoderate ambient conditions could place the well-being of the crew at risk. (It is the responsibility of the Installer to determine if their crew can work in the weather conditions at the site).
2. Material capability.

The highest temperature at which the material can be welded is dependent upon ambient temperature, wind, subgrade conditions exposure to light, material type, and material thickness.

Thinner materials and low density products are the most difficult to seam at high liner temperatures. The problem typically is characterized by frequent burnouts (places in the liner weld where the rollers lose traction and the machine stops moving causing the wedge to burn through the liner). The number of burnouts can often be reduced by adjusting the speed or the temperature at which the welder is operating. If the Installer determines the sheet temperature has reached a temperature in which to large a number of burnouts occurs they can stop welding until favorable conditions return.

The lowest allowable temperature at which welding may be permitted is dependent on ambient temperature, wind, subgrade conditions exposure to light, material type, and material thickness. Typically during cold weather it is necessary to reduce the welders speed and increase the temperature. Pre-heating the liner in advance of the welding apparatus may also be done by using a hot air blower.

At low temperatures, special attention must be made to the pre-weld destructive samples (trial welds). In cold conditions trial welds shall be performed under the same conditions that will be seen during actual seaming conditions. The lowest temperature at which welding may occur is at the temperature which consistent passing trial seams can be performed under actual seaming conditions. In order to obtain passing results, it may be necessary to preheat the sheet in advance and/or shield the sheets from the wind. This is allowable as long as it is done during the actual welding of the liner.

The normally required weather conditions for seaming are as follows:

1. Unless authorized in writing by the Project Manager, no seaming shall be attempted at an ambient temperature below 5°C (40°F) or above 40°C (104°F);
2. Between ambient temperatures of 5°C (40°F) and 10°C (50°F), seaming is possible if the geomembrane is preheated by either sun or hot air device, and if there is no excessive cooling resulting from wind; and
3. In all cases, the geomembrane shall be dry and protected from wind.

If the Installer wishes to use methods which may allow seaming at ambient temperature below 5°C (40°F) or above 40°C (104°F), the Installer shall demonstrate and certify that such methods produce seams which are entirely equivalent to seams produced at ambient temperatures above 5°C (40°F), and that the overall quality of the geomembrane is not adversely affected. In addition, an addendum to the contract between the Owner and the Installer is required which specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane. Then, the temperatures in the above quality assurance procedure shall be modified accordingly.

The Geosynthetics CQA Monitor shall verify that these weather conditions are fulfilled and will advise the Project Manager if they are not. The Project Manager shall then decide if the installation shall be stopped or postponed.

2.3.6 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each four hours, for each seaming apparatus used that day. In

addition, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

An extrusion welded trial seam sample shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Fusion welded trial seam samples shall be at least 15 feet long by 1 foot wide (after seaming) with the seam centered lengthwise.

Ten adjoining specimens, each 1 inch wide, shall be cut from the trial seam sample by the Installer. Five specimens shall be tested for shear strength and five shall be tested for peel using a gauged tensiometer. If a specimen fails to meet the seam requirement set forth in the Project Specifications, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams achieved.

The CQA Monitor shall observe all trial seam procedures. The remainder of the successful trial seam sample shall be assigned a number and marked accordingly by the CQA Monitor, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. At the discretion of the CQA Consultant, samples of trial seams may be submitted to the Geosynthetics Laboratory for analysis.

After completion of the above described tests, the remaining portion of the trial seam sample can be discarded. Alternatively, if agreed upon between the parties involved and documented by the CQA Monitor in his daily report, the remaining portion of the trial seam sample can be subjected to destructive testing. If a trial seam sample fails a test conducted by the Geosynthetics Installer, then a destructive test seam sample shall be taken from each of the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the Geosynthetics Laboratory and, if they fail the tests, the procedure indicated in Section 2.3.9.5 shall apply. The conditions of this paragraph shall be considered fulfilled for a given seam if a destructive seam test sample has previously been taken.

2.3.7 Seaming Procedures

Unless otherwise specified, the general seaming procedure used by the Installer shall be as follows:

1. For fusion welding, a movable protective layer of plastic may be required to be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded;
2. The rolls of the membrane will be overlapped wide enough to weld and test properly; this is usually 3" for extrusion welding and 4" for fusion welding;

3. Fish mouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fish mouths or wrinkles shall be seamed and any position where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions;
4. If seaming operations are carried out at night, adequate illumination shall be provided at the Contractor's expense; and
5. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

The CQA Monitor shall verify that the above seaming procedures are followed, and shall inform the Project Manager if they are not.

2.3.8 Non-Destructive Testing

The Installer shall non-destructively test all field seams over their full length using a vacuum test unit or air pressure test (for double fusion seams only), or other approved method. The purpose of nondestructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

The CQA Monitor shall:

1. Observe all continuity testing;
2. Record location, date, test unit number, name of tester, and outcome of all testing;
3. Inform the Installer and Project Manager of any required repairs;
4. Observe the repair and re-testing of the repair;
5. Mark on the geomembrane that the repair has been made; and
6. Document the results.

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the CQA Monitor.

2.3.8.1 Vacuum Testing

The equipment shall be comprised of the following:

1. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge;

2. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
3. A rubber pressure/vacuum hose with fittings and connections;
4. A bucket and wide brush, mop or spray assembly; and
5. A soapy solution.

The following procedures shall be followed:

1. Energize the vacuum pump;
2. Wet a strip of geomembrane (approximately 12" X 48") with the soapy solution;
3. Place the box over the wetted area;
4. Close the bleed valve and open the vacuum valve;
5. Ensure that a leak tight seal is created;
6. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles;
7. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 75 mm (3 in.) overlap, and repeat the process; and
8. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 2.4.

2.3.8.2 Air Pressure Testing (Fusion Welded Seams)

The following procedures are applicable to those processes that produce a double seam with an enclosed space. The equipment shall be comprised of the following:

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

The following procedures shall be followed:

1. Seal both ends of the seam to be tested;
2. Insert needle or other approved pressure feed device into the tunnel created by the fusion weld;

3. insert a protective cushion between the air pump and the geomembrane;
4. Energize the air pump to a pressure of 30 psi, close valve, and sustain pressure for approximately 5 minutes;
5. If loss of pressure exceeds 3 psi or does not stabilize, locate faulty area and repair in accordance with Section 2.4;
6. Cut opposite end of tested seam after completion of the 5-minute pressure hold period to verify complete testing of the seam. If the pressure gauge does not indicate a release of pressure, locate blockage of the air channel and retest until entire seam is tested; and
7. Remove needle or other approved pressure feed device and seal.

2.3.9 Destructive Testing

Destructive testing provides direct evaluation of seam strength and bonding efficiency which indicates seam strength and durability. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

Destructive testing involves two techniques (1) shear testing and (2) peel testing. Shear testing applies a tensile stress from the top of the sheet through the weld and into the bottom sheet. Peel testing, on the other hand, peels the top sheet back against the overlapped edge of the bottom of the sheet in order to observe how separation occurs. The peel test indicates whether the sheets are continuously and homogeneously connected through the seam.

2.3.9.1 Location and Frequency

The Geosynthetics CQA Monitor shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

- A minimum frequency of one test location per 500 feet of seam length as indicated in **TABLE 7**. This minimum frequency is to be determined as an average taken throughout the entire facility;
- A maximum frequency shall be agreed upon by the Installer, Project Manager and Geosynthetics CQA Monitor at the Resolution and/or Pre-Construction Meeting; and
- Test locations shall be determined during seaming at the Geosynthetics CQA Manager's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

TABLE 7 GEOMEMBRANE SEAM TESTING REQUIREMENTS		
TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Peel Adhesion	ASTM D6392/GRI GM19	1 test per 500 feet seam length
Bond Seam Strength	ASTM D6392	1 test per 500 feet seam length
Vacuum Testing	See Section 2.3.8.1	100% of extrusion welding seams
Air Pressure Testing	See Section 2.3.8.2	100% of welded seams

1. For peel adhesion, seam separation shall not extend more than 10 percent in the same interface. Testing shall be discontinued when the sample has visually yielded a sample.
2. For shear tests, the sheet shall yield before failure of the seam.

Note: For either test, sample failure shall be a Film Tear Bond (FTB) as outlined in NSF 54, Appendix A.

2.3.9.2 Sampling Procedure

Samples shall be cut by the Installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Monitor shall:

1. Observe sample cutting;
2. Assign a number to each sample, and mark it accordingly;
3. Record sample location on layout drawing; and
4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 2.4. The continuity of the new seams in the repaired area shall be tested according to Section 2.3.8.1. At a given sampling location, two types of samples shall be taken by the Installer.

First, two samples for field testing should be taken. Each of these samples shall be 1 inch wide by 12 inch long, with the seam centered parallel to the width. The distance between these two samples shall be 42 inches. If both samples pass the field test described in Section 2.3.9.3, a sample for laboratory testing shall be taken. The sample for laboratory testing shall be located between the two samples for field testing. The sample for laboratory testing shall be 12 inches

wide by 42 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for laboratory testing, (12 in. x 12 in.);
2. One portion for Geosynthetics CQC Firm testing, (12 in. x 18 in.); and
3. One portion to the Owner for archive storage, (12 in. x 12 in.).

Final determination of the sample sizes shall be made at the Pre-Construction Meeting.

2.3.9.3 Field Testing

The ten, 1-inch wide strips mentioned in Section 2.3.9.2 shall be tested in the field, by gauged tensiometer, for peel and shear respectively and shall not fail in the seam in addition to meeting the requirements outlined in the specifications. If any field test sample fails to pass, then the procedures outlined in Section 2.3.9.5 shall be followed.

The CQA Monitor shall witness all field tests and mark all samples and portions with their number. The CQA Monitor shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

2.3.9.4 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Monitor in a manner which will not damage the test sample. The Project Manager will verify that packing and shipping conditions are acceptable. The Project Manager will be responsible for storing the archive samples. This procedure shall be fully outlined at the Resolution Meeting. Test samples shall be tested by the Geosynthetics CQC Firm. The Geosynthetics CQA Consultant shall select the Geosynthetics CQC Firm, with the concurrence of the Project Manager.

Testing shall include "Bonded Seam Strength and Peel Adhesion". At least 5 specimens shall be tested for each test method. Specimens shall be selected alternately be test from the samples (i.e., peel, shear, peel, shear...). A passing test shall meet the minimum required values in at least 4 out of 5 specimens.

The Geosynthetics CQC Firm shall provide test results no more than 24 hours after they receive the samples. The Geosynthetics CQA Manager shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

The Installer's laboratory test results shall be presented to the Project Manager and the CQA Monitor for comments.

2.3.9.5 Procedures for Destructive Test Failure

The following procedure shall apply whenever a sample fails a destructive test, whether the Geosynthetics CQC Firm, the Installer's laboratory, or the gauged tensiometer conducted that test.

1. The Installer shall trace the welding path to an intermediate location at 10 feet minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All acceptable seams must be bonded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs shall be made in accordance with Section 2.4. The CQA Monitor shall document all actions taken in conjunction with destructive test failures.

2.4 Defects and Repairs

2.4.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA Monitor for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination or foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be broomed or washed by the Installer if the amount of dust or mud inhibits examination.

2.4.2 Evaluation

Each suspect location both in seam and non-seam areas shall be non-destructively tested using the methods described in Section 2.3.8.1 as appropriate. Each location that fails the non-destructive testing shall be marked by the CQA Monitor and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

2.4.3 Repair Procedures

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

1. Patching - used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
2. Buffing and re-welding - used to repair small sections of extruded seams;
3. Spot welding or seaming - used to repair small tears, pinholes, or other minor, localized flaws;
4. Capping, used to repair large lengths of failed seams;
5. Removing bad seam and replacing with a strip of new material welded into place (used with large lengths of fusion seams); and
6. Welding of the flap, used to make a new extrusion weld adjacent to an unsatisfactory fusion weld (this procedure may be used only if the flap created by the overlap of the top and bottom panels beyond the fusion weld has not been cut back to the outer edge of the fusion weld).

In addition, the following provisions shall be satisfied:

1. Surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair;
2. All surfaces must be clean and dry at the time of the repair;
3. All seaming equipment used in repairing procedures must be approved;
4. The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Project Manager, Geosynthetics Construction Quality Assurance Manager, and Installer; and
5. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

2.4.4 Repairs - Non-destructive Testing

Each repair shall be non-destructively tested using the methods described in Section 2.3.8.1 as appropriate. Repairs, which pass the non-destructive test, shall be taken as an indication of an adequate repair. Failed test indicate that the repair must be redone and retested until a passing result is obtained.

2.5 Backfilling of Anchor Trench

The anchor trench, if any, shall be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted by the Earthwork Contractor of the Installer, as outlined in the specifications and/or bid documents. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geosynthetics and/or Soils CQA Monitor shall observe the backfilling operation and advise the Project Manager of any problems.

Since backfilling the anchor trench can affect material bridging at the toe of the slope, consideration should be given to backfilling the liner at its most contracted state, preferably during the cool of the morning or extended period of overcast skies.

2.6 Lining System Acceptance

The Installer and the Manufacturers shall retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the Owner. The geosynthetic lining system shall be accepted by the Owner when:

- The installation of all materials are deployed and welded;
- Verification of the adequacy of all seams and repairs, including associated testing, is complete;
- All documentation of installation is completed including the Geosynthetics CQA Consultant's final report; and
- The Project Manager has received certification, including "as built" drawing, sealed by a registered professional engineer.

The Geosynthetics CQA Monitor shall certify that installation has proceeded in accordance with the Geosynthetics CQA Plan for the project except as noted to the Project Manager.

2.7 Materials in Contact with the Geomembrane

The quality assurance procedures indicated in this section are only intended to assure that the installation of these materials does not damage the geomembrane. Additional quality assurance procedures would be necessary to assure that systems built with these materials would be constructed in such a way to enable proper performance.

2.7.1 Soils

The Project Manager shall give a copy of the specifications, prepared by the Designer for placement of soils, to the Geosynthetics CQA Consultant. The Geosynthetics CQA Consultant shall verify that these specifications are consistent with current industry practices.

2.7.2 Concrete

The Project Manager shall give a copy of the specifications, prepared by the Design Engineer for placement of concrete, to the Geosynthetics CQA Monitor. The Geosynthetics CQA Monitor shall verify that these specifications are consistent with the state of the art, including the use of geosynthetic layers between concrete and geomembrane. The Geosynthetics CQA Consultant shall verify the geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. He will also verify that construction methods used are not likely to damage the geomembrane.

2.7.3 Sumps and Appurtenances

The Project Manager shall give a copy of the specifications, prepared by the Design Engineer for sumps and appurtenances, to the Geosynthetics CQA Monitor. The Geosynthetics CQA Monitor shall review these specifications and verify the use of geosynthetic layers between concrete and geomembranes.

The Geosynthetics CQA Monitor shall verify that:

1. Installation of the geomembrane in sump and appurtenance areas, and connection of geomembrane to sumps and appurtenances have been made according to specifications;
2. Care is taken while welding around appurtenances, since neither non-destructive nor destructive testing may be feasible in these areas;
3. The geomembrane has not been damaged while making connections to sumps and appurtenances; and
4. All sumps are tested for primary and secondary geomembrane integrity by filling them with water and making appropriate observations.

3.0 DOCUMENTATION

3.1 Daily Reports

Each of the Geosynthetics CQA Monitors shall complete a daily report and/or logs on prescribed forms, outlining all of his or her monitoring activities for that day. The areas, panel numbers, seams completed and approved, and measures taken to protect unfinished areas overnight should be identified. Failed seams or other panel areas requiring remedial action shall be identified with regard to nature of action, required repair, and precise location. Repairs completed shall also be identified. Any problems or concerns with regard to operations on site shall be noted. This report must be completed at the end of each monitor's shift, prior to leaving the site, and submitted to the Geosynthetics CQA Manager.

The Geosynthetics CQA Manager shall review the daily reports submitted by the Geosynthetics CQA Monitors, and incorporate summary of their reports into his own weekly report. Any matters requiring action by the Project Manager shall be highlighted. This report shall be completed daily, summarizing the previous day's activities, and a copy submitted to the Project Manager at the beginning of each week following the report date.

3.2 Destructive Test Reports

The Geosynthetics CQA Monitor shall collate the destructive test reports from all sources. This includes field tests, Installer's laboratory tests, and Geosynthetics CQC Firm tests. A summary

list of test samples pass/fail results shall be prepared by the Geosynthetics CQA Manager on an ongoing basis, and submitted with the periodic progress reports.

3.3 Progress Reports

Progress Reports shall be prepared by the Geosynthetics CQA Monitor and submitted to the Owner. This report shall include: an overview of progress to date; an outline of any changes made to the plans, drawing, or specifications; any problems or deficiencies in operations at the site, and an outline of any action taken to remedy the situation(s); a summary of weather conditions; and a brief description of activities anticipated for the next reporting period. All Destructive Test Reports for the period shall be appended to each Progress Report.

3.4 Construction Problem and Solution Data Sheets

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, if applicable, and must include the following information, where available:

1. An identifying sheet number for cross-referencing and document control;
2. A detailed description of the situation or deficiency;
3. The location and probable cause of the situation or deficiency;
4. How and when the situation or deficiency was found or located;
5. Documentation of the response to the situation or deficiency;
6. Final results of any responses;
7. Any measures taken to prevent a similar situation from occurring in the future; and
8. The signature of the CQA Manager/Monitor and signature indicating concurrence from the Project Manager.

The Project Manager shall be made aware of significant recurring non-conformance with specifications. The Project Manager shall then determine the cause and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results shall be documented, and the Owner and Design Engineer shall approve any revision to procedures or specifications.

A Summary of all supporting data sheets, along with final testing results and the CQA Engineer's approval of the work, shall be required upon completion of construction.

3.5 Design and/or Specification Changes

Design and/or specifications changes may be required during construction. In such cases, the CQA Engineer shall notify the Project Manager and Design Engineer. Design and/or

specifications changes shall be made only with written agreement of the Project Manager and the Design Engineer, and shall take the form of an addendum to the specifications.

3.6 Record Drawings

Record drawings shall be prepared by the Contractor and approved by the CQA Consultant. A third party independent surveyor should perform the survey. Record drawings shall include, as a minimum, the following information for geomembranes:

1. The limits of the liner or final cover barrier construction;
2. The top and bottom liner or final cover barrier elevation at 50' intervals referenced to the site grid coordination system;
3. If a granular drainage blanket is utilized in the design, top of blanket elevation should be identified at 50' intervals;
4. The location and elevation of slope breaks, leachate piping, leachate sumps and trenches, berms, and any other features which are material to the disposal area construction;
5. A key map showing the location of the construction in relation to the permitted design, along with an identification of areas previously constructed and areas yet to be constructed;
6. Dimensions of all geomembrane field panels;
7. Location, as closely as possible, of each panel relative to the surveyors plan (furnished by the Owner);
8. Identification of all seams and panels with appropriate number or "identification codes" (see Section 2.2.1);
9. Location of all patched and repairs; and
10. Location of all destructive testing samples.

The Record drawing shall address each layer of geomembrane, and if necessary, another drawing shall identify problems or unusual conditions of the geotextile or geonet layers. In addition, applicable cross-sections shall show layouts of geonets, geotextiles or Geogrids which are unusual or differ from the design drawings.

3.7 Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, shall be cross-referenced with observation and testing data sheet(s) and/or construction problem and solution data sheets(s).

These photographs shall serve as a pictorial record of work progress, problems, and mitigation activities. The basic file shall contain color prints; negatives shall also be stored in a separate

file in chronological order; or the photos may be saved electronically. These records shall be presented to the Project Manager upon completion of the project.

3.8 Final Report

A Final Report shall be submitted upon completion of the work. This report shall include all reports prepared by the CQA Consultant personnel, summarize the activities of the project, and document all aspects of the quality assurance program performed. The Final Report shall include as a minimum the following information:

- Personnel involved with the project;
- Scope of work;
- Outline of project;
- Construction quality assurance methods;
- Test results (destructive and non-destructive, including laboratory tests);
- Sealed and signed by a registered professional engineer; and
- Record drawings, sealed and signed by a registered professional engineer.

3.9 Storage of Records

During construction, the Geosynthetics CQA Monitor shall be responsible for submitting the facility Record drawings. The owner/operator, in a manner that will allow for easy access, shall store the document originals. An additional copy should also be kept at the facility.

SECTION 5

OTHER

1.0 GEOTEXTILES

1.1 Manufacturing

The geotextile manufacturer shall provide the Project Manager with a list of guaranteed "minimum average roll value" properties for the type of geotextile to be delivered. Geotextile shall be a minimum 8oz/yd² weight (minimum average roll value), unless otherwise specified in the project specifications. Fabric shall be suitable and durable for the intended application as demonstrated by similar and prior applications. The geotextile manufacturer shall also provide the Project Manager with a written quality control certification signed by a responsible party employed by the manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geotextile. The quality control certificates shall include:

1. Roll identification numbers;
2. Sampling procedures; and
3. Results of quality control testing.

The geotextile manufacturer shall provide, as a minimum, test results for the following in accordance with **TABLE 2**:

1. Mass per unit area;
2. Grab strength;
3. Tear strength;
4. Burst strength;
5. Puncture strength;
6. Wide strip tensile strength;
7. Apparent opening size (AOS);
8. Thickness; and
9. Permeability and apparent opening size.

The geotextile manufacturer shall provide a written certification that the nonwoven, needle-punched geotextiles are continuously inspected and found to be needle-free. Quality assurance tests shall be performed in accordance with the test methods specified in **TABLE 2** for every 100,000 ft² of geotextile produced for the project.

The CQA Consultant shall examine all manufacturer certifications to insure the following: property values listed on the certifications meet or exceed those specified for the particular type

of geotextile; the measurements of properties by the Manufacturer are properly documented; test methods are acceptable; and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project Manager.

1.2 Roll Label Requirements

The geotextile manufacturer shall identify all rolls of geotextile with the following:

1. Manufacturer's name
2. Product identification;
3. Lot number;
4. Roll number; and
5. Roll dimensions.

Additionally, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile, e.g., "This Side Up" or "This Side Against Geonet". The CQA Monitor shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

1.3 Shipping, Handling & Storage

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

Geotextiles shall not be exposed to precipitation prior to being installed. Wrappings protecting geotextile rolls shall be removed less than one hour prior to unrolling the geotextile. After the wrapping has been removed, a geotextile shall not be exposed to sunlight for more than 15 days, unless otherwise specified and guaranteed by the geotextile manufacturer.

The CQA Consultant shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager. Any damaged rolls shall be rejected and replaced at no cost to the Owner.

1.4 Conformance Testing

Upon delivery of the rolls of geotextiles, the CQA Monitor shall insure that samples are removed and forwarded to the Geosynthetics Laboratory for testing to ensure conformance to both the design specifications and the list of guaranteed properties. The material may also be sampled at the manufacturing facility by a third party and forwarded to the Geosynthetic Laboratory. As a minimum, the following tests shall be performed on geotextiles:

1. Mass per unit area;
2. Grab strength;
3. Grab elongation;
4. Puncture strength;
5. Trapezoidal tear strength;
6. Permeability;
7. Permittivity;
8. Thickness; and
9. Apparent opening size.

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the specifications. Testing frequency for the geotextiles is presented in **TABLE 8**.

TABLE 8		
GEOTEXTILE CONFORMANCE TESTING REQUIREMENTS		
TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Mass per Unit Area	ASTM D5261	1 test per 100,000 ft ²
Puncture Resistance	ASTM D6241	1 test per 100,000 ft ²
Permeability (Filter Application only)	ASTM D4491	1 test per 100,000 ft ²
Apparent Opening (Filter Application only)	ASTM D4751	1 test per 100,000 ft ²
Trapezoidal Tear Strength	ASTM D4533	1 test per 100,000 ft ²
Thickness	ASTM D1777	1 test per 100,000 ft ²
Grab Strength	ASTM D4632	1 test per 100,000 ft ²

1.4.1 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three linear feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the machine direction on the samples with an arrow. Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 100,000 ft², whichever is least, as indicated in **TABLE 8** for geotextiles.

1.4.2 Test Results

The CQA Consultant shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager.

1.5 Handling and Placement

The Installer shall handle all geotextiles and geocomposites in such a manner to ensure they are not damaged in any way. The following shall be complied with:

1. On slopes, the geotextile and geocomposites shall be securely anchored in the anchor trench and then rolled down the slope in such a manner as to continually keep the geotextile or the geocomposite sheet in tension;
2. In the presence of wind, all geotextiles and geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earth cover material;
3. Geotextiles/Geocomposites shall be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles/geocomposites; and
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile or the geocomposite.

In addition, the following applies to geotextiles only:

1. During placement of geotextiles, care shall be taken not to entrap in the geotextile: stones, excessive dust, or moisture that could generate clogging of drains or filters, or hamper subsequent seaming; and
2. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

1.6 Seams and Overlaps

On slopes steeper than 10 horizontal/1 vertical, all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped 0.15m (6 in.) prior to seaming. No horizontal seams shall be allowed on side slopes (i.e., seams shall be along, not across, the slope), except as part of a patch. The Design Engineer must approve other seaming options.

On bottom and slopes flatter than 10/1 (horizontal/vertical), geotextiles can be either seamed as indicated above, or thermally bonded. The Installer and CQA Monitor shall pay particular attention at seams to insure that no earth cover material could be inadvertently inserted beneath the geotextile. Any sewing shall be done using polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile.

1.7 Defects and Repairs

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

1. On slopes: A patch made from the same geotextile shall be double seamed into place [with each seam 5 mm to 20 mm (1/4 in. to 3/4 in.) apart and no closer than 25 mm (1 in.) from any edge]. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.
2. Non-slopes: A patch made from the same geotextile shall be spot-seamed in place with a minimum of 0.60m (24 in.) overlap in all directions.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The CQA Consultant shall observe any repair, note any non-compliance with the above requirements and report them to the Project Manager.

1.8 Placement of Soil Materials

The Installer shall place all soil materials located on top of a geotextile or geocomposite, in such a manner as to insure:

1. No damage of the geotextile or geocomposite;
2. Minimal slippage of the geotextile or geocomposite on underlying layers; and
3. No excess tensile stresses in the geotextile.

Unless otherwise specified by the Designer, all lifts of soil material shall be in conformance with the following guidelines:

Equipment Ground Pressure (psi)	Minimum Loose Lift Thickness (inches)
< 9	9
9-12	12
9-16	18
>16	24

Any non-compliance shall be noted by the CQA Consultant and reported to the Project Manager. If portions of the geotextile or the geocomposite are exposed, the CQA Consultant shall periodically place two (or more, at his discretion) marks on the geotextile or the

geocomposite 3 m (10 ft.) apart along the slope and measure the elongation of the geotextile or the geocomposite during the placement of soil. The Designer shall relate this elongation to the tensile stress in the geotextile or the geocomposite.

2.0 GEONETS AND GEOCOMPOSITES

2.1 Manufacturing

The geonet, unless otherwise specified, shall be made from the same type of resins used to manufacture HDPE geomembranes. The raw material will consist of polyethylene resin, heat stabilizers, and anti-oxidant additives.

The geonet and geocomposite manufacturer shall provide the Project Manager with a list of guaranteed "minimum average roll value" properties for the type of geonet and/or geocomposite to be delivered. The manufacturer shall also provide the Project Manager with a written quality control certification signed by a responsible party employed by the manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geonet. The quality control certificates shall include:

1. Roll identification numbers;
2. Resin batch numbers;
3. Nominal thickness;
4. Sampling procedures; and
5. Results of quality control testing:
 - Polymer-specific gravity;
 - Mass per unit area; and
 - Thickness.

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

The manufacturer shall provide the origin, identification, and production date of the resin and quality control certificates for the resin used in the manufacture of the geonets and/or geocomposite. Quality assurance tests shall be performed in accordance with the test methods specified in **TABLE 9** for every 100,000 ft² of geonet and/or geocomposite produced for the project.

The CQA Consultant shall examine all manufacturer's certifications to insure the following: property values listed on the certifications meet or exceed those specified; the measurements of properties by the manufacturer are properly documented; test methods are acceptable; and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project Manager.

2.2 Roll Label Requirements

The manufacturer shall identify all rolls of geonets and/or geocomposite with the following:

1. Manufacturer's name;
2. Product identification;
3. Lot number;
4. Roll number; and
5. Roll dimensions.

The CQA Monitor shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.3 Shipping, Handling, and Storage

Protecting the geonet and/or geocomposite for cleanliness is important to ensure proper drainage characteristics are maintained. The CQA Consultant shall verify that geocomposite and/or geonet rolls are wrapped in polyethylene sheets or otherwise protected against dust and dirt during shipping and storage. The wrapping shall be removed just prior to the deployment of the rolls. The CQA Consultant shall verify that geonets and/or geocomposite are free of dirt and dust just before installation. The CQA Consultant shall report the outcome of this verification to the Project Manager. If the geonets and/or geocomposite are judged dirty, they shall be cleaned by the Installer prior to installation.

2.4 Conformance Testing

2.4.1 Testing Requirements

Upon delivery of the rolls of geonets, the CQA Consultant shall take conformance samples of the geonet and/or geocomposite, to ensure conformance to both the design specifications and the list of guaranteed properties. The material may also be sampled at the manufacturing facility by a third party and forwarded to the Geosynthetic Laboratory. The tests presented in **TABLE 9** shall be performed on the geonet and/or geocomposite.

TABLE 9 GEONET AND GEOCOMPOSITE CONFORMANCE TESTING REQUIREMENTS		
TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Carbon Black Content	ASTM D1603	1 test per 100,000 ft ²
Polymer Density	ASTM D1505	1 test per 100,000 ft ²
Thickness	ASTM D5199	1 test per 100,000 ft ²
Transmissivity	ASTM D4716	1 test per 100,000 ft ²
Mass per Unit Area	ASTM D3776	1 test per 100,000 ft ²

1. Manufacturer’s conformance testing shall be completed at a frequency of 1 test per each roll provided for the project.

2.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three linear feet. Unless otherwise specified, samples shall be 3 ft wide by the roll width.

2.4.3 Test Results

The CQA Monitor shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager. Any lots not meeting conformance testing specifications will result in the rejection of the lot.

2.5 Installation of the Geonet

2.5.1 Handling and Placement

The Installer shall take steps necessary to insure that any underlying layers are not damaged during the placement of the geonet and/or geocomposite. These steps shall include but are not limited to the following conditions:

1. During placement of geonets and/or geocomposite, care shall be taken not to entrap in the geonet, dirt or excessive dust that could cause clogging of the drainage system. If dirt or excessive dust is entrapped in the geonet, it should be hosed clean prior the placement of the next material on top of it. In this regard, care should be taken with the handling of sandbags, to prevent rupture or damage of the sandbag;
2. Geonets and/or geocomposite shall only be cut using scissors or curved blade (hook blade) utility knife that will not damage underlying geosynthetics;
3. On slopes, the geonets and/or geocomposite shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet and/or geocomposite shall be positioned

- by hand after being unrolled to minimize wrinkles. Geonets and geocomposites can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of a slope, if an extra layer is required, this extra layer can be placed in the horizontal direction). The Designer shall identify such locations in the design drawings. Designers should note that placement of layers at 90 degree angles to each other will result in a partial loss of effective thickness and transmissivity; and
4. In the presence of wind, all geonets and/or geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

The CQA Monitor will note any deficiencies or non-compliance and report it to the Project Manager.

2.5.2 Stacking Geonets/Geocomposites

When several layers of geonets and/or geocomposite are stacked, care should be taken to prevent strands from one layer from penetrating the channels of the next layer, thereby significantly reducing the transmissivity. This cannot happen if stacked in the same direction. A stacked geonet shall never be laid in perpendicular directions to the underlying geonet (unless otherwise specified by the Designer). In the corners of side slopes of rectangular landfills, adjacent overlapping geonets are usually perpendicular and special precautions shall be taken as discussed below. The CQA Monitor shall note any non-compliance and report it to the Project Manager.

2.5.3 Joining and Splicing

Adjacent geonets and/or geocomposite shall be joined according to construction drawings and specifications. As a minimum, the following requirements shall be met:

1. Geonets may be butt-joined or lapped if specified;
2. Nylon/plastic cable ties will be applied to the net edge at five foot intervals along the edge; and
3. End splices will be made as follows:
 - On slopes, the ends will overlap two feet with the uphill panel on top with two rows of cable ties applied; and
 - In flat areas, the end will be overlapped a minimum of two inches and one row of cable ties applied.

The CQA Monitor shall note any non-compliance and report it to the Project Manager.

2.5.4 Defects and Repairs

If the geonet and/or geocomposite are damaged, it can be repaired by the following methods at the discretion of the CQA Monitor. Holes and tears in the geonet shall be repaired by placing a patch extending 2 feet beyond edges of the hole or tear. The patch shall be secured to the original geonet by spot welding or tying every 6 inches. Tying devices shall be as indicated in Section 2.5.3. If the hole or tear width across the roll is more the 50% the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be joined as indicated in Section 2.5.3.

The CQA Monitor shall observe any repair, note any non-compliance with the above requirements and report them to the Project Manager.

3.0 OTHER PROJECT CONSTRUCTION

The CQA Consultant shall be responsible for reviewing, verifying and testing all aspects of the Construction Project. The Scope of the CQA Consultant's responsibilities shall include the review and quality control testing of all road installations, concrete structure installations, and other construction addressed in the Contractor's Project Specifications, but not discussed in this CQA Plan. Performance Criteria, and Quality Control Testing frequencies for construction not associated with the landfill footprint is addressed in applicable sections of the Project Specifications.

Quality Assurance for incidental Items – Quality assurance procedures for other materials deployed in the construction, such as geotextiles, geonets, granular drainage blankets, etc., shall also be included in the QA plans. There above requirements are only intended to act as minimum values and will not relieve the facility of the burden to prepare a project specific quality assurance plan.

ATTACHMENT A

DEFINITIONS

SOIL RELATED TERMS

Aggregate - any combination of sand, gravel and crushed stone in their natural or processed state.

Atterberg limits - The liquid limit, plastic limit, and shrinkage limit for soil. The water content where the soil behavior changes from liquid to the plastic state is the liquid limit; from plastic to semisolid state is plastic limit; and from the semisolid to the solid state is the shrinkage limit.

Backfill - Soil material placed back into an area that has been excavated, such as against structures, in anchor trenches and in pipe trenches

Borrow - Soil material obtained from an off-site source for the clay liner, leachate collection layer, daily cover, or other construction projects.

Clays - Very small soil particles having a crystalline (layer structure, created as the result of the chemical alteration of primary rock minerals. Since the clay particles are very small, the air voids are very small and the flow of water through the soil material is very slow.

Coarse Aggregate - is generally considered to be a crushed stone or gravel almost all of which is retained on a No. 4 sieve.

Compaction - The process of increasing the density or unit weight of a soil by rolling, tamping, vibrating, or other mechanical means.

Density - The mass per unit volume.

Fine Aggregate - is considered to be any aggregate material that will pass a 3/8 in. sieve and essentially all of which will pass a No. 4 sieve and is predominately retained on a No. 4 sieve.

Liquid Limit - The water content where the soil behavior changes from liquid to the plastic state.

Hydraulic Conductivity - the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles.

In situ - Refers to soil when it is at its natural location in the earth and in its natural condition

Permeability - A generic term for the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles. Properly called *hydraulic conductivity*.

Plastic Limit - The water content where the soil behavior changes from plastic to semisolid state.

Plasticity - Term applied to fine-grained soils (particularly clays) to indicate the soils' (plus included water's) ability to flow or be remolded without raveling or breaking apart.

Sand - The category of coarse-grained soil whose particles size range between about 0.07 mm and 5 mm in diameter.

Silt - The category of fine-grained soil particles whose mineralogical composition remains similar to the rock they were derived from.

Shrinkage Limit - The water content where the soil behavior changes from the semisolid to the solid state.

Sump - Small excavation or pit provided in the floor of a structure, or in the earth, to serve as a collection basin for surface water and leachate.

Water content - The ratio of the quantity of water in a soil (by weight) to the weight of the soil solid (dry soil), typically expressed as a percentage.

GEOTEXTILE AND GEOTEXTILE-RELATED* TERMS

Actinic degradation - The strength of fibers and fabrics due to exposure to sunlight or an accelerated weathering light source.

Arching - The formation of soil particles upstream of a geotextile where the particles arch (or bridge) over the fabrics' voids.

Basis weight* - A deprecated term for *mass per unit area*.

Blinding - The condition in which soil particles block the voids at the surface of a geotextile, thereby reducing the hydraulic conductivity of the geotextile.

Blocking - A synonym for *blinding*.

Bonding - The process of combining fibers, filaments, or films into sheets, webs, or bats by means of mechanical, thermal, or chemical binding.

Clogging - The movement by mechanical action or hydraulic flow of soil particles into the voids of a fabric and retention therein, thereby reducing the hydraulic conductivity of a geotextile.

Composite - See Fabric, composite.

Cross-plane - The direction of a geosynthetic which is perpendicular to the plane of its manufactured direction. Referred to in hydraulic situations.

Deformation - The change in length of a geosynthetic under load from its original manufactured dimensions.

Denier - The weight in grams of 9000 m of yarn.

Density* - The mass per unit volume.

Direction, cross-machine - The direction perpendicular to the long, machine, or manufactured direction (synonyms: *woven geotextiles*, *weft direction*).

Direction, machine - In textiles, the direction in a machine-made fabric parallel to the direction of movement the fabric followed in the manufacturing process (synonym: *lengthwise*, or *long direction*, and for woven geotextiles, *wrap direction*).

Downstream - The direction of the opposite side of a geotextile from which liquid is moving.

Elongation - The increase in length produced in the gage length of the test specimen by a tensile load.

Elongation at break - The elongation corresponding to the maximum load.

Elongation, percent - For geosynthetics, the increase in length of a specimen expressed as a percentage of the original gage length (i.e., engineering strain).

Fabric - Term used interchangeably with geotextile, particularly after placement in the manner described in this book.

Fabric, composite - A textile structure produced by combining nonwoven, woven, or knit manufacturing methods.

Fabric, knit - A textile structure produced by interlooping one or more ends of yarn or comparable material.

Fabric, nonwoven - For geotextiles, a planar and essentially random textile structure produced by bonding, interlocking of fibers or both, accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof.

Fabric, woven - A planar textile structure produced by interlacing two or more sets of elements, such as yarns, fibers, rovings, or filaments, where the elements pass each other, usually at right angles, and one set of elements are parallel to the fabric axis.

Filament yarn - The yarn made from continuous filament fibers.

Fill - A deprecated term for *filling*.

Filing - The yarn running from selvedge to selvedge at right angles to the wrap in a woven fabric.

Filling Direction - See Direction, cross-machine. *Note:* For use with woven fabrics only.

Filter cake - The soil structure developed upstream of a geotextile by separating the suspended soil from liquid as the mixture attempts to pass through a soil fabric system.

Filter cloth - A deprecated term for *geotextile*.

Geocell - A three-dimensional structure filled with soil, thereby forming a mattress for increased stability when used with loose or compressible subsoils.

Geocomposite - A manufactured material using geotextiles, geogrids, geonets, and/or geomembranes in laminated or composite form.

Geogrid - A deformed or nondeformed gridlike polymeric material formed by intersecting ribs joined at the junctions used for reinforcement with foundations, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project structure or system.

Geomembrane - An essentially impermeable membrane used as a liquid or vapor barrier with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

Geonet - A netlike polymeric material formed from intersecting ribs integrally joined at the junctions used for drainage with foundation, soil, rock, earth, or any other geotechnical-related material as an integral part of a human-made project, structure, or system.

Geopipe - Any plastic pipe used with foundation, soil, rock, earth, or any other subsurface related material as an integral part of a human-made project, structure, or system.

Geosynthetic clay liner (GCL) - Factory-manufactured hydraulic barriers consisting of a layer of bentonite clay or other very low permeability material supported by geotextiles and/or geomembranes, and mechanically held together by needling, stitching, or chemical adhesives.

Geosynthetics - The generic term for all synthetic materials used in geotechnical engineering applications; it includes geotextiles, geogrids, geonets, geomembranes, and geocomposites.

Geotechnical engineering* - The engineering application of geotechnics.

Geotechnics* The application of scientific methods and engineering principles to the acquisition, interpretation, and use of knowledge of materials of the earth's crust to the solution of engineering problems, it embraces the field of soil mechanics, rock mechanics, and many of the engineering aspects of geology, geophysics, hydrology, and related sciences.

Geotextile* - Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

Gradient - The degree of slope or a rate of change of a parameter measured over distance.

Heat bonded Thermally bonded by melting the fibers to form weld points.

Hydrophilic - A material's attraction to water.

Hydrophobic - A material's repulsion of water.

In-plane - The direction of a geosynthetic that is parallel to its long, manufactured, or machine direction. Referred to in hydraulic situations.

Knit - See Fabric, knit.

Mass per unit area - The proper term to represent and compare to the amount of material per unit area (units are oz./yd² or g/m²). Often incorrectly called "weight" or "basis weight."

Melt bonded - See Heat bonded.

Modulus of elasticity - The initial linear portion of the stress-versus-strain test of a geosynthetic during its evaluation in a tensile strength test (units are lb./in.², kPa, lb./in., or kN/m).

Needle-punched - Mechanically bonded by needling with barbed needles.

Nonwoven - See Fabric, nonwoven.

Normal direction* - For geotextiles, the direction perpendicular to the plane of a geotextile.

Permeability - A generic term for the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles. Properly called *hydraulic conductivity*.

Permittivity - For a geotextile, the volumetric flow rate of water per unit cross-section area, per unit head, under laminar flow conditions, in the normal direction through the fabric.

pH - A measure of the acidity or alkalinity of a material, liquid, or solid. pH is represented on a scale of 0 to 14; 7 represents a neutral state; 0 represents the most acid, and 14 the most alkaline.

Resin bonded - The joining of fibers at their intersection points by resin in the formation of a nonwoven geotextile or geocomposites.

Siphoning - The transferring of a liquid to a lower level over an intermediate higher elevation than both of the endpoints, which can be achieved by saturated geotextiles in planar flow.

Staple - Short fibers in the range 0.5 to 3.0 in. (1 cm to 8 cm) long.

Staple yarn - Yarn made from staple fibers.

Tenacity - The fiber strength on a grams per denier basis.

Tex - Denier multiplied by 9 and is the weight in grams of 1000 m of yarn.

Transmissivity - For a geotextile, the volumetric flow rate per unit thickness under laminar flow conditions, within the in-plane direction of the fabric.

Transverse direction - A deprecated term for *cross-machine direction*.

Ultraviolet degradation - The breakdown of polymeric structure when exposed to natural light.

Upstream - The direction from which flowing liquid approaches a filter or drain.

Voids - The open spaces in a geosynthetic material through which flow can occur.

Wrap - The yarn running the length of the fabric in the machine direction when manufacturing woven fabrics.

Wrap direction - See Direction, machine. *Note:* For use with woven fabrics only.

Water table - (1) The upper limit of the part of the soil or underlying rock material that is wholly saturated with water. (2) The upper surface of the zone of saturation in ground water in which the hydrostatic pressure is equal to atmospheric pressure.

Weft - The cross-machine direction when manufacturing woven geotextiles.

Width - For a geotextile, the cross-direction edge-to-edge measurement of a fabric in a relaxed condition on a flat surface.

Woof - A deprecated term for *cross-machine direction*.

Woven - See Fabric, woven.

Woven, monofilament - The woven fabric produced with monofilament yarns.

Woven, multifilament - The woven fabric produced with multifilament yarns.

Woven, slit-film - The woven fabric produced with yarns produced from slit film.

Yarn* - A generic term for continuous strands of textile fibers or filaments in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric. *Yarn* may refer to (1) a number of fibers twisted together, (2) a number of filaments laid together without twist (a zero-twist yarn), (3) a number of filaments laid together with more or less twist, or (4) a single filament with or without twist (a monofilament).

* *Those items marked by an asterisk (*) are from ASTM's Committee D35 on Geotextiles Tentative Terminology Standard.*

GEOMEMBRANE AND GEOMEMBRANE-RELATED* TERMS

Adhesion - The state in which two surfaces are held together by interfacial forces which may consist of molecular forces or interlocking action or both. Measured in shear and peel modes.

Air lance - A device used to test, in the field, the integrity of field seams in plastic sheeting. It consists of a wand or tube through which compressed air is blown.

Alloys, polymeric - A blend of two or more polymers (e.g., a rubber and plastic) to improve a given property (e.g., impact strength).

Antioxidants - Primary types include phenols and amines that scavenge extraneous free radicals. Secondary types decompose peroxides as a source of free radicals.

Berm - The upper edge of an excavation on which the ends of a geomembrane are buried to hold it in place or to anchor the material.

Blocking - Unintentional adhesion usually occurring during storage or shipping between plastic films or between a film and another surface.

Bodied solvent adhesive - An adhesive consisting of a solution of the geomembrane compound used in the seaming of geomembranes.

Boot - A bellows-type covering to exclude dust, dirt, moisture, etc., from a geomembrane protrusion.

Breaking factor - Tensile strength at break in force per unit of width. Expressed in Newtons per meter or pounds per inch.

Calender - A machine equipped with three or more heavy internally heated or cooled rolls, revolving in opposite directions. Used for preparation of continuous sheeting or plying up of polymer compounds and frictioning or coating of fabric with rubber or plastic compounds.

Catalysts - Used in the polymerization process to make plastics. Generally they do not become part of the polymers. Typical examples are metal oxides (to make polyolefins) and the Ziegler-Natta systems containing aluminum alkyls and transition metal salts.

Chlorosulfonated polyethylene (CSPE) - Family of polymers that is produced by polyethylene reacting with chlorine and sulfur dioxide. Present CSPEs contain 25 to 43% chlorine and 1.0 to 1.4% sulfur. They are used in both vulcanized and nonvulcanized forms. Most membranes based on CSPE are nonvulcanized. (ASTM designation for this polymer is CSM.)

Coated fabric - Fabric that has been impregnated and/or coated with a rubbery or plastic material in the form of a solution, dispersion, hot melt, or powder. The term also applies to materials resulting from the application of a performed film to a fabric by means of calendering.

Creep - The slow change in length or thickness of a material under prolonged stress.

Cross-linking - A general term referring to the formation of chemical bonds between polymeric chains to yield an insoluble, three-dimensional polymeric structure. Cross-linking of rubbers is vulcanization. See *also* Vulcanization.

Curing - See Vulcanization.

Denier - A unit used in the textile industry to indicate the fineness of continuous filaments. Fineness in deniers equals the mass in grams of 9000-m length of the filament.

Dielectric seaming - See Heat seaming.

Elasticity - The property of matter by virtue of which it tends to return to its original size and shape after removal of the stress that caused the deformation.

Elastomer - See Rubber.

EPDM - A synthetic elastomer based on ethylene, propylene, and a small amount of a nonconjugated diene to provide sites for vulcanization.

EVA - A family of copolymers of ethylene and vinyl acetate used for adhesives and thermoplastic modifiers. They possess a wide range of melt indexes.

Extruder - A machine with a driver screw for continuous forming of polymeric compounds by forcing through a die; regularly used to manufacture geomembranes.

Fabric reinforcement - A fabric, scrim, and so on, used to add structural strength to a two-ply (or more) polymeric sheet. Such sheeting is referred to as *supported*.

Fill - As used in textile technology refers to the threads or yarns in a fabric running at right angles to the wrap. Also called *filler threads*.

Film - Sheeting having nominal thickness not greater than 10 mils.

Heat seaming - The process of joining two or more thermoplastic geomembranes by heating areas in contact with each other to the temperature at which fusion occurs. The process is usually aided by a controlled pressure (synonym: *heat fusion*).

Hot wedge - Common method of heat seaming of thermoplastic geomembranes by a fusing process wherein heat is delivered by a hot wedge passing between the opposing surfaces to be bonded.

Lapped seam - A seam made by placing one surface to be joined partly over another surface and bonding the overlapping portions.

Leachate - Liquid that has percolated through or drained from solid waste or other human-emplaced materials and contains soluble, partially soluble, or miscible components removed from such waste.

Leno fabric - An open fabric in which two warp yarns wrap around each fill yarn to prevent the warp or fill yarns from sliding over each other.

Liner - A layer of emplaced materials beneath a surface impoundment or landfill which serves to restrict the escape of waste or its constituents from the impoundment or landfill [*Fed. Regist.*].

Membrane - A continuous sheet of material, whether prefabricated as a flexible polymeric sheeting or sprayed or coated in the field, such as a sprayed-on asphalt (synonym: *geomembrane*).

Modulus - The stress on deforming a material to a given strain value (e.g., E₅₀ and E₁₀₀).

Modulus of elasticity - The ratio of stress to strain within the elastic range, also known as Young's modulus [ASTM].

Nylon - Generic name for a family of polyamide polymers characterized by the presence of the amide group, CONH₂. Used as a scrim in fabric-reinforced geomembranes.

Plastic - A material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and at some stage in its manufacture or processing into finished articles can be shaped by flow.

Plasticizer - A plasticizer is a material, frequently solvent-like, incorporated in a plastic or a rubber to increase its ease of workability, its flexibility, or distensibility. Adding the plasticizer may lower the melt viscosity, the temperature of the second-order transition, or the elastic modulus of the polymer. Plasticizer may be monomer liquids (phthalate esters), low-molecular-weight liquid polymers (polyesters), or rubbery high polymers (EVA). The most important use of plasticizers is with PVC geomembranes, where the choice of plasticizer will dictate under what conditions the liner may be used.

Polyester fiber - Generic name for a manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of an ester of a dihydric alcohol and terephthalic acid. Scrim made of polyester fibers are used for fabric reinforcement.

Polyethylene - A polyolefins formed by bulk polymerization (for low density) or solution polymerization (for high density) where the ethylene monomer is placed in a reactor under high pressure and temperature. The oxygen produces free radicals which initiate the chain polymerization. For solution polymerization the monomer is first dissolved in an inert solvent. Catalysts are sometime required to initiate the reaction.

Polymer - A macromolecular material formed by the chemical combination of monomers having either the same or different chemical composition. Plastics, rubbers, and textile fibers are all high-molecular-weight polymers.

Polymeric liner - Plastic or rubber sheeting used to line disposal sites, pits, ponds, lagoons, canals, and so on.

Polyolefin - A family of polymeric materials that includes polypropylene and polyethylene, the former being very common in geotextiles, the latter in geomembranes. Many variations of each exist.

Polyvinyl chloride (PVC) - A synthetic thermoplastic polymer prepared from vinylchloride, PVC can be compounded into flexible and rigid forms through the use of plasticizers, stabilizers, fillers, and other modifiers; rigid forms used in pipes and well screens; flexible forms used in manufacture of geomembranes.

Puncture resistance - Extent to which a material is able to withstand the action of a sharp object without perforation.

Quality assurance (QA) - A planned system of activities whose purpose it to provide a continuing evaluation of the quality control program, initiating corrective action were necessary. It is applicable to both the manufactured product and its field installation.

Quality control (QC) - Actions that provide a means of controlling and measuring the characteristics of (both) the manufactured and the field installed product.

Roll goods - A general term applied[lied to rubber and plastic sheeting, whether fabric reinforced or not. It is usually furnished in rolls.

Rubber - A polymeric material which, at room temperature, is capable of recovering substantially in shape and size after removal of a deforming force. Refers to both synthetic and natural rubber. Also called an *elastomer*.

Scrim - A woven, open-mesh reinforcing fabric made from continuous-filament yarn, that is, a high-percent--open-area geotextile. Used in the reinforcement of some geomembranes.

Seam strength - Strength of a seam of geomembrane material measured either in shear or peel modes. Strength of the seam is reported either in absolute units (e.g., pounds per inch of width) or as percent of the strength of the sheet.

Sheeting - A form of plastic or rubber in which the thickness is very small in proportion to length and width and in which the polymer compound is present as a continuous phase throughout, with or without fabric (synonym: *geomembrane*).

Slope - Deviation of a surface from the horizontal expressed as a percentage, by a ration, or in degrees, In engineering, usually expressed as a percentage of vertical to horizontal change [EPA].

Spread coating - A manufacturing process whereby a polymeric material is spread in a continuous fashion on a fabric substrate thereby forming a reinforced geomembrane composite.

Strikethrough - A term used in the manufacture of fabric-reinforced polymeric sheeting to indicate that two layers of polymer have made bonding contact through the scrim.

Support sheeting - See Fabric reinforcement.

Surface cure - Curing or vulcanization that occurs in a thin layer on the surface of a manufactured polymeric sheet or other items.

Tear strength - The maximum force required to tear a specified specimen, the force acting substantially parallel to the major axis of the test specimen. Measured in both initiated and uninitiated modes. Obtained value is dependent on specimen geometry, rate of extension, and type of fabric reinforcement. Values are reported in force (e.g., pounds) or force per unit of thickness (e.g., pounds per inch).

Tensile strength - The maximum force required to cause tension failure in a given test specimen. The obtained value is dependent on specimen geometry, rate of extrusion and property of material. Values are reported in maximum stress (e.g., pounds per square inch) or force per unit thickness (e.g., pound per inch width).

Thermoplastic elastomers - New materials that are being developed and that are probably related to elasticized polyolefins. Polymers of this type behave similarly to cross-linked rubber. They have a limited upper-temperature service range which, however, is substantially above the temperature encountered in waste disposal sites (200°F may be too high for some TPEs).

Thread count - The number of threads per inch in each direction with the warp mentioned first and the fill second. A thread count of 20 X 10 means 20 threads per inch in the warp and 10 threads per inch in the fill direction.

Ultimate elongation - The elongation of a stretched specimen at the time of break. Usually reported as percent of the original length. Also called *elongation at break* (synonym: *engineering strain at failure*).

Unsupported sheeting - A polymeric sheeting consisting of one or more plies without a reinforcing-fabric layer or scrim.

Vacuum box - A device used to assess the integrity of field seams in geomembrane installations.

Vulcanize - Used to denote the product of the vulcanization of a rubber compound without reference to shape or form.

Vulcanization - An irreversible process during which a rubber compound, through a change in its chemical structure (cross-linking), becomes less plastic and more resistant to swelling by organic liquids, and during which elastic properties are conferred, improved, or extended over a greater range of temperature.

Warp - In textiles, the lengthwise yarns in a woven fabric.

Water vapor transmission (WVT) - Water vapor flow normal to two parallel surfaces of a material, through a unit area, under the conditions of a specified test such as ASTM E96.

** Many of these terms are from Lining of Waste Impoundment and Disposal Facilities, by Matrecon, Inc., for U.S. EPA Municipal Environmental Research Laboratory, Cincinnati, OH, R. Landreth, Project Officer, 1984, EPA/SW870, March 1983, G.P.O. No. 055-000-00231-2.*

Attachment C

Operating Plan and Narrative

Operating Plan and Narrative

Ash Grove Cement Company
Class 3N Landfill
Permit No. 0302-S3N
AFIN: 41-00230

April 2016
Project No. 35147187

Prepared for:

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Terracon

PROFESSIONAL ENGINEER'S CERTIFICATION

"I certify to the best of my professional judgment that this document and all attachments properly adhere to established, sound engineering practices. This certification is contingent on the fact that all information supplied to the signatory authority, up to the date of this certification, is unquestionably accurate and was provided in good faith."

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1.0 INTRODUCTION

1.1 Purpose, Scope, and Applicability

The following document comprises the Operating Plan and Narrative (Plan) for the Ash Grove Cement Company Class 3N Cement Kiln Dust Landfill (CKD Landfill) located near Foreman, Arkansas. This document is intended to comply with the requirements of Reg.22.510 through Reg.22.521 of Arkansas Regulation 22. This Plan presents site specific methods and procedures by which Ash Grove Cement Company will maintain and document compliance, and address the regulatory requirements applicable to the construction, operation and maintenance of the CKD Landfill.

This Plan has been prepared to assist in the operation and maintenance of the AG Landfill. This document includes procedures for the following:

- Site development;
- Waste disposal;
- Operating procedures;
- Stormwater management;
- Inspection and maintenance;
- Health and safety;
- Emergency response and contingency action; and
- Recordkeeping and reporting.

1.1.2 Relationship to Other Facility Documents

This document will serve as a guide for the construction, operation and maintenance of the CKD Landfill. It should be used in connection with the following supporting documents to ensure efficient and effective operation of the CKD Landfill:

- *Arkansas Regulation 22-Solid Waste Management Rules* (Arkansas Pollution Control and Ecology Commission, March 28, 2008)
- Permit No. 0302-S3N issued on June 25, 2002 by the ADEQ
- Permit Modification Application dated October 2001 by CH2M Hill; ADEQ Doc# 15430

1.1.3 Operating Permit

Ash Grove was issued Permit No. 0302-S3N by the ADEQ on June 25, 2002 to construct and operate a Class 3N landfill. A copy of the permit is included in **APPENDIX A**.

1.2 Facility Description

The Facility is located in Little River County in southwestern Arkansas, about 4 miles east of the Oklahoma border and 4 miles north of the Texas border. The towns of Foreman and Ashdown are about 1.5 miles northeast and 17 miles east of the site, respectively. The Facility is located in parts of Sections 21 and 28, Township 12 South, Range 32 West and approximately 94 degrees, 25 minutes, 5 seconds longitude; 33 degrees, 42 minutes latitude. Total acreage of the site, including quarry, plant, process ponds, and landfill is 2,018 acres.

The design of the AG Landfill was developed to comply with *Arkansas Regulation 22*. The following sections outline the design concept for the AG Landfill.

1.2.1 Waste Disposal Area

The parcel containing the CKD Landfill is bounded on the north and east by wooded areas, on the west by the Kiamichi Railroad, and on the south by Highway 108. The CKD Landfill site—including the landfill area and associated process water pond and process area, drainage ditches, and perimeter dikes—encompasses 91 acres. The landfill itself occupies approximately 41 acres.

1.2.2 Waste Stream

The CKD Landfill is permitted for the disposal of solid waste generated by Ash Grove Cement Company at the Ash Grove Cement Plant. The authorized waste stream is predominately cement kiln dust (CKD) captured by air pollution control devices at the cement manufacturing plant. Incidental amounts of cement and clinker ingredients (i.e. clay and limestone sources), air pollution control device captured dust, cement clinker, and related plastic liner wastes are also authorized for disposal in the landfill facility.

As approved by Site Specific Condition 3(a) of Permit No. 0320-S3N, additional waste items not mentioned above may be authorized by the ADEQ for disposal at the facility on a case-by-case basis when requested by the permittee. Also stated in Site Specific 3(b), regulated PCBs and PCB items as defined in 40 CFR 761 or “Hazardous Waste,” as defined by Regulation Number 23, are not authorized for disposal in the facility.

ADEQ issued an RCRA Permit No. 21-H at Module VI.H, which specifies the management requirements for CKD generated when a kiln burns hazardous waste. Under these requirements, CKD will be evaluated during each 24-hour period. The evaluation will be one that meets or exceeds the requirements of Regulations 23.266.112 and 261.4(b)(8), called the Bevil exclusion. It calls for comparison of analysis and test results for CKD generated while burning hazardous waste with either CKD generated when not burning hazardous waste or with the health-based limits found in ADEQ Regulation 23 Section 266, Appendix VII. In the unlikely event that CKD is found to be a hazardous waste that CKD will not be disposed of in the landfill. It will be disposed of offsite at a properly permitted hazardous waste landfill.

2.0 GENERAL OPERATING REQUIREMENTS

This Operating Plan and Narrative (Operating Plan) presents site specific methods and procedures by which the Facility will maintain and document compliance, and address the regulatory requirements applicable to the construction, operation and maintenance of the Facility. The Operating Plan will be updated as required to reflect current operations and regulations. All revisions to the Operating Plan will be submitted to the ADEQ for approval. This Operating Plan for the Facility is prepared in accordance with the requirements of **Reg.22.510** through **Reg.22.521**.

2.1 General Operating Requirements

2.1.1 Conformance with Permit Documents

In accordance with **Reg.22.510(a)** of Arkansas Regulation 22 the current operation at the Facility and the operations that are proposed by this Operating Plan are in accordance with the requirements of Chapter 4 of Arkansas Regulation 22, except where noted in this Operating Plan and Narrative.

2.1.2 Operator Licensing

In accordance with **Reg.22.510(b)**, operations at the CKD Landfill shall be performed under the direction of an Arkansas licensed operator. The operator may be a Ash Grove employee or a contract operator. Licensing, training, and certification updates shall comply with the requirements of *APC&EC Regulations 22 and 27*. Copies of certifications shall be kept in the Class 3N Facility Permanent Operating Record (POR).

2.1.3 Working Face Size

In accordance with **Reg.22.510(c)** the Facility will limit waste disposal to the smallest possible area. The Facility personnel will supervise the unloading and dumping at the site. One working face will be used for the placement of wastes. If an additional working face is needed Ash Grove will submit a request with justification to the ADEQ.

2.1.4 Waste Spreading and Compacting

As required by **Reg.22.510(d)**, as rapidly as solid waste is unloaded for disposal, it will be spread and compacted in the smallest practical area. The waste shall be leveled, spread in lifts, and compacted. Water may be applied to improve compaction of the waste and control fugitive dust.

2.1.5 Salvage Operations

Salvage operations will not be performed at the operating face of the landfill as required by **Reg.22.510(e)**. If in the future the Facility desires to perform salvage operations at the Landfill, a detailed plan documenting the proposed salvage operations will be submitted to the ADEQ for approval. Salvage operations may be approved by the ADEQ under the following conditions:

- An area has been designated by the permittee for the recovery of salvageable material;
- The operations shall not interfere with or otherwise delay the activities of the working face;
- The recovery of salvageable material must be conducted in an orderly manner; and
- All salvaged materials shall be removed from the landfill site daily, or properly stored so that they will not create a nuisance or unsightly appearance.

2.1.6 Prohibited Activities

As required under **Reg.22.510(f)**, the following activities will be prohibited at the Facility:

- Scavenging of materials;
- Feeding of farm or domestic animals;
- Depositing waste in standing water; and
- Open burning, as defined by Regulation 22.

2.1.7 Litter Control

In accordance with **Reg.22.510(g)** of Arkansas Regulation 22, the Facility will maintain litter control provisions at all times with CKD cover.

2.1.8 Additional Surface Water Controls and Best Management Practices

As required by **Reg.22.510(h)**, the Facility will contour the surface of the active portion of the landfill to minimize surface water run-on onto or through the working face. Surface water will be managed during filling operations by constructing temporary diversion berms and ditches. Grading, diking, terracing, diversion berms, ditches, silt fencing, silt traps, and other best-management practices for stormwater control will be utilized to control/prevent off-site sediment accumulation from Facility operations. The final and interim slope stabilization will conform with the requirements of **Reg.22.427(f)**.

2.1.9 Final Cover Vegetation and Maintenance

As required by **Reg.22.510(i)**, once a sufficient area of the landfill has reached the permitted final grades, a final cover system will be installed in accordance with the Facility design plans. The final cover system will be seeded with perennial vegetation. A list of the types of vegetation used at the CKD Landfill may vary. The Facility will consult with the local Agricultural Extension Service to identify appropriate types of vegetation and planting seasons. The vegetation cover will be mowed at least once annually to control the growth of undesirable annual weeds and woody vegetation, and to allow for inspection of the integrity of the cover system.

2.1.10 Equipment Requirements

In accordance with **Reg.22.510(j)**, the Facility will be equipped with suitable equipment associated with the daily operation of the landfill. The types and amounts of equipment and quantity of personnel required to operate the CKD Landfill will vary depending on the types and quantities of waste requiring disposal. **TABLE 1** below lists the typical equipment and personnel associated with the operation of the CKD Landfill. Additional equipment may be obtained from outside sources as needed to support the construction, operation, and maintenance needs of the Landfill.

TABLE 1 EQUIPMENT AND PERSONNEL REQUIREMENTS		
EQUIPMENT/PERSONNEL	TYPICAL QUANTITY	PURPOSE/USE
Equipment		
Excavator, dozer, or front end loader	1	Used for excavation of waste areas and general site earthwork.
Compactor	1	Used for the compaction of waste
Dump Trucks	1 to 2	Used to deliver the waste/cover soil to the landfill.
Personnel		
Class 3N Landfill Manager	1	Manages operations of the Class 3N Landfill. Completes the required paperwork associated with management of the facility. Will be licensed in accordance with Arkansas Regulation 27
Class 3N Landfill Operators	1 to 2	Perform operations of the Class 3N Landfill including directing waste placement, earthwork, and general facility maintenance. Operators will perform tasks under supervision of the Landfill Manager
Truck Drivers	1 to 2	Haul waste/cover soil to landfill. Will include but is not limited to the Class 3N Landfill Operators.

The equipment will be inspected on a regular basis to ensure the equipment is in good operating condition. Adequate back-up equipment will be leased or borrowed within 24 hours in the event of equipment breakdowns.

2.1.11 Communications and Emergency Response

As required by **Reg.22.510(k)** of Arkansas Regulation 22 a radio and/or telephone communication system is available at the Facility. Emergency response procedures are included in the Facility’s Contingency Plan and include the following:

- Notification;
- Identification of hazardous materials;
- Assessment;
- Fires and/or explosions;
- Evacuation; and
- Recordkeeping and reporting.

2.1.12 Employee Facilities

As required by **Reg.22.510(l)** of Arkansas Regulation 22, the Facility currently has an on-site building/office located at the Plant. Potable water and sanitary facilities are provided for site personnel at the Plant. In the event the sanitary facilities are down for maintenance or other unknown reasons, portable toilets will be supplied for plant and landfill operators.

2.1.13 Nuisance Avoidance

To prevent the Landfill from becoming a public nuisance or public health hazard, procedures will be implemented to ensure compliance with **Reg.22.510(m)**. These procedures include dust control, litter control, maintaining stormwater control structures, and general facility maintenance.

2.1.14 Maintenance of Cover Systems

Section 22.510(n) of Arkansas Regulation 22 states that: “**The owner or operator shall be responsible for maintaining the cover system integrity and shall promptly repair erosion, washout, tracking, or other defects that result in exposed refuse in daily or intermediate cover, or exposure of the infiltration barrier layer of the final cover system. Areas of leachate seepage, or areas exhibiting evidence of leachate seepage such as staining and discoloration of the cover system shall also be promptly repaired.**” .

The integrity of the cover system for the landfill will be maintained throughout the active life of the Landfill and during the post-closure care period. Erosion, washouts, tracking and other cover system defects will be repaired as weather allows.

2.1.15 Wet Weather Repairs

In accordance with **Reg.22.510(o)**, in the event that repairs to the landfill cover system are needed during inclement weather conditions, precautions will be exercised to prevent the creation of additional cover defects. Temporary measures shall be implemented until permanent repairs can be executed. Installation of final cover and establishment of permanent vegetative cover on closed waste disposal modules will be scheduled so as to minimize the impacts to the Facility of performing work during the wet season.

2.2 Procedures for Excluding the Receipt of Hazardous Waste & Unauthorized Waste

The Facility currently only disposes of cement kiln dust and other eligible waste that is generated on site. Site personnel are trained to identify the appropriate waste stream to ensure that only the approved CKD waste is disposed of in the Landfill. Other Class 3N waste materials, such as cement or other ingredients that are part of the process, may be disposed of in the Landfill only upon the Landfill Manager's approval. Hazardous waste materials are currently not allowed in the Ash Grove Cement Company Class 3N Landfill.

2.3 Cover Material Requirements

In accordance with **Reg.22.512**, owners or operators of Class 3 landfills must cover disposed solid waste with 6 inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging to limit the generation of leachate. A compacted layer of cover soil of sufficient quantity to ensure there is not exposed waste (not less than 12 inches) must be applied to surfaces that will not receive an additional application of waste or final cover within 30 days.

Site Specific Condition 5 of Permit No. 0302-S3N grants a variance for requirements for application of daily cover material and for intermediate cover material at the CKD Landfill.

The landfill surface shall be observed during the disposal operation, especially during dry and/or windy days, for the presence of fugitive dust. Upon observation of dust conditions, appropriate measures, such as irrigating the surface or using dust suppressants, shall be implemented as soon as practicable to mitigate the condition and minimize further occurrence.

2.4 Disease Vector Control

In accordance with **Reg.22.513**, the facility will implement procedures to prevent or control onsite populations of disease vectors using techniques appropriate for the protection of human health and the environment. Although the Landfill will not accept putrescible waste which is likely to attract disease vectors, if disease vectors become a problem, an appropriate exterminator will be contracted to remedy the situation.

2.5 Explosive Gases Control

According to **Reg.22.514**, Class 3 Noncommercial landfills shall not be required to implement a routine methane monitoring program unless the Director determines that:

- The nature and quantity of waste poses a significant potential for the generation of explosive gases; or
- Explosive gases have been detected in concentrations exceeding the standards identified in Reg.22.514(a).

The monitoring program, if required, shall meet the requirements of **Reg.22.415**. Per Site Specific Condition 4 of Permit No. 0302-S3N, the CKD Landfill is not required, at this time, to implement routine methane monitoring.

2.6 Air Criteria

In accordance with **Reg.22.515(a)**, Ash Grove will ensure that the CKD Landfill does not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the Administrator pursuant to section 110 of the Clean Air Act, as amended.

As required by **Reg.22.515(b)**, open burning of solid waste, except for the infrequent burning of agricultural wastes, silvicultural wastes, landclearing debris, diseased trees, or debris from emergency clean-up operations and ordinance that may be allowed by the Arkansas Air Pollution Control Code, is strictly prohibited at the CKD Landfill.

The Landfill is operated in a manner that does not pose a fire hazard to personnel or property. However, in the event that a fire does occur, stockpiles of soil are readily accessible on the east side of the Landfill. Portable fire extinguishers are kept in the landfill office, on landfill operating equipment and on the 1500 ton CKD storage bin located near the Landfill Stormwater pond. In the event a fire cannot be contained by onsite personnel, the Landfill Operator will contact the Control Room to notify emergency services.

2.7 Access Requirements

Reg.22.516(a) outlines specific requirements and standards for landfill operations in relation to public access control. Specifically, owners and/or operators of waste disposal facilities must control public access and prevent unauthorized vehicular traffic and illegal dumping of wastes by using artificial barriers, natural barriers, or both, as appropriate to protect human health and safety, and the environment.

As required by **Reg.22.516(b)**, a fence has been installed around the perimeter of the landfill site, where natural barriers do not exist, to control unauthorized access to the premises. A manually locked gate, which can only be opened by Ash Grove or the contracted Landfill Operator, is located at the entrance to the Facility. However Ash Grove loads Durabase, a CKD product, onto hauling trucks at various times of day, including nights and weekends, and therefore it is typically not possible to lock the gate. Public traffic is prohibited from entering the property. The site has only one entrance and has natural topographic and vegetation barriers which serve to effectively isolate the landfill from unauthorized access.

A sign near the entrance gate displays the name of the facility, permit number, hours and days of operation and emergency telephone number, as required by **Reg.22.516(b)**.

As required by **Reg.22.516(c)**, the design of the Facility includes a system of all-weather operational roads to allow easy access in all weather conditions to all portions of the active

disposal area and other operational areas. Roads generally have a gravel surface and are regularly maintained by the Landfill operator to facilitate all weather access.

In accordance with **Reg.22.516(d)**, access to the site will only be permitted during the hours when operating personnel are on the site. At least one licensed landfill operator or manager will be present on site during operating hours. According to Appendix A-2 of Regulation 27, a person who hauls dirt and dumps it where an operator instructs, and leaves it for an operator to manage, does not require a solid waste operator license. The hauling truck operators receive pre-approved instructions on where to dispose of the Durabase product prior to arrival on site, and do not disturb the waste after disposal. The Ash Grove Control Room has the ability to monitor the haul truck drivers through camera observation at all times.

2.8 Run-On/Runoff Control Systems

Reg.22.517 states that at a minimum, Class 3 Noncommercial landfills shall design, construct, and maintain:

- A run-on control system to prevent flow onto the active portion of the Landfill or waste processing area during the peak discharge from a 24-hour, 10-year storm;
- A runoff control system from the active portion of the Landfill or waste processing area to collect and control at least the water volume resulting from a 24-hour, 10-year storm; and
- Best management practices for pollution prevention shall be implemented at all sites to control the release of sediment and waste from the site.

Compliance with this section of the regulation is described in Section 4.0 of this Operating Plan.

2.9 Surface Water Requirements

Reg.22.518 states that Class 3 landfills shall not:

- Cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act (CWA), including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to Section 402 of the CWA;
- Cause the discharge of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or state-wide water quality management plan that has been approved under Section 208 or 319 of the CWA, as amended;
- Cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under Section 404 of the CWA, as amended;
- Deposit waste in standing water; and shall not

- Allow the discharge of leachate from the landfill unit unless the discharge is permitted under the NPDES system.

Discharges from the site will be monitored under the Industrial NPDES Permit ARR001101, issued by the ADEQ. Compliance with this section of the regulation is further described in Section 4.0 of this Plan.

2.10 Liquids Restrictions

In accordance with **Reg.22.519**, The CKD Landfill does not accept bulk or non-containerized liquid waste or containers containing liquid waste. In addition, the Landfill does not accept liquid waste for treatment or liquid wastes that have been treated at another location. Wastes failing a paint filter test will not be accepted for disposal at the Landfill.

2.11 Recordkeeping Requirements

Reg.22.520 outlines the documents to be retained in an operating record maintained at the facility. Recordkeeping at the Landfill is described in Section 9.0 of this Operating Plan.

2.12 Operating Plan and Narrative

In accordance with **Reg.22.521**, this Operating Plan has been developed to fulfill the requirements of this section of the regulation and will be updated as required to reflect current operations and regulations. Revisions to the document will be submitted to the ADEQ which has reserved the right to require that the changes be accomplished through permit modification prior to implementation.

2.13 Annual Engineering Inspection Reports

In accordance with this **Reg.22.522**, an Arkansas-registered Professional Engineer will inspect the landfill site at least annually. The engineer will prepare a report addressing operational compliance with permit conditions, permit plans and specifications, the facility operating plan, and applicable regulations. The report will address the 12-month period from January through December and shall be submitted to the ADEQ no later than June 30 of the following year. The report shall contain, at a minimum, the specific requirements as defined in **Reg.22.522(a)**.

2.14 Survey Control

As required by **Reg.22.526**, the CKD Landfill has developed a survey control system in accordance with the requirements of **Reg.22.426** (Survey Control). The survey control system is used to insure and document that the Facility is developed in accordance with the approved permit drawings. A grid coordinate system is utilized at the landfill to allow the Facility features to be located in a three dimensional manner. The grid system is based upon the State Plane Coordinate System and surveyed to mean sea level.

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At least three permanent benchmarks have been established at the site from which the site grid can be referenced. Grid markers may be utilized, as necessary at positions to allow visual inspection of the progression of the fill and other features.

When applicable, the prominent landfill features to be located and referenced to the approved site grid include:

- Property boundaries or corners;
- Monitoring wells and piezometers;
- Leachate risers, manholes and collection piping;
- Limits of refuse placement and perimeter of flexible membrane liner;
- Bottom Liner and Final Cover limits and elevations (top and bottom);
- Point source discharges;
- Gas monitoring facilities;
- Utility lines within 50 feet of the disposal area; and
- Other features deemed significant by the operator or the ADEQ.

3.0 LANDFILL OPERATING PROCEDURES

Construction and operation of the Landfill is an ongoing activity throughout its life. Construction often takes place at recurring intervals. Ongoing construction activities include development of new waste areas; repair and expansion of access roads and drainage facilities; waste filling; and installation of cover. This section of the document provides guidance to those individuals involved with the daily operations specifically related to the disposal area of the landfill facility.

3.1 Waste Filling Operations

3.1.1 Placement of Waste

Waste will be delivered to the CKD Landfill by truck and deposited onto the working face of the active area. Water may be added to the CKD prior to delivery to control fugitive dust. Waste will be spread as needed to assist the facility operations at the site. The quantity of waste disposed of in the Landfill will be established by dry weight, volume or visual inspection. An Arkansas-licensed landfill operator or manager shall be present during operating hours at the Landfill to direct disposal activities. However, in accordance with Regulation No. 27, personnel who perform repetitive tasks, such as the disposal of the Durabase product, do not need to obtain a solid waste operating license, and therefore do not require a landfill operator or manager to be present during disposal.

The location for disposal of waste within the active module will vary throughout the life of a waste area. For the initial placement of waste in a new module, the disposal vehicles haul the waste to the bottom area of the module for disposal. In order to protect the integrity of the containment system, it is recommended that landfill equipment not be allowed to operate directly on the protective layer of the containment system. Initial operations in the module should be directed towards developing a working deck for equipment by establishing at least two feet of CKD atop the protective layer. A two-foot thick haul road (may be CKD) should be placed over the containment system to the point where the initial lift of CKD is placed. The first loads of CKD should then be dumped and spread away from the haul road using the bulldozer, maintaining a minimum 2-foot thickness of CKD beneath equipment. This process should be repeated until a haul road and associated deck area are constructed over the floor of the containment system. This initial lift of CKD over the protective layer should receive only the compactive effort of the bulldozer and the hauling equipment. Once two feet of CKD is in place over the protective cover, the tamping foot compactor can be utilized. In accordance with **Reg.22.510(c)** of Regulation No. 22, the landfill operator shall spread and compact the waste in the smallest practical area as it is unloaded.

3.1.2 Kiln Brick Placement

Prior to placement of Kiln Brick onto the active face of the CDK landfill, measures need to be taken to protect the integrity of the containment system. A minimum two-foot thick layer of waste shall be placed on top of the bottom liner system. For the initial placement of waste at the CKD

landfill, refer to section **3.1.1 Placement of Waste** of this document. Kiln Brick shall then be delivered to the CKD landfill by truck and placed on top of current waste grades followed by placement of an equal volume of CKD. The Kiln Brick and CKD mixture shall then be compacted in lifts. To protect the integrity of the final cover system, a five-foot thick layer of waste shall be placed on top of the Kiln Brick and CKD mixture following disposal.

3.1.3 Configuration and Development of Landfill

The landfill is configured to be developed in four modules starting with Module A at the west end and progressing eastward through B, C, and D as shown in the Permit Plans (ADEQ Doc. ID 15430). The Landfill will be developed from Module A to Module D as described in the Permit Design Narrative (ADEQ Doc. ID 15430). As of September 2014, Module A and Module B have been prepared for waste, and waste has been placed in approximately 42% of Module A and Module B, collectively. The Landfill progression is generally from the west to the east in the prepared areas. Ash Grove began filling Module A at the west side of the Landfill on June 15, 2003. The Landfill will be closed as it is developed, the closure sequence will progress from west to east.

The side slopes of the completed modules will be graded to 3:1 (horizontal to vertical). The top of the Landfill will be graded to a 4% slope to promote runoff. A perimeter, all-weather access road will surround the Landfill and a stormwater letdown structures will be constructed as shown in the Permit Plans (ADEQ Doc. ID 15430).

In general, a typical waste module is developed by the following steps:

1. Excavating a new waste disposal area to the depths and dimensions shown on the Construction Drawings. Excavated soils are stockpiled onsite.
2. Constructing a bottom liner system to the dimensions shown on the Construction Drawings and in accordance with the plans and specifications for the construction project. A typical detail of the bottom liner system is shown on the Permit Plans.
3. Grading the area around the waste module and constructing diversion berms to minimize run-on into waste module.
4. Placing initial lift (approximately 10-ft thick) across bottom of new module.
5. Moving disposal activities to top of previously completed and covered waste, progressing on each new lift to give the site positive drainage at all times.
6. Starting the cycle over in subsequent waste area.

Future waste Modules C and D will be developed sequentially in accordance with the facility Permit Design Narrative.

3.1.4 Site Capacity and Service Life

The planned maximum final elevation of the Landfill is approximately 452 feet MSL. The remaining capacity as of February 2014 was approximately 2.17 million cy. Based upon the

2013 annual utilization rate of 15,251 cy disposal rate for the facility, the estimated remaining life for the Landfill is estimated at approximately 142 years.

3.2 Bottom Liner System Construction

Waste modules are constructed with a bottom containment system that is designed as a composite system consisting of a compacted clay liner and a 60-mil HDPE geomembrane liner. The compacted clay liner will have a maximum hydraulic conductivity of 1.0×10^{-7} cm/sec and a thickness of 24 inches. The geomembrane liner will be placed directly on the compacted clay liner. The geomembrane is covered with a 12-inch protective cover layer. The first lift of waste in each module will be free of bulky and sharp components and will be placed to avoid displacement of the protective cover layer and to protect the liner system. The bottom liner system details are shown on the Permit Plans (ADEQ Doc. ID 15430). The bottom liner system will be constructed in accordance with the plans and specifications for the construction project.

3.3 Daily and Intermediate Cover Placement

Site Specific Condition 5 of Permit No. 0302-S3N grants a variance for requirements for application of daily cover material and for intermediate cover material at the CKD Landfill.

The landfill surface shall be observed during the disposal operation, especially during dry and/or windy days, for the presence of fugitive dust. Upon observation of dust conditions, appropriate measures, such as irrigating the surface or using dust suppressants, shall be implemented as soon as practicable to mitigate the condition and minimize further occurrence.

3.4 Final Cover Placement

The approved final cover system for the Landfill consists of the following configuration from bottom to top (as shown on the Permit Plans):

- A 6-inch thick bedding layer;
- A 40-mil low-linear density polyethylene (LLDPE) geomembrane;
- A composite drainage net;
- A 12-inch compacted soil base; and
- A minimum 6-inch vegetative layer.

The cover system will be installed in phases, in accordance with the plans and specifications that are developed for each closure construction project. Surveying shall be performed prior to placement of the final cover to verify that waste grades are within the permitted contours. A final survey shall be completed to identify any additional features related to the cover system (i.e., stormwater structures, roads, berms, etc.). A certification report will be developed by an Arkansas-registered Professional Engineer which will include a summary of the construction activities, description of installed items and materials used, an “as-built” plan at a scale of one

Operating Plan and Narrative

Ash Grove Cement Company ■ Class 3N Landfill
April 2016 ■ Terracon Project No. 35147187



inch equals 100 ft or less, and a summary statement signed and sealed by the certifying professional.

Upon completion of installation of the cover system, erosion control devices such as straw bale check dams, silt fences, or erosion control matting will be installed in areas where excessive erosion may occur such as on side-slopes, discharge locations of stormwater structures, and drainage channels.

3.5 Standard Operating Procedures (SOPs)

At a minimum, Sections 3.1 - 3.4 of this plan will be followed as landfill operating procedures. In addition, routine activities carried out during operation of the landfill, associated facilities, and processes will be defined by Ash Grove as Standard Operating Procedures (SOPs). The SOPs are established procedures that personnel may carry out for a given operation or a given situation. The aim of the SOPs is to achieve uniform actions or reactions to processes or events, and may include issues such as safety, effectiveness, coordination, limitations, and efficiency. The operations and maintenance procedures will be developed and maintained by Ash Grove in a standard SOP format as internal documents.

4.0 SURFACE WATER MANAGEMENT

The Facility is designed to control run-on, minimize erosion and promote settling of sediment through a series of stormwater management components including ditches, mid-slope swales or benches, diversion berms, letdown structures, drainage pipes and a process ponds.

The stormwater management components listed above may not all be constructed at any given time. Each component may be introduced as the Landfill is developed and such measures are deemed necessary.

The surface of the working portion of the Landfill is contoured to minimize surface run-on or flow into or through the working face. As the Landfill is developed, stormwater runoff outside the active waste area may be directed away from the active module(s) by a combination of mid-slope swales, letdowns, and perimeter ditches and then routed to the north process pond. Erosion and sediment control measures such as silt fences, rock check dams, and erosion control matting may be used to reduce the potential for excessive sedimentation problems.

4.1 Water Conveyance

The CKD Landfill process pond is designed to maintain peak flows from a 24-hour, 10-year storm. All watercourses are designed to reduce erosion. Ditches and swales will be concrete- or grass-lined, and will have a maximum gradient of 5%. Steeper slopes will use rock-lined ditches or letdowns.

4.2 NPDES Monitoring

Stormwater runoff from the landfill facility shall be collected in the north process pond system as shown on the Design Plans (ADEQ Doc. ID 15430). The collected water shall be discharged to the south process pond located south of the Plant. The monitoring program shall be in accordance with the Industrial NPDES Permit AR0042846 as issued by the ADEQ.

4.3 Seeding

Seeding of the landfill cover system shall be conducted in the spring and fall (typically during February through April and September through November) on recently completed waste modules and areas requiring additional grass cover. Operations are typically timed to provide the maximum area available for seeding operations. Seeding operations include preparation of the seedbed, applying fertilizer or lime as necessary, applying seed blend, and applying mulch as necessary.

4.4 Erosion Control Measures

Because exposed earth fill is subject to erosion, temporary and permanent erosion control measures are used to mitigate the potential for severe erosion and are part of the active maintenance program at the Landfill. In addition to seeding, other erosion control measures include the following:

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- Terracing;
- Slope drains;
- Concrete-lined perimeter channel
- Rock-lined ditches and swales; and
- Grass-lined ditches and swales.

Temporary erosion control measures are used as necessary to reduce erosion of exposed slopes on waste disposal areas, berms, or stockpiles. Temporary erosion control measures include the following (use will depend on the time of year and the length of time it is anticipated the soil will remain exposed):

- Seeding on soil stockpiles;
- Tracking slopes perpendicular to the fall line;
- Erosion control blankets;
- Straw wattles
- Terracing; and
- Diversion ditches and slope drains.

Tracking of slopes (bulldozer tracks made perpendicular to the fall line of the slope) is completed as soon as the slope is finished, regardless of the time of year. Erosion control blankets and straw wattles on slopes may be used to prevent erosion. Diversion ditches and slope drains will be constructed as necessary to prevent surface water flow from eroding exposed and covered slopes as well as preventing runoff generated on surrounding land from running into the active areas of the Landfill.

4.5 Sedimentation Control

The erosion control measures described in Section 4.4 will mitigate offsite sedimentation by reducing the amount of soil or CKD carried away in the runoff. Additional sedimentation controls include sediment barriers and process ponds used as sediment basins.

4.5.1 Sediment Barriers

Sediment barriers include rock check dams and silt fencing. They require no engineering design and are placed as needed during operations. They are most frequently placed below disturbed slopes to prevent silt in overland flow from reaching channels or ditches. The barriers will be installed as necessary. Sediment control fences will also be constructed and maintained in the drainage channels of the active areas of the site. Sediment shall be removed to keep channels open and the soil replaced at the source as required.

4.5.2 Sediment Basins

The facility was designed to have a sedimentation pond (north process pond) that collects sediments from the Landfill prior to releasing stormwater from the site.

4.6 System Maintenance Procedures

It is very important that the stormwater management system at the CKD Landfill be maintained so that it may function properly during a storm event. The following maintenance is recommended especially after large storm events.

- Keep all ditches and swales unobstructed;
- Remove sediment from ditches, swales, sediment basins, and sediment barriers routinely. Sediment controls are most effective when sediment is removed regularly;
- Inspect and clean check dams and outlet control structures of sediment and other materials that may restrict flow;
- Periodically inspect the stormwater system for damage and repair immediately; and
- Inspect and clean the stormwater system following a major storm event.

Additional inspection and maintenance requirements and procedures are included in Section 7.0 of this document.

4.7 Emergency Procedures and Contingency Action

If necessary, immediate action will be taken to control damage by constructing physical barriers or channeling flows away from critical structures. Onsite drainage structures will be immediately repaired and returned to service. Any contaminated surface water or soils will be removed if determined to be necessary.

5.0 GROUNDWATER AND EXPLOSIVE GAS MONITORING

5.1 Groundwater Monitoring

Groundwater at the Facility is monitored as part of the overall site groundwater monitoring program in accordance with the existing Class S3N Permit and **Reg.22.524(c)**. The CKD Landfill groundwater monitoring system shall include, at a minimum, four (4) monitoring wells. Two wells located up gradient (MW-1 and MW-2), and two wells located down gradient (MW-3 and MW-4).

5.2 Explosive Gas Control Monitoring

See Section 2.5 of this document for Explosive Gas Control Monitoring (EGCM) requirements. In the event an EGCM Program is required, please refer to **Reg.22.415** of Arkansas Regulation 22.

6.0 INSPECTION AND MAINTENANCE

Inspections and maintenance of the CKD Landfill will be performed routinely. Records of inspections conducted at the Landfill, and documentation of any maintenance resulting from the inspections will be recorded on an Inspection Form, such as the one included in **APPENDIX B** of this document. The inspection form is an example and may be modified. A proposed minimum inspection and maintenance schedule is included in **TABLE 2** below. Inspection records will be placed in the Class 3N Facility POR System.

TABLE 2 INSPECTION AND ROUTINE MAINTENANCE SCHEDULE CHECKLIST	
ITEM	MINIMUM FREQUENCY
Surface Water System	Monthly
Landfill Cover System	Quarterly
Facility Roads	Monthly
Emergency Response Equipment	Monthly
Fences and Gates	Quarterly
Survey Control Monuments	Annually
Survey Grid Markers	Annually
Groundwater Monitoring Wells	Semi-Annually
Earth Moving Equipment	Monthly

6.1 Surface Water System

Stormwater features including all ditches, temporary and permanent erosion control structures, ponds and culverts shall be inspected monthly or after each significant rainfall event, whichever is more frequent. Stormwater facilities shall be cleaned, repaired, or replaced as necessary.

It is very important that the stormwater management system at the Landfill be maintained so that it functions properly during a storm event. The following maintenance is recommended:

- Keep all ditches and swales unobstructed;
- Remove sediment from ditches, swales, sediment basins, and sediment barriers routinely;
- Check and clean rock check dams and outlet control structures of sediment and other materials that may restrict flow; and

- Periodically inspect the stormwater system (including pumps) for damage and repair immediately.

Additional inspection and maintenance requirements and procedures are included in Section 4.0 of this document.

6.2 Final Cover System

The final cover system shall be inspected quarterly for evidence of erosion, cracking or surface depressions. Where severe erosion has taken place, soil cover should be re-applied and seeded, given the appropriate seeding conditions. Temporary or permanent erosion control measures shall be used if significant erosion occurs. Various types of erosion control methods are discussed in Section 4.4 of this document. All final cover repair and/or reconstruction activities must be conducted in a manner to maintain the integrity of the as-built final cover system. Fill materials should be placed in layers consistent with the layers placed during the original final cover construction. Additionally, the repair of the geosynthetic cover will also be consistent with the procedures used during initial installation.

6.3 Facility Roads

Temporary and permanent access roads shall be inspected monthly and maintained as needed to provide access, and to control dust and mud accumulations. The Landfill access roads shall be graded and additional gravel applied as necessary to minimize rutting, washboarding, mudding, and dust accumulation.

6.4 Emergency Response Equipment

Communication equipment, the list of emergency phone numbers, and all first aid kits will be checked monthly and items replaced as necessary. Fire extinguishers shall be tested monthly by a third party agency.

6.5 Fences and Gates

Integrity of facility fencing shall be inspected quarterly and repaired as necessary. The entrance gate to the facility shall be inspected daily to assure the locking mechanism is properly functional.

6.6 Survey Control Monuments

The survey control monuments will be inspected annually as part of the annual engineering inspection. In the event benchmarks are damaged, the monuments shall be re-established immediately in accordance with **Reg.22.426(c)** and the ADEQ shall be notified.

6.7 Landfill Grid Marker System

The waste grid markers will be inspected annually. Repairs or replacements will be accomplished as necessary in accordance with **Reg.22.426(d)**.

6.8 Gas Monitoring Probes

Gas monitoring probes are not required at the CKD Landfill at this time. See Section 2.5 of this document for Explosive Gas Control Monitoring (EGCM) requirements. In the event an EGCM Program is required, please refer to **Reg.22.415** of Arkansas Regulation 22.

6.9 Groundwater Monitoring Wells

The groundwater monitoring wells shall be inspected semi-annually during sampling operations. The well casing, the concrete pad and the pipe bollards shall be inspected for damage and the wells shall be inspected for any obstruction. Any defects or obstructions to the wells shall be repaired as soon as practical.

6.10 Earth Moving Equipment

Earth moving equipment will be inspected monthly and repaired as needed. If earth-moving equipment will be disabled for an extended period of time for repairs, additional equipment will be leased as necessary to support the Class 3N Landfill.

6.11 CKD Delivery System

The CKD delivery system will be maintained by the kiln maintenance crew, the electrical department and plant operations personnel.

7.0 HEALTH AND SAFETY

7.1 Introduction

The primary purpose of this section is to provide guidance to help prevent personal injuries or illnesses that could be caused by conditions typically found at Class 3N solid waste facilities similar to the CKD Landfill. It is not the intent of this section to establish a comprehensive safety program for Ash Grove employees or contractors; but rather to augment the existing program with awareness of special hazards related to Class 3N solid waste facilities. Unless otherwise authorized by Ash Grove, all on-site contractors and facility personnel shall refer and adhere to the plant wide Ash Grove Safety Plan requirements (including OSHA and MSHA requirements).

7.1.1 General

The primary purpose of this section is to provide guidance to help prevent personal injuries or illnesses that could be caused by conditions typically found at Class 3N solid waste facilities similar to this Class 3N Landfill. It is not the intent of this section to establish a comprehensive safety program for Ash Grove employees or contractors; but rather to augment the existing program with awareness of special hazards related to Class 3N solid waste facilities.

7.1.2 Reporting and Investigation of Accidents and Illnesses

Accidents must be reported PROMPTLY to the employee's immediate supervisor for evaluation and/or investigation. Immediate reporting is mandatory not only to comply with applicable laws and regulations, but also to ensure that steps are taken to correct the conditions that contributed to the accident. Since every accident includes a sequence of contributing factors, it is possible to avoid a repeat of the first event by recognizing and eliminating these factors. The removal of just a single factor could prevent a recurrence. Reporting procedures should be in compliance with the Ash Grove facility wide safety program.

7.2 Potential Hazards

The CKD Landfill personnel work in all types of weather, with different types of heavy equipment, and with a variety of materials presenting diverse hazards. For this reason, safety equipment must be used and maintained in a sanitary and reliable condition. Personal protective equipment (for eyes, face, head, hearing, and extremities), protective clothing, respiratory devices, and other protective equipment must be worn whenever hazards of processes or environment are capable of causing injury.

7.3 Hazard Abatement

The following procedures, guidelines, and recommendations represent standards in the solid waste industry presently in use to mitigate or eliminate the various safety and health hazards that may exist at the Class 3N Facility.

7.3.1 Traffic Control

To prevent unnecessary traffic in and around the working face, trucks will be directed to dump waste only in designated areas.

7.3.2 Scavenging and Salvaging

Scavenging at the Landfill will not be permitted. No salvage operations are conducted at the working face.

7.3.3 Personal Protective Equipment

Facility personnel shall refer to the Ash Grove Safety Plan for personal protective equipment requirements.

7.3.4 Operations Safety

Transporting and unloading solid waste is a serious area of safety concern. Uncontrolled dust, differing flows and direction of traffic and operational equipment, and equipment operation angles pose dangers to those in the vicinity of the working face. For these reasons, safeguards will be provided on Class 3N Landfill equipment to protect the operator and the vehicle. Operating personnel who direct the placement of the delivery vehicles must take care to maintain sufficient clearance between the vehicle and the equipment. Normal safety precautions will be exercised while operating or working in the vicinity of heavy equipment.

7.3.5 Fire Prevention and Control

The potential for a fire at the CKD Landfill is minimal due to the non-combustible wastes disposed in the Class 3N Landfill. However, in the event that a fire does occur, operators shall attempt to control it as soon as possible by:

- Covering it with soil;
- Removing and covering it with soil; and/or
- Using a fire extinguisher.

Personnel will become familiar with fire extinguishers locations. The extinguishers will be inspected annually and maintained in a ready condition. To assist in fire control, soil stockpiles are readily available on the southwest side of the Landfill. Portable fire extinguishers are kept in the 1500 ton CKD storage bin area and on landfill operating equipment. Personnel will be trained in the use of these extinguishers and should become familiar with their locations. The extinguishers will be tested annually and checked quarterly by Ash Grove personnel and maintained in a ready condition. Additionally, the extinguishers are checked monthly by a third-party fire extinguisher company.

Water from the sedimentation pond may be pumped or trucked to assist in fire control. In the event that a fire cannot be controlled by onsite means, the local fire department will be contacted to respond.

The potential for surface fires can be minimized by not allowing hot loads to be dumped at the site. The potential for subsurface fires can be reduced by restricting the availability of oxygen by effective application of cover soils.

7.3.6 Contaminant Releases

Liquid byproducts of decomposition and contaminated water caused by precipitation percolating through the waste, as well as contaminated soil cover materials that run off during periods of wet weather are a potential hazard. In the event of a contaminant release, the Landfill personnel will:

- Take immediate action to stop, contain, and clean up any unauthorized discharge;
- Take all reasonable steps to minimize adverse impacts to waters of the state and correct the problem; and
- Notify the ADEQ with the necessary information described in Section 9.0 of this Plan.

7.4 Emergency Procedures

The emergency conditions discussed in this section are general. It is not intended to cover every possible emergency situation. The Class 3N Landfill personnel must be constantly aware that problems may arise. In addition, all landfill operators shall have a radio available at all times. This radio can be used to communicate with the Control Room in emergency situations. After being notified, the Control Room shall contract the appropriate personnel for the applicable emergency situation. A list of important phone numbers should be kept at the Class 3N Landfill and should be updated regularly. Facility personnel, when necessary, will provide emergency telephone numbers.

7.5 Handling of Unacceptable Wastes

Only wastes described in the permit and current operating plan are allowed for disposal at the CKD Landfill. Any wastes other than the approved wastes shall be approved by the Arkansas Department of Environmental Quality before placement in the landfill.

8.0 RECORDKEEPING AND REPORTING

8.1 Landfill Permanent Operating Record (POR)

Ash Grove maintains the POR at the Plant administrative office. The POR contains records required by Arkansas Regulation 22 or permit conditions. All information contained in the facility POR is available for inspection and is provided to the ADEQ upon request. Ash Grove will maintain these records until the Director of the ADEQ authorizes the destruction of the records following the completion of the post-closure care monitoring period. The POR includes the following information:

- Permit information, regulations, and operator licenses;
- Location restriction demonstrations;
- Groundwater monitoring plan and reports;
- Operational plans and programs;
- Inspection records, training procedures and records, and notification procedures;
- Design demonstrations;
- Geotechnical and hydrogeological information;
- Any reports and testing data related to final closure of areas; and
- Financial assurance documentation.

Notifications of the above entries have been or will be submitted to the Solid Waste Management Division (SWMD) of the ADEQ as required by this section of the regulation.

8.2 Inspection Log

Inspections of the overall site, facilities, and operations are carried out on a routine basis. Inspections are performed often enough to identify problems in time to correct them before they harm human health or the environment. Inspections also prevent malfunction, deterioration, and operator error from affecting the performance of the facilities and operations.

The frequency of inspections are noted on the inspection checklist (Operations Inspection Form is located in **APPENDIX B** of this document). Inspections are also carried out after any major storm event or natural disaster. The inspection checklist will be kept in the POR and will be made available to the SWMD of the ADEQ on request.

8.3 Reports

8.3.1 Waste Quantity Reports

The facility prepares and submits the required waste quantity reports on a quarterly basis. The reports include the weight and class of solid waste that has been disposed at the Landfill during the previous 3 months. Copies of waste quantity reports will be maintained in the facility POR.

8.3.2 Monitoring Results

Records of monitoring activities and results are submitted to the ADEQ, as required, and will be maintained in the facility POR until destruction of the records is authorized by the Director of the ADEQ following completion of the post-closure care monitoring period.

8.3.3 Annual Engineering Report

An annual report will be prepared by an Arkansas-registered Professional Engineer and submitted to the SWMD of the ADEQ by June 30 of each year. This document will include the following:

1. The volume remaining in the current landfill module or area and the projected date for opening new modules or areas;
2. The estimated remaining volumetric capacity of all permitted Class 3 landfill units, the landfill capacity used during the past 1-year reporting period, and the estimated remaining site life based upon the utilization rate during the previous 1-year period;
3. Documentation of compliance of facility fill progression with the approved permit plans and specifications, and this Operating Plan;
4. Documentation of compliance with the operating requirements of Regulation No. 22, facility permit conditions, permit plans and specifications, and this Operating Plan;
5. An updated contour map that depicts with reasonable accuracy:
 - a. The horizontal and vertical extent of the active and inactive fill areas;
 - b. The status of each permitted landfill unit or module (future unit, active unit, inactive, under construction, under interim cover, undergoing closure, closed, post-closure, etc.);
 - c. The survey grid system required by §22.426;
 - d. The location of any other visible surface features or improvements such as roads, fences, buildings, gas control systems, surface water control systems, etcetera; and
 - e. The person responsible for gathering survey data and the date(s) that survey data were taken to prepare the map.
6. Quantity, location, and characteristics of leachate collected, recirculated, and disposed;
7. Maintenance of stormwater controls and other best management practices for erosion control;
8. Status of remedial or corrective actions taken;
9. Revised or updated facility Closure Plan and the Post-Closure Care Plan in accordance with the requirements contained in Chapter 13 Closure and Post-Closure Care of these regulations;
10. Updated Financial Assurance documentation; and
11. Any other items impacting compliance at the landfill.

8.4 Incident Reports

8.4.1 Emergency Reports

Ash Grove will submit a written report to the SWMD of the ADEQ within 48 hours after an emergency has occurred at the landfill facility. The report will describe the emergency and the actions taken to minimize hazards to human health and the environment. The report will also outline any follow up procedures that will be implemented. Emergencies include fires, explosions, storm damage, and any other events requiring the prompt intervention of Ash Grove personnel, police, fire department, or other public health and safety officials.

8.4.2 Notifying Government Agencies

In the event that Ash Grove does not, or is unable to, comply with any of the conditions specified in the facility's operating permit, Ash Grove will do the following:

- Provide the SWMD of the ADEQ with a description of the nature and cause of noncompliance;
- Inform the SWMD of the ADEQ of the period of noncompliance, including exact dates and times and/or the anticipated time when the facility will return to compliance;
- Notify the SWMD of the ADEQ of steps taken or to be taken to reduce, eliminate, and prevent recurrences of the noncompliance; and
- Take the first three actions listed above within 24 hours in the case of any noncompliance that could constitute a threat to human health, welfare or the environment, and, if the requisite information is provided orally, provide it in writing within 5 days, unless this requirement is waived or extended by the SWMD of the ADEQ on a case-by-case basis.

Attachment A
PERMIT NO. 0292-S3N



ARKANSAS
Department of Environmental Quality

August 2, 2011

Carey Austell
Ash Grove Cement Company
4343 Highway 108
Foreman, Arkansas 71836

**RE: Administrative Permit Modification
Removal of Expiration Date and Responsible Official Change
Ash Grove Cement Class 3N Landfill
Permit Number: 0302-S3N AFIN: 41-00230
Document Number: 60599 Cross Reference Number: 60383**

Dear Carey Austell:

The Arkansas Department of Environmental Quality-Solid Waste Management Division (ADEQ-SWMD) has received and reviewed a permit modification application for the Ash Grove Cement Class 3N Landfill. The modification application, submitted in July 2011, requests removal of the permit expiration date. The modification application also includes a notification of the responsible official name change.

Under current regulations the landfill permit is effective as long as the waste remains within the permitted boundaries and does not exceed the permitted capacity, fill volume or elevations. The ADEQ-SWMD hereby provides this administratively modified permit with the expiration date removed. Attached is the new permit cover page for the Ash Grove Cement Class 3N Landfill. Please replace the existing cover page of your permit with the new cover page. ADEQ also recognizes the responsible official name change to Carey Austell, Plant Manager.

If you have any questions regarding this correspondence, please contact Clark McWilliams, P.E. at (501) 682-0510.

Sincerely,


Roger Lawrence, Chief
Solid Waste Management Division

Enclosure: Revised Permit 0302-S3N Cover Page

cc: Bill Sadler, Geologist Supervisor, SWMD
Heidi Love, Inspector Supervisor, SWMD
Scott McWilliams, Enforcement Coordinator, SWMD
Sheldon Hadley, District Field Inspector SWMD



PERMIT

FOR THE CONSTRUCTION AND OPERATION OF A
SOLID WASTE DISPOSAL FACILITY

ISSUED BY

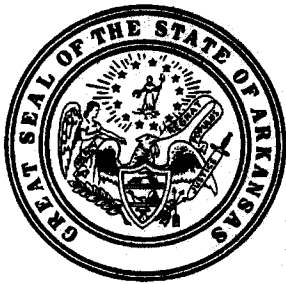
STATE OF ARKANSAS
DEPARTMENT OF ENVIRONMENTAL QUALITY
SOLID WASTE MANAGEMENT DIVISION



Class 3N Landfill

Permit Number	0302-S3N
AFIN	41-00230
Effective Date	June 25, 2002
Expiration Date	June 25, 2012 (<i>Administrative Amendment, August 2011- Permit Expiration Date Removed</i>)
Permit Owner & Address	Ash Grove Cement Company 4457 Highway 108 Foreman, AR 71836
Facility Site Name & Address	Ash Grove Cement Plant 4457 Highway 108 Foreman, AR 71836
Location	A portion of the NW $\frac{1}{4}$ of Section 28, and a portion of the N $\frac{1}{2}$ of the SW $\frac{1}{4}$ of Section 28, lying North and West of the Highway 108 R-O-W, Township 12 South, Range 32 West, Little River County, Arkansas
911 Address	Ash Grove Cement Plant 4417 Highway 108 Foreman, AR 71836
Latitude/Longitude	33° 42' / 94° 25' 5"
Design Engineer	CH2MHILL, Little Rock, Arkansas

This permit authorizes the operation of the solid waste disposal facility as set forth in the permit application by Ash Grove Cement Company, hereinafter called "owner/operator" or "permittee," dated October 4, 2001 and supporting documents. This permit is issued pursuant to the provisions of the Arkansas Solid Waste Management Act (Arkansas Code Annotated 8-6-201 et seq.) as amended, hereinafter called the "Act"; Regulation Number 22, Arkansas Solid Waste Management Code, as adopted by the Pollution Control and Ecology Commission, hereinafter called "Regulation 22"; and all other applicable rules and regulations of the Department of Environmental Quality, hereinafter called "Department", and the following terms and conditions:



PERMIT

FOR THE CONSTRUCTION AND OPERATION OF A
SOLID WASTE DISPOSAL FACILITY

ISSUED BY

STATE OF ARKANSAS
DEPARTMENT OF ENVIRONMENTAL QUALITY
SOLID WASTE MANAGEMENT DIVISION



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DESCRIPTION OF THIS PERMIT ACTION

This permit is for a new Class 3N (Non-Commercial) landfill facility.

SITE SPECIFIC CONDITIONS

1. This permit is for a 91-acre site with waste disposal to occur on approximately 41 acres as indicated on the approved plans. This permit shall expire upon the expiration date shown above or when the authorized fill elevations have been attained and the facility is closed out in accordance with the provisions of Regulation 22, whichever occurs first.
 - a. The Department shall be notified in writing upon construction of each waste containment module and upon facility closure in order that it may be inspected.
 - b. Changes to or deviations from the construction/layout and operation of the facility, as indicated on the approved facility plans indicated below, and on the approved permit application documentation, are not authorized unless approved in writing by the Department.
 - c. The approved design drawings and specifications (Attachment D to the Permit Application) by CH2MHILL include the following:

G-1, G-2, G-3, C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9, C-10, C-11, C-12, C-13, C-14, C-15, C-16, C-17, C-18, and C-19 dated October 2001 (ADEQ, SWD Document Identifier #15430).
2. The initial amount of financial assurance is \$1,345,000.00. This amount shall be subject to annual adjustments and may be increased at the discretion of the Department based upon the estimated cost for a third party to close the largest area requiring final cover during the active life of the facility and the cost for a third party to perform post closure care.
 - a. The instruments used must be in one of the forms set forth in Regulation 22 or as otherwise approved by the Department.
 - b. Operations allowed under this permit shall not commence until all financial assurance is satisfactorily filed with the Department.
 - c. A portion or all of the financial assurance may be held by the Department beyond the time of cessation of disposal operations at the site to ensure satisfactory closure and post closure care in accordance with Regulation 22.
3. This permit is for the disposal of solid waste generated by Ash Grove Cement Company at the Ash Grove Cement Plant, Foreman, Arkansas. The authorized waste stream is predominately cement kiln dust (CKD) captured by air pollution control devices (electrostatic precipitators [ESPs]) at the cement manufacturing plant. Incidental amounts of cement and clinker ingredients (i.e., clay and limestone sources), air pollution control device captured dust, cement clinker, and related plastic liner wastes are also authorized for disposal in the landfill facility.
 - a. Additional waste items not mentioned above may be authorized by the Department for disposal at the facility on a case-by-case basis when requested by the permittee.
 - b. Regulated PCBs and PCB items as defined in 40 CFR 761 or "Hazardous waste," as defined by Regulation Number 23, are not authorized for disposal in the facility.
4. The permittee is exempted from implementing a routine methane monitoring program unless the Department determines that:
 - a. The nature and quantity of waste poses a significant potential for the generation of explosive gases;
or

- b. Explosive gases have been detected in concentrations exceeding the standards identified in Regulation 22.514 (a).
5. The permittee shall properly control disease vectors, fires, odors, blowing litter, and scavenging in accordance with Section 22.512 of Regulation 22, except a variance is hereby granted from requirements for application of daily cover material and for intermediate cover material. Options proposed in the Operations Plan (Appendix F to the Permit Application), including spraying/irrigating waste with water or applying dust suppressants, may be used to comply with the requirements herein for the CKD landfill.
 - a. The Department reserves the right to rescind this variance if deemed necessary to provide for the control of disease vectors, fires, odors, blowing litter, scavenging, or to prevent harm to human health or the environment, or to properly control fugitive dust.
6. Measures to control and prevent storm water run-on from running through or into the active disposal area shall be constructed and maintained. Grading, dikes, diversion ditches, silt fencing, silt traps, and other best management practices (BMP) for storm water control shall be provided as necessary to control/prevent off-site sediment accumulation from landfill-related operations.
7. Each landfill waste module shall be constructed in the sequence indicated on the approved plans and specifications. The waste containment system for any newly constructed waste module shall consist of the following (top to bottom):
 - a. 12-inch protective layer.
 - b. 60-mil HDPE geomembrane.
 - c. \geq 24-inch compacted clay liner (permeability $\leq 1 \times 10^{-7}$ cm/sec).
 - d. Construction of the waste containment system of each module shall be observed and certified to the Department in writing by a Registered Professional Engineer in a construction certification report in accordance with the approved CQA Plan prior to the use of the new module.
 - i.) The report shall include CQA/QC test results as indicated in the approved CQA Plan; drawings indicating the location, designation, and extent of area(s) actually constructed for use, and test locations.
 - ii.) The report shall be submitted to the Department at least fourteen (14) days prior to waste placement in that module.
8. The final cover system shall consist of the following (top to bottom):
 - a. Dense cover vegetation that properly holds soil in place and prevents erosion of the final cover system.
 - b. \geq 6-inch vegetative layer.
 - c. 12-inch compacted soil base.
 - d. Composite drainage net.
 - e. 40-mil LLDPE geomembrane.
 - f. \geq 6-inch bedding layer.
 - g. After the final elevations are attained, the final cover system shall be constructed and a thick vegetation cover shall be established and maintained. Following establishment of cover vegetation, the vegetation shall be properly mowed as needed during the growing season to control undesirable annual weed and woody vegetation growth and to facilitate proper inspection of the cover.

9. The post closure maintenance period for this facility shall be a minimum of two (2) years starting on the date the Department accepts closure of the facility. The length of the post closure period may be decreased or increased by the Director in accordance with Regulation 22.1302.

GROUND WATER MONITORING

1. A ground water monitoring system shall be established and maintained at the Class 3N landfill that consists of a sufficient number of wells or sampling points, installed at appropriate locations and depths that will most likely yield representative samples of ground water quality.
 - a. The ground water monitoring system shall include, at a minimum, four (4) monitoring wells. Two wells will be located up gradient (MW-1 and MW-2). Two monitoring wells (MW-3 and MW-4) will be installed down gradient.
 - b. The monitoring well locations are shown on Figure 1 in the Groundwater Monitoring Plan (Appendix I to the Permit Application) dated October 2001.
2. The ground water monitoring system shall be certified by a Registered Professional Geologist or a qualified ground water scientist as stipulated in Regulation 22.1202(e).
 - a. An original of the monitoring system certification document signed and stamped by the certifying professional shall be forwarded to ADEQ upon completion. The certification shall demonstrate the monitoring system components have been constructed and developed in an acceptable manner following appropriate ASTM D5092 construction protocols.
 - b. The ground water monitoring system certification must also confirm the monitoring wells for this facility are most likely of yielding water samples that are representative of the uppermost aquifer ground water quality at the sampling point.
3. All monitoring wells yielding sufficient water for sampling shall be sampled quarterly for a period of one year to establish baseline water quality conditions. Thereafter, all monitoring wells shall be sampled semi-annually. Sample analysis shall be performed by a laboratory that is certified by the ADEQ.
 - a. Following preliminary QA/QC by the permittee, analytical results shall be submitted directly to the Solid Waste Management Division from the contract laboratory.
4. Each monitoring well shall be sampled and static water levels measured in accordance the approved Groundwater Monitoring Plan dated October 2001 (Appendix I to the Permit Application).
 - a. Each monitoring well shall be sampled by personnel trained and familiar with proper procedures and techniques for the collection of ground water samples.
 - b. Prior to purging the monitor wells, static water level measurements shall be taken, recorded and the data used to establish ground water flow direction in the upper most aquifer. Measurements are to be taken from the surveyed benchmark on the top rim of the well casing. The permittee may use alternate methods, including but not limited to, micro-purging, to prepare the wells for sampling. Such alternate techniques must be approved in writing prior to implementation by the permittee or their agents.
 - c. Ground water sampling and analysis shall comply with the requirements of Subpart E of 40 CFR Part 258 as adopted in Regulation 22.

5. Quarterly background water samples, if available, shall be analyzed for the following parameters:

Antimony	Fluoride	Nitrate	Sulfate
Arsenic	Iron	pH	Temperature
Barium	Lead	Selenium	Total Dissolved Solids
Cadmium	Manganese	Silver	Total Organic Carbon
Chloride	Mercury	Specific Conductance	Turbidity
Chromium			

Semi-annual ground water samples shall be analyzed for the following parameters:

Antimony	Fluoride	Nitrate	Sulfate
Arsenic	Iron	pH	Temperature
Barium	Lead	Selenium	Total Dissolved Solids
Cadmium	Manganese	Silver	Total Organic Carbon
Chloride	Mercury	Specific Conductance	Turbidity
Chromium			

6. Analysis of ground water samples shall be in accordance with EPA Report SW-846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Vols. IA, IB, IC and II, Third Edition, Rev.1, December 1987 or equivalent as specified in 40 CFR Part 136.
- Analysis for metals shall utilize either Method 6010 or a method from the 7000 series. Method detection limits for each parameter must be reported.
 - Parameter concentrations that are above the Method Detection Limit (MDL) but below the Practical Quantitation Limit (PQL) must be reported.
 - The Department may modify the analytical parameters, sampling frequency, or methods required under this permit based upon analytical results or new laboratory techniques.
7. The Permittee shall comply with Regulation 22.1103 (a), which requires that following construction, each well shall be developed to the degree necessary to restore formation hydraulic conductivity and insure turbidity-free samples that are representative of formation ground water quality. The permittee may use alternate methods, including but not limited to, micro-purging, to prepare the wells for sampling. Such alternate techniques must be approved in writing prior to implementation by the permittee or their agents.
- Monitoring wells in which turbidity values exceed 5 Nephelometric Turbidity Units (NTU) must be redeveloped. If the turbidity remains above 5 NTU, a qualified groundwater scientist shall evaluate the integrity of the well. If the well is found to be unreliable, it must be replaced prior to the next scheduled sampling event.
 - Reports of replaced or decommissioned wells shall be submitted to the Department within 60 days of completion and shall be placed in the Operating Record.
8. The Permittee must select a statistical method approved by the Department for evaluating monitoring results for each ground water constituent in order to determine whether a statistically significant increase (or decrease in the case of pH) occurs for each ground water monitoring constituent in conformance with the requirements of Regulation 22.1203.
9. In accordance with Regulation 22.1204, should a statistically significant increase over background be detected for one or more of the detection monitoring constituents, the permittee must:

- a. Within 14 days of this finding, place a notice in the Operating Record indicating which constituents have shown statistically significant changes from background levels, and notify the Department;
 - b. Establish an assessment monitoring program meeting the requirements of Regulation 22.1205 within 90 days except as provided for in Regulation 22.1204(c)(3).
 - c. If, after 90 days, a successful demonstration provided for in Regulation 22.1204(c)(3) is not made, the Permittee must sample and analyze for Appendix 2 constituents in accordance with Regulation 22.1205.
10. If one or more of the Appendix 2 constituents is detected at a statistically significant level exceeding the ground water protection standards defined under Regulation 22.1205 (h) or (i), the Permittee must initiate an assessment of corrective measures in accordance with Regulation 22.1206. Based upon the results of the assessment, the Permittee must proceed with selection of a remedy in accordance with Regulation 22.1207 and then proceed with implementation of a corrective action program in accordance with Regulation 22.1208.

GENERAL PERMIT CONDITIONS FOR CLASS 3N FACILITIES

1. This permit is issued in reliance upon the statements and representations made in the application, operating narrative, plans, specifications, correspondence, and other related documents. The Department bears no responsibility for the adequacy or proper functioning of the disposal facility. Nothing contained herein shall be construed as releasing the permittee from any liability from damage to persons or property due to the installation, maintenance, or operation of the disposal facility or any act of the permittee, or the permittee's employees or agents.
2. The disposal facility shall be constructed, maintained, and operated in accordance with the final plans, specifications and operation narrative as approved by the Department and in compliance with applicable provisions of the Act, Regulation 22, and all other applicable rules and regulations.
3. Any statements in the operational narrative, specifications, and/or engineering plans that conflict with Regulation 22, permit conditions herein, or other applicable laws and regulations shall not be considered authorized by the Department.
4. At all times the disposal facility shall be maintained in good condition and operations shall be conducted by licensed, qualified on-site operators holding the appropriate license as required by Regulation Number 27, Certification of Sanitary Landfill Operators.
5. The final grades and elevations shown on the plans shall not be exceeded in anticipation of settlement and consolidation of the waste mass.
 - a. Timely initiation and completion of closure of landfill cells or units shall be made in accordance with Regulation 22.1301(f) and (g).
 - b. Proper construction of the final cover system shall be observed and certified in writing to the Department by a Registered Professional Engineer in a Construction Certification Report in accordance with the approved CQA Plan whenever a cell, module, area or phase of the landfill is closed-out.
 - c. The Certification Report shall include CQA/QC test results as indicated in the approved CQA Plan; drawings indicating the location, designation and extent of closed area(s); and test locations.
6. The permittee shall maintain an Operating Record at the location indicated in the permit application, or at an alternate location approved in writing by the Department.
 - a. At a minimum, the following documents and materials shall be retained in the facility operating record for review by authorized representatives of the Department:
 - i.) The approved facility operating plan, approved permit plans and specifications, CQA reports, site inspection reports, operator licenses, this disposal permit and written authorizations issued by the Department that provide modifications to the facility or its operations, all environmental monitoring or test results, and other pertinent records, certifications and correspondence as required by Regulation 22 or other permit conditions herein; and
 - ii.) All construction test results, certifications, acceptances, construction reports, photographs, layout drawings, record (as-constructed) drawings, shop drawings, construction drawings, and other documentation required by the specifications, and CQA/QC plans, reports and documents; and
 - iii.) Other documents that pertain to the operation and maintenance closure and/or post-closure of the facility, or as directed by the ADEQ.

- b. The permittee shall forward a copy of information from the Operating Record when requested by the Department.
7. This permit may be revoked or modified whenever, in the opinion of the Department, the facility is no longer in compliance with the Act, Regulation 22, or other applicable rules and regulations. Except where expressly authorized by the Department, this permit shall not relieve the permittee, or the permittee's employees or agents, from compliance with the provisions of the Act and Regulation 22.
8. The Department may issue modifications or amendments to this permit governing the design, operation, maintenance, closure or post closure of the facility during the term of this permit. Such modifications or amendments shall be attached to this permit and shall be fully maintained and enforceable as a condition or conditions of this permit.
9. The Department has received an initial permit fee from the permittee. Annual permit fees due thereafter shall be assessed in accordance with Regulation Number 9, Fee System for Environmental Permits. Failure to pay annual fees when due may result in revocation of this permit.
10. Any change in ownership or control of the operation of this landfill may require a permit transfer and therefore must be fully disclosed to the Department. For purposes of this evaluation, ownership or control may result from a change in the debt or equity of the permittee of five percent (5%) or more. A permit transfer will not be required when a change in ownership or control of the facility is among the persons and/or entities previously disclosed to the Department in Section E of the Disclosure Statement or similar disclosure.
11. The permittee shall furnish the Department annual engineering inspection reports in accordance with Regulation 22.522. This report is due on June 30 of each year and shall cover the preceding period beginning April 1 and ending March 31.
12. A survey control system shall be established and maintained at the landfill site that complies with Regulations 22.526 and 22.426.
13. The landfill working face will be confined to the active cell which is the smallest practical area.
14. The permittee shall not engage in or allow salvage operations at the facility except with written authorization from the Department. The Department may review and approve requests for future salvage of disposed materials for recycling purposes on a case-by-case basis.
15. Disposal of bulk liquid waste in the landfill is prohibited. Liquid waste is waste that contains "free liquids" as defined by Method 9095 (Paint Filter Liquids Test) in EPA Publication No. SW-846.
16. Appropriate NPDES construction/storm water permit(s) shall be obtained for storm water discharges from the landfill site and borrow sites. A Storm Water Pollution Prevention Plan (SWPPP), which outlines erosion and sediment control measures, shall be prepared and implemented in accordance with applicable NPDES requirements. A copy of the SWPPP shall be maintained on-site for reference by operating staff.
17. The permittee shall comply with the air criteria requirements of Regulation 22.515. Those requirements include meeting the State Implementation Plan (SIP) pursuant to Section 110 of the Clean Air Act; prohibiting open burning of solid waste, unless authorized by the Department; and establishing fire safety procedures.
18. The permittee shall implement a hazardous waste screening and detection program at the facility in accordance with the approved operating plan and Regulation 22. The program shall include procedures for evaluation of any questionable wastes prior to disposal to determine whether the waste complies with the Regulation 22 requirements for disposal in the facility.
19. Erosion and sediment controls shall be implemented and maintained on an ongoing basis at each borrow site (whether on-site or off-site) to minimize sediment losses until final reclamation/stabilization of the borrow site is accomplished and final reclamation of the borrow site is determined to be acceptable by the Department. Final reclamation/stabilization of each borrow site shall include final grading to promote proper drainage and establishment of suitable perennial grasses such that all disturbed areas are fully stabilized, or reclamation

through other means approved in writing by the Department. Final sideslopes at borrow pits shall not be any steeper than 3:1 (H:V).

20. Erosion and sediment controls shall be implemented and maintained on an ongoing basis at each soil stockpile to minimize sediment losses. Alternately, run-on and run-off control berms and/or ditches may be constructed such that run-on is diverted away from soil stockpiles while run-off is contained and routed to either the proposed process pond or to the existing process pond for treatment prior to discharge.
21. The Department, its employees, agents, or any authorized person shall have the right to enter the property at any time for any reason as set out in Regulation 22 for the purposes of, including but not limited to taking samples, reviewing the operating record, inspecting the facility, and perform other enforcement or engineering action without interference or delay from the permittee.
22. The Department's decision to issue this permit is final for purposes of appeal as of the date indicated in the Certificate of Service below. If any provision of these conditions or the application of these conditions thereof to any person or circumstance is held invalid, such invalidity shall not affect other provisions or applications of these conditions that can be given effect without the invalid provision or application. Therefore, to this end, the provisions of these conditions are declared to be severable.

APPROVED BY: Arkansas Department of Environmental Quality
8017 I-30, Post Office Box 8913
Little Rock, Arkansas 72219-8913



For The Director

6-25-02

Date

CERTIFICATE OF SERVICE

I, C. Herder, hereby certify that a copy of this permit has been mailed by first-class mail to Mr. Terry Kerby, Plant Manager, Ash Grove Cement Company, 4457 Highway 108, Foreman, AR 71836, on or before this 25 day of June, 2002.

Attachment B
SAMPLE INSPECTION FORM

ASH GROVE CEMENT COMPANY CLASS 3N LANDFILL INSPECTION FORM

DESCRIPTION	INSPECTION INTERVAL	PASS	FAIL**
Surface Water System			
▪ Drainage Ditches & Culverts	Monthly	_____	_____
▪ Berms	Monthly	_____	_____
▪ Letdown Structures	Monthly	_____	_____
▪ Stormwater Pond Outlet Structure	Monthly	_____	_____
Earth Moving Equipment (Landfill)	Monthly	_____	_____
Landfill Cover System			
▪ Erosion	Monthly	_____	_____
▪ Ponded Water	Monthly	_____	_____
▪ Settlement	Monthly	_____	_____
▪ Vegetation	Monthly	_____	_____
Facility Roads			
▪ Safety	Monthly	_____	_____
▪ Condition	Monthly	_____	_____
Emergency Response Equipment			
▪ Fire Extinguisher	Test annually, check in Jan/April/August/December	_____	_____
▪ Plant Radios	Monthly	_____	_____
▪ First Aid Kits	Monthly	_____	_____
Survey Grid Markers	Annually	_____	_____
Survey Control Markers	Annually	_____	_____
Fences and Gates	Quarterly	_____	_____
Groundwater Monitoring Wells	Semi-Annually	_____	_____

** Explain failure on back of form.

DATE: _____ INSPECTOR: _____

ASSOCIATED WORK REQUEST NO.(S): _____



ASH GROVE CEMENT COMPANY CLASS 3N LANDFILL INSPECTION FORM

Comments: _____

Actions: _____

DATE: _____ **INSPECTOR:** _____

ASSOCIATED WORK REQUEST NO.(S): _____



Attachment D

Closure Construction Drawings

CONSTRUCTION DRAWINGS FOR THE

PROPOSED 7.5 ACRE PARTIAL CLOSURE FOR ASH GROVE CEMENT COMPANY CEMENT KILN DUST LANDFILL

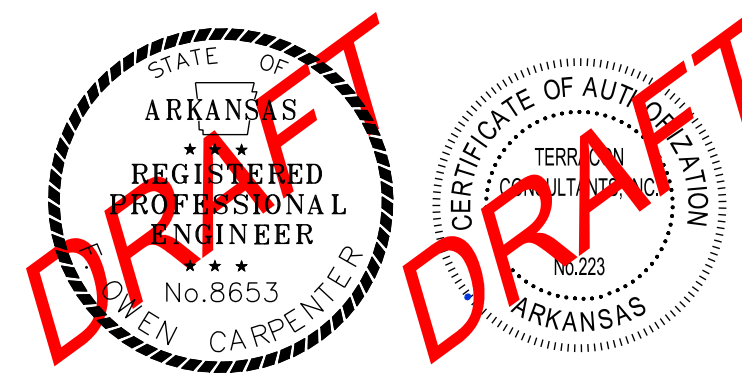
NOVEMBER 2015
PROJECT NO. 35147187

PREPARED FOR



ASH GROVE CEMENT COMPANY
4343 HIGHWAY 108
FOREMAN, ARKANSAS 71836
(870) 542-3000

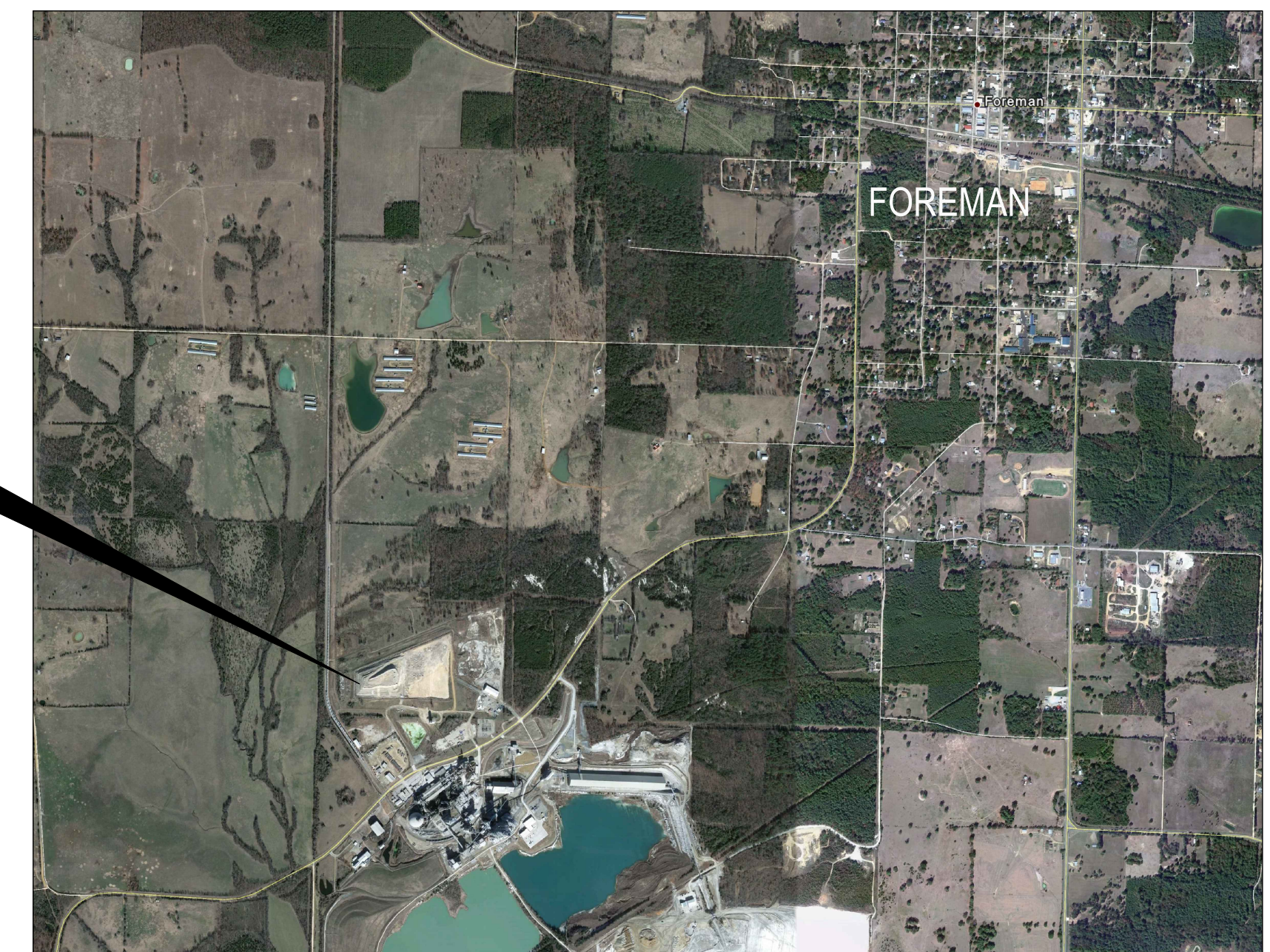
PREPARED BY



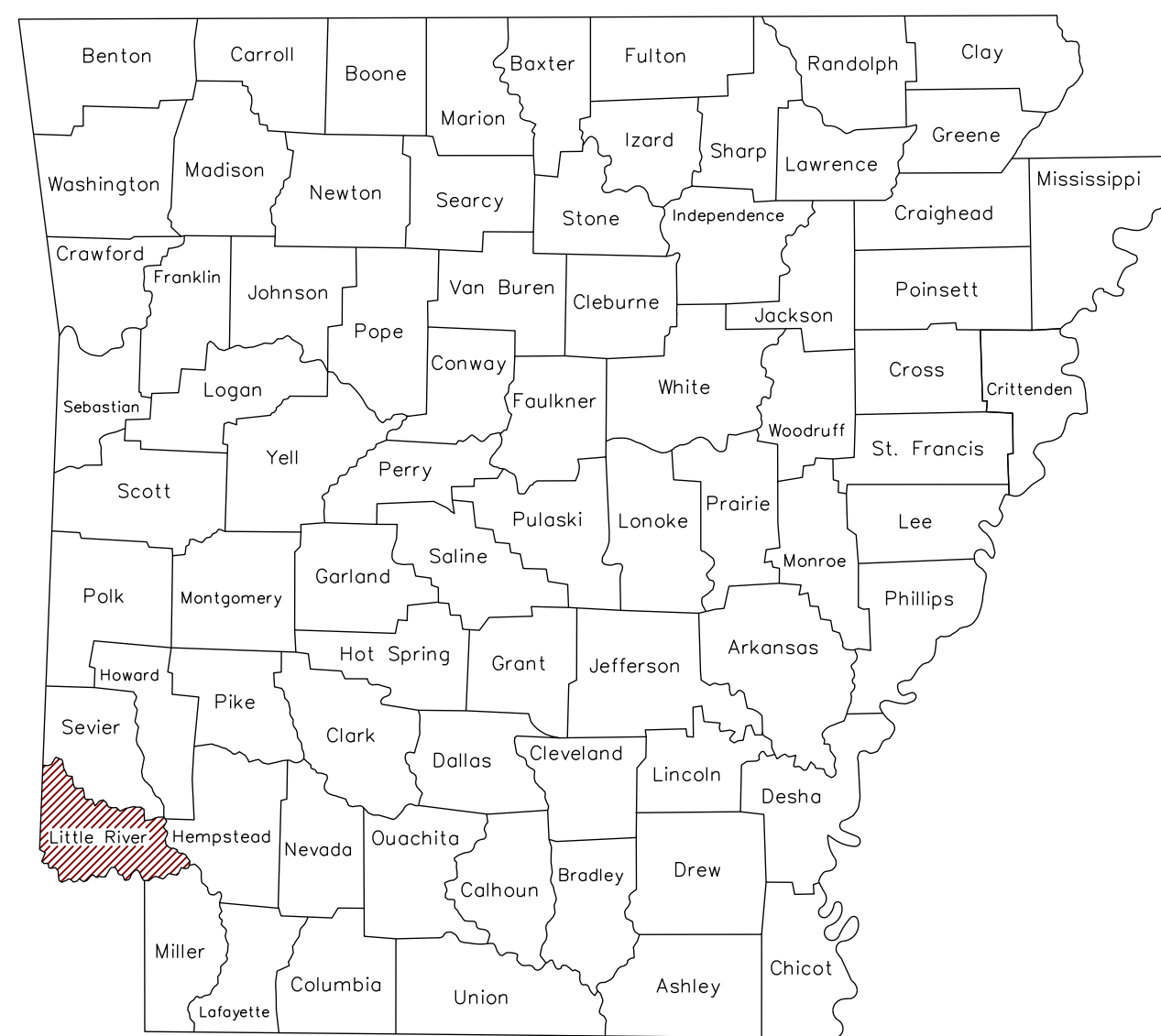
25809 I-30 SOUTH
PH. (501) 847-9292

BRYANT, AR 72022
FAX. (501) 847-9210

ISSUED FOR BID PURPOSES ONLY

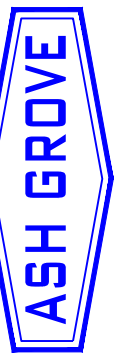


SITE LOCATION MAP
SCALE: N.T.S.



VICINITY MAP
N.T.S.

REV.	DATE	BY	O.C.	ISSUED FOR BID	DESCRIPTION
0	10/26/15				



COVER SHEET

7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
CEMENT KILN DUST LANDFILL

ARKANSAS

FOREMAN

Terracon
Consulting Engineers and Scientists

BRYANT, AR 72022
PH. (501) 847-9292
FAX. (501) 847-9210

DRAWING 1	
DESIGNED BY:	JDW
DRAWN BY:	JSS
APPROVED BY:	BNF
SCALE:	AS SHOWN
DATE:	10/26/2015
JOB NO.:	005-001-3514718
ACAD NO.:	011
SHEET NO.:	1 OF 9

INDEX OF DRAWINGS

ABBREVIATIONS AND SYMBOLS

GENERAL NOTES

DRAWING NO.	TITLE
1	COVER SHEET
2	INDEX SHEET
3	EXISTING SITE CONDITIONS
4	PROPOSED CLOSURE FINAL WASTE GRADES
5	PROPOSED CLOSURE FINAL COVER GRADES
6	CROSS SECTIONS A-A', B-B' & C-C'
7	MISCELLANEOUS DETAILS - SHEET 1
8	MISCELLANEOUS DETAILS - SHEET 2
9	MISCELLANEOUS DETAILS - SHEET 3

ABBREVIATIONS	SYMBOLS
ADEQ ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY	--- x --- x --- EXISTING FENCE
CB CATCH BASIN	--- x --- x --- PROPOSED SILTFENCE
DIA DIAMETER	EXISTING BUILDING
DWG DRAWING	EXISTING BUILDING ROAD
ELEV ELEVATION	EXISTING ASPHALT
EXIST EXISTING	DRAINAGE PATHWAY
FT FEET	EXISTING INDEX CONTOUR
HDPE HIGH DENSITY POLYETHYLENE	EXISTING INTERMEDIATE CONTOUR
HORZ HORIZONTAL	320 PROPOSED INDEX CONTOUR (COLOR VARIES)
ID INSIDE DIAMETER	320 PROPOSED INTERMEDIATE CONTOUR (COLOR VARIES)
IN INCHES	--- OHE --- OHE OVERHEAD ELECTRIC
INV INVERT	--- LFG --- LFG LEACHATE FORCEMAIN
MAX MAXIMUM	--- LFG --- LFG LANDFILL GAS LINE
MH MANHOLE	PROPOSED ACCESS ROAD
MIN MINIMUM	--- W --- W WATERLINE
MSL MEAN SEA LEVEL	WS=1294.6 WATER SURFACE ELEVATION
NOM NOMINAL	X 325.8' EXISTING SPOT ELEVATION
NSPS NEW SOURCE PERFORMANCE STANDARDS	BM-10 PERMANENT SITE BENCHMARK
NTS NOT TO SCALE	SITE GRID MARKER
OD OUTSIDE DIAMETER	MW-1 GROUNDWATER MONITORING WELL
R _L PROPERTY LINE	GMP-1 GAS MONITORING PROBE
SDR STANDARD DIMENSION RATIO	POWER POLE
TYP TYPICAL	EW-1 LANDFILL GAS EXTRACTION WELL
VERT VERTICAL	DRAINAGE CULVERT
NPDES NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM	VEGETATION
	GEOMEMBRANE
	GEOTEXTILE
	GEOCOMPOSITE
	GCL (GEOSYNTHETIC CLAY LINER)
	PLYWOOD
	SUBGRADE
	ON-SITE SELECT FILL
	COMPACTED CLAY LINER
	PROTECTIVE COVER
	GRAVEL / RIP-RAP
	CONCRETE
	WASTE
	INTERMEDIATE / INTERIM COVER
	TOP SOIL

- EXISTING TOPOGRAPHIC INFORMATION SHOWN IN THE ACTIVE AREA IS BASED ON FIELD SURVEYS PROVIDED BY FBL & ASSOCIATES AND WERE PERFORMED ON FEBRUARY 24, 2014 AND OCTOBER 31, 2014.
- SURVEY CONTROL POINTS AND CONSTRUCTION CONTROL POINTS LISTED ON THESE DRAWINGS ARE BASED ON STATE PLANE COORDINATES (NAD 83 ARKANSAS SOUTH).
- PERMANENT BENCHMARKS ARE SHOWN ON APPROPRIATE DRAWINGS AND SHOULD BE FIELD VERIFIED.
- EXISTING FACILITIES AND FEATURES ARE SHOWN LIGHT-LINED AND/OR SCREENED. NEW FACILITIES AND FEATURES ARE SHOWN SOLID AND HEAVY LINED.
- REFER TO THE PROJECT SPECIFICATIONS, DATED DECEMBER 2014 FOR ALL WORK SHOWN ON THESE DRAWINGS.
- THE EROSION CONTROL FEATURES ILLUSTRATED ON THESE PLANS ARE THE MINIMUM FEATURES REQUIRED. ADDITIONAL FEATURES MAY BE REQUIRED TO CONTROL EROSION.
- SLOPES AND GRADES ARE IN UNITS OF FT/FT, UNLESS OTHERWISE NOTED.
- THE MATERIAL QUANTITIES SHOWN ON THESE DRAWINGS ARE ESTIMATES ONLY.
- CONTRACTORS SHALL NOT INTERRUPT OWNER'S DAILY OPERATION OF THE LANDFILL WITH CONSTRUCTION ACTIVITIES.
- CONTRACTORS SHALL TAKE EXTRA CARE NOT TO DISTURB EXISTING ENVIRONMENTAL MONITORING STRUCTURES (GROUNDWATER WELLS, GAS MONITORING PROBES, ETC.).
- CONTRACTOR SHALL ENTER THE CONSTRUCTION AREA THROUGH THE LANDFILL ACCESS ROADS AS DEPICTED ON THE MAP BELOW, OR SPECIFICALLY DIRECTED BY ASH GROVE CEMENT COMPANY.
- CONTRACTOR SHALL BE RESPONSIBLE FOR BRINGING TO THE OWNER'S ATTENTION ANY CONSTRUCTION ELEMENT THAT HAS NOT BEEN ADDRESSED IN THESE DRAWINGS OR SEEN TO BE DIFFERENT FROM THE LIKE ELEMENT DEPICTED IN THESE DRAWINGS.
- CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVAL OF ALL CONSTRUCTION RELATED DEBRIS FROM THE CLOSURE AREA AT THE COMPLETION OF THE PROJECT.
- CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING LOCATION OF UTILITIES PRIOR TO WORKING IN PROJECT AREAS. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO UTILITIES CAUSED BY CONSTRUCTION OPERATIONS.
- AS-BUILT BOTTOM GRADES FOR MODULE A WERE PROVIDED BY FBL & ASSOCIATES INC., AND ARE DATED 6-27-02.
- AS-BUILT BOTTOM GRADES FOR MODULE B WERE PROVIDED BY FBL & ASSOCIATES INC., AND ARE DATED 7-11-07.

ISSUED FOR BID PURPOSES ONLY



SITE ENTRANCE MAP

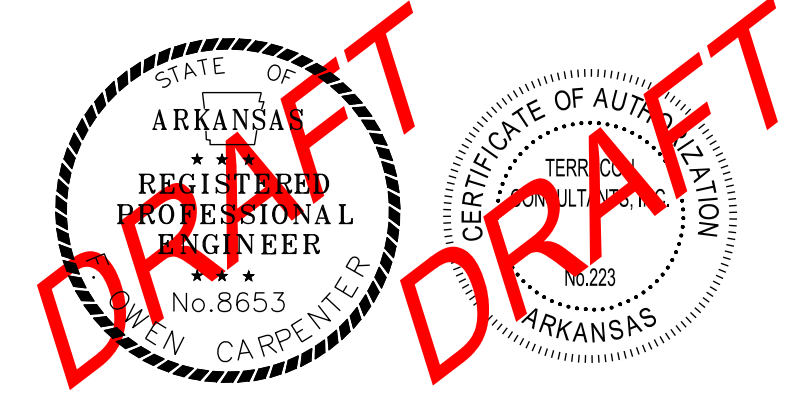
REV.	DATE	BY	DESCRIPTION
0	07/06/16	O.C.	ISSUED FOR BID



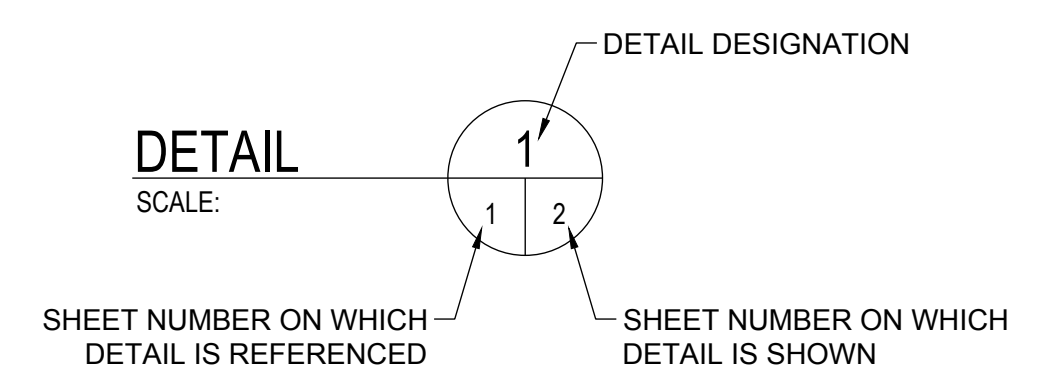
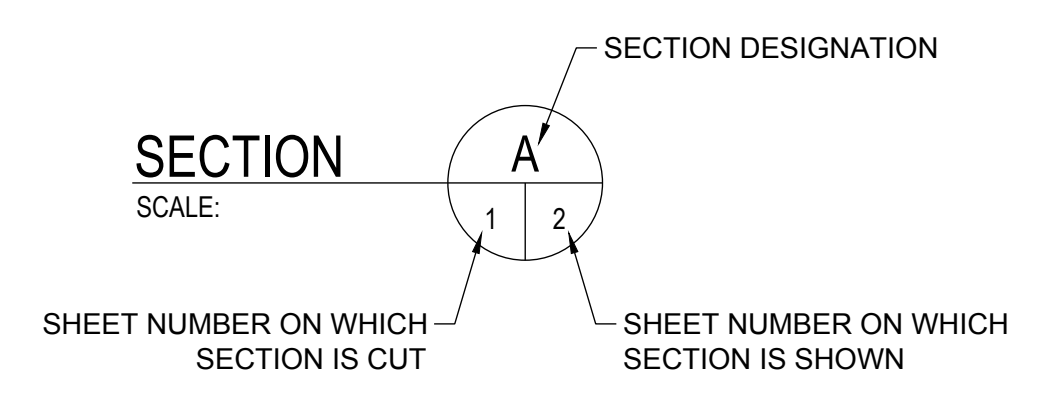
INDEX SHEET
 7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
 CEMENT KILN DUST LANDFILL
 ARKANSAS
 FOREMAN

Terracon
 Consulting Engineers and Scientists
 25809 I-30 SOUTH BRYANT, AR 72022
 PH: (501) 847-9292 FAX: (501) 847-9210

DRAWING 2	
DESIGNED BY:	JDW
DRAWN BY:	JSB
APP'D BY:	BNP
SCALE:	N.T.S.
DATE:	10/28/2015
JOB NO.:	005-001-3514718
ACAD NO.:	012
SHEET NO.:	2 OF 9



SITE/DETAIL KEY

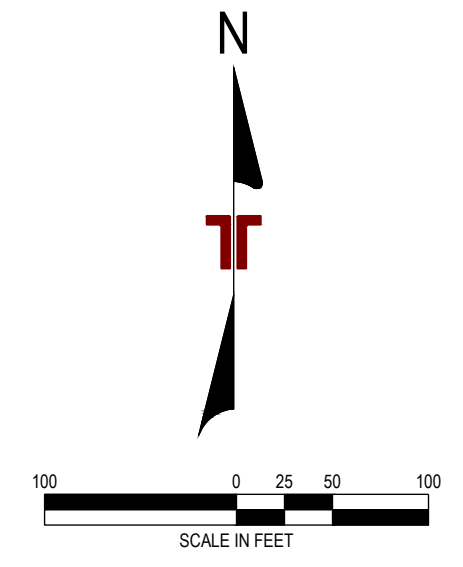
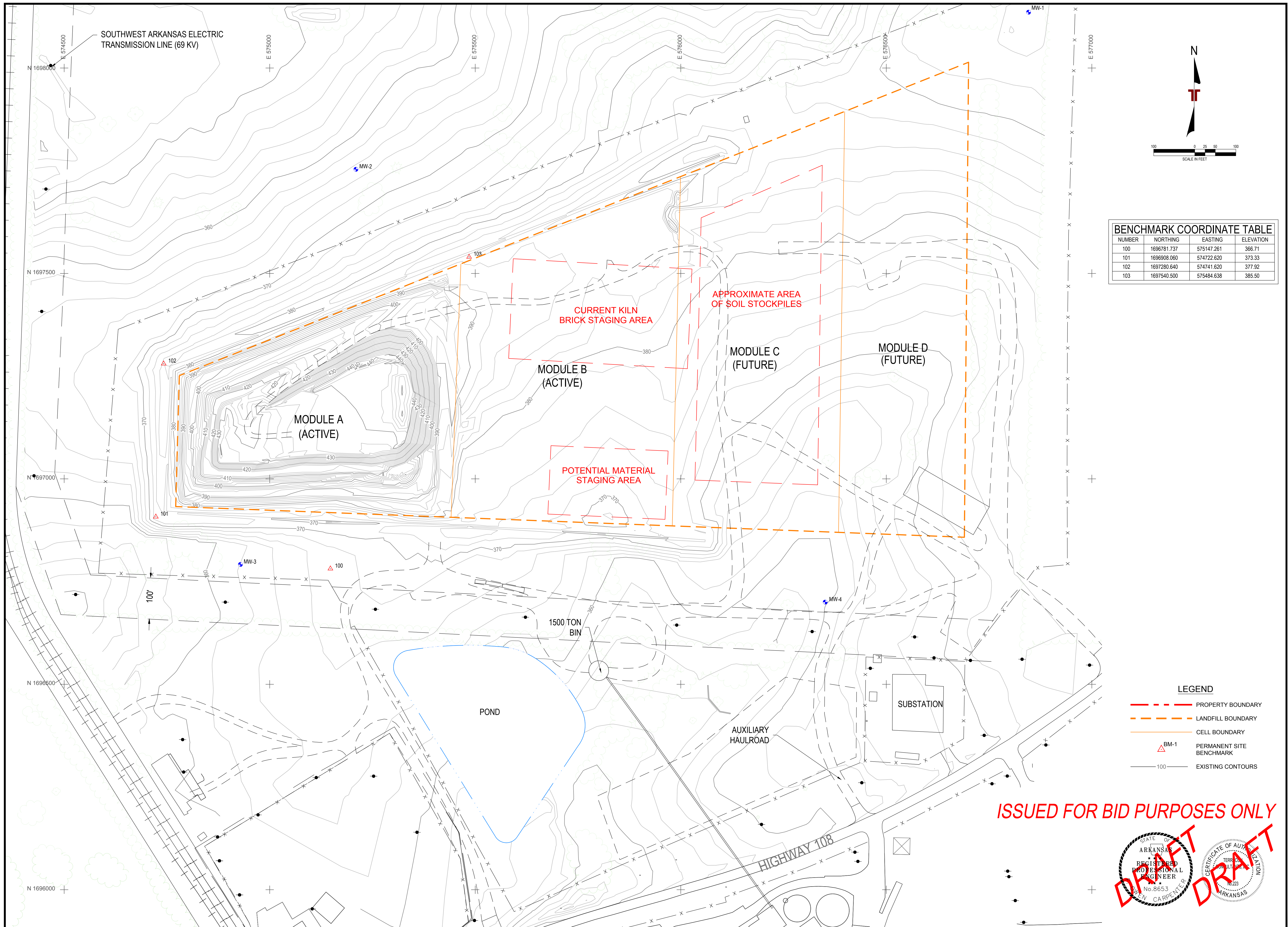


CONTACT INFORMATION

OWNER:
 ASH GROVE CEMENT COMPANY
 ATTENTION: KEITH BYERLY - ENVIRONMENTAL MANAGER
 4343 HIGHWAY 108
 FOREMAN ARKANSAS 71836
 PHONE: (870) 542-3217
 EMAIL: keith.byerly@ashgrove.com

ENGINEER:
 TERRACON CONSULTANTS, INC.
 ATTENTION: BRAD N. FUREIGH, P.E. - PROJECT MANAGER
 25809 INTERSTATE 30 SOUTH
 BRYANT, ARKANSAS 72022
 PHONE: (501) 847-9292
 EMAIL: brad.fureigh@terracon.com

REGULATORY AUTHORITY:
 ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY
 SOLID WASTE MANAGEMENT DIVISION
 ATTENTION: SOLID WASTE MANAGEMENT DIVISION CHIEF
 5301 NORTHSORE DRIVE
 NORTH LITTLE ROCK, ARKANSAS 72118-5317
 PHONE: (501) 682-0600



BENCHMARK COORDINATE TABLE

NUMBER	NORTHING	EASTING	ELEVATION
100	1696781.737	575147.261	366.71
101	1696908.060	574722.620	373.33
102	1697280.640	574741.620	377.92
103	1697540.500	575484.638	385.50

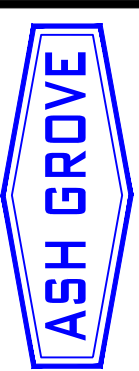
LEGEND

	PROPERTY BOUNDARY
	LANDFILL BOUNDARY
	CELL BOUNDARY
	PERMANENT SITE BENCHMARK
	EXISTING CONTOURS

ISSUED FOR BID PURPOSES ONLY



REV. DATE	BY	O.C.	DESCRIPTION
0	07/02/16		ISSUED FOR BID



EXISTING SITE CONDITIONS
7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
CEMENT KILN DUST LANDFILL

FOREMAN

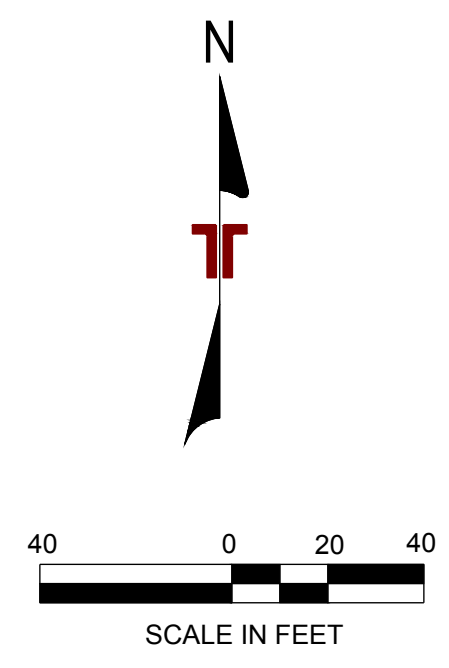
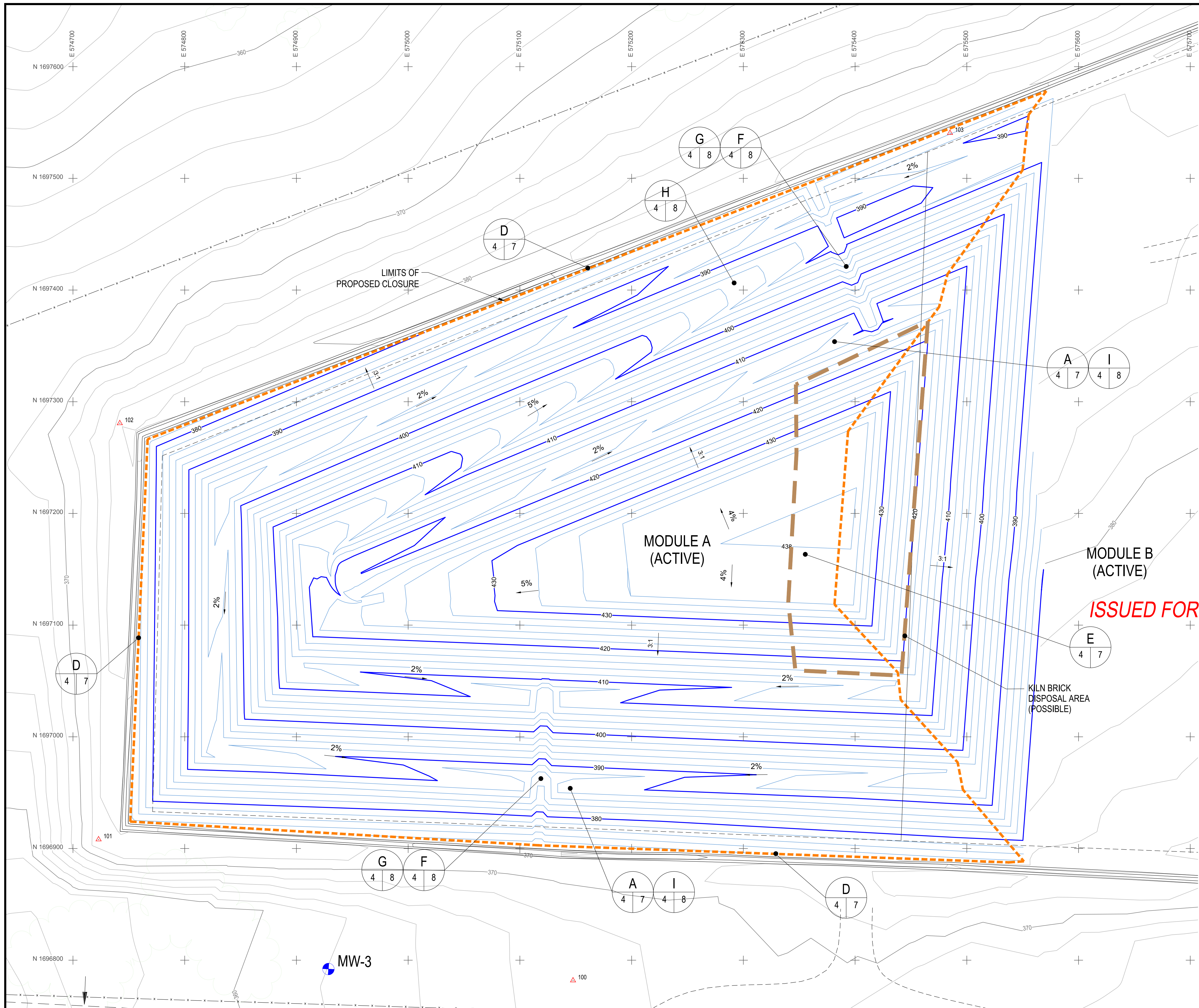
ARKANSAS

Terracon
 Consulting Engineers and Scientists

2609 S.30 SOUTH BRYANT, AR 72022
 PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 3

DESIGNED BY:	JDW
DRAWN BY:	JSB
APP'D BY:	BNP
SCALE:	1" = 100'
DATE:	10/28/2015
JOB NO.:	005-001-3514718
ACAD NO.:	013
SHEET NO.:	3 OF 9



BENCHMARK COORDINATE TABLE

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102	1697280.640	574741.620	377.92
103	1697540.500	575484.638	385.50

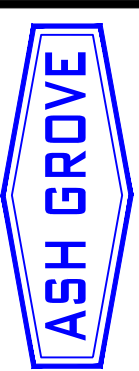
NOTES:
 1. KILN BRICK DISPOSAL AREA SHALL CONSIST OF APPROXIMATELY 1,500 CUBIC YARDS OF BRICK MIXED WITH APPROXIMATELY 3,000 CUBIC YARDS OF CKD MATERIAL. MINIMUM OF 5 FEET OF CKD MATERIAL TO BE BETWEEN BRICK AND GEOMEMBRANE.

ISSUED FOR BID PURPOSES ONLY

LEGEND

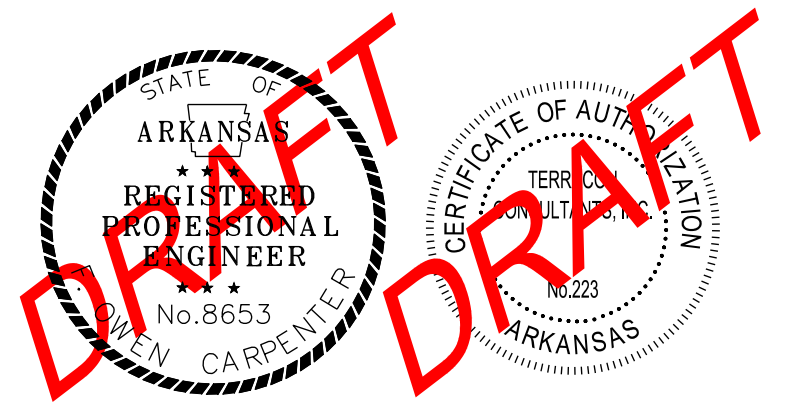
	PROPERTY BOUNDARY
	LANDFILL BOUNDARY
	CELL BOUNDARY
	PERMANENT SITE BENCHMARK
	EXISTING CONTOURS
	PROPOSED CONTOURS
	LIMITS OF PROPOSED CLOSURE

REV.	DATE	BY	DESCRIPTION
0	07/28/16	J.C.C.	ISSUED FOR BID
1	07/28/16	J.C.C.	ADDENDUM NO. 2



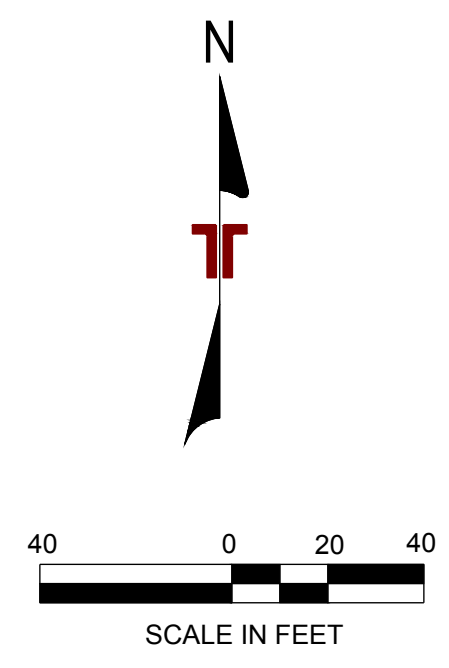
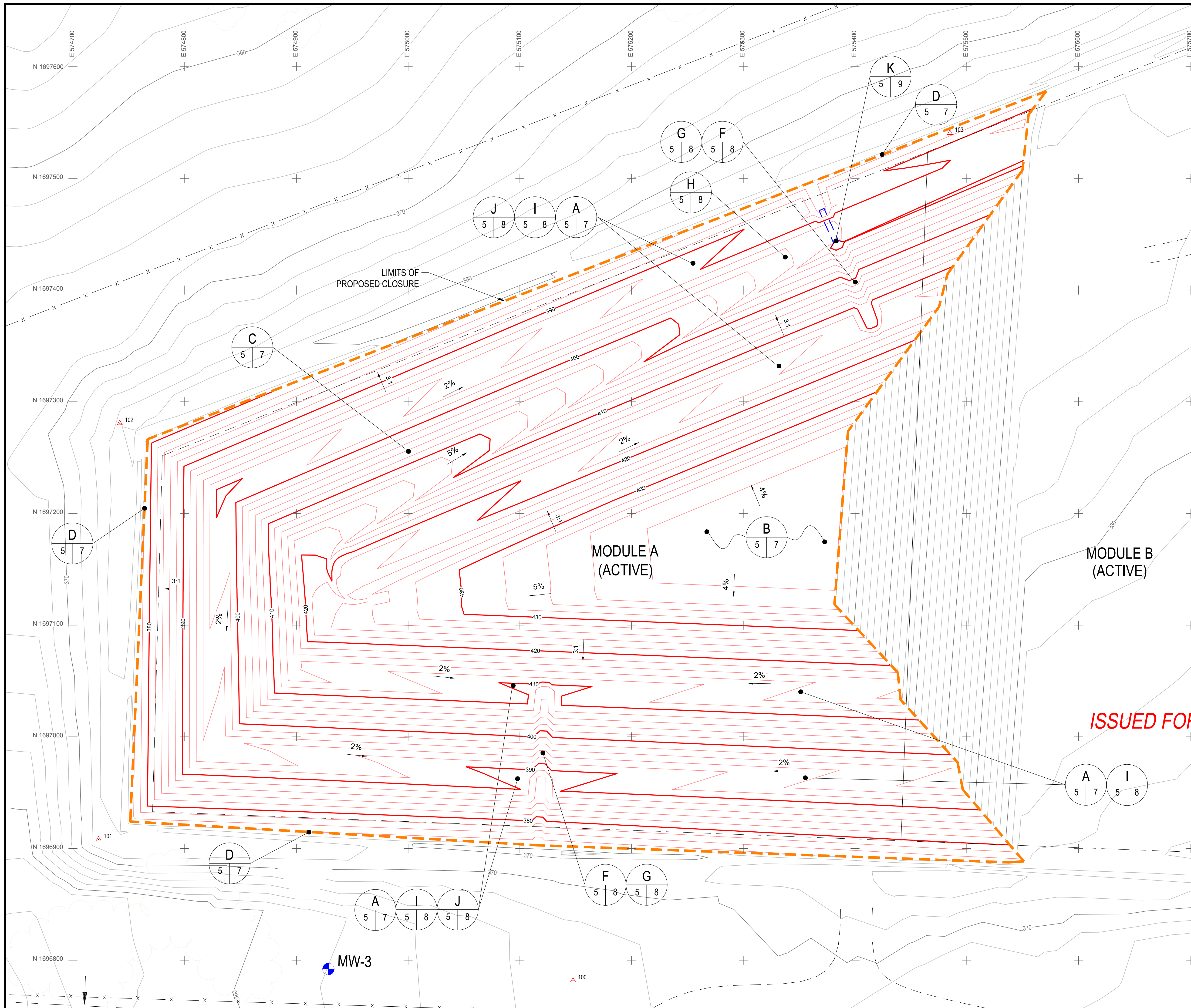
PROPOSED CLOSURE FINAL WASTE GRADES
7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
 CEMENT KILN DUST LANDFILL
 ARKANSAS
 FOREMAN

Terracon
 Consulting Engineers and Scientists
 BRYANT, AR 72022
 PH. (501) 847-9292 FAX. (501) 847-9210



DRAWING 4

DESIGNED BY:	JDW
DRAWN BY:	JSB
APP'D BY:	BNP
SCALE:	1" = 40'
DATE:	10/28/2015
JOB NO.:	005-001-3514718
ACAD NO.:	014
SHEET NO.:	4 OF 9

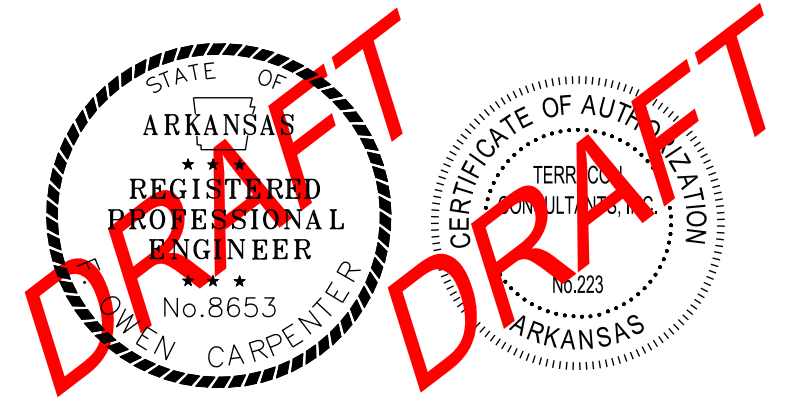


BENCHMARK COORDINATE TABLE

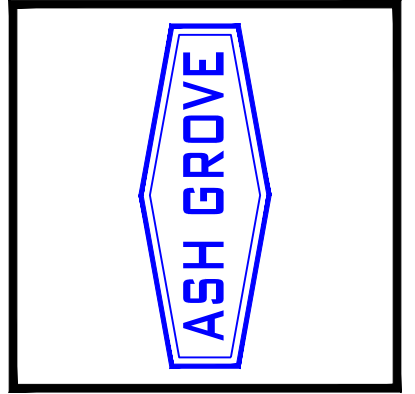
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101	1696908.060	574722.620	373.33
102	1697280.640	574741.620	377.92
103	1697540.500	575484.638	385.50

ISSUED FOR BID PURPOSES ONLY

- LEGEND**
- PROPERTY BOUNDARY
 - LANDFILL BOUNDARY
 - CELL BOUNDARY
 - ▲ BM-1 PERMANENT SITE BENCHMARK
 - 100 EXISTING CONTOURS
 - 100 PROPOSED CONTOURS
 - LIMITS OF PROPOSED CLOSURE



REV. DATE	BY	DESCRIPTION
0	07/08/16	O.C. ISSUED FOR BID

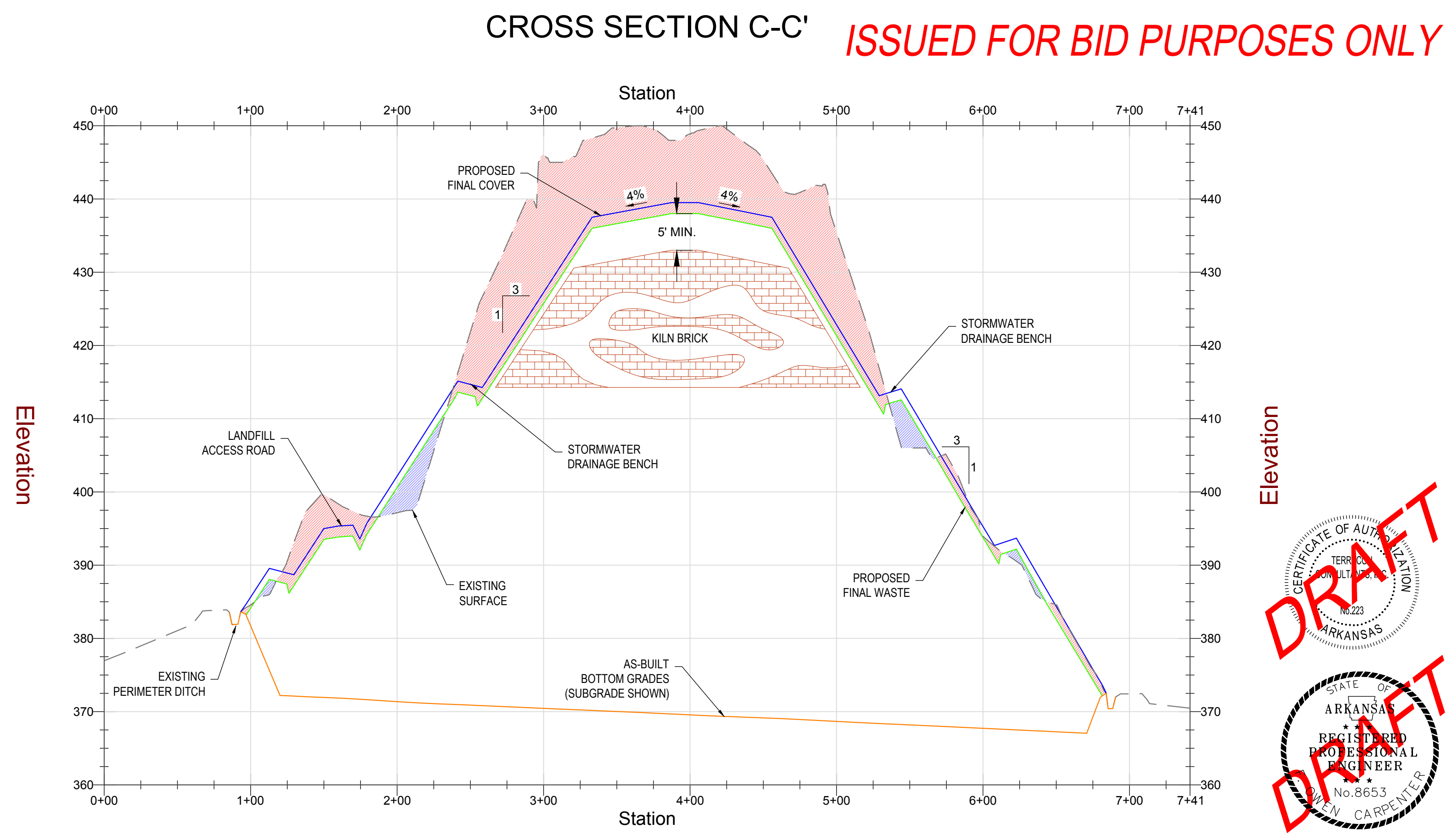
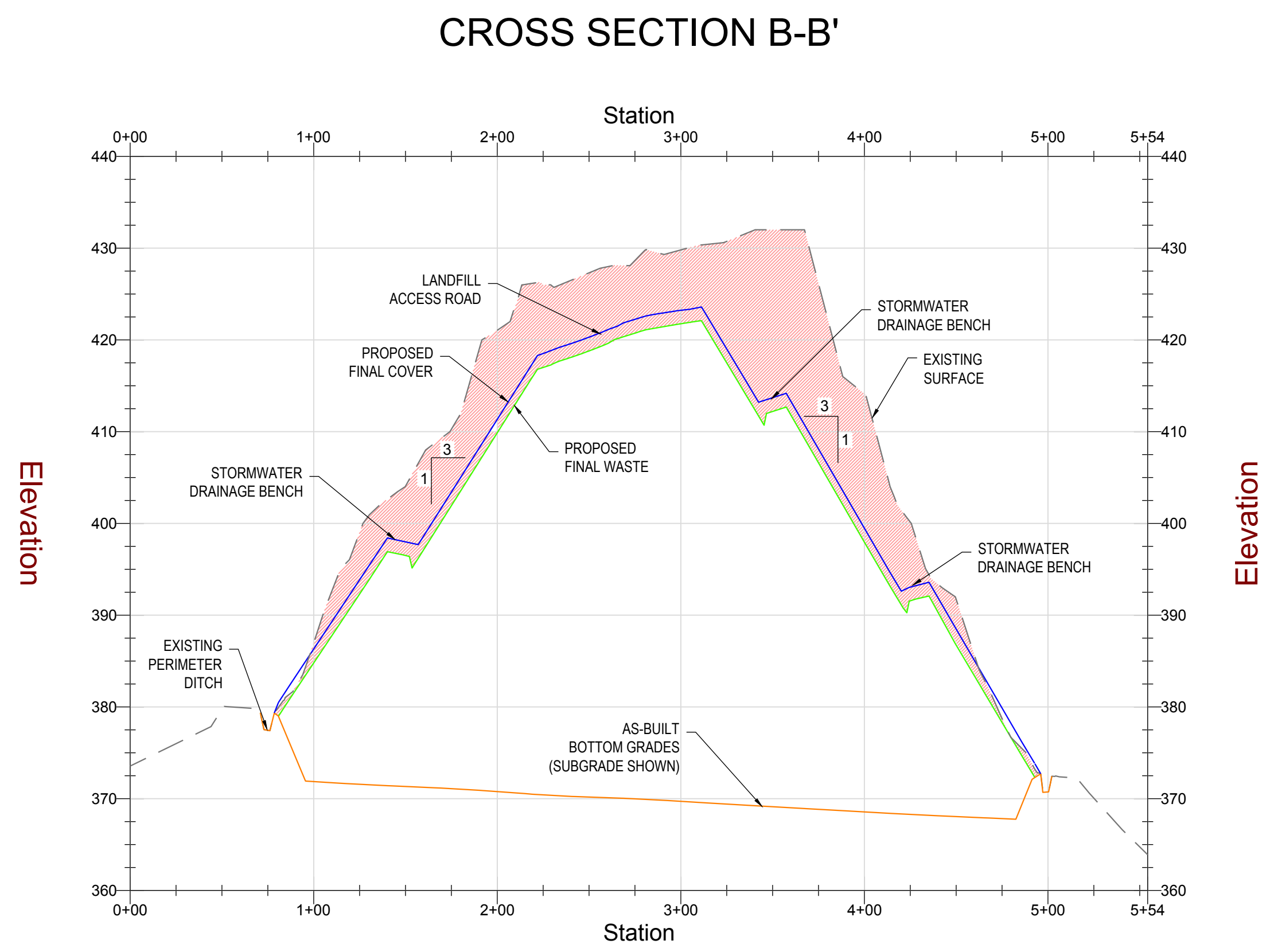
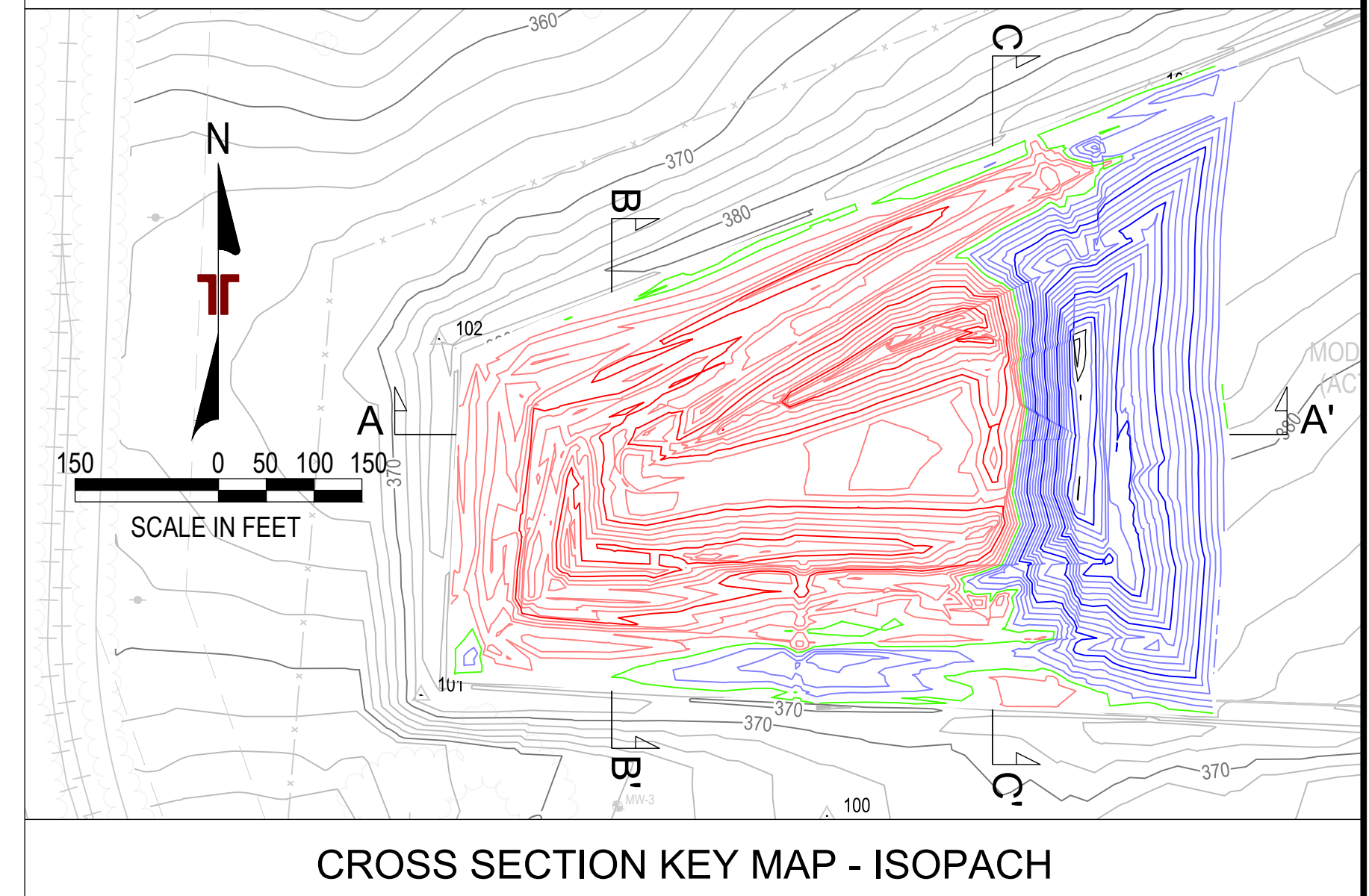
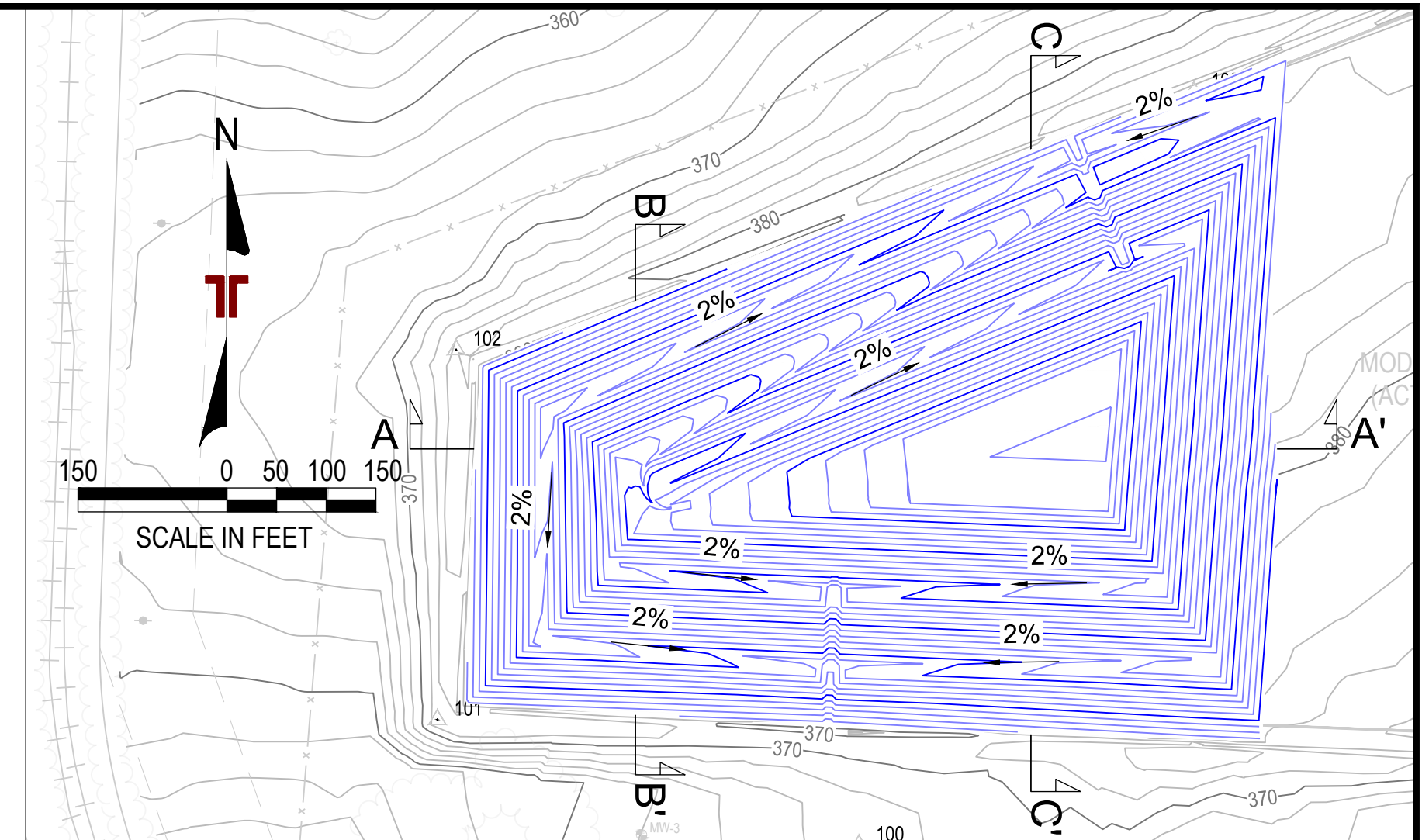
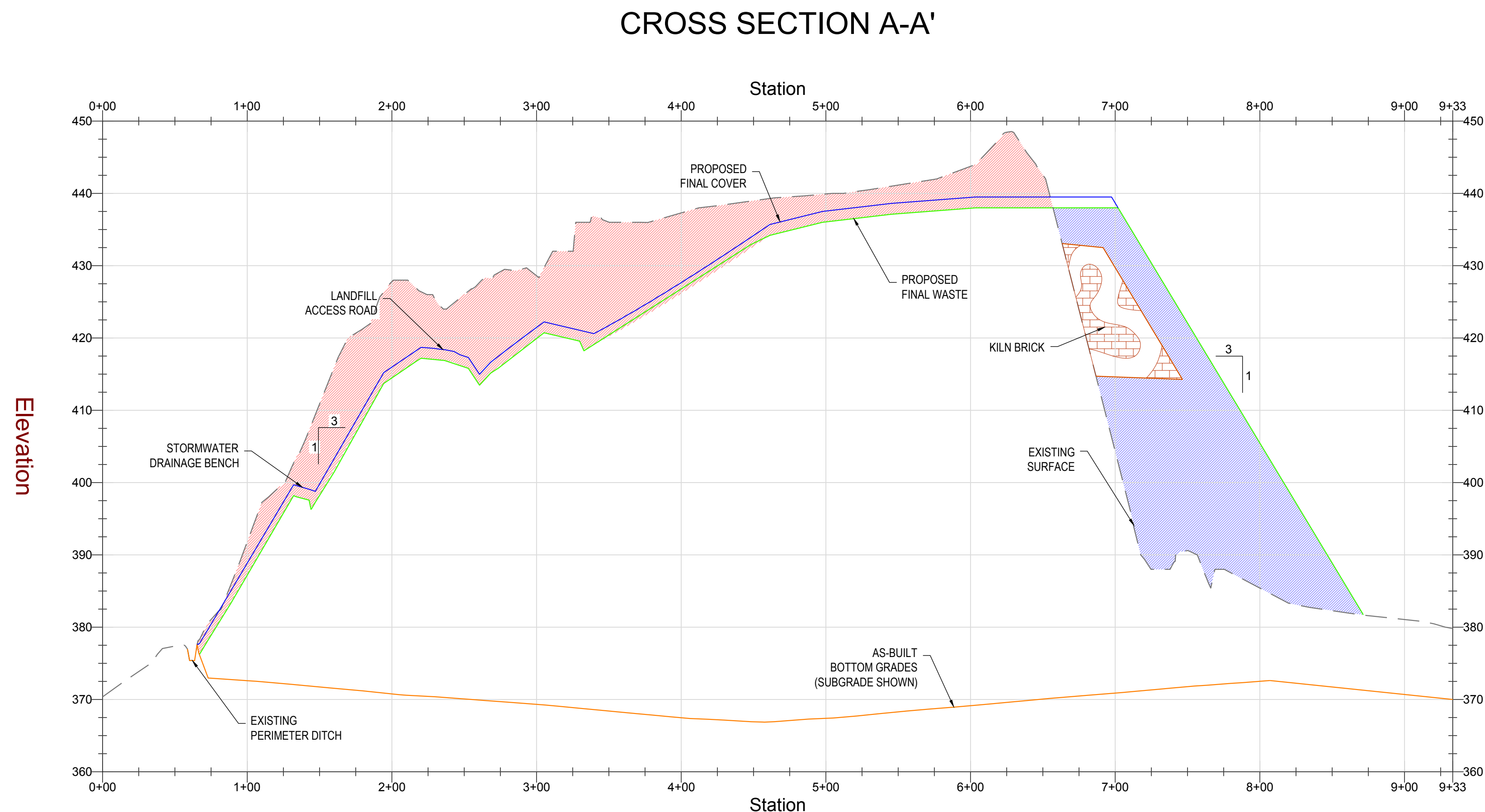


PROPOSED CLOSURE FINAL COVER GRADES
7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
 CEMENT KILN DUST LANDFILL
 FOREMAN ARKANSAS

Terracon
 Consulting Engineers and Scientists
 25809 I-30 SOUTH BRYANT, AR 72022
 PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 5

DESIGNED BY:	JDW
DRAWN BY:	JSB
APP'D BY:	BNP
SCALE:	1" = 40'
DATE:	04/22/2015
JOB NO.:	005-001-3514718
ACAD NO.:	015
SHEET NO.:	5 OF 9

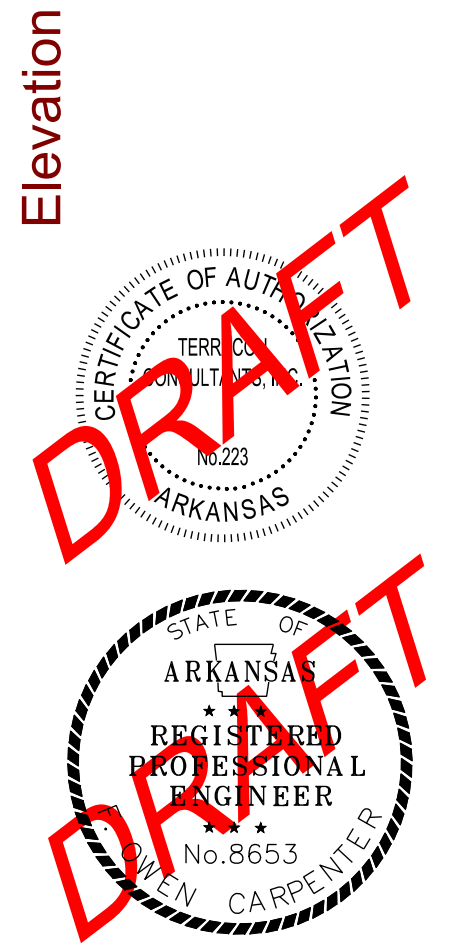


REV.	DATE	BY	DESCRIPTION
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1	07/28/16	JCB	ADDENDUM 2

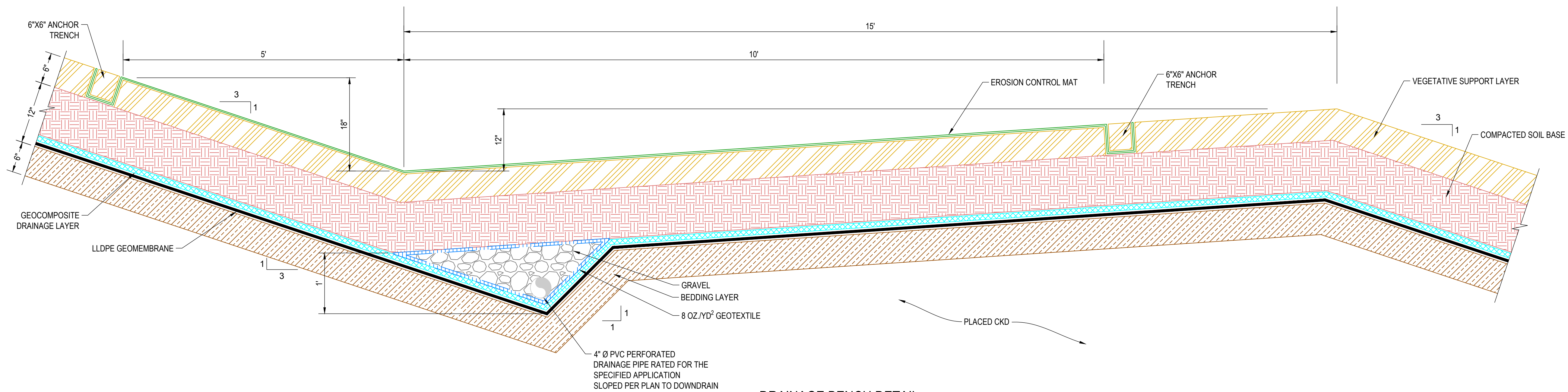


CROSS SECTIONS A-A', B-B' & C-C'
 7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
 CEMENT KILN DUST LANDFILL
 ARKANSAS
 FOREMAN

Terracon
 Consulting Engineers and Scientists
 BRYANT, AR 72022
 PH: (501) 847-9292
 FAX: (501) 847-9210

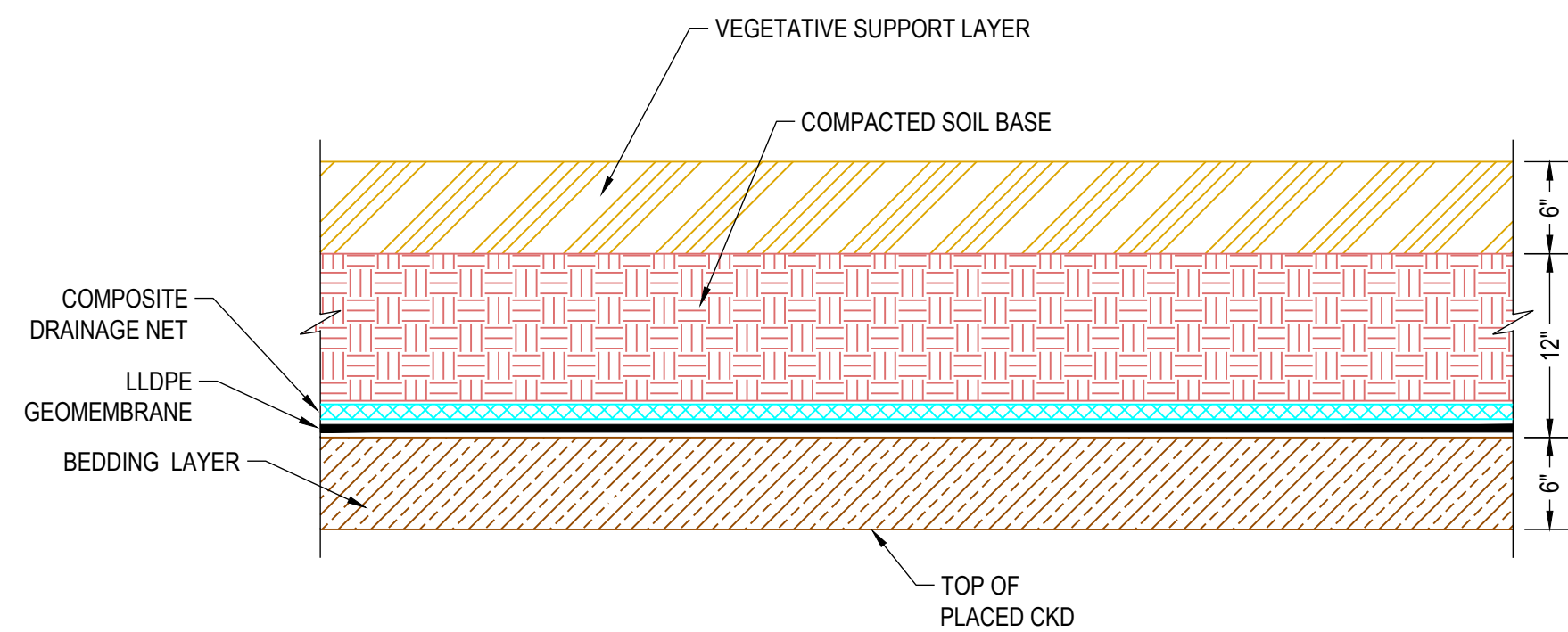


DESIGNED BY:	JSB
DRAWN BY:	JSB
APPROVED BY:	BNP
SCALE:	AS SHOWN
DATE:	1-8-15
JOB NO.:	005-001-3514718
ACAD NO.:	016
SHEET NO.:	6 OF 9



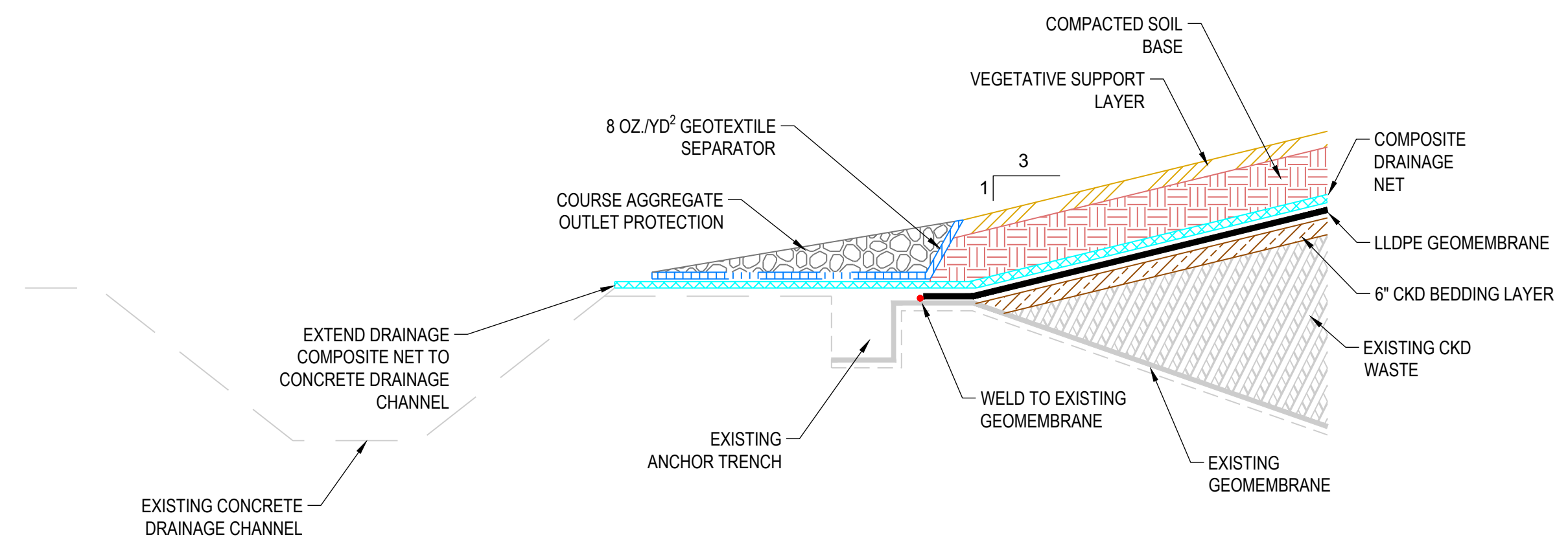
DRAINAGE BENCH DETAIL

DETAIL A
SCALE: N.T.S.



DECK FINAL COVER DETAIL

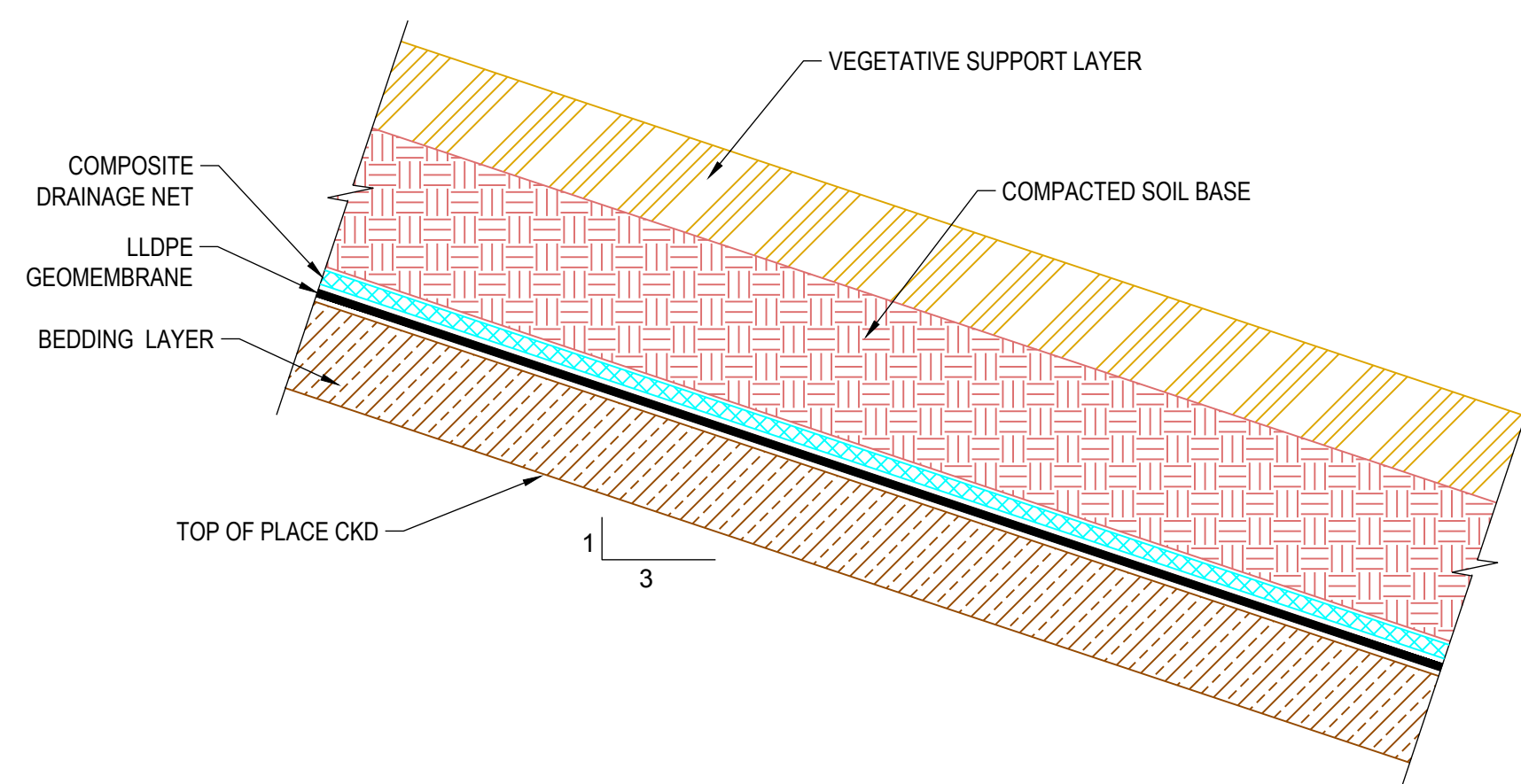
DETAIL B
SCALE: N.T.S.



BOTTOM-SIDE SLOPE CONTAINMENT SYSTEM TRANSITION (TYP.)

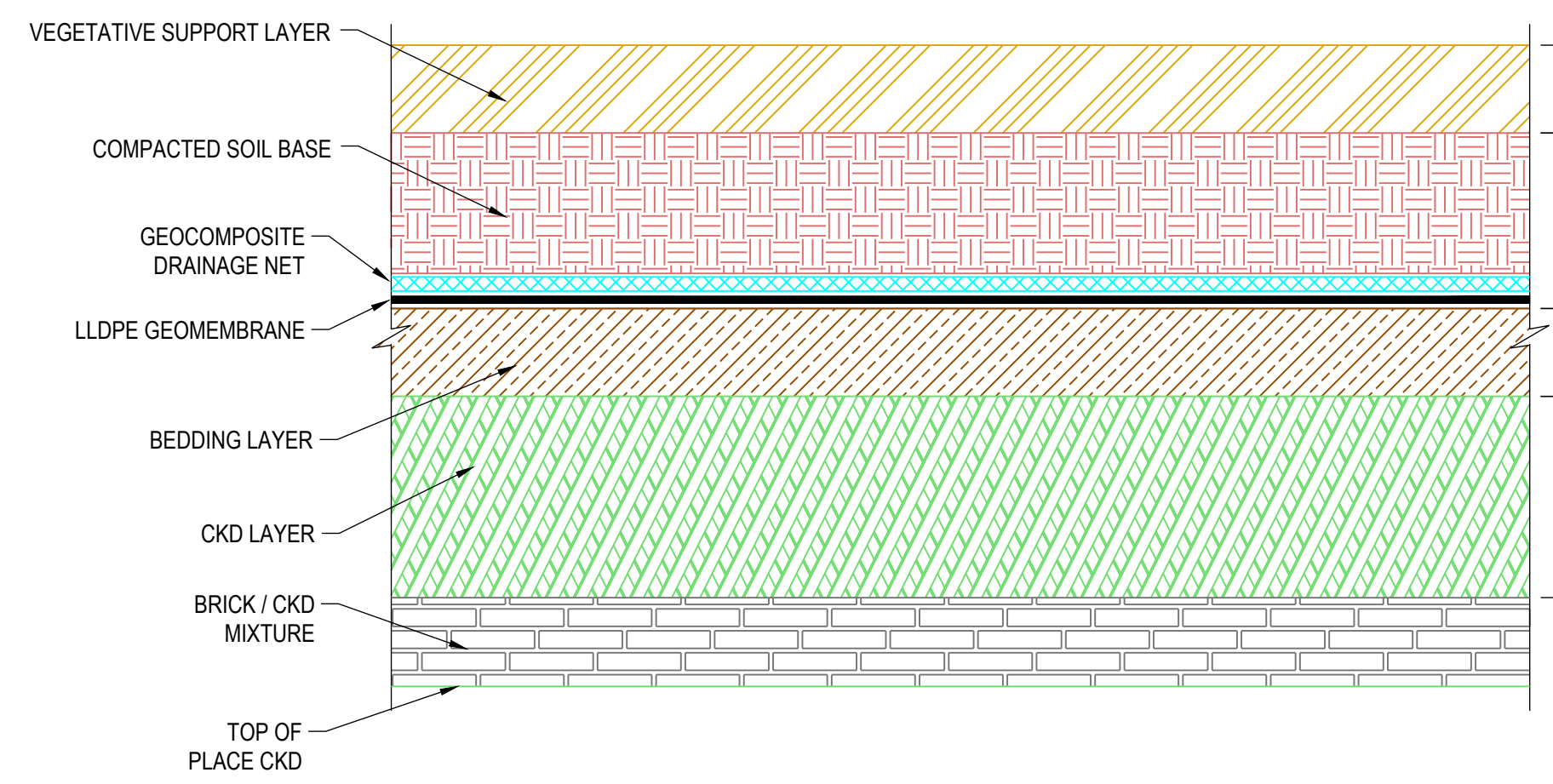
DETAIL D
SCALE: N.T.S.

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SLOPE FINAL COVER DETAIL

DETAIL C
SCALE: N.T.S.



BRICK / CKD MIXTURE LAYER DETAIL

DETAIL E
SCALE: N.T.S.

REV.	DATE	BY	DESCRIPTION
0	01/08/16	O.C.	ISSUED FOR BID
1	01/28/16	O.C.	ADDENDUM NO. 2

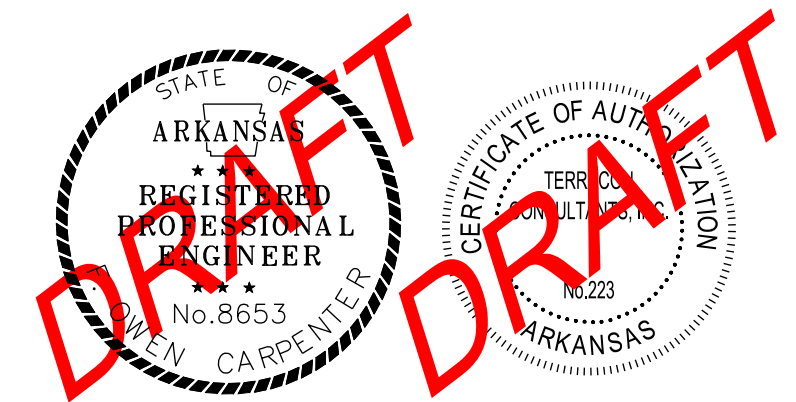


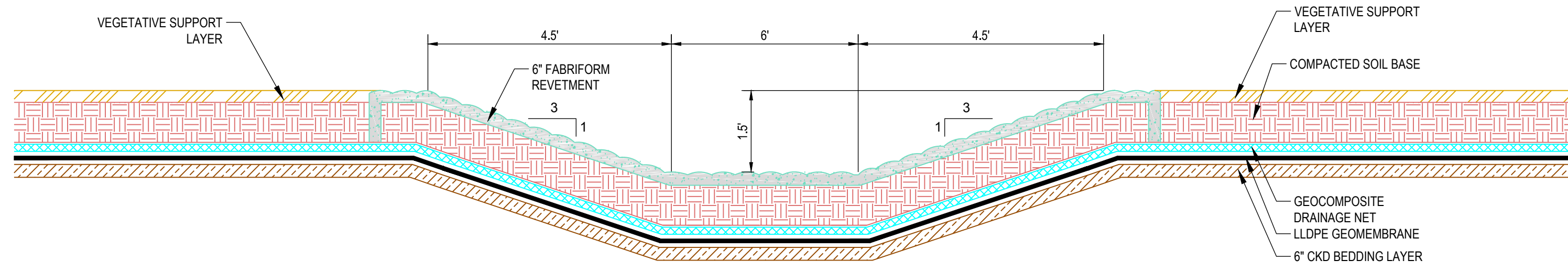
MISCELLANEOUS DETAILS - SHEET 1
7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
CEMENT KILN DUST LANDFILL
FOREMAN
ARKANSAS

Terracon
Consulting Engineers and Scientists
BRYANT, AR 72022
PH: (501) 847-9232
FAX: (501) 847-9270

DRAWING 7

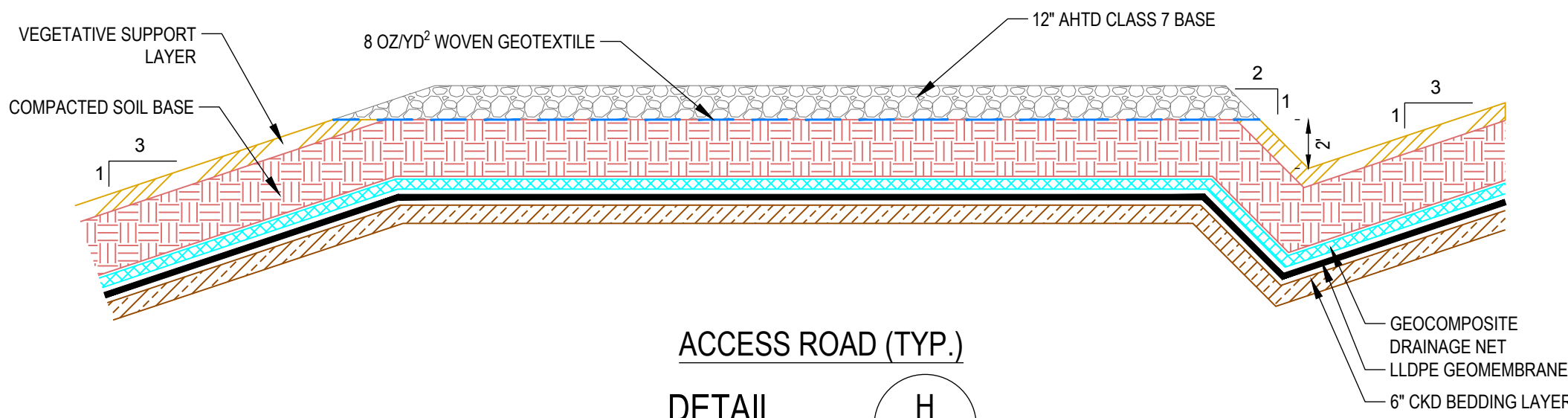
DESIGNED BY:	JSB
DRAWN BY:	JSB
APP'D BY:	BNF
SCALE:	N.T.S.
DATE:	04/22/2015
JOB NO.:	005-001-35147187
ACAD NO.:	017
SHEET NO.:	7 OF 9





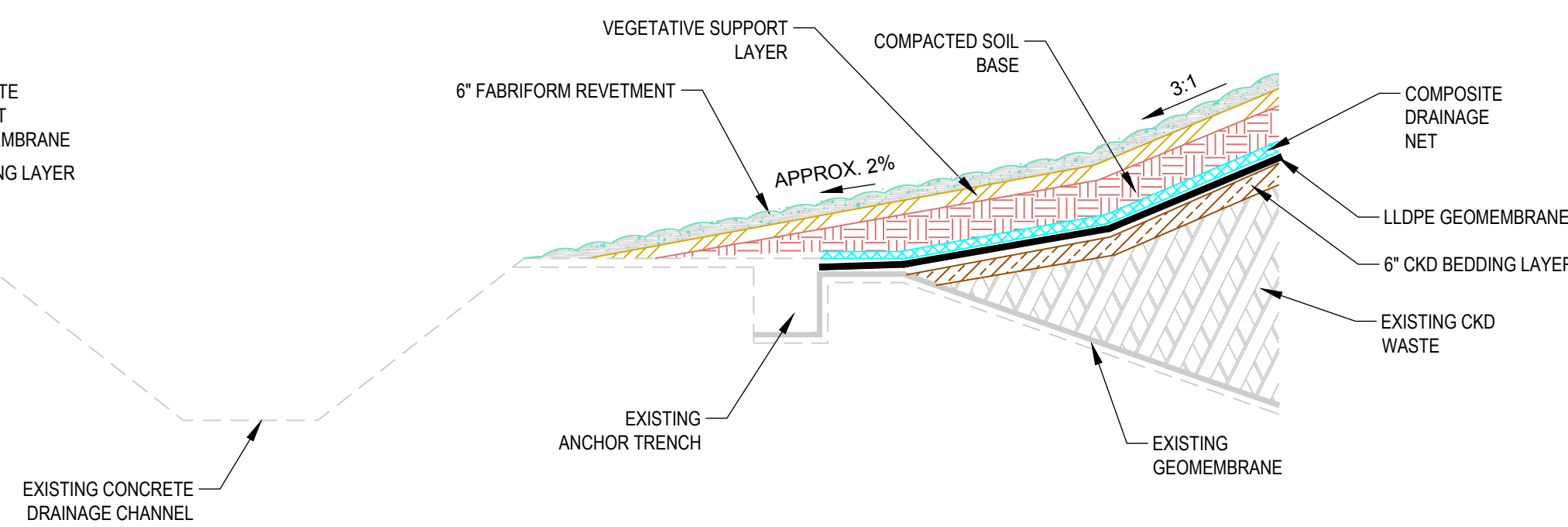
LETDOWN STRUCTURE (TYP.)

DETAIL F
SCALE: N.T.S.



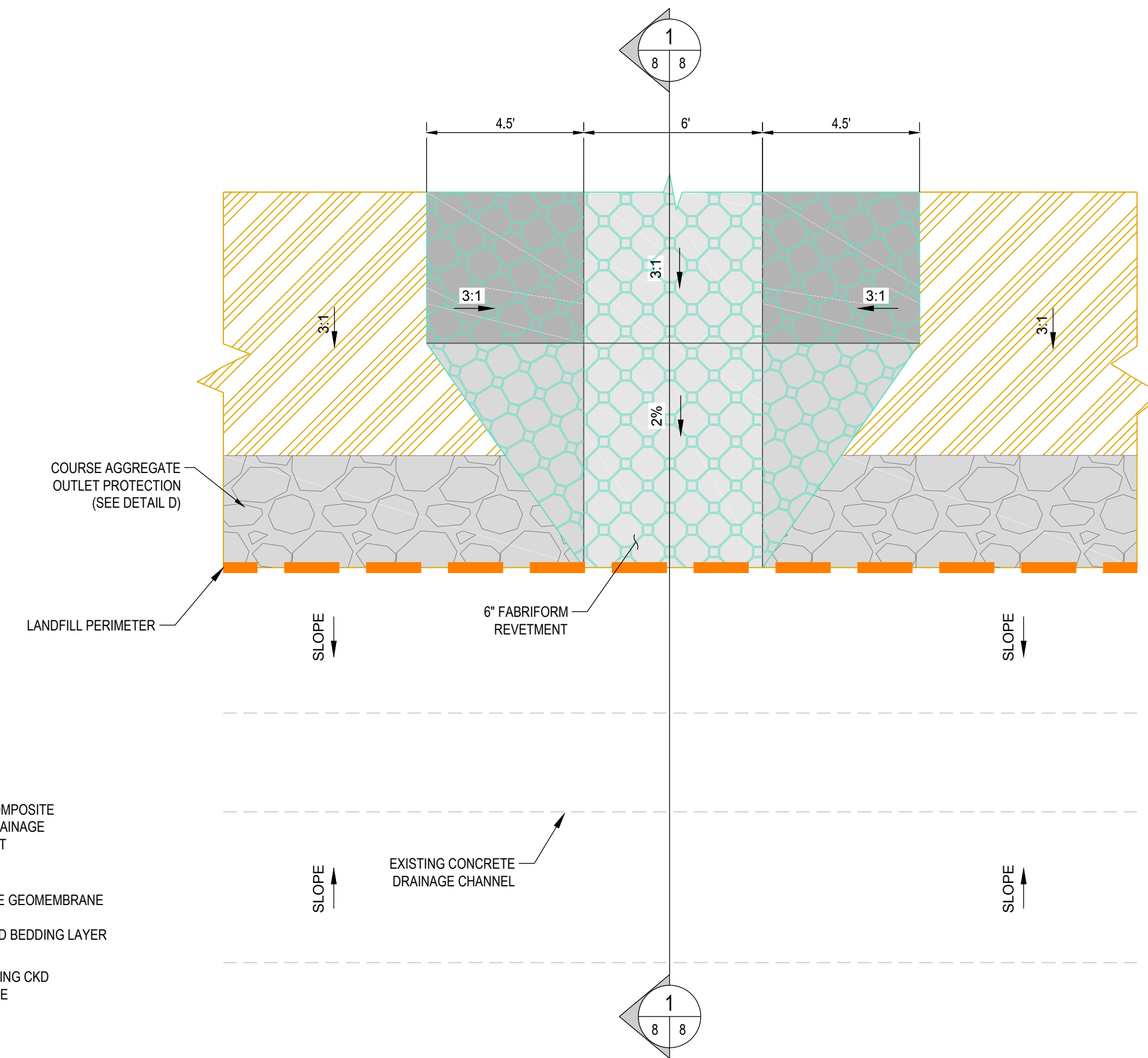
ACCESS ROAD (TYP.)

DETAIL H
SCALE: N.T.S.



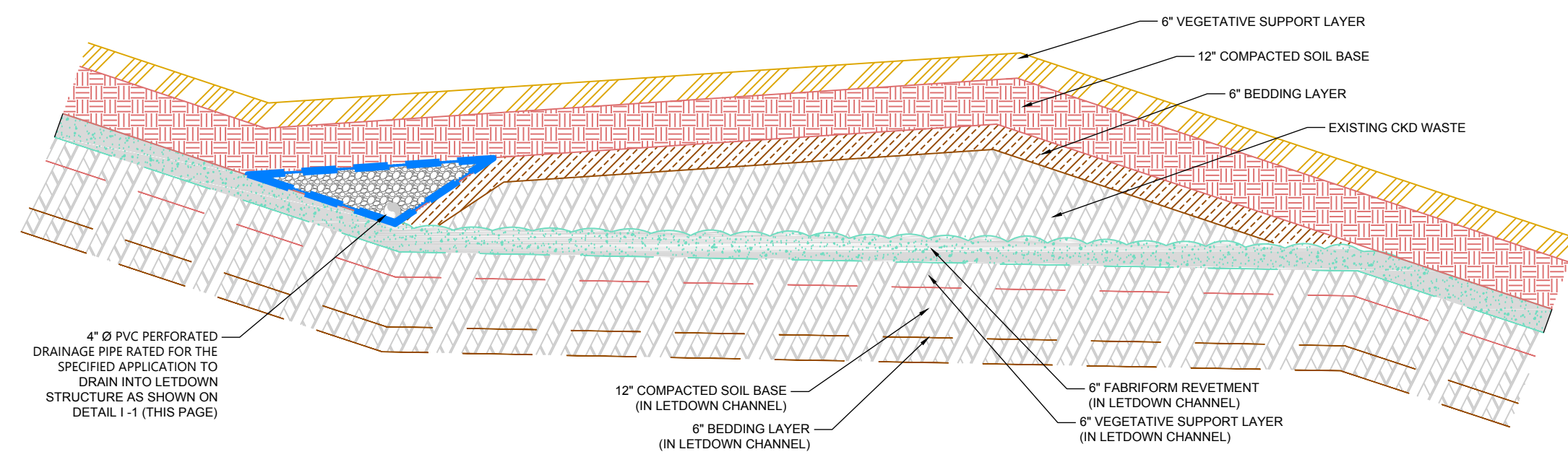
LETDOWN STRUCTURE AT PERIMETER DITCH

SECTION 1
NTS



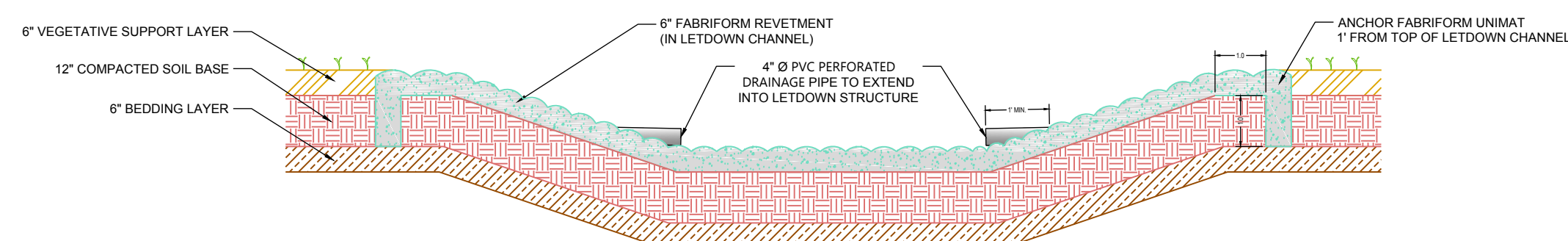
LETDOWN AT PERIMETER DITCH

DETAIL G
SCALE: N.T.S.



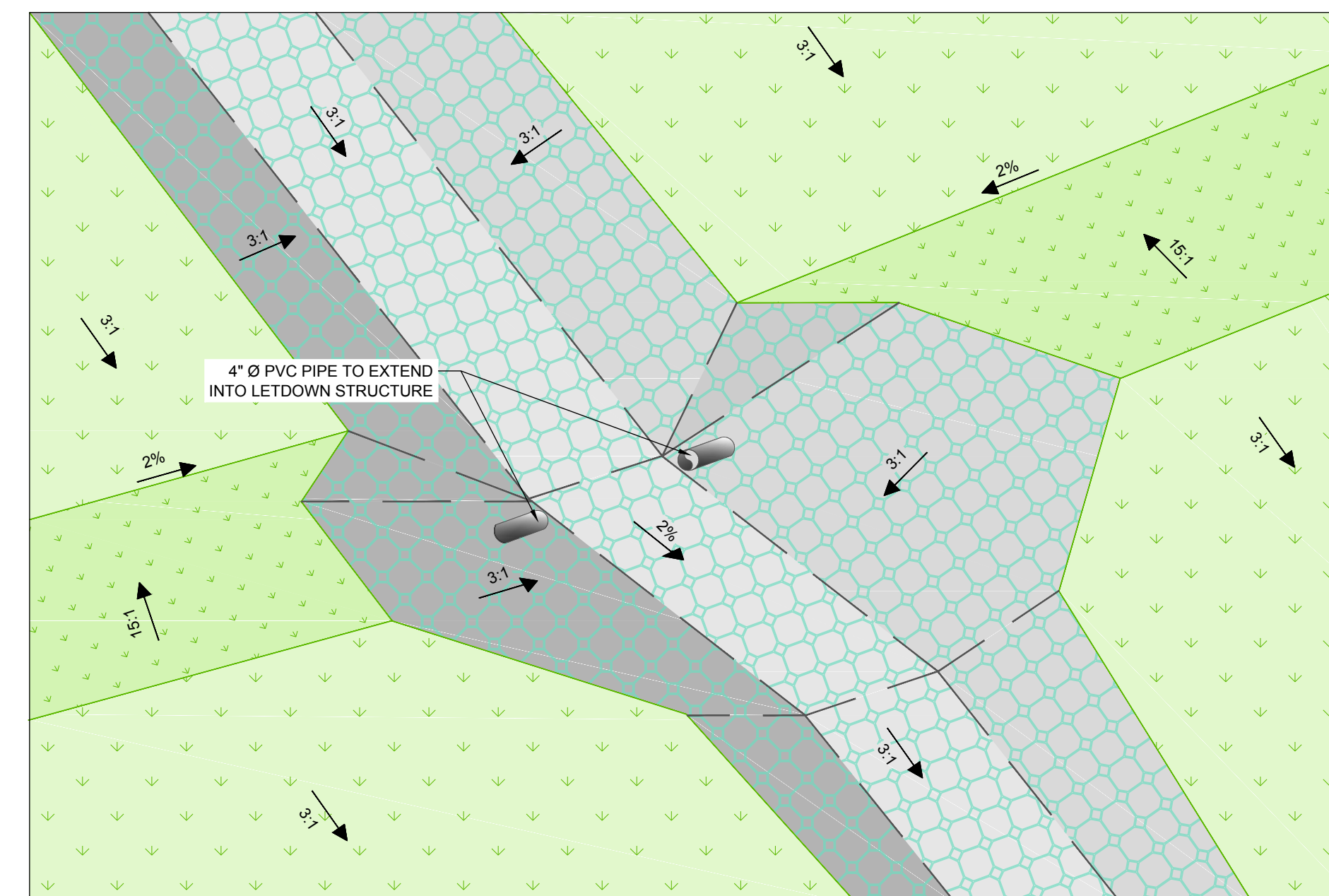
STORMWATER DIVERSION BENCH AT LETDOWN STRUCTURE

DETAIL I
SCALE: N.T.S.



LETDOWN AT STORMWATER DIVERSION BENCH

DETAIL I-1
SCALE: N.T.S.



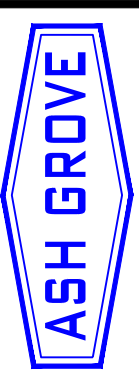
ISOMETRIC VIEW OF LETDOWN STRUCTURE

DETAIL J
SCALE: N.T.S.

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REV.	DATE	BY	DESCRIPTION
0	07/28/16	J.C.	ISSUED FOR BID
1	07/28/16	J.C.	ADDENDUM NO. 2

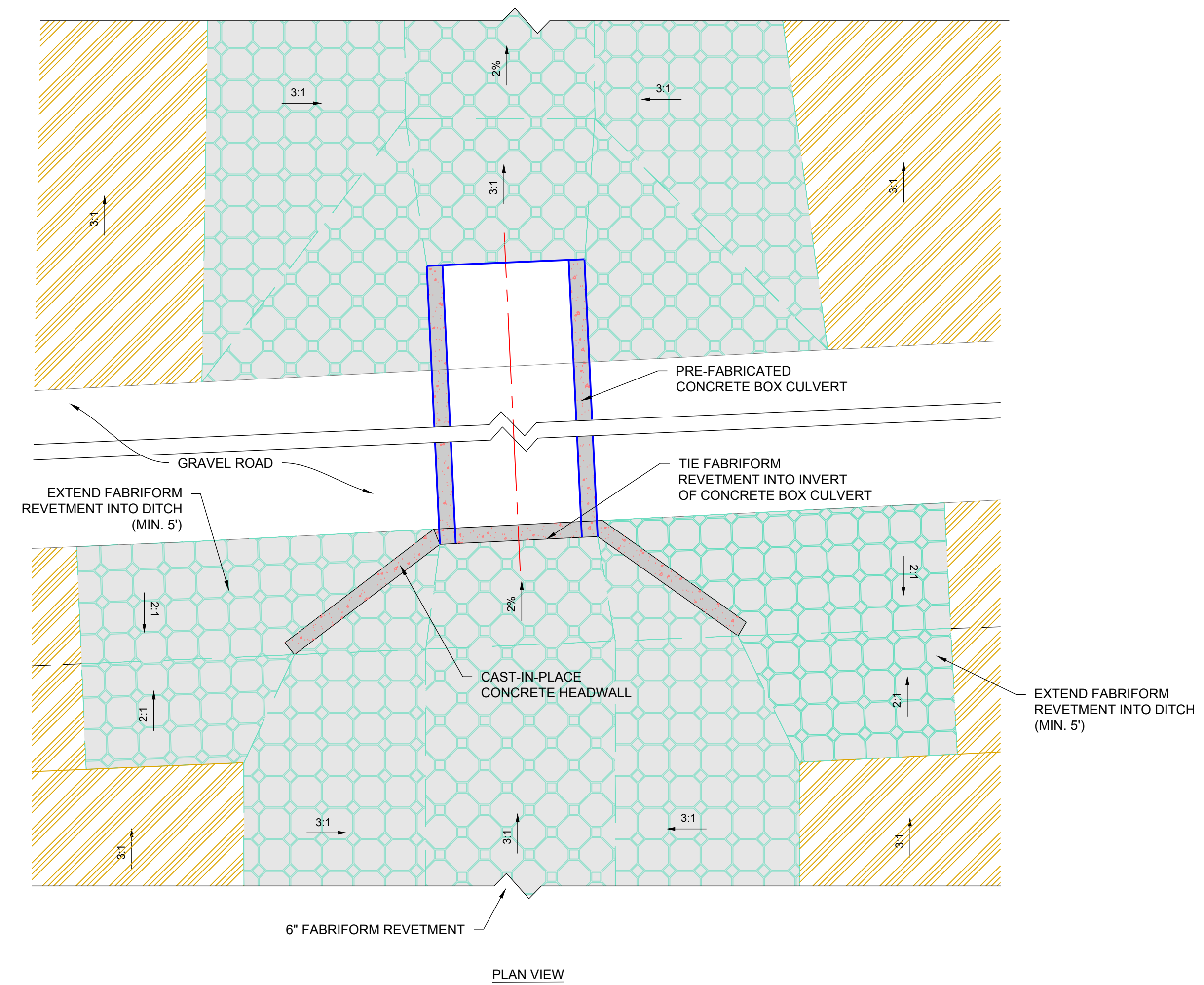
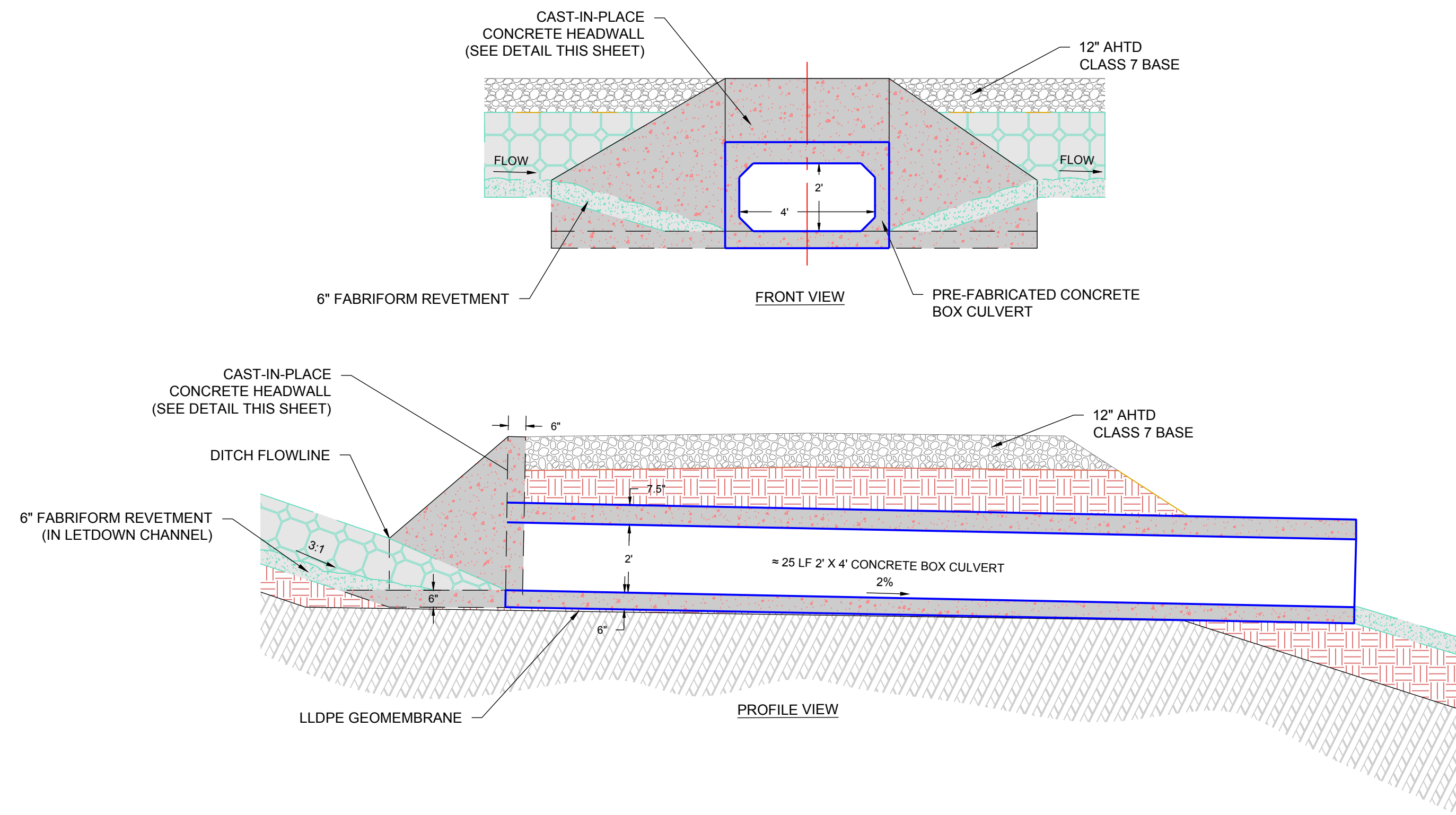


MISCELLANEOUS DETAILS - SHEET 2
7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
CEMENT KILN DUST LANDFILL
FOREMAN
ARKANSAS

Terracon
Consulting Engineers and Scientists
BRYANT, AR 72022
25809-130 SOUTH
PH: (501) 847-9292
FAX: (501) 847-9210

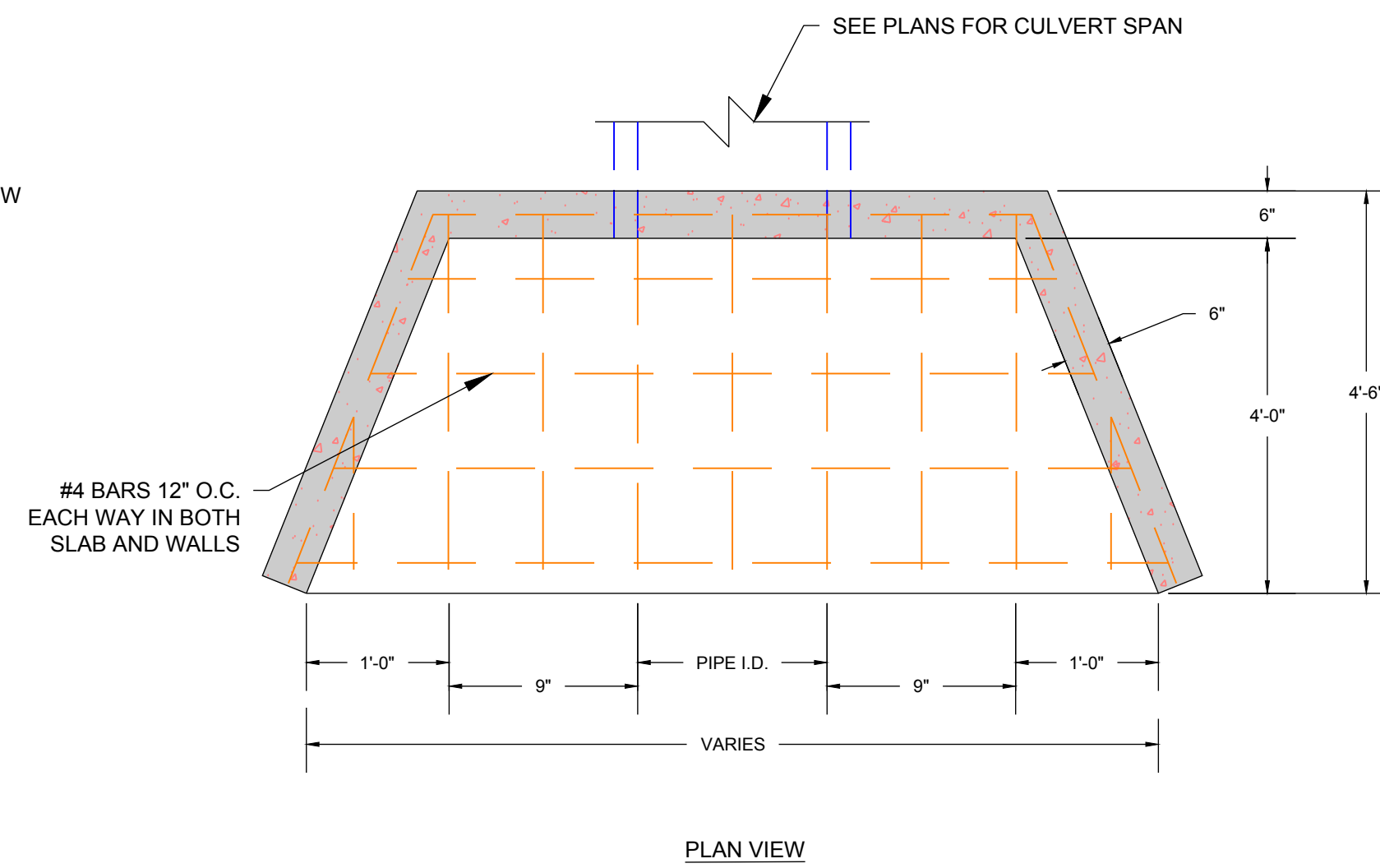
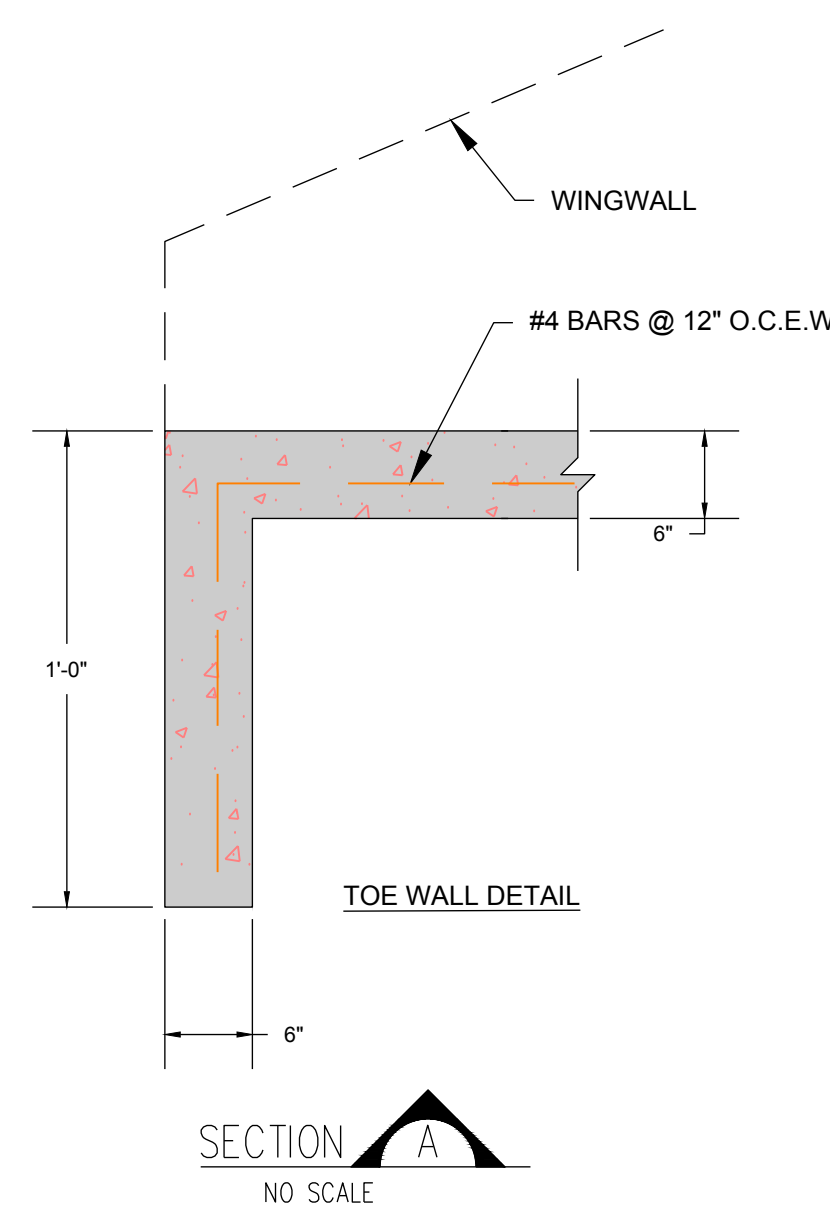
DRAWING 8

DESIGNED BY:	JDW
DRAWN BY:	JSB
APPROV. BY:	BNP
SCALE:	NTS
DATE:	04/23/2015
JOB NO.:	005-001-35147187
ACAD NO.:	018
SHEET NO.:	8 OF 9



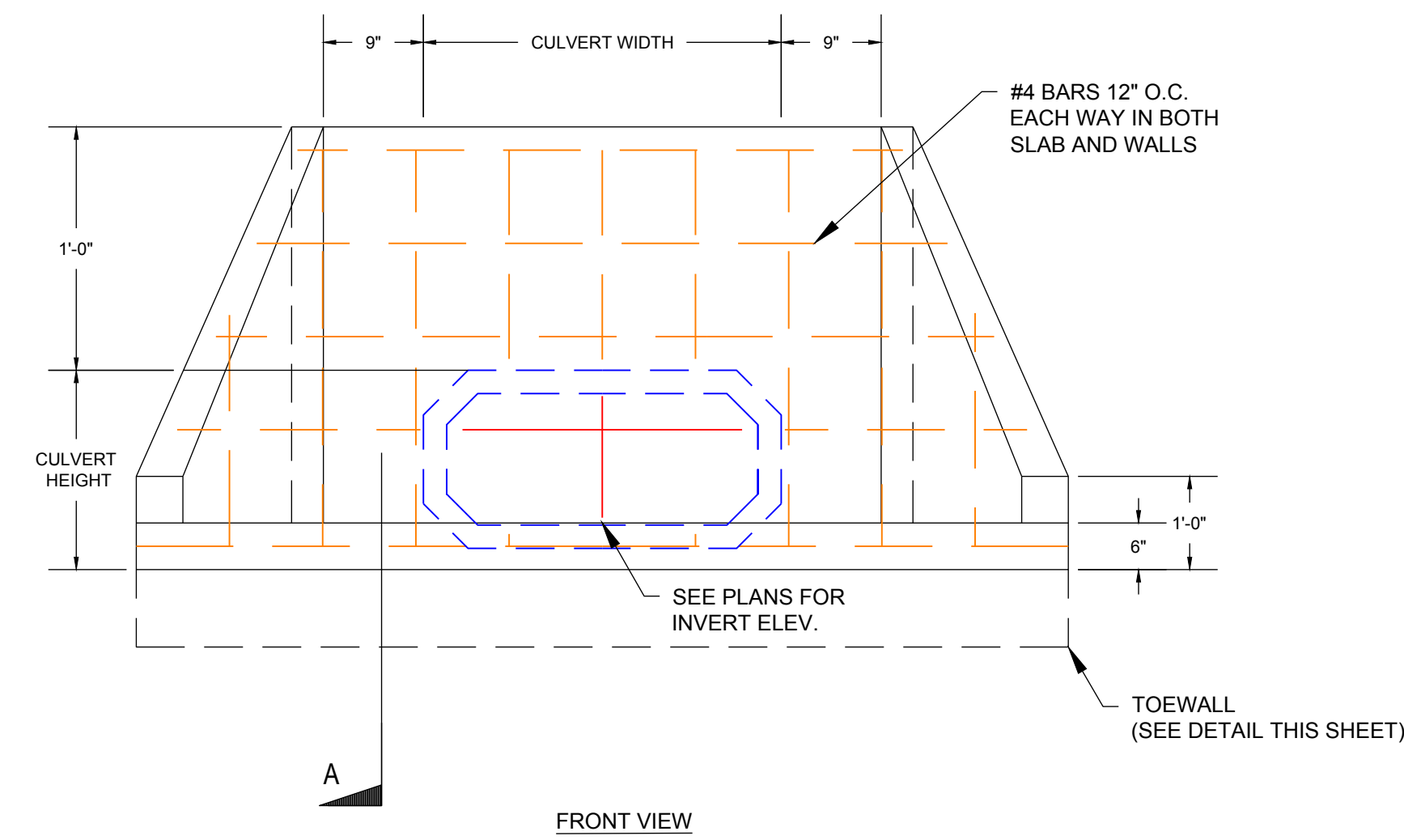
CONCRETE BOX CULVERT AT ROAD CROSSING

DETAIL K
SCALE: N.T.S.



HEADWALL AT BOX CULVERT

DETAIL L
SCALE: N.T.S.



ISSUED FOR BID PURPOSES ONLY



REV.	DATE	BY	DESCRIPTION
0	07/28/16	JCB	ISSUED FOR BID
1	07/28/16	JCB	ADDENDUM NO. 2



MISCELLANEOUS DETAILS - SHEET 3
7.5 ACRE PARTIAL CLOSURE CONSTRUCTION DRAWINGS
ASH GROVE CEMENT
CEMENT KILN DUST LANDFILL
FOREMAN
ARKANSAS

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Consulting Engineers and Scientists
BRYANT, AR 72022
PH. (501) 847-9292
FAX. (501) 847-9210

DRAWING 9

DESIGNED BY:	JSB
DRAWN BY:	JSB
APPRD. BY:	BNP
SCALE:	N.T.S.
DATE:	11/03/2015
JOB NO.:	005-001-35147187
ACAD NO.:	018b
SHEET NO.:	9 OF 9

Attachment E

Technical Specifications

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

- Description of Payment Items
- Work Covered by Contract Documents.
- Work by Others.
- Work Sequence.
- Existing Site Conditions.
- Contractor's Use of Premises.
- Erosion and Sediment Controls.
- Temporary and Permanent Seeding.
- Interim Stormwater Run-on and Run-off Controls.

1.02 DESCRIPTION OF PAYMENT ITEMS

- A. The Contractor shall be responsible for the work as described in this document and as indicated in the construction drawings. Payment for work will be made as indicated in the pay items listed below. Any work, which the Contractor believes not to be covered by one of these pay items shall be addressed in the bid, submitted to the Owner.

The Contractor shall take all necessary actions needed to meet the proposed schedule, taking into account weather as could be expected for the project area and season. Unless otherwise approved by the Owner, construction activities at the site and material deliveries to the Facility shall be limited to hours approved by the Owner.

1.03 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work consists of, in general, excavation and fill placement of cement kiln dust to achieve final grades, placement and compaction of kiln brick, placement and compaction of a 6-in cement kiln dust barrier layer, installation of a geomembrane infiltration barrier layer, installation of a geocomposite drainage layer, placement and compaction of a 12-in soil base, placement and compaction of a 6-in vegetative support layer, installation of bench drains, installation of a toe drain, installation of stormwater letdowns, installation of an erosion control

product, and seeding at the Ash Grove Cement Kiln Dust Landfill facility located near Foreman, Arkansas.

B. The following bid items correspond to the drawing sets entitled *Construction Drawings for the 7.5 Acre Closure for Ash Grove Cement Company Cement Kiln Dust Landfill*.

1. **Mobilization/Demobilization** – The Contractor shall mobilize all equipment, materials, personnel, etc. to the site and demobilize after completion of construction, leaving allocated work areas, including borrow sources, haul roads and stockpiles, in a satisfactory condition. The Owner is not responsible for assisting the Contractor with unloading or loading of any materials or equipment. In addition to unloading geosynthetic liner materials, the Contractor shall be responsible for storing and protecting the materials from weather. Assume one mobilization for the project.

The Lump Sum Price for Mobilization and Demobilization shall be payment in full for all labor, equipment, material and other incidentals to the site, as well as Contractor provided utilities and ongoing related expenses, considered normal for administration of the work. Fifty (50) percent of the Lump Sum price bid will be paid with the first payment request following satisfactory evidence of mobilization of sufficient labor, equipment and material to adequately progress the work of this contract. The remaining fifty (50) percent of the Lump Sum price bid will be paid with the Final Payment request after satisfactory substantial completion of the Project. The total price paid for this item in the first installment shall not exceed six (6) percent of the original Contract amount for the Contract. Assume one mobilization for the project.

2. **Common Excavation and General Fill to Prepare CKD Final Waste Grades** – The Contractor shall excavate, haul, place, grade, and compact CKD in accordance with the Contract Drawings and Technical Specifications to achieve final waste grade elevations within the CKD landfill area and any other area within the construction limits as shown on the Contract Drawings.

The volume of excavation (and compacted fill materials) shall be calculated by grid methods based on topographic surveys of the ground surface before and after excavation and compacted fill within the limits of Construction. Volumes will be calculated as in-place bank cubic yards with no adjustment factor. No additional allowances shall be permitted for unauthorized filling or excavation beyond the limits of Subgrade (top of

7.5 Acre Partial Closure Technical Specifications

Ash Grove Cement Company ■ Cement Kiln Dust Class 3N Landfill
January 2015 ■ Terracon Project No. 35147187



waste grades) within the cell or finished grade outside of the cell as set forth by the Drawings or Specifications.

The Contract Unit Price for the preparation of CKD final waste grades shall be for excavation (cut quantity) only, including all labor, material, equipment, and other incidentals, such as, excavating, moving, compacting, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Drawings and Specifications (unless specifically identified as a pay item). Compaction of relocated CKD shall be in accordance with Specification 02200 Earthwork, Section 3.12 (min. 95% Standard Proctor density). Payment for this task shall be on a volumetric basis for material cut for the unit price provided in the bid form.

3. **Kiln Brick Disposal** – The Contractor shall excavate from stockpiles, haul, place, grade, and compact kiln brick in accordance with the Contract Drawings and Technical Specifications to an area within the CKD landfill as shown on the Contract Drawings.

The volume of excavation and compacted fill materials shall be calculated by grid methods based on topographic surveys of the ground surface before and after excavation/loading of the kiln brick within the limits of Construction. Volumes will be calculated as in-place with no adjustment factor. No additional allowances shall be permitted for unauthorized filling or excavation beyond the limits of Subgrade within the cell or finished grade outside of the cell as set forth by the Drawings or Specifications.

The Contract Unit Price for kiln brick disposal shall be for excavation and compacted fill, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Drawings and Specifications (unless specifically identified as a pay item). Payment for this task shall be on a volumetric basis of stockpiled kiln brick prior to excavation/loading for the unit price provided in the bid form.

4. **Compacted CKD Bedding Layer** – The Contractor shall excavate from onsite mass excavation, haul, place, and compact the 6-inch thick compacted CKD Bedding layer above the final waste grade elevations in the CKD Landfill in accordance with the Contract Drawings and Technical Specifications.

The volume of recompacted CKD liner shall be calculated by a topographic survey of the plan area of approved recompacted CKD liner. The plan area and minimum design thickness shall be used to determine the volume of recompacted CKD liner constructed. Volumes will be calculated as in-place with no adjustment factor. No additional allowances shall be permitted for unauthorized filling beyond the limits of the cell as set forth by the Contract Drawings or Technical Specifications.

The Contract Unit Price for the CKD Bedding layer shall be for placed and compacted CKD material, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item). Payment for this task shall be on a volumetric basis for the unit price provided in the bid form.

5. **Compacted Soil Base Layer** – The Contractor shall excavate from onsite stockpiles, haul, place, and compact the 12-inch thick compacted Soil Base layer in a single lift above the geocomposite drainage layer in the CKD Landfill in accordance with the Contract Drawings and Technical Specifications.

The volume of soil shall be calculated by a topographic survey of the plan area of approved Soil Bedding layer. The plan area and minimum design thickness shall be used to determine the volume of the Soil Bedding layer constructed. Volumes will be calculated as in-place with no adjustment factor. No additional allowances shall be permitted for unauthorized filling beyond the limits of the cell as set forth by the Contract Drawings or Technical Specifications.

The Contract Unit Price for the Soil Bedding layer shall be for placed and compacted soil material, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item). Payment for this task shall be on a volumetric basis for the unit price provided in the bid form.

6. **Vegetative Support Layer** – The Contractor shall excavate from onsite stockpiles, haul, place, and compact the 6-inch thick Vegetative Support

layer above the Soil Base layer in the CKD Landfill in accordance with the Contract Drawings and Technical Specifications.

The volume of soil shall be calculated by a topographic survey of the plan area of approved Vegetative Support layer. The plan area and minimum design thickness shall be used to determine the volume of the Vegetative Support layer constructed. Volumes will be calculated as in-place with no adjustment factor. No additional allowances shall be permitted for unauthorized filling beyond the limits of the cell as set forth by the Contract Drawings or Technical Specifications.

The Contract Unit Price for the Vegetative layer shall be for placed and compacted soil material, including all labor, material, equipment, and other incidentals, such as, excavating, moving, placing and segregating, stockpiling, stockpile grading and maintenance, dewatering, and erosion and sedimentation control materials and practices as required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item). Payment for this task shall be on a volumetric basis for the unit price provided in the bid form.

7. **Erosion, Sediment and Dust Control** – The Contractor shall be responsible for providing all necessary equipment and labor to maintain slopes and control erosion, sediment and dust within the limits of the construction area for the duration of the project. The Work includes all steps necessary to maintain compliance with the Owner’s Stormwater Permit. The Contractor shall be responsible for all equipment, labor, and materials for slope maintenance and erosion and sediment control. The Owner will provide equipment and water for dust control.

The Lump Sum Price for Erosion, Sediment and Dust Control shall be payment in full for all labor, equipment, material and other incidentals to the site, as well as Contractor provided utilities and ongoing related expenses. Payment will be made based on the percentage of the project that has been completed at the time of payment request.

8. **LLDPE 40-mil Textured Geomembrane Liner** - Price includes all Work and Materials necessary to install a 40-mil LLDPE textured geomembrane liner system overlying the landfill compacted CKD bedding layer, as shown on the Drawings. Payment quantities will be based on the surveyed planar surface area as measured from the outside of the anchor trench.

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The price shall include all equipment, personnel, labor and all else required to place, seam, construct and all else that is required to the limits shown on the Drawings. The price shall also include complete preparation of, and if necessary, repair of, the liner if testing requirements are not met. No separate payment will be made for overlap, scrap, surplus, anchor trench quantity or wasted material.

Unless the Owner has directed in writing that the textured LLDPE should be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

9. **Geocomposite Drainage Layer** - Price includes all Work and Materials necessary to install the geocomposite system as shown on the Drawings. Payment quantities will be based on the surveyed planar surface area as measured from the outside of the anchor trench.

The price shall include all equipment, personnel, labor and all else required to place, seam, construct and all else that is required to the limits shown on the Drawings. The price shall also include complete preparation of, and if necessary, repair of, the layer if testing requirements are not met. No separate payment will be made for overlap, scrap, surplus, or wasted material.

Unless the Owner has directed in writing that the geocomposite drainage layer should be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

10. **Geosynthetic Anchor Trench** – The Contractor shall excavate, backfill, and compact a one-foot deep by one-foot wide geosynthetics anchor trench to the lines and grades shown on the Contract Drawings and in accordance with the Technical Specifications. The construction of the anchor trench shall be coordinated with the Geosynthetics Installer and shall include the anchoring of geosynthetics along the east termination of the final cover system. The price shall include also include the exaction, hauling, placing, compacting and grading of the termination berm above the anchor trench as shown the Contract Drawings and in accordance with the Technical Specifications.

The length of the geosynthetic anchor trench excavated, backfilled, compacted and approved as indicated on the Drawings and Specifications shall be calculated. The quantity for the calculation shall be the planimetric measured linear distance of in-place, approved anchor trench. No additional allowances shall be permitted for unauthorized

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trenches beyond the depths or limits of anchor trench as set forth on the Contract Drawings or Technical Specifications. The Surveyor of Record shall determine the actual length of anchor trench installed as directed by this Specification and shall show the anchor trench on Record Drawings.

The Contract Unit Price for anchor trench shall be full compensation for anchor trench, including all excavation, backfill, compaction, labor, material, equipment, and other incidentals. Final payment shall be based on the actual length of anchor trench installed as shown on approved Record Drawings.

11. **Liner Tie-in Preparation** – Measured by the linear foot (LF). Measurement of tie-in preparation will include excavating tie-in area cover CKD, hauling to fill placement area, hauling to active landfill area, or hauling to stockpile location as determined by OWNER. Also, will include exposing existing liner system, providing clean working area for geosynthetics installation, and providing adequate working area to tie-in Final Cover Liner System.

12. **Bench Drains** – The Contractor is responsible for the installation of the bench drains for the final cover system. The Contractor is responsible for supplying pipe, gravel, connections, and fittings and non-woven geotextile. The Contractor shall be responsible for installation of all pipe, geotextile, and associated gravel necessary for the installation. The Contractor shall be responsible for the purchase, hauling and placing of the gravel as required by the Contract Drawings and Technical Specifications. The gravel, geotextile and pipe shall meet all required specifications. Stockpiling must be coordinated with the Owner as construction progresses.

The Surveyor of Record shall determine the actual length of piping installed as directed by this Specification and shall show the piping locations, dimensions, fittings and outlets on Record Drawings.

The Contract Unit Price for bench drains shall be full compensation for the trench, including all hauling and placing gravel, labor, pipe fitting, materials, equipment, and other incidentals. Final payment shall be based on the actual length of drains installed as shown on approved Record Drawings.

13. **Perimeter Toe Drain** – The Contractor is responsible for the installation of the perimeter toe drain for the final cover system. The Contractor is responsible for gravel and non-woven geotextile. The Contractor shall be

responsible for installation of all gravel and geotextile necessary for the installation. The Contractor shall be responsible for the purchase, hauling and placing of the gravel as required by the Contract Drawings and Technical Specifications. The gravel and geotextile shall meet all required specifications. Stockpiling must be coordinated with the Owner as construction progresses.

The Surveyor of Record shall determine the actual length of drain installed as directed by this Specification and shall show the location on Record Drawings.

The Contract Unit Price for the perimeter drain shall be full compensation for the drain system, including all hauling and placing gravel, geotextile, equipment, and other incidentals. Final payment shall be based on the actual length of drain installed as shown on approved Record Drawings.

14. **Drainage Letdown Structures** – The Contractor shall be responsible for providing all necessary materials, equipment and labor to install the drainage letdowns as shown on Contract drawings. The Contractor is responsible for supply, installation of all concrete, Fabriform, and other appurtenances as needed to complete the installation as required by the Contract Drawings and Technical Specifications. The Contractor is also responsible for excavation, hauling, placing, compacting and grading of soils required to construct the letdown berms and bench crossings as shown in Contract Drawings.

The Contract Unit Price shall be for all labor, materials, equipment, and other incidentals, such as transporting, unloading, and storing materials as required to comply with the Drawings and Specifications (unless specifically identified as a pay item). Payment for this task shall be on a liner foot basis for the unit price provided in the bid form. Full payment will be made upon completion of task.

15. **Concrete Box Culvert** - The Contractor shall be responsible for the installation of pre-fabricated box culvert, including cast-in-place headwall and tie-in of Fabriform erosion control system. Box culvert shall meet the requirements of AHTD standard specification 607. The Contractor will provide all necessary equipment and labor to complete the task.

The Contract Unit Price shall be for all labor, materials, equipment, and other incidentals, such as transporting, unloading, and storing materials as required to comply with the Drawings and Specifications (unless

specifically identified as a pay item). Payment for this task shall be on an lump sum basis. Full payment will be made upon completion of task.

16. **Stormwater Control** – The Contractor shall be responsible for providing all necessary equipment and labor to control and/or pump stormwater within the limits of the construction area for the duration of the project. The Work includes all steps necessary to maintain compliance with the Owners Stormwater Permit. The Contractor shall be responsible for all equipment, labor, and materials for stormwater control. The Contractor will provide necessary maintenance accept.

The Lump Sum Price for Stormwater Control shall be payment in full for all labor, equipment, materials and other incidentals to the site, as well as Contractor provided utilities and ongoing related expenses. Payment will be made based on the percentage of the project that has been completed at the time of payment request.

17. **Road Aggregate** – The Contractor shall purchase, haul, and stockpile or place road aggregate as directed by the Owner. The Contractor shall also purchase, transport, store and place the underlying woven geotextile to comply with the Contract Drawings.

Payment for this task shall be on an area basis for the unit price provided in the bid form and shall include all costs associated with completing the road aggregated paving. Full payment will be made upon completion of task.

18. **Existing Concrete Ditch Maintenance** – The Contractor shall be responsible for providing all necessary equipment and labor to maintain the Existing Concrete Ditch within the limits of the construction area, for the duration of the project. This includes cleaning-out and repair of the concrete ditch due to routine operations such as cleaning-out or mobile equipment crossing during the project. Contractor shall be responsible for cleaning out concrete ditch to remove sediment and any other deleterious material upon satisfactory completion of the cover system installation and stabilization/seeding program.

The Contract Unit Price for existing concrete ditch maintenance shall be full compensation for all labor, materials, equipment, and other incidentals, required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item). Full payment will be made upon completion of task.

19. **Construction Layout Surveying** – The Contractor shall be responsible for providing third-party surveying for construction layout and cut/fill quantity calculations.

Payment for this task shall be on a lump sum basis for the unit price provided in the bid form and shall include all costs associated with surveying by the contractor.

20. **Seeding & Mulching** – The Contractor shall be responsible for providing seeding and mulching in accordance with the Contract Drawings and Technical Specifications.

The Contract Unit Price for seeding and mulching shall be full compensation for all labor, materials, equipment, and other incidentals, required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item). Final payment shall be based upon the area of completed and approved seeding and mulching as determined by the Surveyor of Record from a physical survey around the seeded areas as shown on an approved Record Drawing.

21. **Permanent Rolled Erosion Control Product (RECP)** – The Contractor shall be responsible for providing and placing RECP in accordance with the Contract Drawings and Technical Specifications.

The Contract Unit Price for RECP shall be full compensation for all labor, materials, equipment, and other incidentals, required to comply with the Contract Drawings and Technical Specifications (unless specifically identified as a pay item). Final payment shall be based upon the area of completed and approved RECP as determined by the Surveyor of Record from a physical survey around the completed areas as shown on an approved Record Drawing.

22. **Performance and Payment Bond** – A performance and payment bond may be required and shall be no less than the contract amount in accordance with the Agreement. This shall be a lump sum item.

1.05 WORK SEQUENCE

Sequencing of the Work shall be the responsibility of the Contractor as long as the requirements of these specifications are met, the Contractor's progress is according to the schedule approved by the Engineer and Owner, and compliance with Contract Times stated in the Agreement are met.

1.06 EXISTING SITE CONDITIONS

The CKD Landfill is an active disposal facility. Construction operations shall not disturb normal landfill operations.

1.07 CONTRACTOR'S USE OF PREMISES

- A. All of the Contractor's operations on the Owner's premises, including the storage of materials, shall be confined to areas approved by the Owner or Engineer.
- B. Contractor's personnel shall abide by the Owner's regulations concerning site entry and exit. The Contractor shall use of a flagman whenever crossing public roads to gain access to borrow area. Flagman responsibilities will include directing traffic and keeping tracks clean and free of debris.
- C. The Owner and Engineer will not assume responsibility for damages to facilities on the site due to negligence or carelessness on the part of the Contractor. The Owner and Engineer will not be liable for loss or damage of Contractor's tools equipment or materials due to theft, vandalism or any other causes whatsoever.

1.08 EROSION AND SEDIMENT CONTROLS

Temporary measures to control soil erosion and sediment transport within the construction limits shall be constructed.

1.09 TEMPORARY AND PERMANENT SEEDING

A stand of grass shall be established on all areas disturbed by construction within the construction limits.

1.10 INTERIM STORMWATER RUN-ON AND RUN-OFF CONTROLS

- A. Stormwater management system improvements as shown on the Drawings shall be constructed.
- B. Related Sections:
 - 1. Section 02200 - Earthwork
 - 2. Section 02223 - Trenching, Backfilling, and Compacting

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

NOTE:

At all times this landfill facility must remain in compliance with laws and regulations governing the operation and construction of such a facility. Accordingly, the CONTRACTOR must at all times sequence their work and implement the necessary temporary facilities or activities to maintain the proper operation and compliance of this facility. Furthermore, all of the CONTRACTOR's activities must be completed while focusing on the proper management of stormwater, landfill leachate and dust control. The Drawings provide the overall scope of work. It is the CONTRACTOR's responsibility to review and understand the necessary tasks required to complete the work. The CONTRACTOR may need to implement steps not necessarily shown on the Drawings in order to maintain landfill operations and landfill compliance. The CONTRACTOR is responsible for all bid items noted on the Bid Sheet and must complete all the work shown on the Drawings while maintaining the landfill operation and environmental compliance.

END OF SECTION

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 DESCRIPTION OF WORK

- A. The project is specified as the Proposed 7.5 Acre Closure for Ash Grove Cement Company Cement Kiln Dust Landfill near Foreman Arkansas.
- B. Payment shall be made on a Lump Sum basis and only be made for Work as specifically described in these Specifications and the Contract Documents. All other work shall be considered incidental to the Work. No payment shall be made for defective work or work beyond the lines and grades of the required Work.
- C. Payment shall only be made for approved, in-place materials and Work, unless specifically permitted otherwise by these Specifications.

PART 2 PRODUCTS

- A. Products are defined herein specific to the various aspects of construction. Products are considered to include those purchased and delivered to the site as well as those constructed on the site.

PART 3 EXECUTION

3.01 UNIT PRICE SCHEDULE

- A. See Bid Document 00301 Bid Form

3.02 CONTRACT PAY ITEMS

- A. See Specification 01010 – Summary of Work.

3.03 INCIDENTALS

- A. Some items are considered incidental to the Work and shall not be measured or paid. Items not specifically listed as a pay item are considered incidental.

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Coordination
- B. Pre-construction conference
- C. Progress Meetings

1.02 COORDINATION

- A. Contractor Shall
 - 1. Coordinate scheduling, submittals, and Work of the various sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
 - 2. Coordinate work of various sections having independent responsibilities for fabrication, installation, connection to, and placing in service, such equipment.
 - 3. Coordinate space requirements and installation of structural work which are indicated diagrammatically on Drawings.
 - 4. Coordinate completion and cleanup of Work of separate sections in preparation for Substantial Completion.
 - 5. After occupancy of premises by Owner, coordinate access to site for correction of defective Work and Work not in accordance with Specifications, to minimize disruption of Owner's activities.

1.03 PRECONSTRUCTION CONFERENCE

- A. Engineer will schedule a pre-construction conference.
- B. Agenda:
 - 1. Distribution of Specifications.
 - 2. Finalize estimated progress schedule, Shop Drawing Schedule and schedule of values.
 - 3. Designation of personnel representing the parties in Contract, and the

Engineer.

4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
5. Scheduling.

1.04 PROGRESS MEETINGS

A. Contractor shall:

1. Schedule and administer meetings throughout progress of the Work at intervals specified by the Owner.
2. Make arrangements for meeting, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to Engineer, Owner, participants, and those affected by decisions made.

B. Attendance Required: Contractor, Owner, Engineer, and others as appropriate to agenda topics for each meeting.

C. Agenda:

1. Review minutes of previous meetings.
2. Review of Work in progress.
3. Field observations, problems, and decisions.
4. Identification of problems which impede planned schedules.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected progress.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. Safety issues relating to Work.
14. Other business relating to Work.

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PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01040

COORDINATION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. The Contractor shall coordinate material supply, construction, and inspection to assure efficient and orderly completion of the Work:
- B. The Contractor shall notify the Owner in writing when coordination of the Owner's or other contractors' activities is required.

1.02 PROJECT PERSONNEL

- A. The Engineer is:
Owen Carpenter, P.E.
Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022
(501) 847-9292 email: owen.carpenter@terracon.com
- B. The Owner is:
David Dorris, Plant Manager
Ash Grove Cement Company
4343 Highway 108
Foreman, Arkansas 71836
- C. The Project Owner's Representative is:
Keith Byerly, Environmental Manager
Ash Grove Cement Company
4343 Highway 108
Foreman, Arkansas 71836
(870) 542-3017 email: keith.byerly@ashgrove.com
- D. The Technical/Quality Assurance Representative is:
To Be Determined

END OF SECTION

SECTION 01050

FIELD ENGINEERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract including General Conditions, Supplementary Conditions and other Exhibits included in Section 1 – Bidding and Contract Documents apply to work of this section. This section applies to work of all sections of the Specifications.

1.02 OWNER'S RESPONSIBILITY

- A. The Owner will provide reference dimensions for the Contractor's use in determining and controlling horizontal dimensions and vertical elevations of improvements as follows:

Baseline control and benchmark data as shown on Drawings.

1.03 CONTRACTOR'S RESPONSIBILITY

- A. Protect all control points, property pins, right-of-way markers, and elevation bench marks. Replace points disturbed or damaged by Contractor at no additional cost to Owner.
- B. Provide additional engineering control surveys as deemed necessary for Contractor's benefit. Employ qualified and approved surveyor, engineer, or engineering technician for field surveys.
- C. Provide detailed construction layout staking as required for proper construction of site improvements.
- D. Where work requires the removal of property pins, or right-of-way monuments or markers; employ an approved Arkansas Professional Land Surveyor to reference points before they are disturbed and to reset points in their original position and condition after the work in that area is complete.

1.04 CONSTRUCTION LAYOUT STAKING

- A. The specifications of this subsection shall be applicable in the event that Contractor employs the Engineer to furnish detailed construction layout staking.

B. Notification and request for Services:

1. Properly coordinate requests for staking services with construction activities so as to preclude inefficient scheduling of staking crews.
2. Notify Engineer a minimum of 48 hours in advance of the date that specific services are desired.
3. Stipulate the particular stakes or marks required giving the specific location and/or limiting stations, offsets and other pertinent information.

C. Control Staking:

1. Control stakes which are referenced points for all construction, work shall be conspicuously and visibly marked with flagging tape, paint, or other suitable means.
2. Contractor shall protect all control points and shall replace points disturbed or damaged by Contractor at his expense.
3. Control stakes which are located in the work area and which require removal in order to properly execute work will be referenced and removed at no cost to Contractor.

D. Flagging for Clearing:

1. For utilities, road right-of-way or other proposed improvements presently located in wooded areas, Engineer will flag proposed centerline or one side of right-of-way to be cleared.
2. After clearing and grubbing is completed, the remainder of construction will be staked.

E. Road Alignment and Grade Staking:

1. Contractor is responsible for constructing the proper road cross-section as shown on the Drawings.
2. One set of initial alignment and cut and fill stakes shall be set along one right-of-way for rough grading purposes. Stakes at 100 foot intervals and at other critical points shall indicate cut and/or fill to finished centerline elevation.

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3. One set of final hubs shall be set on 100 foot stations along one side of the road and shall indicate finish gravel course alignment and cut and/or fill to top of gravel.
- F. Restaking and Checking:
1. Contractor responsible for verifying location and elevation of all reference stakes and all markings noted thereon.
 2. At Contractor's request, Engineer shall check validity of any questionable stake. Any stakes found to be in error will be reset at no charge to the Contractor.
 3. Engineer not responsible for any standby or "down" time as a result of such checking and/or resetting.
 4. All stakes or reference marks described in this section shall be set one time only. Upon written request by Contractor, Engineer will perform restaking at Contractor's expense.

END OF SECTION

SECTION 01051

CONTROL OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the control of Work, including:
 - 1. Plans and working drawings;
 - 2. Conformity with plans and specifications;
 - 3. Construction stakes, lines, and grades;
 - 4. Load restrictions;
 - 5. Maintenance of traffic; and
 - 6. Maintenance during construction.

1.02 PLANS AND WORKING DRAWINGS

- A. Plans will show such details of all structures, lines, grades, location, and design of all structures and pipelines as are necessary to give the comprehensive idea of the proposed construction. The Contractor shall keep one set of the most current plans available on the project at all times.
- B. The plans will be supplemented by such working drawings as are necessary to adequately control the Work.

1.03 CONFORMITY WITH PLANS AND SPECIFICATIONS

- A. All Work performed and all materials furnished shall be in conformity with the lines, grades, details, dimensions, and material requirements including tolerances as indicated on the drawings or in the specifications.
- B. In the event the Engineer finds the materials, the finished product in which the materials are used, or the Work performed are not in conformity with the drawings and specifications or within tolerances specified on the drawings or in the specifications and the Engineer finds that this has resulted in an inferior or unsatisfactory product, the Work or materials shall be removed and replaced or otherwise corrected by, and at the expense of the Contractor.
- C. In the event the Engineer finds the materials, the finished product in which the materials are used, or the Work performed are not in conformity with the drawings

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and specifications or within tolerances specified on the drawings or in the specifications, but that reasonably acceptable Work has been produced, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials.

1.04 CONSTRUCTION STAKES, LINES AND GRADES

- A. The Contractor shall be responsible to provide his own construction control stakes to establish lines, slopes, and grades as necessary for layout and completion of the Work. All survey work performed for layout of the site and final grade checks shall be performed by a licensed surveyor of the State of Arkansas. The Surveyor shall have construction experience with projects of similar type and nature to this project.

1.05 LOAD RESTRICTIONS

- A. The Contractor shall comply with all legal load restrictions in the hauling of materials on public highways beyond the limits of the project. The Contractor shall be responsible for all damage done by his hauling equipment and his construction activities.

1.06 MAINTENANCE OF TRAFFIC

- A. All public and private roads used for haul roads shall be maintained to provide an adequate and safe driving condition for all public and private traffic.

1.07 MAINTENANCE DURING CONSTRUCTION

- A. The Contractor shall maintain the Work during construction and until the project is accepted. The maintenance shall constitute continuous and effective work performed day to day with adequate equipment and forces such that all structures are kept in satisfactory condition at all times.
- B. The Contractor shall provide all necessary drainage control and diversion structures, and sufficient pumping equipment and manpower to keep the construction area well drained and free of standing water that may adversely impact construction procedures and schedules.

1.08 FUEL STORAGE, WASTE PRODUCTS, TRASH AND DEBRIS

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- A. The Contractor shall observe all federal, state, and local requirements and regulations regarding the transportation, storage, and containment of fuels.

- B. The Contractor shall be responsible for proper containment and labeling of containers, handling and disposal of all waste products and trash from all machinery, vehicles, and any other items used during the Work.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.01 SUMMARY

Section includes submittal procedures and types of submittals required prior to the beginning of certain phases of the Work, prior to the incorporation of products in the Work, and during the progress of the Work.

1.02 INITIAL SUBMITTALS

- A. Submit the following to the Engineer for review not more than fourteen calendar days after the Effective Date of the Agreement:
 - 1. Preliminary Schedule of Values.
 - 2. Initial Construction Progress Schedule (specified in this Section).
 - 3. Preliminary Schedule of Shop Drawing and Sample Submittals (specified in this Section).
 - 4. Proposed Products List (specified in this Section).

1.03 PROGRESS SUBMITTALS

- A. Submit the following to the Engineer for review during the progress of the Work:
 - 1. Applications for Payment.
 - 2. Individual processing submittals and change orders.
 - 3. Independent quality control inspection and testing information.
 - 4. Project Record Documents.
 - 5. Equipment manufacturer's instructions and certificates.
 - 6. All other miscellaneous submittals not mentioned herein and as specified in other individual specification Sections.

1.04 SUBMITTAL PROCEDURES

- A. Timing of Submittals

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1. Make submittals in advance of scheduled dates for installation, as specified in individual specification sections, to allow for reviews, for securing necessary approvals, for possible revisions and resubmittals, and for placing orders and securing deliveries. Preferred timing for the submittals will be discussed during the Preconstruction Meeting.
 2. Contractor shall be responsible for delays occasioned by incomplete submittals.
- B. Submittals shall be complete, and shall be combined into one package for each Section of the specifications, unless otherwise specified.
 - C. Sequentially number the transmittal forms.
 - D. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification section number, as appropriate.
 - E. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
 - F. Schedule submittals to expedite the project, and deliver to Engineer. Coordinate submission of related items.
 - G. Identify variations from Contract Documents and product or system limitations, which may be detrimental to successful performance of the completed Work.
 - H. Provide a four-inch square blank space for Engineer's review stamp.
 - I. Revise and resubmit submittals in the same quantity as required for the original submittal. Identify all changes made since previous submittal.
 - J. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.
 - K. Maintain one copy of each submittal in Project Record Documents.

1.05 CONSTRUCTION PROGRESS SCHEDULE

- A. Submit initial Construction Progress Schedule (first revision of schedule submitted with the Bid) in duplicate within the time specified in subsection 1.02 of this Section.

- B. Submit revised Schedule with each Application for Payment, identifying changes since previous version.
- C. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration. Schedule shall be in accordance with the required work sequence and completion dates specified in Section 01010 and elsewhere in the Contract Documents.
- D. Indicate estimated percentage of completion for each item of Work at each submission.
- E. Indicate submittal dates required for shop drawings, product data, samples, product delivery, and quality control test reports.
- F. The Schedule shall be revised as required throughout the project to indicate anticipated and actual duration and sequence of activities. Copies of revised Schedules shall be provided promptly to the Engineer for review and comment.

1.06 PROPOSED PRODUCTS LIST

- A. Within the time specified in subsection 1.02 of this Section, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
- C. Indicate on the list the product delivery dates, including those furnished by the Owner.

1.07 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- A. Within the time specified in subsection 1.02 of this Section, submit a preliminary Schedule of Shop Drawings and Samples in accordance. Include the following:
 - 1. The dates for Contractor's submittals.
 - 2. The dates submittals will be required for Owner-furnished products, if applicable.
 - 3. The dates approved submittals will be required from the Engineer.
 - 4. A list of all long lead items (equipment, materials, etc.).

B. Shop Drawings and Product Data Submittals

1. Submit the number of copies, which Contractor requires, plus three copies, which will be retained by Engineer.
2. Mark each copy of product data submittals to identify applicable products, models, options, and other data. Supplement manufacturer's standard data to provide information unique to this Project.

C. Sample Submittals

1. Submit samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
2. Include identification on each sample, with full project information.
3. Submit the number of samples specified in the individual specification Sections. The Engineer will retain one sample.

D. After review, distribute in accordance with subsection 1.03 above.

1.08 MANUFACTURERS' INSTRUCTIONS

- A. When specified in individual specification Sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Shop Drawings and Product Data in subsection 1.07.A above.
- B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.09 MANUFACTURERS' CERTIFICATES

- A. When specified in individual specification Sections, submit manufacturers' certificates to Engineer for review, in quantities specified for Shop Drawings and Product Data in subsection 1.07.A above.
- B. Indicate material or product conforms to or exceeds specified requirements Submit supporting reference data, affidavits, and certificates as appropriate.
- C. Certificates shall be based on test results acceptable to the Engineer.

1.10 INSPECTION AND TEST CERTIFICATES

- A. Submit to Engineer for review, inspection and test certificates required for demonstrating proof or compliance of materials with specification requirements.
- B. Each certificate shall be signed by an official authorized to certify on behalf of the manufacturing company and shall indicate the name and address of the Contractor, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates apply.
- C. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the test to which the report applies.
- D. Certification will not be construed as relieving the Contractor from furnishing satisfactory material, if, after tests are performed on selected samples, the material is found not to meet the specified requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01400

QUALITY CONTROL AND ASSURANCE SERVICES

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Owner will employ and pay for the services of the Technical Representative to perform construction monitoring and testing services to assure the Owner that the Work is completed according to the Specifications and Drawings.
- B. Contractor shall cooperate with the Technical Representative to facilitate the execution of its required services.
- C. Employment of the Technical Representative shall in no way relieve Contractor's obligations to perform the Work and supply materials in accordance with the Contract Documents.
- D. The Contractor shall provide any additional testing and services required to control construction quality at no additional cost to the Owner. Quality control testing and services do not include activities performed by the Technical Representative.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall:

- A. Cooperate with the Technical Representative and its personnel and provide access to Work and to Supplier's operations.
- B. Secure and deliver to the Technical Representative adequate quantities of representative samples of materials proposed to be used which require testing.
- C. Furnish copies of Supplier's test reports as required.
- D. Furnish incidental labor and facilities:
 - 1. To provide access to Work to be tested;
 - 2. To obtain and handle samples at the Project site or at the source of the product to be tested;
 - 3. To facilitate inspections and tests; and
 - 4. For storage and curing of test samples.
- E. Coordinate activities to accommodate services with a minimum delay. Notify

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Technical Representative 48 hours in advance of operations to allow for laboratory assignment of personnel and scheduling of tests. When tests or inspections cannot be performed after such notice, reimbursing Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence;

- F. Employ and pay for the services of a separate, qualified independent testing laboratory to perform additional inspections, sampling and testing required:
 - 1. For the Contractor's convenience;
 - 2. As required by the Specifications or approved Quality Control Plans; or
 - 3. When initial tests indicate Work does not comply with Contract Documents.
- G. Promptly notify the Technical Representative of observed irregularities or deficiencies of Work or products;
- H. Promptly submit a copy of a written report of each test to Technical Representative. Each report shall include:
 - 1. Date issued;
 - 2. Project title and number;
 - 3. Testing laboratory name, address and telephone number;
 - 4. Name and signature of laboratory inspector;
 - 5. Date and time of sampling or inspection;
 - 6. Record temperature and weather conditions;
 - 7. Date of test;
 - 8. Identification of product and specification section;
 - 9. Location of sample or test in the Project;
 - 10. Type of inspect or test;
 - 11. Results of tests and compliance with Contract Documents; and
 - 12. Interpretation of test results, when requested by Technical Representative.
- I. Be responsible for retesting where results of inspections and tests prove unsatisfactory and indicates noncompliance with requirements.

3.02 REPAIR AND PROTECTION

Unless specified otherwise, the Contractor shall protect construction exposed for testing and shall repair construction damaged by sampling, testing or inspection.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Mobilization.
2. Temporary Utilities.
3. Barriers and enclosures.
4. Protection of existing utilities and installed Work.
5. Site security.
6. Access roads and parking.
7. Temporary Controls: construction cleaning; noise; water; soil erosion and sediment; pollution; and, dust.
8. Traffic control and haul routes.
9. Project identification and signs.
10. Field offices and sheds.
11. Removal of temporary utilities, facilities and controls.

1.02 MOBILIZATION

- A. Mobilize to the site and be prepared to initiate the construction activities within 15 days after receiving Notice to Proceed from the Owner.**
- B. Mobilization shall not be attempted unless the Contractor has:**
1. Obtained all permits, licenses and OSHA training certificates necessary to perform the Work, where required.
 2. Received approval from the Owner for the location of temporary structures and storage areas.
 3. Submitted initial documents to the Engineer as listed in subsection 1.02 A of Section 01300.
- C. Mobilization includes, but is not necessarily limited to: transportation of personnel, equipment and operating supplies to the site; establishment of offices,**

buildings, all necessary temporary utilities; installation and relocation of necessary facilities at the site; and, other preparatory work at the site.

1.03 TEMPORARY UTILITIES

- A. Connect to existing power service to provide required temporary electrical utilities to the project area. Contractor shall pay all costs for connection of service and costs for power service. A licensed electrical contractor shall install temporary electrical utilities.
- B. Provide and maintain adequate lighting for construction operations and field offices.
- C. Provide and pay for adequate drinking water for construction operations.
- D. Provide adequate fire protection at the site as required by local fire codes and standards.
- E. Provide adequate temporary sanitary facilities in compliance with laws and regulations. Arrange for proper maintenance of such facilities. Pay all costs for installation and maintenance of the facilities.
- F. Provide, maintain and pay for telephone service to Contractor's offices.
- G. Provide, maintain and pay for any other temporary utility that is necessary to accomplish the Work.

1.04 BARRIERS AND ENCLOSURES

- A. Provide barriers to prevent unauthorized entry to construction areas to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide barricades, covered walkways and other temporary construction required by governing authorities for public rights-of-ways.
- C. All temporary construction shall be in accordance with applicable federal, state and local laws and building codes.
- D. Provide protection for plant life designated to remain. Trim tree branches if necessary for access and only if permitted by the Owner. Replace damaged plant life, or repair as follows:

1. Damaged branches shall be properly pruned and all wounds covered with approved tree paint.
 2. Repair work shall be done on a daily basis without exception.
- E. Protect non-covered vehicular traffic, stored materials, site and structures from damage.

1.05 PROTECTION OF EXISTING UTILITIES

- A. Contact and cooperate with the Owner and utility companies to locate all utilities (including pipelines, cables, power poles and other structures) on the construction site prior to beginning the Work.
- B. All utilities shall be protected from damage during construction, unless otherwise indicated to be removed or abandoned.
- C. Comply with requirements of the utility owners for clearances and access for all construction within and adjacent to the utility right-of-way.
- D. If damaged, the utilities shall be repaired as required by the Owner at the Contractor's expense.
- E. If a utility is encountered which is not shown on the Drawings or otherwise made known to the Contractor prior to beginning the Work, promptly take necessary steps to assure that the utility is not damaged, and give written notice to the Owner or Engineer and to the utility owner. The Owner and Engineer will then review the conditions and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence of the utility.

1.06 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where required in individual specification sections.
- B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

1.07 SECURITY

Provide security and facilities to protect Work from unauthorized entry, vandalism or theft.

1.08 ACCESS ROADS AND PARKING

- A. Construct and maintain temporary roads accessing existing roads to serve construction area.
- B. Extend and relocate, as Work progress requires. Provide detours necessary for unimpeded traffic flow.
- C. Designated existing on-site roads may be used for construction traffic, unless otherwise directed by the Owner or Engineer.
- D. Construct temporary gravel surface parking areas in areas approved by the Owner to accommodate construction personnel.
- E. When site space is not adequate, provide additional off-site parking.
- F. Repair existing roads damaged by operation of construction equipment, as determined by the Engineer.

1.09 CONSTRUCTION CLEANING

- A. Maintain areas free of trash and rubbish. Maintain site in a clean and orderly condition.
- B. No trash or rubbish containers will be supplied by Owner. Supply all containers required for storage and removal of trash, rubbish and debris resulting from the Work included in this project.
- C. Remove trash and rubbish from the construction area periodically and dispose in active waste area.

1.10 NOISE CONTROL

Contractor's vehicles and equipment shall be such as to minimize noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and state, county and local ordinance requirements, and in no case will noise levels be permitted which interfere with the work of the Owner or others.

1.11 WATER CONTROL

Provide and maintain water control as specified in Section 01563.

1.12 SOIL EROSION AND SEDIMENT CONTROL

Provide and maintain soil erosion and sediment control as specified in Section 01565.

1.13 POLLUTION CONTROL

- A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.
- B. Provide equipment and personnel, perform emergency measures required to contain significant spillage on-site, as determined necessary by the Engineer and Owner. Collect all oil and other fluids discharged during vehicle maintenance operation in drums and dispose of properly.
- C. Take special measures to prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers. Conform to Owner's existing NPDES permit for the facility.
- D. Provide systems for control of atmospheric pollutants. Prevent toxic concentrations of chemicals, and prevent harmful dispersal of pollutants in the atmosphere.
- E. All Contractors' equipment used during construction shall conform to all current federal, state and local laws and regulations.

1.14 DUST CONTROL

- A. Maintain all excavations, embankments, stockpiles, roads, and all other work areas within or outside the project boundaries free from visible airborne dust that would cause a hazard or nuisance to others.
- B. Approved temporary methods of stabilization, consisting of sprinkling with clean water, or similar methods, will be required to control dust. Sprinkling must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times.

1.15 TRAFFIC CONTROL

- A. Coordinate movement of construction equipment and hauling vehicles with Owner to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.
- B. Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

1.16 HAUL ROUTES

- A. Consult with authority having jurisdiction in establishing public thoroughfares to be used for haul routes and site access.
- B. Confine construction traffic to designated haul routes.

1.17 FIELD OFFICES AND SHEDS

- A. Office: Weather-tight, with lighting, electrical outlets, heating, cooling and ventilating equipment, and equipped with sturdy furniture.

1.18 REMOVAL OF TEMPORARY UTILITIES, FACILITIES AND CONTROLS

- A. Remove temporary above-grade and buried utilities, equipment, facilities and materials prior to final inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01563

CONTROL OF WATER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Controlling surface water runoff.
- B. Dewatering trenches, excavations, and other elements.
- C. Controlling water of every origin.

1.02 SUBMITTALS

Submit in accordance with Section 01300 -Submittals

PART 2 PRODUCTS

Provide structures, machinery, appliances, and equipment designed and manufactured to control water.

PART 3 EXECUTION

3.01 GENERAL

- A. Dewatering Procedures: The Contractor shall construct, maintain, and operate channels, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work.
- B. Dewater and dispose of water in a manner that will not cause injury to public and private property.
- C. Do not cause a nuisance to the Owner's operations.
- D. Keep sufficient pumping equipment and machinery on hand at all times for emergencies, including electric power failures.

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- E. Keep experienced personnel available at all times to operate pumping equipment, machinery and appliances.
- F. Do not shut down dewatering systems between shifts, on holidays and weekends, nor during Work stoppages, unless authorized by Owner or Engineer.

END OF SECTION

SECTION 01565

TEMPORARY SOIL EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

Section includes construction of temporary measures to control soil erosion and sediment transport within the construction limits.

1.02 REFERENCES

- A. "Erosion and Sediment Control Handbook", published by McGraw-Hill Book Company.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM D 488, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

1.03 SUBMITTALS

Submit product data and specifications for approval as required by the Engineer prior to use.

1.04 QUALITY ASSURANCE

Comply with the requirements of governmental authorities having jurisdiction.

1.05 PROJECT REQUIREMENTS

- A. Obtain all required permits prior to commencement of Work in areas requiring erosion control measures.
- B. The use of temporary control measures shall be coordinated with the permanent erosion control features specified elsewhere to the extent practical, to assure effective and continuous erosion control.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Mulch: Hay, straw, wood chips, or other suitable material reasonably clean of noxious weeds and deleterious material.
- B. Grasses: Rye grass, cereal grasses, or other quick-growing species suitable to the area and as a temporary cover, which will not compete with the grasses specified for permanent cover.
- C. Silt Fencing: "Envirofence" by Mirafi, "Propex Silt Stop" by Amoco, or equivalent. Posts shall be as shown on the Drawings.
- D. Check Dams shall be constructed of locally available sound crushed stone; size conforming to ASTM D 448, size number 1.

PART 3 EXECUTIONS

3.01 GENERAL

- A. All Work under this contract shall be performed in such a manner that objectionable erosion shall not be created in watercourses through or adjacent to the project area.
- B. The Contractor shall be responsible for the selection of appropriate temporary erosion control measures to suit the intended construction methods. The Contractor shall submit a scheme of control measures for each potentially impacted area prior to construction for approval by the Engineer.
- C. Notify the Engineer and Owner in the event of conflict between these specification requirements and pollution control laws, rules or regulations of other federal, state, or local agencies.

3.02 EROSION AND SEDIMENT CONTROL

- A. The Engineer shall have the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow, and fill operations and to direct the Contractor to provide immediate, permanent or temporary sediment control measures to minimize damage to adjacent property and to minimize effects on adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment.

- B. Incorporate all permanent erosion control features (including seeding) into the project at the earliest practical time. Temporary control measures shall be those that are needed prior to installation of permanent control features; or that is needed temporarily to control erosion that develops during normal construction activities, but are not associated with permanent control features on the project.
- C. Where erosion is likely to be a problem, clearing and grubbing operation should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures may be required between successive construction stages.

3.03 INSTALLATION AND MAINTENANCE OF SILT FENCING

- A. Install in accordance with details shown on the Drawings and as specified in paragraphs B through E below. In slope areas greater than 30 percent slope, install two parallel silt fences.
- B. Install posts at a maximum spacing of six feet, and to depth of approximately 18 inches, or as otherwise approved by the Engineer and Owner.
- C. Excavate six-inch wide by six-inch deep trench along line of posts and upslope from barrier.
- D. Fasten fabric to upstream side of posts using heavy-duty wire staples (at least one-inch long), tie wires or hog rings. Eight inches of the fabric shall extend into the trench.
- E. Backfill trench and compact soil over the fabric.
- F. Remove sediment deposits when deposits reach approximately one-half the height of the barrier. Sediment shall be placed in areas approved by the Engineer and spread uniformly over the ground surface.
- G. Replace fabric when it has deteriorated, is torn, loose or no longer effectively performs.
- H. Replace any silt fence, which has been overtopped with two new parallel fences.

3.04 APPLICATION OF TEMPORARY GRASS AND MULCH

- A. Comply with Section 02930.
- B. Temporary seeding shall be applied to areas lacking vegetation if no construction activities will be performed in the area for more than 30 days. Temporary seed mixtures shall be applied to such areas within 21 days of temporarily suspending work in the area.

3.05 CONSTRUCTION AND MAINTENANCE OF CHECK DAMS

- A. Construct across creeks within the project limits as shown on the Drawings.
- B. Inspect after each rainfall event. Make required repairs if the check dams have deteriorated to the extent that their effectiveness is reduced.
- C. Remove sediment deposits when deposits reach approximately one-half the height of the dams. Sediments shall be placed in areas approved by the Engineer and spread uniformly over the ground surface.
- D. Check dams shall be removed after completion of construction activities. Coarse aggregate shall be deposited on-site where approved by the Engineer.

3.06 INSTALLATION AND MAINTENANCE OF OTHER EROSION CONTROL MEASURES

- A. Install according to manufacturer's recommendations and standard local practice.
- B. Maintenance of the installations shall be performed as required for proper erosion and sediment control until the Work is accepted by the Owner.

3.07 REMOVAL OF SILT FENCING

- A. Silt fencing shall be removed when approved by the Engineer and Owner, after a sufficient stand of grass has been established on all disturbed areas.
- B. Any sediment deposits remaining after the silt fence is removed shall be dressed to conform to the existing grade, prepared, and seeded.

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Addresses:

1. Products;
2. Transportation and handling;
3. Storage and protection;
4. Product options; and
5. Substitutions.

1.02 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

1.03 TRANSPORTATION AND HANDLING

- A. Contractor shall transport and handle products in accordance with manufacturer's instructions.
- B. Contractor shall promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, and damage.

1.04 STORAGE AND PROTECTION

- A. Contractor shall store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Contractor shall store sensitive products in weather-tight, climate controlled enclosures.
- B. For exterior storage of fabricated products, materials shall be placed on sloped supports, above ground.

- C. Contractor shall provide off-site storage and protection when site does not permit on-site storage or protection.
- D. Contractor shall cover products subject to deterioration with impervious sheet covering. Contractor shall provide ventilation to avoid condensation.
- E. Contractor shall store loose granular materials on solid flat surfaces in a well-drained area. Contractor shall make every effort to prevent mixing with foreign matter.
- F. Contractor shall provide equipment and personnel to store products by methods to prevent damage.
- G. Contractor shall arrange storage of products to permit access for inspection. Contractor shall periodically inspect storage areas to assure products are undamaged and are maintained under specified conditions.

1.05 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications; no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.06 SUBSTITUTIONS

- A. Engineer will consider requests for Substitutions only within 15 days after Effective Date of Agreement.
- B. Subsequent Substitutions will be considered only when a product becomes unavailable through no fault of the Contractor. Improper planning will not be considered as a reason to increase Contract Price as a result of product substitution.
- C. A request constitutes a representation that the Contractor:
 - 1. Will provide the same warranty for the Substitution as for the specified product.

2. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the Owner.
 3. Waives claims for additional costs or time extension which may subsequently become apparent.
 4. Will reimburse Owner for review or redesign services associated with re-approval by Engineer and Engineer's consultants and regulatory agencies.
- D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- E. Substitution Submittal Procedure:
1. Contractor will submit copies of each request for Substitution for consideration. Contractor shall limit each request to one proposed Substitution.
 2. Contractor shall submit the number of copies required for all submittals, as specified in Section 01300.
 3. Contractor shall submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.

1.07 MANUFACTURER'S INSTRUCTIONS

- A. Installation of equipment and materials shall comply with manufacturer's instructions. Contractor shall obtain and distribute printed copies of such instructions to parties involved in installation, including two copies to Owner.
1. Contractor shall maintain one set of complete instructions at job site during installation and until completion of work.
- B. Contractor shall handle, store, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformance with specifications.
1. If job conditions or specified requirements conflict with manufacturer's instructions, Contractor shall consult with Owner or Engineer for further instructions.
 2. Contractor shall not proceed with work without written instructions.

1.08 INSTALLATION, INSTRUCTIONAL, AND POST START-UP SERVICES

A. Installation Services:

1. Where installation services are called for in Specifications, Contractor shall provide competent and experienced technical representatives of manufacturers of equipment and systems to resolve assembly or installation procedures attributable to, or associated with, equipment furnished.
2. After equipment is installed, representatives shall perform initial equipment and system adjustment and calibration to conform to Specifications and manufacturer's requirements and instructions.
3. Contractor shall provide "Certificate of Installation Services" stating proper adjustments have been made to equipment or system and equipment or system ready for start-up and operation.

B. Instructional Services:

1. Where training is called for in Specifications, Contractor shall provide competent and experienced technical representative of supplier to provide detailed instructions to Owner's personnel for operation of equipment. Training services shall include maintenance of instrumentation, maintenance of process equipment and operation of process equipment in classroom and on-site equipment instruction, as stated in Specifications.
2. Contractor shall coordinate pre-startup training periods with Owner and supplier's representatives.
 - a. Contractor shall notify Owner at least 48 hours before training sessions are to begin so Owner can make arrangements with operating personnel.
 - b. Contractor shall reschedule canceled training sessions 48 hours in advance.
 - c. Failure of supplier's or manufacturer's representative to appear for scheduled training, failure to notify Owner 24 hours in advance of need to cancel scheduled training or failure to arrive within 30 minutes of start of scheduled training shall result in reimbursement to Owner for time lost by Owner's operating personnel in waiting for arrival of manufacturer's representative. Except in case of failure to arrive on time, time will not exceed one hour for each employee scheduled to receive training. Failure to arrive on time will be reimbursed by actual time late up to one hour, after one hour training will be rescheduled.

3. Similar types of equipment differing in model, size or manufacturer shall require equal service time as stated in specific Specification section.
4. Contractor shall complete pre-startup training 14 days prior to system operations demonstrations.
5. O&M data shall constitute basis of instruction.
 - a. Contractor shall review data contents with personnel in full detail to explain aspects of operations and maintenance.
6. Contractor shall provide "Certificate of Instructional Services," co-signed by Owner and supplier's representative, verifying training accomplished to satisfaction of all parties.

1.09 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

- A. Contractor shall furnish, in accordance with manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those specially designed or adapted for use on parts of equipment, and not customarily and routinely carried by maintenance mechanics.
- B. Special tools and lubricating equipment (when applicable) will be delivered to Owner when unit placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.
- C. Tools and lubricating equipment shall be of quality compatible to equipment manufacturer has furnished.

1.10 LUBRICATION

- A. Where lubrication is required for proper operation of equipment, Contractor shall incorporate necessary and proper provisions in equipment in accordance with manufacturer's requirements. Where possible, lubrication shall be automated and positive.
- B. Where oil is used, reservoir shall be of sufficient capacity to supply unit for 24-hour period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Owner will have the right to the access of all records, such as correspondence and claims that are maintained on site or any other locations by Contractor.

- B. Contractor shall maintain at site for Owner one record copy of:
 - 1. Drawings;
 - 2. Specifications;
 - 3. Addenda;
 - 4. Change orders and other modifications to Contract;
 - 5. Field orders, written instructions, or clarifications;
 - 6. Approved submittals;
 - 7. Field test records;
 - 8. All associated permits; and
 - 9. Certificates of inspection and approvals.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Contractor shall maintain documents in clean, dry, legible condition and in good order. Contractor shall not use record documents for construction purposes.

- B. Contractor shall provide secure space for storage of samples and maintain same in good order.

- C. Contractor shall make documents and samples available at all times for inspection by Owner.

- D. Failure to properly maintain record documents may be reason to delay a portion of progress payments until records comply with Contract Documents.

1.03 RECORD DOCUMENTS

- A. Contractor shall maintain a record set of drawings and specifications legibly changed to transfer approved modifications in completed work that differ from Contract Documents.

- B. Contractor shall label each document "PROJECT RECORD" in neat, large printed letters.
- C. Contractor shall record information concurrently with construction progress.
 - 1. Contractor shall not cancel any work until required information is recorded.
 - 2. Contractor shall record changes made by Written Amendment, Field Order, Change Order, or Work Directive Change.
- D. Drawings
 - 1. Using data accumulated during the project, the third party surveyor shall submit a set of As-Built Record Drawings for inclusion in the Construction Documentation Report.
 - 2. Submit separate document indicating changes made to specifications during work.

1.04 SUBMITTALS

- A. At substantial completion Contractor shall:
 - 1. Deliver one set of marked up record drawings to Owner; and
 - 2. Deliver documents described in Paragraph 1.01.B to Owner.
- B. Submittals shall include a transmittal letter in duplicate, containing:
 - 1. Date;
 - 2. Project title and number;
 - 3. Contractor's name and address;
 - 4. Title of record document; and
 - 5. Signature of Contractor or authorized representative.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 02110

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes clearing and grubbing of vegetation, stripping of topsoil, and disposal of vegetation.

1.02 QUALITY ASSURANCE

- A. Site clearing shall be performed in a manner that does not disturb existing structures, utilities, monitoring wells, or other facilities not indicated to be removed or abandoned.
- B. Conform to applicable local codes for disposal of cleared and grubbed vegetation.
- C. Coordinate clearing work with utility companies.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

- A. Remove exposed trees, brush, logs, grass, and other vegetative material resting on or protruding through the ground surface in those areas identified for clearing on the Drawings.
- B. Remove roots of all vegetation (including tree stumps) to a minimum depth of one foot below existing grade, or the proposed subgrade elevation, whichever is lower.

3.03 TOPSOIL STRIPPING

- A. Excavate topsoil from areas to receive fill.
- B. Stockpile topsoil in an area on-site where approved by the Owner or Engineer for later placement on surface to be seeded. Implement temporary erosion and sediment control measures specified in Section 01565.

3.04 DISPOSAL OF WOOD AND BRUSH

- A. All wood and brush shall be disposed of within 15 days after cutting or felling unless otherwise approved. Coordinate disposal with owner.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes general earthwork for grading of the site, excavation, subgrade fill, general fill, fill placement for access roads, berms, underground pipelines, and stormwater facilities.
- B. Related Sections:
 - 1. Section 02220 - Excavation and Backfilling

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 - 3. ASTM D 1140, Standard Test Method for Amounts of Material in Soils Finer than the Number 200 Sieve.
 - 4. ASTM D 1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using Ten-Pound (4.54 kg) Hammer and 18-Inch (457 mm) Drop.
 - 5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
 - 6. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
 - 7. ASTM D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

8. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
9. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 DEFINITIONS

- A. Excavation: Consists of the removal of material encountered to subgrade elevations and the reuse disposal of materials removed.
- B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below base course.
- C. Borrow: Soil or other fill materials obtained from borrow areas when sufficient approved material is not available from excavations.
- D. Unauthorized Excavation: Consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Engineer. Unauthorized excavation shall be at the Contractor's expense.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

Owner will retain the services of an inspection and testing firm to determine conformance of the materials and constructed work with the specifications.

1.05 PROJECT CONDITIONS

- A. Provide temporary controls as specified in Sections 01563 and 01565.
- B. The Contractor is solely responsible for excavation slope stability. Excavation work shall be in compliance with applicable OSHA regulations and State regulations.

PART 2 PRODUCTS

2.01 GENERAL

Provide all labor, materials, and equipment necessary to accomplish the Work specified in this section.

2.02 SOIL MATERIALS

- A. General Fill: On-site soil or borrow material free of large rock, debris, waste, frozen material, vegetation, and other deleterious matter with a maximum particle size of six inches.
- B. Prepared Subgrade: In areas to be filled, unless otherwise noted, upper eight inches of in-situ soil or CKD, scarified and recompactd to density of subsequent layer of fill/backfill material.

2.03 OTHER MATERIALS

Provide other materials, not specifically described herein but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

2.04 WATER FOR COMPACTION

Furnish as required. Contractor will have to obtain a source from Owner.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion control measures to prevent erosion or displacement of soils or other fill materials and discharge of material-bearing water runoff or airborne dust to adjacent properties.

3.02 DEWATERING

- A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site surrounding areas.

- B. Protect subgrade soils or other fill materials from softening and damage by rain or water accumulation.

3.03 EXCAVATION

- A. Perform excavation of every type of material encountered within the limits of the Work to the lines, grades, and elevations indicated on the Drawings and specified herein.
- B. Satisfactory Excavated Materials shall be transported to, and place in, fill or embankment areas within the limits of Work.
- C. Unsatisfactory Excavated Materials
 1. Unsatisfactory material excavation shall include excavation and disposal of soft or compressible soils, old spoil material, or any other materials judged by the Engineer to be unsuitable for foundations or the placement of compacted soils.
 2. Excavate to a distance below grade as directed by the Engineer, and replace with satisfactory materials.
 3. The Contractor shall include excavation of unsatisfactory materials, and replacement by satisfactory materials, as parts of the Work of this Section.
 4. Dewatering shall be provided in areas of undercutting to a depth of at least two feet below the bottom of the excavation and shall be maintained until compacted earth fill is placed to at least three feet above the original water level or original ground level, whichever is higher.
- D. Surplus Materials or unsatisfactory excavated materials, and surplus satisfactory excavated material, shall be disposed of on-site in designated areas.

3.04 DITCHES AND GUTTERS

- A. Cut accurately to the cross sections, grades and elevations shown on the Drawings.
- B. Maintain excavation from detrimental quantities of debris until completion of work.

- C. Dispose of excavated materials as shown on the Drawings or as directed by the Engineer; except do not, in any case, deposit materials less than three feet from the edge of a ditch.

3.05 UNAUTHORIZED EXCAVATION

Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific instruction from the Engineer.

3.06 STABILITY OF EXCAVATIONS

Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.07 APPROVAL OF SUBGRADE

- A. Notify Engineer when excavations have reached required subgrade.
- B. When Engineer determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Engineer.

3.08 STORAGE OF SOIL MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill materials, including acceptable borrow materials. Stockpile materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.
- B. Stockpile material away from edge of excavations. Do not store within drip line of remaining trees or coordinate with owner.

3.09 GENERAL BACKFILLING

- A. Backfill excavations promptly, but not before completing the following:

1. Acceptance of construction below finish grade including, where applicable, damproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Testing, inspecting, and approval of underground utilities.
4. Removal of trash and debris from excavation.
5. Removal of temporary shoring, bracing, and sheeting.
6. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.10 FILL

- A. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactorily soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.
- B. Place fill material in not more than eight to nine-inch loose layers to required elevations for each location listed below.

3.11 MOISTURE CONTROL

- A. Unless otherwise noted, uniformly moisten or aerate subgrade and each subsequent fill or backfill layer to obtain compaction of 95% of the standard proctor.
 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact to specified density.
 3. Stockpile or spread and dry removed wet satisfactory soil material.

3.12 COMPACTION

- A. Place backfill and fill materials in layers not more than eight to nine inches in loose depth for material compacted by heavy compaction equipment, and not more than four inches loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations.

- C. Unless otherwise noted, scarify and recompact upper six inches of subgrade to density not less than required for the subsequent layer of fill/backfill material.
- D. Percentage of Maximum Dry Density Requirements: Unless otherwise noted, compact soil to not less than the following percentages of maximum dry density according to ASTM D 698:
 - 1. All areas: compact each layer of backfill or fill material at 95 percent maximum dry density.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and evaluations indicated.
 - 1. Provide a smooth transition between existing adjacent grades and new grades.
 - 2. Cut off soft spots, fill low spots, and trim high spots to conform to required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within plus or minus 0.10-foot tolerances:

3.14 TOPSOIL

After rough grading is completed and reviewed by Engineer, spread topsoil over specified areas as shown on the Drawings to a minimum compacted thickness of twelve inches.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
 - 1. Perform field in-place density tests by the nuclear method according to ASTM D 2922.

- B. When testing agency reports that subgrades, fills, or backfill are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.16 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace material to depth directed by the Engineer; reshape and recompact to optimum moisture content or the required density.
- C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
- D. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

END OF SECTION

SECTION 02210

FILL COMPACTION FOR EARTHWORK STRUCTURES OTHER THAN CLAY LINER

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of earthwork structures as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.
- B. The work of this Section shall include, but not necessarily be limited to: separating, hauling, stockpiling, backfilling, compacting, and grading of soils and other materials. The work of this Section may pertain in whole or in part to construction of the following: final grading, roads, stormwater benches, berms and other earthworks. The work of this Section also includes dewatering and protection. The Contractor shall be prepared to construct the structural fill in conjunction with other construction activities and subcontractors at the site.
- C. Notwithstanding the prequalification of any material sources for the structural fill, the Contractor shall be entirely responsible for meeting the requirements of this Section.

1.02 REFERENCES

- A. *Construction Quality Control Plan*
- B. Latest version of American Society for Testing and Materials (ASTM) standards:
 - 1. ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m<sup>3 - 3. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 4. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m^{3 - 5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.}</sup>

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6. ASTM D 2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. ASTM D 2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
9. ASTM D 4220, Standard Practices for Preserving and Transporting Soil Samples.
10. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

- A. The Contractor shall discuss with the Owner and the CQA Consultant the proposed methods of construction, including stripping, dewatering, excavation, filling, compaction, and backfilling for the various portions of the work. The review shall be for method only. The Contractor shall remain responsible for the adequacy and safety of the methods.
- B. For each material type specified in Part 2 of this Section, the Contractor shall submit to the Owner and the CQA Consultant the following information and samples a minimum of 14 days prior to starting construction:
 1. the proposed material source;
 2. the results of grain-size analyses conducted on the proposed material in accordance with ASTM D 422;
 3. for fine-grained materials, the results of liquid and plastic limit tests conducted on the proposed material in accordance with ASTM D 4318;
 4. the results of a moisture-density relation test (ASTM D 698); and
 5. a 50-lb sample of each of the proposed material or authorization to access the proposed source(s) for sampling.
- C. The Contractor shall notify the Owner and the CQA Consultant in writing at least seven days in advance of intention to perform the work of this Section.

- D. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and the CQA Consultant immediately and provide a plan and schedule for resumption of the work.
- E. The Contractor shall abide by all qualification requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

- A. The construction of the structural fill shall be performed in accordance with the requirements of this section and the CQA Plan.
- B. The construction of the structural fill shall be monitored by the CQA Consultant as outlined in the CQA Plan.
- C. The Contractor shall be aware of the activities outlined in the CQA Plan and account for these CQA activities in the construction schedule.

1.05 PROTECTION

- A. The Contractor shall contact utility companies and locate, mark and protect all existing utilities before commencement of construction.
- B. The Contractor shall protect trees, shrubs, lawns, rock outcroppings and other features remaining as part of final landscaping.
- C. The Contractor shall protect benchmarks, survey markers, fences, roads, sidewalks, paving, curbs and other existing structures from damage due to the Contractor's activities.
- D. The Contractor shall repair damage caused by the construction operations.
- E. Erosion control must be maintained. Erosion control measures shall be as noted on the grading plan or as directed by the Company.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All laboratory testing to evaluate the suitability or conformance of materials for the structural fill shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.

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- B. Structural fill shall consist of relatively homogeneous, natural soils that are free of debris, foreign objects, large rock fragments, roots, and organics. No materials larger than three in. shall be allowed. If structural fill is to be placed above geosynthetics, no materials larger than one in. shall be allowed within one ft of the geosynthetics. The structural fill shall be classified according to the Unified Soil Classification System (USCS) as SP, SW, SM, SC, ML, CL, CH, or MH material.

PART 3 EXECUTION

3.01 FAMILIARIZATION

- A. Prior to implementing any work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and 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 work of all other Sections and verify that all work is complete to the point where the installation of the work specified in this Section may properly commence without adverse impact.
 - 2. If the Contractor has any concerns regarding the installed work of other Sections, the Owner should be immediately notified in writing within 48 hours of the site inspection. Failure to notify the Owner or continuance with structural fill placement shall be construed as Contractor's acceptance of the related work of all other Sections.

3.02 SITE PREPARATION

- A. The Contractor shall develop access to the construction area in accordance with the requirements of the Drawings and any supplemental Specifications.
- B. The Contractor shall install silt fences immediately down-slope of each area to be disturbed prior to the beginning of work in that area. The Contractor shall maintain the silt fences for the duration of construction. Accumulated sediment behind the silt fences shall be disposed of on-site by the Contractor in a manner approved by the Owner.
- C. All brush, vegetation, rubbish, and other objectionable material shall be removed from the construction area and disposed of in an area designated by the Owner.
- D. All topsoil shall be removed from the construction area and stockpiled.

- E. Diversion ditches, either permanent or temporary, shall be constructed in accordance with the Drawings. The Contractor shall be responsible for constructing diversion ditches as required to divert potential run-on around the construction area. The construction of temporary ditches not shown on the Drawings shall not be undertaken until the Contractor's plan for constructing the ditches is approved by the Owner.

3.03 EXCAVATION AND STOCKPILING

- A. Excavated materials to be used as structural fill shall be stockpiled in designated areas segregated from soils not suitable for use as fill, clearing debris, or other objectionable materials. Stockpile areas shall be designated by the Owner.
- B. Stockpiles of structural fill shall have side slopes no steeper than 3H:1V (3 horizontal:1 vertical) unless approved otherwise by the Owner. The stockpiles of structural fill shall be graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the Owner, and dressed daily during periods when structural fill is taken from the stockpile. The Contractor may cover structural fill stockpiles with plastic sheeting or other material approved by the Owner in order to preserve the moisture content of the structural fill.
- C. Stockpiles that shall remain out of active use for a period greater than seven months shall either be covered as described in Part 3.03.C of this Section or stabilized by seeding and fertilizing in accordance with the requirements given in Section 02930.
- D. Surplus excavated materials shall not be removed from the site or disposed of by the Contractor unless such removal or disposal is approved by the Owner.

3.04 STRUCTURAL FILL

- A. The structural fill used during this construction shall be constructed to the lines and grades shown on the Drawings using the appropriate material.
- B. The structural fill shall meet the requirements of Part 2.01 of this Section.
- C. The structural fill shall be placed in a loose lift that results in a compacted lift thickness of no greater than 12 inches.
- D. The Contractor shall be responsible for installation of suitable material that meets the projects specifications for classification, moisture content and density. The Contractor shall not proceed to the next lift until the current lift has been tested and approved by the CQA representative. The Contractor will be held responsible for proceeding to the next lift without prior approval from the CQA Firm.

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- E. Each lift shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 6938 (Method B).
- F. If the moisture content of the structural fill is not suitable for proper compaction, the structural fill shall be moisture conditioned and reworked, as appropriate. Wetting shall be accomplished using a water truck and spray nozzle, unless the CQA Consultant approves an alternative method. During wetting or drying, the structural fill shall be regularly disced or otherwise mixed so that uniform moisture conditions in the appropriate range are obtained. In the event the moisture content is at optimum \pm 1 percent and the compaction requirement of 95 percent can not be achieved, the lift thickness shall be reduced.
- G. The Contractor shall not place frozen structural fill, nor shall structural fill be placed on frozen ground.
- H. If the structural fill freezes during construction, the Contractor shall remove the frozen structural fill, scarify the remaining unfrozen fill, and then place and compact new structural fill in accordance with these Specifications and any supplemental Specifications. The frozen structural fill shall not be reused until it has thawed, been disced, and then reworked to an acceptable uniform moisture content.

3.05 SURVEY CONTROL

- A. The Contractor shall survey the location and elevation of the structural fill, access road, drainage ditches, and drainage swales.
- B. The Owner may supply surveying for quality assurance purposes and Record Drawings.

3.06 PROTECTION OF WORK

- A. The Contractor shall use all means necessary to protect all materials and all partially-completed and completed work specified in this Section and prior work of other Sections.
- B. At the end of each day, the Contractor shall verify that the entire work area was left in a state that promotes surface drainage off and away from the area and from finished work. If threatening weather conditions are forecast, compacted surfaces shall be seal-rolled to protect finished work.

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- C. In the event of damage to prior work or work completed as specified in this Section, the Contractor shall submit a repair plan to the Owner and CQA Consultant(s). The repair plan shall describe the areas requiring repair, and the Contractor shall make all repairs and replacements necessary to the approval of the Owner and CQA Consultant(s) and at no additional cost to the Owner.

3.07 PUMPING AND DRAINAGE

- A. At all times during construction, the Contractor shall provide and maintain proper equipment and facilities to remove all water entering excavations and keep such excavations dry so as to obtain a satisfactory condition for progress of work.
- B. Drainage shall be disposed of only in an area approved by the Owner. Drainage shall be disposed of in a manner which prevents flow or seepage back into the excavated area.

END OF SECTION

SECTION 02220

EXCAVATION AND BACKFILLING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes excavation, backfilling and compaction for installation of landfill liner system components.

- B. Related Sections:
 - 1. Section 02200 - Earthwork
 - 2. Section 02226 - Protective Cover Layer
 - 3. Section 02227 – Drainage Aggregate

- C. Definitions:
 - 1. Excavation: Consists of the removal of material encountered to subgrade elevations.
 - 2. Unauthorized Excavation: Consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Engineer. Unauthorized excavation shall be at the Contractor's expense.
 - 3. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below proposed structure or facility.
 - 4. Borrow: Materials obtained from borrow areas when sufficient approved material is not available from excavations.
 - 5. Unsuitable Material: Topsoil, peat, organic soils, lignite, debris, rubble, and soft, loose or saturated soils, as determined by the Owner.
 - 6. Lift: Constructed portion of backfill layer comprised of suitable material placed in specified compacted thickness.

1.02 REFERENCES

- A. *Construction Quality Assurance Plan*
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 - 3. ASTM D 1140, Standard Test Method for Amounts of Material in Soils Finer than the Number 200 Sieve.
 - 4. ASTM D 1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using Ten-Pound (4.54 kg) Hammer and 18-Inch (457 mm) Drop.
 - 5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
 - 6. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
 - 7. ASTM D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 8. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 - 9. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.
- C. Submit as-built survey maps of each specified fill layer.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

- A. Testing shall be done in accordance with the most current version of the *Construction Quality Assurance Plan*
- B. Testing work be performed with the specifications, in accordance with Section 01400.
- C. Use special testing frequency at discretion of Owner or Engineer when visual observations of construction performance indicate potential problem. Additional testing for suspected areas should be considered when:
 - 1. Rollers slip during rolling operation.
 - 2. Lift thickness is greater than specified.
 - 3. Fill materials are at improper or variable moisture content.
 - 4. The number of roller passes is less than specified number.
 - 5. Compaction equipment have dirt-clogged rollers.
 - 6. Compaction equipment may not be using optimum ballast.
 - 7. Fill materials differ substantially from those specified.
 - 8. Degree of compaction is doubtful.
 - 9. Directed by Owner or Engineer.
- D. During construction, testing frequency may also be increased in following situations:
 - 1. Adverse weather conditions.
 - 2. Breakdown of equipment.
 - 3. At start or finish of grading.
 - 4. Material fails to meet specifications.
 - 5. Work area is reduced.

1.05 PROJECT CONDITIONS

- A. Work shall be performed in a manner that does not disturb existing environmental monitoring wells or other site facilities not indicated to be removed within the construction limits.
- B. Provide temporary controls as specified in Section 01563.
- C. The Contractor is solely responsible for excavation slope stability. Excavation work shall be in compliance with applicable OSHA regulations.

PART 2 PRODUCTS

2.01 GENERAL

- A. Proposed materials shall be approved for use on this project by the Engineer as specified, prior to use of the material in the construction.
- B. Fill material to be reasonably well-graded material derived from on-site and borrow sources.
- C. Materials on-site, in-place, and/or in stockpiles are available for use the construction operations. These materials are to be used subject to acceptance by the Engineer.

2.02 GENERAL FILL

- A. Material shall meet the standards as defined in Section 02210, subsection 2.02.
- B. Place in areas as shown on Drawings, including geomembrane anchor trenches and waste cell separator berms.

2.03 PROTECTIVE COVER LAYER

- A. Material to conform to the requirements of Section 02226.
- B. Protective Cover material shall be placed on landfill base and side-slopes as shown on the Drawings.

2.04 Drainage Aggregate

- A. Material to conform to the requirements of Section 02227.
- B. Shall be installed within the collection pipe trench surrounding the collection pipe, as shown on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

- A. Prior to beginning excavation work, Contractor shall review and satisfy himself with the adequacy and accuracy of the control surveys and data established by the Owner for the purpose of computing payment quantities. Contractor may make such measurements and surveys as deemed necessary to confirm the Owner's control surveys. The Engineer will resolve any variances or discrepancies. When control surveys and data have been established to both parties' satisfaction, the Contractor shall indicate his acceptance by signing a copy of the Owner's field survey notes, which shall be maintained at the job site by the Engineer throughout the Work.
- B. Flag and protect all known utilities and environmental monitoring stations.

3.02 EXCAVATION

- A. Excavation consists of open-cut excavation and removal of all types of material encountered when establishing required subgrade and finished grade.
- B. Unauthorized excavation consists of removal of materials beyond indicated subgrade or finished elevations without specific direction of Engineer or Owner. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense. Backfill and compact unauthorized excavations with material of subsequent layer and meet specified density of that layer.
- C. Excavate areas as indicated on the Drawings in a safe manner and in conformance with all local, state, and federal regulations.
- D. Separate excavated materials into stockpiles as shown on the Drawings and as directed by the Engineer. Maintain stockpiles in free-draining condition.
- E. Grade final surfaces to the lines and elevations shown on the Drawings with a tolerance of 0.1 foot.

- F. Final surfaces shall be free of loose material, clods, and other debris including grading stakes and hubs.
- G. Grade top perimeter of excavation to prevent surface water from draining into excavation area.
- H. Upon completion of excavation, notify Engineer before proceeding with backfilling operations.
- I. Provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade:
 - 1. Areas subject to vehicular traffic: 36 inches
 - 2. Areas not subject to vehicular traffic: 18 inches
 - 3. All areas: Electrical cables: 42 inches
Electrical ducts: 36 inches
 - 4. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, provided it will not interfere with the structural integrity of the slab or pavement.
 - 5. Where the minimum cover is not provided, encase the pipes in concrete as indicated on Drawings. Provide concrete with a minimum 28-day compressive strength of 2,500 pounds per square inch.

3.03 REMOVAL OF WATER

Provide and operate equipment adequate to keep all excavations free of water as specified in Section 01563.

3.04 PREPARATION

- A. Prior to placement of fill materials, examine all surfaces and subgrades to receive fill to identify the existence of soft areas caused by ponding water or unsuitable materials. Proof-roll area with a large rubber-tired vehicle of sufficient weight to reveal unstable areas. Remove all unsuitable materials and backfill with subsequent materials and compact to density as specified for that material layer.
- B. Scarify top six to eight inches of subgrade, moisture condition, and unless otherwise noted, compact to moisture content and minimum density not less than the subsequent layer of fill/backfill material.

- C. Survey Engineer - approved prepared subgrade area for record drawings in conformance with Section 01400. Acceptable tolerances on survey coordinates shall be +0.1 foot to -0.0 foot on elevations and coordinates, unless otherwise specified.
- D. Maintain benchmarks and other elevation control points; re-establish, if disturbed or destroyed, at no additional cost to the Owner.

3.05 BACKFILLING

- A. Notify Engineer at least 48 hours prior to placing any fill material.
- B. Place fill material in accordance with procedures required to achieve specified performance standards outlined in each referenced section.
- C. Hauling and spreading equipment will not be considered as compaction equipment unless Contractor has demonstrated suitability on test pad.
- D. Contractor is responsible for maintaining proper lift thickness to achieve compaction as stated below. Place and compact fill materials in maximum uncompacted lift thickness and to minimum density indicated.
- E. Material not meeting specified density shall be additionally compacted to meet specifications, or removed. Material not within specified moisture content range shall be scarified, moisture conditioned, and recompact to meet the specifications, or removed.

**TABLE 02220-1
 GENERAL COMPACTION REQUIREMENTS**

Material	Maximum Lift Thickness (inches)	Minimum Compaction (%)	Moisture Requirements
General Fill	9 inches	95 Standard Proctor	±5% of OMC

3.06 FIELD QUALITY CONTROL

- A. Tests specified below shall be performed by the CQA testing firm during placement of fill.
- B. Testing of General Fill:

Compaction/Density tests, (using ASTM D 2922) and Moisture Content (using ASTM D 3017): Minimum of one test per 10,000 square feet area for each compacted lift or minimum of six tests per lift, and at every material change.

- C. Testing of Protective Cover as per Section 02226.
- D. Compacted fill, which does not meet density specifications shall be scarified, the moisture content adjusted, and the area recompactd and re-tested at Contractor's expense.
- E. Surveying shall be performed to monitor as-built layer elevations. Measure on a 50-foot maximum grid pattern at the following locations:
 - 1. Prepared Subgrade; and
 - 2. Protective Cover.
- F. Provide topographic survey drawings of the as-built surfaces to Engineer for review and approval before proceeding with subsequent construction. Survey maps shall be prepared by an Arkansas Registered Professional Land Surveyor.

3.07 STOCKPILING

- A. Locate stockpiles as shown on Drawings, or as directed by the Engineer. Do not exceed 50 feet height of piles unless permitted by the Engineer or Owner. Place, grade, and shape stockpiles for proper drainage. Stockpiles shall not exceed slopes of 3 horizontal to 1 vertical.
- B. Provide erosion control fences and barriers to prevent loss of material or movement outside the stockpile limits, as necessary.

END OF SECTION

SECTION 02223

TRENCHING, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section addresses excavation, backfill and compaction for installation of underground pipelines and anchor trenches for geosynthetics installations.
- B. Related Sections:
 - 1. Section 02200 – Earthwork

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 - 3. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
 - 4. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
 - 5. ASTM D 6938, Standard Test Methods for Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

- A. Submittals shall be submitted under the provisions in Section 01300.
- B. Test Results:
 - 1. The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications; and
 - 2. The test results shall be submitted within three days after samples are obtained.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

- A. Owner will retain the services of an independent inspection and testing firm(s) to determine conformance of the materials and constructed work with the specifications, in accordance with the General Conditions.

1.05 PROJECT CONDITIONS

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- A. Work shall be performed in a manner that does not disturb existing environmental monitoring wells or other site facilities not indicated to be removed within the construction limits.
- B. Contractor shall provide temporary controls to prevent erosion as specified in the General Conditions.
- C. The Contractor is solely responsible for excavation slope stability. Excavation work shall be in compliance with applicable OSHA regulations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. Proposed materials shall be approved for use on this project by the Engineer as specified, prior to use of the material in the construction.

2.02 PIPE BEDDING MATERIAL, HAUNCHING MATERIAL, AND INITIAL TRENCH BACKFILL

- A. Pipe bedding material shall be sand or fine gravel, having characteristics consistent with SW, SP, GW or GP soils as defined by the Unified Soil Classification System (ASTM D 2487).
- B. Shall be substantially free of sharp edges or corners, and debris. Maximum particle size shall be 3/8-inch or less.
- C. Testing of Soil:
 - 1. Soil Type (ASTM D 2487): Minimum of one test for each visible change in material.

2.03 FINAL TRENCH BACKFILL

- A. Soil used for final backfill in all pipe trenches may be soil excavated from trench except if it is an organic or silt (MH, ML) soil. The soil shall be substantially free of organic matter or other perishable matter, rocks larger than two inches in maximum dimension, pavement material, litter, and topsoil.
- B. For pipe trenches beneath areas which will carry vehicular traffic, trench backfill shall consist of same material as pavement surface coarse material.

2.04 GEOCOMPOSITE ANCHOR TRENCH BACKFILL

- A. General fill material to be placed in Geocomposite anchor trenches.
- B. Material shall conform to the requirements as specified in Section 02279.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Testing of Geosynthetic Anchor Trench Backfill:
 - 1. Compaction/Density tests, using ASTM D 6938: Minimum of one test for each six inch completed lift of backfill placed and for every 100 feet of trench, or fraction thereof.
- B. Materials not meeting density specification requirement shall be scarified, recompacted and retested at Contractor's expense.
- C. The Engineer may require additional tests to establish gradation, maximum density, and in-place density as required by working conditions, at the Contractor's expense.

3.02 PREPARATION

- A. Contractor shall establish required lines and levels, and check contours and datum.
- B. Contractor shall remove and replace or compact in-situ soils or compacted fill material softened by surface water as required by the Engineer.
- C. Unsuitable materials shall be removed from within the trench.
- D. Contractor shall provide and operate equipment adequate to keep all excavations free of water as specified in the General Conditions.
- E. Contractor shall maintain benchmarks and other elevation control points; re-establish, if disturbed or destroyed, at no additional cost to the Owner.

3.03 TRENCH EXCAVATION

- A. Trenches shall be excavated to the dimensions shown on the Drawings, and as indicated in the following paragraphs.
- B. For pipe installation across existing pavement, cut edge of pavement in a uniform straight alignment on each side of excavation at a distance of approximately twelve inches beyond top of excavation. Maintain pavement cuts in good order until pipe installation and pavement patching operations are completed.
- C. If existing material below the trench bottom grade is unsuitable for properly laying pipe, as determined by the Engineer, excavate and remove the unsuitable material to a depth of approximately four inches and replace the same with Pipe Bedding Material (meeting the qualifications of subsection 2.02 of this Section) properly compacted to produce a firm and even bearing surface.
- D. Removal of materials beyond the indicated subgrade elevations, without authorization by the Engineer, shall be classified as unauthorized excavation and shall be backfilled and compacted at no additional cost to the Owner.
- E. Contractor shall remove water from the excavations as required for installation of piping, and placement of backfill and geotextile (if applicable), in accordance with

these specifications and the details shown on the Drawings.

- F. Contractor shall notify Engineer before proceeding with installation of fill material or piping.
- G. Cover:
 - 1. Contractor shall provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade:
 - a. Areas subject to vehicular traffic: 24 inches
 - b. Areas not subject to vehicular traffic: 12 inches
 - c. All areas:
 - i. Electrical cables: 42 inches
 - ii. Electrical ducts: 36 inches
 - 2. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, provided it will not interfere with the structural integrity of the slab or pavement.

3.04 PIPE INSTALLATION

- A. Engineer must approve pipe bedding prior to placement of piping.
- B. Installation of all pipe and appurtenances shall be subject to the review of the Engineer.
- C. Contractor shall install piping as shown on the Drawings and as specified in Section 02715.

3.05 BACKFILLING AND COMPACTING FOR PIPING

- A. This subsection includes backfilling only for piping outside the limits of the landfill.
- B. Contractor shall not completely backfill trenches until the piping system as installed conforms to the specifications.
- C. Contractor shall place haunching material around the pipe up to at least the pipe spring line. Haunching material shall be placed on both sides of the pipe at the same time and to approximately the same elevation. Contractor shall compact using manually-guided compaction equipment, being careful not to damage the pipe.
- D. Contractor shall place initial trench backfill over the pipe (if applicable), in layers not exceeding four inches loose thickness, up to approximately 12 inches above the top of the pipe. Each layer shall be thoroughly compacted using manually-guided compaction equipment.
- E. Final Trench Backfill shall be placed in layers not exceeding eight inches loose

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thickness up to final grade. For pipe crossing roads or adjacent to roads, backfill shall be compacted to achieve at least 95 percent of the material's maximum dry density as determined by ASTM D 698. The upper twelve inches of backfill below pavement subgrade shall be compacted to at least 95 percent maximum dry density.

- F. Compaction of Final Trench Backfill shall be performed in a manner that does not damage the pipe. Pipe that is damaged shall be replaced at the Contractor's expense.
- G. The minimum depth of compacted trench backfill or fill over pipelines shall be as indicated in subsection 3.03 above, or as otherwise shown on the Drawings. Construction traffic shall not be allowed to cross installed pipelines prior to placement of aggregate subbase for the pavement or crushed stone fill (as applicable), unless concrete cover (concrete arch) is provided over the pipe.

3.06 BACKFILL AND COMPACTING FOR GEOSYNTHETIC ANCHOR TRENCH

- A. Contractor shall place general fill material within geosynthetic anchor trench as shown on the Drawings.
- B. Material shall be placed in loose lifts of nine inches.
- C. Contractor shall compact fill with power tamper or wheel roll with proper moisture conditioning to meet 95 percent of the maximum dry density of the material at a maximum of six inch lifts, being careful not to damage geosynthetic material.

END OF SECTION

SECTION 02226

PROTECTIVE COVER LAYER

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes description of soil protective cover layer above geomembrane liner and geocomposite drainage net on side-slopes and floor of landfill cell. Also, includes on-site soil protective cover layer above geomembrane liner and Geotextile drainage net on final cover system.

- B. Related Sections
 - 1. Section 02220 - Excavation and Backfilling
 - 2. Section 02277 – Geomembrane
 - 3. Section 02278 - Geotextile and Geocomposite

1.02 REFERENCES

- A. Construction Quality Assurance Plan

- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 2434, Standard Test Method for Permeability of Granular Soils (Constant Head).
 - 3. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300.

- B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

- C. Submit as-built survey map of installed protective cover layer as shown on Drawings.

PART 2 PRODUCTS

2.01 PROTECTIVE COVER LAYER

A. Landfill Floor

1. All laboratory testing to evaluate the suitability or conformance of materials for the protective cover and barrier protective layer shall be carried out in accordance with the test methods indicated in Section 1.02.
2. The protective cover shall consist of on-site select fill material that is free of debris, foreign objects, large rock fragments, roots, and organic. The hydraulic conductivity of the protective cover shall be $K \geq 1 \times 10^{-5}$ cm/sec.
3. Soil testing will be provided by Owner through the Soils CQA Monitor and the Soils CQA Testing Laboratory.

B. Side-slopes of Landfill Cell

1. All laboratory testing to evaluate the suitability or conformance of materials for the protective cover and barrier protective layer shall be carried out in accordance with the test methods indicated in Section 1.02.
2. The protective cover shall be on-site select fill material that is free of debris, foreign objects, large rock fragments, roots, and organic.
3. Soil testing will be provided by Owner through the Soils CQA Monitor and the Soils CQA Testing Laboratory.

C. Landfill Cap

1. All laboratory testing to evaluate the suitability or conformance of materials for the protective cover and barrier protective layer shall be carried out in accordance with the test methods indicated in Section 1.02.
2. The protective cover shall consist of on-site select fill material that is free of debris, foreign objects, large rock fragments, roots, and organic.

3. Soil testing will be provided by Owner through the Soils CQA Monitor and the Soils CQA Testing Laboratory.

PART 3 EXECUTION

3.01 GENERAL

- A. Place material only when underlying leachate drainage layer material, leachate collection system and geosynthetics are completed.
- B. Place to the lines and grades shown on the Drawings.
- C. Place material in single uniform lifts of no less than 12 inches. Do not operate any equipment closer than 12 inches to underlying geosynthetics.
- D. Finish grade material to a tolerance of 0.1 foot.
- E. Do not compact material; only use track vehicles with ground pressures of five pounds per square inch (psi) or less to place material.
- F. Restrict rubber-tired vehicles (10,000-pound axle loads maximum) to areas with three feet of cover over underlying geosynthetics.
- G. Perform survey of approved prepared subgrade for as-built drawing of landfill cell in accordance with Section 01400.
- H. Perform depth checks on landfill cap protective cover to verify thickness (Survey would not be adequate due to settlement).

3.02 QUALITY ASSURANCE/QUALITY CONTROL

- A. The sand protective cover layer material shall be tested as outlined in Table 02226-1 below.

TABLE 02226-1

SAND PROTECTIVE COVER LAYER MATERIAL

TEST	ASTM METHOD	PASSING CRITERIA
<i>Pre-construction Testing:</i>		
Minimum of one test per source		
Classification	D 2487	GW, GP, SW, SP, SM, ML
Permeability	D 2434	1 x 10 ⁻⁵ cm/sec or greater
<i>Construction Testing:</i>		
Minimum of one test per source		
Classification	D 2487	GW, GP, SW, SP, SM, ML
Permeability	D 2434	1 x 10 ⁻⁵ cm/sec or greater

TABLE 02226-2

ON-SITE SELECT FILL PROTECTIVE COVER LAYER TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
<i>Pre-construction Testing</i>		
Minimum of one test per source		
Classification	D 2487	CL, ML, CH, SC
Permeability	D 2434	1 X 10 ⁻⁵ cm/sec or greater
<i>Construction Testing</i>		
Minimum of one test per source		
Classification	D 2487	CL, ML, CH, SC
Permeability	D 2434	1 x 10 ⁻⁵ cm/sec or greater

END OF SECTION

SECTION 02227

DRAINAGE AGGREGATE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes description of granular material placed in the toe drain and bench drains of the landfill final cover system, as shown on the Contract Drawings.
- B. Related Sections:
 - 1. Section 02220 - Excavation and Backfilling
 - 2. Section 02226 - Protective Cover Layer

1.02 REFERENCES

- A. *Construction Quality Assurance Plan*
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM D 422, Standard Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Test Results: The testing laboratory shall submit written reports of all specified tests, showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

PART 2 PRODUCTS

2.01 AGGREGATE

- A. Drainage aggregate shall be classified as a GP or GW in accordance with the Unified Soil Classification System (USCS) and ASTM D 422.

- B. Material shall be obtained from off-site sources and shall be relatively homogeneous, natural granular soils which are free of debris, foreign objects, large rock fragments, roots, and organics.
- C. The drainage aggregate shall be washed gravel or crushed aggregate with a maximum of 5% passing the 3/8-inch sieve. The maximum particle size shall be three inches in diameter.

PART 3 EXECUTION

3.01 GENERAL

- A. Place material only when underlying composite liner system is completed.
- B. Place to the lines and grades shown on the Drawings.
- C. Place material in single uniform lifts.
- D. Do not compact material.

3.02 QUALITY ASSURANCE/QUALITY CONTROL

- A. Washed Gravel shall be tested as outlined in Table 02227-1 below.

**TABLE 02227-1
 WASHED GRAVEL
 PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS**

TEST	ASTM METHOD	PASSING CRITERIA
<i>Pre-construction Testing:</i>		
Minimum of one test per source		
Grain Size Analysis	D 422	Maximum of 5% passing the 3/8-inch sieve Maximum particle size of 3 inches
Calcium Carbonate		Maximum 15%
USCS Classification	D2487	GW or GP
Permeability	D 2434	1 x 10 ⁻² cm/sec
<i>Construction Testing:</i>		
Minimum of one test per source		
Grain Size Analysis	D 422	Maximum of 5% passing the 3/8-inch sieve Maximum particle size of 3 inches
Permeability	D 2434	1 x 10 ⁻² cm/sec

END OF SECTION

SECTION 02230 COMPACTED CEMENT KILN DUST (CKD) LAYER

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction of the compacted CKD as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.
- B. The Contractor shall be prepared to coordinate the construction of the compacted CKD with other construction activities and subcontractors at the site.
- C. Notwithstanding the prequalification of any material sources for the compacted CKD, the Contractor shall be entirely responsible for meeting the requirements of this Section.
- D. The work of this Section shall include, but not necessarily be limited to, the construction of the composite liner CKD component of the final cover lining system.

1.02 RELATED SECTIONS

- A. Section 02200 – Earthwork
- B. Section 02277 – Geomembrane
- C. Section 02278 – Geotextile and Geocomposite

1.03 REFERENCES

- A. *Construction Quality Control Plan*
- B. Latest version of American Society for Testing and Materials (ASTM) standards:
 - 1. ASTM D 422 Standard Test Method for Particle-Size Analysis of Soils.
 - 2. ASTM D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 3. ASTM D 1140 Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-µm) Sieve.
 - 4. ASTM D 1556 Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 5. ASTM D 1557 Test Method for Laboratory Compaction Characteristics of Soil

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- Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
6. ASTM D 2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
 7. ASTM D 2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 8. ASTM D 6938 Standard Test Methods for Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 9. ASTM D 2937 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
 10. ASTM D 4220 Standard Practices for Preserving and Transporting Soil Samples.
 11. ASTM D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 12. ASTM D 5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter.
 13. ASTM D 5093 Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring.

1.04 SUBMITTALS

- A. The Contractor shall notify the Owner and CQA Consultant in a minimum of 3 days prior to starting construction of the compacted CKD. The notice shall state the source of the material to be used, the equipment to be used, the date and time that placement operations shall start, and the name of the person in the field who shall be in charge of the construction of the compacted CKD.
- B. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and CQA Consultant immediately and provide a plan and schedule for resumption of the work.

1.05 CONSTRUCTION QUALITY ASSURANCE

- A. The construction of the compacted CKD shall be monitored by the CQA Consultant 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 activities in the construction schedule.

PART 2 - PRODUCT

2.01 MATERIAL FOR COMPACTED CKD

- A. All laboratory testing to evaluate the suitability or conformance of soil materials for the compacted CKD shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.
- B. The compacted CKD shall consist of CKD material from on-site. The material shall meet the requirements of Part 2.01-D of this Section. The soils selected shall not be gap-graded or susceptible to piping. Materials which do not meet all the requirements of this Section shall be segregated at the source and not be permitted at the work area. Any material which is found by the CQA Consultant to be unsuitable shall be removed from the work area by the Contractor at no extra cost to the Owner.
- C. The compacted CKD shall have an in-situ (i.e., after compaction) hydraulic conductivity less than 1.0×10^{-5} cm/sec as measured in the laboratory.
- D. Soil testing shall be provided by the Owner through the CQA Consultant.

PART 3 - EXECUTION

3.01 FAMILIARIZATION

- A. Prior to implementing any work of this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section and the CQA Plan.
- B. Inspection:
 - 1. Prior to implementing any work of this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all such work is complete to the point where the installation of this Section may properly commence without adverse impact.
 - 2. If the Contractor has any concerns regarding the installed work of other Sections or the site, the Contractor shall notify the CQA Consultant and Owner in writing within 48 hours of the site inspection. Failure to notify the CQA Consultant and Owner of installation of the compacted CKD shall be construed as the Contractor's acceptance of the related work of all other Sections.

4.02 COMPACTED CKD PLACEMENT

- A. The Contractor shall construct the compacted CKD to the grades, slopes, and elevations shown on the Drawings and as specified in this Section.

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- B. No frozen or partially thawed compacted CKD material shall be placed, spread or compacted.
- C. No compacted CKD material shall be placed or spread while the surface on which the material is to be placed is frozen or thawing, during unfavorable weather conditions, or during periods of precipitation.
- D. The compacted CKD surface shall be made smooth and free from ruts or indentations at the end of every working day when precipitation is forecast and/or at the completion of the compaction operations in that area.
- E. The entire area shall be left in a manner to promote runoff at the end of each day.
- F. The final surface of the compacted CKD shall be compacted using a smooth drum or pneumatic wheel compactor. The equipment shall operate only over previously placed compacted CKD material.
- G. The compacted CKD material shall be placed in loose lifts which result in a maximum compacted lift thickness of 9 in. The total thickness of the compacted CKD layer shall not be less than the minimum thickness shown on the Drawings.
- H. The Contractor shall not proceed to the next lift until the current lift has been tested and approved by the CQA representative. The Contractor will be held responsible for proceeding to the next lift without prior approval from the CQA Firm.
- I. The compacted CKD material shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. The moisture condition as necessary to meet the compaction requirements. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 6938 (Method B) at the frequencies presented in the CQA Plan.
- J. The compacted CKD shall be sampled and tested for in-situ hydraulic conductivity (i.e. after compaction) at the frequencies and procedures outlined in the CQA Plan.

4.03 FIELD QUALITY CONTROL AND TESTING

A. Frequency:

1. The frequency of quality control testing is outlined below. The Contractor shall take this testing frequency into account in planning his construction schedule.
 - a. The minimum testing frequencies for material evaluation and construction quality evaluation shall be as presented in the CQA Plan.
 - b. Sampling locations shall be selected by the CQA Consultant. If necessary, the location of routine in-place moisture content and dry density tests shall be determined using a non-biased sampling plan.
 - c. Undisturbed compacted CKD material samples for laboratory hydraulic conductivity testing shall be taken with the assistance of the Contractor such that the sample tube is inserted vertically into the compacted CKD with a continuous smooth stroke from the construction equipment used to drive the sampler.
 - d. A special testing frequency shall be used at the discretion of the Owner and/or the CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas shall be considered when:
 - i. the rollers slip during rolling operation;
 - ii. the lift thickness is greater than specified;
 - iii. the compacted CKD soil is at improper and/or variable moisture content;
 - iv. fewer than the specified number of roller passes are made;
 - v. dirt-clogged rollers are used to compact the material;
 - vi. the rollers do not have optimum ballast; or
 - vii. the degree of compaction is doubtful.
 - e. During construction, the frequency of testing may also be increased in the following situations:
 - i. adverse weather conditions;
 - ii. breakdown of equipment;
 - iii. at the start and finish of grading;
 - iv. if the material fails to meet specifications; or
 - v. the work area is reduced.

B. Perforations:

1. Perforations in the compacted CKD that must be filled shall include, but not be limited to, the following:
 - a. nuclear density test probe locations;
 - b. hydraulic conductivity sampling locations; and
 - c. test pit locations.
2. Perforations in the compacted CKD shall be backfilled with similar CKD material and compacted to achieve a hydraulic conductivity less than 1×10^{-5} cm/s. Alternatively, bentonite chips or pellets may be used.

C. Defective Areas:

1. If a defective area is discovered in the compacted CKD, the CQA Consultant shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the defect.
2. After determining the extent and nature of a defect, the CQA Consultant shall notify the Contractor and schedule appropriate retests when the work deficiency has been corrected.
3. The Contractor shall correct the deficiency to the satisfaction of the CQA Consultant. The cost of corrective actions shall be borne by the Contractor.
4. All retests recommended by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant shall also verify that all installation requirements are met and that all submittals are provided.

4.04 SURVEY CONTROL

- A. The contractor shall be responsible for all layout work. Once the Compacted CKD Liner is completed and CQA verified, the Contractor shall be responsible for providing certification surveying of the top of Compacted CKD Liner at 100 ft. intervals. Final elevations of the top of Compacted CKD surface shall be 0 to +0.1 ft. compared to the grades shown on the Construction Drawings.

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4.05 PRODUCT PROTECTION

- A. The Contractor shall use all means necessary to protect all prior work, including all materials and completed work specified in this and other Sections.

- B. In the event of damage to prior work or work completed as specified in this section, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Owner and CQA Consultant and at no additional cost to the Owner.

END OF SECTION

SECTION 02273

ROLLED EROSION CONTROL PRODUCT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes furnishing and installing rolled erosion control product (RECP) to provide surface stabilization of drainage ditches and slopes as directed by the Engineer.

1.02 SUBMITTALS

- A. Manufacturer's certificates of compliance with the specifications.

PART 2 - PRODUCTS

2.01 ROLLED EROSION CONTROL PRODUCT

- A. Shall be a wood machined mat of curled wood excelsior, CURLEX I, with standard polypropylene netting, as manufactured by American Excelsior Company, P.O. Box 17873, 313 Phillips Road, North Little Rock, Arkansas 72117, (501) 945-4661 or (800) 432-2217, or approval equal.
 - 1. Install CURLEX I where indicated on the Drawings or directed by Engineer.

PART 3 - EXECUTION

3.01 SITE PREPARATION

- A. Redirect runoff away from the area to be covered during installation of matting.
- B. Grade surface of installation area, shaping and smoothing the soil. Remove significant soil clods, rocks, roots, trash, or vehicle imprints.

3.02 INSTALLATION OF RECP

- A. Distribute lime fertilizer and seed over prepared soil surface as specified in Section 02930 prior to placement of RECP

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- B. Place RECP in areas as directed by the Engineer
- C. Secure RECP on the slopes as shown on the Drawing.
- D. Roll RECP over the prepared soil surface using sequence, arrangement, and overlapping of adjacent sections, as shown on the Drawing.
- E. Installed RECP shall lay flush with the soil surface, in correct alignment and location, and properly anchored to prevent displacement.
- F. No heavy earthwork equipment shall be allowed on the installed RECP.

END OF SECTION 02273.

SECTION 02277

GEOMEMBRANE

PART 1 GENERAL

1.01 SUMMARY

Section includes furnishing and installing geomembrane as part of landfill liner and cover system construction, which will be done by others.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 6693, Standard Test Method for Tensile Properties of Plastics.
2. ASTM D 746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
3. ASTM D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
4. ASTM D 1204, Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
5. ASTM D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastomer.
6. ASTM D 1505, Standard "Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
8. ASTM D 6392, Standard Practice for Determining the Integrity of Field Seams Used in joining Flexible Polymeric Sheet Geomembranes.
9. ASTM D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
10. ASTM D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembrane.
11. ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

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- B. FTM Standard Number 101C, Method 2065, Puncture Resistance and Elongation Test (1/8 inch Radius Probe Method).
- C. GRI Test Method GM6, "Pressurized Air Channel Test for Dual Seamed Geomembranes".
- D. GRI Test Method GM17 "Standard Specification for LLDPE Geomembranes".
- E. GRI Test Method GM19 "Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes".

1.03 SUBMITTALS

- A. Submit the following to the CQA Firm, for review and approval, no later than 14 calendar days prior to scheduled shipment of geomembrane:
 - 1. Documentation of manufacturers' qualifications as specified in subsection 1.04.A of this Section.
 - 2. Manufacturer's quality control program manual, or descriptive documentation.
 - 3. List of material properties and samples of the material.
 - 4. Manufacturers' certification that the products to be furnished will comply with all product specifications in this section.
 - 5. Documentation of installers' qualifications, as specified below and in subsection 1.04.E of this Section.
 - a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of Owner, Design Engineer, Manufacturer, Fabricator, if applicable; name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; and type of seaming, patching, and tacking equipment.
 - b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and all technicians to be assigned to this project.
- B. Shop Drawings

1. Submit copies of shop drawings for approval as soon as possible after award of contract. Shop drawings shall show a proposed installation panel layout identifying seams and details. The layout diagram shall indicate the location of pre-assembled panels.
 2. Placement of geomembrane will not be allowed to proceed until CQA Firm has received and approved the shop drawings. Any proposed deviation from these documents shall be submitted in writing to the CQA Firm a minimum of one to two working days prior to the scheduled start of geomembrane installation and will be accepted/rejected by the CQA Firm prior to start of installation activities.
- C. Submit the following to the CQA Firm for review and approval no later than one calendar day prior to shipment of the products:
1. Origin and quality control certificates from the supplier of the resin used to manufacture the geomembrane, and certification that the properties of the resin meet the requirements for the project.
 2. The manufacturers' quality control certifications, including results of source quality control testing of the products, as specified in subsection 2.01 of this Section, to verify that the materials supplied for the project are in compliance with all product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
- D. No geomembrane shall be deployed until the certifications and quality control certificates are submitted to and approved by the CQA Firm. Should geomembrane material be deployed prior to CQA Firm's approval, it shall be at sole risk of the Geomembrane Installer and Contractor, and if the material does not meet project specifications, it shall be removed from the project at the expense of the Contractor.
- E. Additional Submittals (In-Progress and at Completion):
1. Quality Control test results (refer to subsection (2.01.A.4)).
 2. Manufacturer's warranty (refer to subsection 1.06).
 3. Liner installation guarantee (refer to subsection 1.07).

4. Inventory of geomembrane rolls received on-site (refer to subsection 1.05.C).
5. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
6. Low temperature-seaming procedures, if applicable (refer to subsection 3.03.A).
7. Pre-qualification test seam samples (refer to subsection 3.05.A.3).
8. Non-destructive field seam test results (refer to subsection 3.05.13.1).
9. Destructive field seam test results (refer to subsection 3.05.C.5).
10. As-built survey drawing, as discussed in subsection 3.06.

1.04 QUALITY CONTROL/QUALITY ASSURANCE

- A. Owner will retain the services of independent inspection and testing firms (Geosynthetics Quality Assurance Firm and Geosynthetics Quality Assurance Laboratory) to perform quality control and to check conformance of the materials and field seaming with the specification.
- B. Codes and Standards: Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.
- C. Furnish all labor, materials, equipment, services, incidentals and other items necessary for the placement and installation of geomembrane as shown on the Contract Drawings and as specified herein.
- D. Manufacturer's Qualifications: The manufacturer shall be a specialist in the manufacture of geomembrane of the type and shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 square feet of the specified type of geomembrane during the last five years.
- E. Installer's Qualifications
 1. The Geomembrane Installer shall be the manufacturer or an approved contractor trained and licensed to install the manufacturers geomembrane.
 2. The Geomembrane Installer shall be a specialist in the installation of geomembranes of the type specified and shall have at least five years experience in the installation of such geomembranes.
 3. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on site and be in responsible

charge, throughout the liner installation, for liner layout, seaming, patching, testing, repairs, and all other activities by the Installer.

4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Installation Supervisor or Crew Foreman). The Master Seamer shall have experience in the same type of geomembrane specified, using the same type of seaming apparatus specified in the current project. This Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.
5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians trained by the Geomembrane Installer.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.
- B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
- C. Provide all labor and equipment required to assist the CQA Firm in the observation of materials delivered to the site. Generate, update and submit to the CQA Firm an inventory of geomembrane rolls received on-site from the manufacturer/distributor. The inventory shall include all the information appearing on the label of each roll.
- D. Rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two rolls high.

1.06 MATERIAL WARRANTY

- A. Membrane manufacturer shall warrant the membrane material against manufacturing defects and material degradation in the outdoor exposure for a period of 20 years from the date of installation.
- B. The manufacturer shall provide new material to replace, on a prorated basis over the remaining life of the membrane, any material, which fails from the above causes within the warranty period.

- C. The manufacturer shall furnish the CQA Firm with a written warranty covering the requirements of this paragraph.

1.07 LINER INSTALLATION GUARANTEE

- A. Guarantee the membrane installation against defects in installation and workmanship for one year commencing with the date of final acceptance.
- B. The guarantee shall include the services of qualified service technicians and all material required for the repairs at no expense to the Owner.

1.08 GEOMEMBRANE PRE-CONSTRUCTION MEETING

- A. A Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. As a minimum, the meeting shall be attended by the Geomembrane Installer, Project Manager, CQA Firm and/or his representative, and Contractor.
- B. Topics for this meeting shall include:
 - 1. Responsibilities of each party.
 - 2. Lines of authority and communication.
 - 3. Methods for documenting and reporting, and for distributing documents and reports.
 - 4. Procedures for packaging and storing archive samples.
 - 5. Review of time schedule for all installation and testing.
 - 6. Review of panel layout and numbering systems for panels and seams.
 - 7. Preparation of the as-built panel and seam drawing.
- C. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. Manufacturing Quality Control
 - 1. Every effort shall be made to minimize the number of lots of geomembrane needed to complete the work.

2. The following test methods shall be used by the manufacturer for the quality control/quality assurance of the geomembrane prior to delivery.
 - a. Density - ASTM D 1505/D 792 (min. one test per 200,000 lbs);
 - b. Carbon Black Content - ASTM D 1603 or 4218 (min. one test per 20,000 lbs);
 - c. Carbon Black Dispersion - ASTM D 5596 (min. one test per 45,000 lbs);
 - d. Thickness - ASTM D 5994 (min. one test per roll);
 - e. Tensile Properties - ASTM D 6693 (min. one test per 20,000 lbs); and
 - f. Puncture Resistance - ASTM D 4833 (min. one test per 45,000 lbs).
3. Results of environmental stress crack resistance test (ASTM D 5397 - single point). At a minimum, test value shall be 200 hr. and test shall be performed once every resin lot.
4. Quality Control certificates, signed by a responsible party employed by the Manufacturer, shall be submitted to the CQA Firm prior to the installation of the geomembrane. The certificates shall include roll identification numbers, testing procedures, and results of quality control tests.

B. Conformance Testing

1. Upon the delivery of the geomembrane rolls to the project site, a qualified representative of the CQA Firm shall obtain samples of the material at a frequency of at least one sample per 100,000 square feet and at least one sample per lot of material shipped, and forward the samples to the Geosynthetics Quality Assurance Laboratory for conformance testing. Alternatively, sampling at the manufacturer may be scheduled by request to the geosynthetics testing firm.
2. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The CQA Firm representative shall mark the machine direction on the samples.
3. Conformance testing shall include the following tests, as a minimum:
 - a. Density or Specific Gravity - ASTM D 1505 or ASTM D 792 Method A
 - b. Carbon Black Content - ASTM D 1603 or 4218
 - c. Carbon Black Dispersion - ASTM D 5596

- d. Thickness - ASTM D 5994 (textured) or ASTM D 5199 (smooth)
- e. Tensile Properties (Break Strength and Elongation at Break) - ASTM D 6693, Type IV or GRI-GM-17
- f. Puncture Resistance – ASTM D 4833
- g. Tear Resistance - ASTM D 1004, Die C

2.02 GEOMEMBRANE

- A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane shall be an unmodified seamless, linear low-density polyethylene (LLDPE) containing no plasticizers, fillers, chemical additives, or extenders. The geomembrane shall be textured on both sides and shall be supplied as a continuous sheet with no factory seams in rolls. The roll length and width shall be maximized to provide the largest manageable sheet for the fewest field seams.
- B. The geomembrane material shall be produced free of holes, blisters, undispersed raw materials or any signs of contamination by foreign matter. Defects shall be repaired by replacement and by using the extrudate welding technique in accordance with the manufacturer's recommendations.
- C. The geomembrane shall be 40-mil LLDPE (textured) for bottom and slope lining.
- D. Physical Properties
 - 1. Geomembrane for the bottom lining and final cover systems shall meet or exceed the following specifications:

**TABLE 02277-1
 GEOMEMBRANE MATERIAL SPECIFICATIONS**

Property	Units	Test Method	40-mil LLDPE Textured	Testing Frequency (minimum)
Thickness <ul style="list-style-type: none"> • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values 	mils	ASTM D 5994	Nom. (-5%) -10% -15%	Per roll
Asperity Height (1)	mils	GM 12	10	Every 2 nd roll (2)
Density	g/ml	ASTM D 1505/D 792	0.939	200,000 lb
Tensile Properties (3) <ul style="list-style-type: none"> • Break strength • Break elongation 	lb/in %	ASTM D 6693 Type IV	60 250	20,000 lb
2% Modulus	lb/in	ASTM D 5323	2400	Per formulation
Tear Resistance	lb	ASTM D 1004	22	45,000 lb
Puncture Resistance	lb	ASTM D 4833	44	45,000 lb
Axi-Symmetric Break Resistance Strain	%	ASTM D 5617	30	Per formulation
Carbon Black Content	%	ASTM D 1603 (4)	2.0-3.0	45,000 lb
Carbon Black Dispersion	Category	ASTM D 5596	Note (5)	45,000 lb

- (1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 9.
- (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 gage length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 in Categories 1 or 2 and 1 in Category 3

**TABLE 02277-2
 GEOMEMBRANE SEAM SPECIFICATIONS**

Type of Material	ASTM Method	Peel Extrusion	Peel Fusion	Shear Extrusion	Shear Fusion
40-mil LLDPE Textured	ASTM D 6392	44 PPI and FTB	50 PPI and FTB	60 PPI	60 PPI

Values listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of listed values

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. The subgrade shall be prepared as specified in Section 02200. The subgrade shall be smooth and uniform, and free of all trash and debris, prior to installation of the geomembrane.

- B. The Geomembrane Installer and the CQA Firm representative shall walk over the surface to be covered with geomembrane on each day's operations prior to placement of geomembrane.
- C. The Geomembrane Installer shall provide to the CQA Firm written acceptance daily for the surface to be covered by geomembrane in that day's operations. The surface shall be maintained as acceptable during geomembrane installation.
- D. Subgrade damaged by construction equipment during the geomembrane deployment operation shall be repaired prior to placement of the geomembrane. The repairs shall be approved by the CQA Firm or his representative.
- E. Subgrade damaged by erosion, rutting, or other means following geomembrane deployment shall be exposed and the damage repaired. Repairs shall be in accordance with Section 02220. The subgrade shall be re-approved in accordance with subsection 3.01.C of this section.

3.02 GEOMEMBRANE PLACEMENT

- A. The geomembrane shall be installed as shown on the Drawings.
- B. Panel Nomenclature
 - 1. A field panel is defined as unit of geomembrane, which is to be seamed in the field. A field pane is a roll or a portion of a roll cut in the field. The CQA Firm shall be responsible to ensure that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be as simple and logical as possible and shall be agreed upon by the Project Manager, Installer and CQA Firm.
 - 2. The CQA Firm shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.
- C. Panel Deployment Procedure
 - 1. The CQA Firm shall review the panel deployment progress of the Installer and advise the Project Manager on changes in panel deployment. The CQA Firm shall also review the panel deployment for suitability to actual field condition such as issues relating to wind, rain, soil liner desiccation and other site-specific conditions. The CQA Firm shall verify that the condition of the underlying soil does not change detrimentally during installation. The CQA Firm shall record the identification code, location, and date of installation of each field panel.

D. Deployment Weather Conditions

1. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.
2. The normal acceptable weather conditions for seaming are as follows:
 - a. Ambient temperature between 32° F and 104° F.
 - b. Dry conditions (no precipitation or other excessive moisture).
 - c. No excessive winds.
3. Ambient temperature shall be measured and ambient conditions appraised by the CQA Firm in the area in which the panels area to be placed.
4. The CQA Firm shall inform the Project Manager of any weather-related problems, which may not allow geomembrane placement to proceed. The Project Manager will determine if the installation is to be stopped or special procedures are to be used.

E. Method of Deployment

1. Before the geomembrane is handled on site, the CQA Firm shall verify that deployment equipment and method of deployment proposed by the Installer to be used on the site is adequate and does not pose risk of damage to the geomembrane or underlying subgrade. If vehicles are used which must operate on the geomembrane, driver shall proceed with caution during deployment of the geomembrane to prevent spinning of tires, sharp turns and quick stops. During handling, the CQA Firm shall observe and verify that the Installer's personnel handle the geomembrane with care.
2. The CQA Firm shall verify the following:
 - a. Equipment used does not damage the geomembrane or underlying subgrade by handling.
 - b. The prepared surface underlying the geomembrane is acceptable immediately prior to geomembrane placement.
 - c. Geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

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- d. Personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities, which could damage the geomembrane.
- e. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting roll.
- f. The method used to place the panels minimizes wrinkles especially differential wrinkles between adjacent panels.
- g. Adequate temporary lading and/or anchoring (such as sandbags or tires), not likely to damage the geomembrane, are placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.
- h. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where repeated traffic use may be expected.
- i. Liner has promptly been anchored in trench where applicable.

The CQA Firm shall notify the Project Manager if the above conditions are not fulfilled.

F. Damage and Defects

1. Upon delivery to the site, the CQA Firm shall conduct a surface observation of all rolls for defects and for damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. The CQA Firm shall advise the Project Manager, in writing, of any rolls or portions of rolls, which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.
2. The CQA Firm shall examine each panel, after placement and prior to seaming, for damage and/or defects. The CQA Firm shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the CQA Firm. Repairs shall be made using procedures described in 3.06 of this section.

G. Writing on the Liner

To avoid confusion, the Installer and the CQA Firm shall each use different colored markers or other materials approved by the Project Manager that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane. The Installer shall use a white marker to write on the geomembrane while the CQA Firm shall use a yellow marker.

3.03 FIELD SEAMING

A. Seam Layout

1. Before installation begins, the Installer shall provide the Project Manager and the CQA Firm's with a panel layout drawing. The drawing shall present all the proposed seams of the lining system at the facility. The CQA Engineer shall review the panel layout drawing and verify that it is consistent with accepted industry standards.
2. In general, seams should be oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than five feet from the toe or crest of the slope, or from areas of potential stress concentrations, unless otherwise authorized by the Project Manager.
3. Horizontal seams shall be allowed under the following conditions:
 - a. Seams are offset in adjacent panels by one panel width.
 - b. Seams are "shingled" downhill.
4. A seam numbering system compatible with the panel numbering system shall be used by the CQA Firm.

B. Accepted Seaming Methods

1. Approved processes for field seaming are fusion and extrusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Project Manager for approval. The Project Manager shall submit all documentation regarding seaming methods to be used to the CQA Firm for review.

2. Fusion Process

- a. The CQA Firm shall log ambient, seaming apparatus and geomembrane surface temperatures at appropriate intervals and report any noncompliance to the Project Manager.
- b. The CQA Firm shall also verify that:
 - i. The Installer maintains on-site the number of spare operable seaming apparatus agreed at the pre-construction meeting.
 - ii. Equipment used for seaming is not likely to damage the geomembrane.
 - iii. The electrical generator is placed on a smooth base such that no damage occurs to the geomembrane and any fuel spills are promptly cleaned up. Fuel shall not be stored on the liner surface.
 - iv. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.
 - v. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and to prevent debris from collecting around the pressure rollers.
 - vi. In general, the geomembrane panels shall be aligned to have an overlap of four to six inches for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
 - vii. No solvent or adhesive is used.
 - viii. The geomembrane is protected from damage in heavy traffic areas.

3. Extrusion Process

- a. The CQA Firm shall log ambient, seaming apparatus and geomembrane surface temperatures at appropriate intervals and report any noncompliance to the Project Manager.
- b. The CQA Firm shall also verify that:

- i. The Installer maintains on-site the number of spare operable seaming apparatus agreed at the pre-construction meeting.
- ii. Equipment used for seaming is not likely to damage the geomembrane.
- iii. Prior to beginning a seam, the extruder is purged until all heat degraded extrudate has been removed from the barrel.
- iv. Clean and dry welding rods or extrudate pellets are used.
- v. The electric generator is placed on a smooth base that no damage occurs to the geomembrane.
- vi. Grinding is completed no more than one hour prior to seaming.
- vii. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.
- viii. The geomembrane is protected from damage in heavy traffic areas.
- ix. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instances shall exposed grinding marks extend more than 1/4 inch from the finished seamed area.
- x. In general, the geomembrane panels are aligned to have a nominal overlap of three inches for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
- xi. No solvent or adhesive is used.
- xii. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged.

C. Seam Preparation

1. The CQA Firm shall verify that prior to seaming; the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the CQA Firm must ensure that the process is completed according to the Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The CQA Firm shall also verify that seams are aligned with the fewest number of wrinkles and "fishmouths".

D. Trial Seams

1. Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Trial seams shall be made under the same conditions as production seams.
2. The trial seam sample shall be at least five feet long by one foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 3.03 B. Three specimens shall be cut from the sample with one-inch wide die.
3. The specimens shall be tested in peel and shear using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. They should not fail in the seam as described in Section 3.05 E. If a specimen fails, the entire trial seam operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The CQA Firm shall observe all trial seam procedures.
4. The remainder of the successful trial seam sample shall be retained until project completion in the CQA Firm's archives for possible laboratory testing. Each sample shall be assigned a number and marked accordingly by the CQA Firm, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.
5. If agreed upon by the Project Manager and the CQA Engineer, and documented by the CQA Engineer in his daily report, the remaining portion of the trial seam sample can be subjected to destructive testing as indicated in Section 3.05 F. If a trial seam sample fails a test conducted by the CQA Laboratory, then a destructive seam test sample shall be taken from each of

the seams completed by the seamer during the **shift related the subject trial** seam. These samples shall be forwarded to the CQA Laboratory and, if they fail the tests, the procedure indicated in Section 3.05 G shall apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

E. General Seaming Procedures

1. During general seaming, the CQA Firm shall ensure the following:
 - a. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of six inches beyond the cut in all directions.
 - b. If seaming operations are carried out at night, adequate illumination shall be provided.
 - c. Seaming shall extend to the outside edge of panels placed in the anchor trench.
 - d. All cross seam tees should be extrusion welded to a minimum distance of four inches on each side of the tee.
 - e. A firm substance may be required to be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

The CQA Firm shall verify that the above seaming procedures or any other procedures agreed upon and indicated in the project Quality Assurance Plan are followed, and shall inform the Project Manager of any nonconformance.

F. Seaming Weather Conditions

1. Cold Weather Conditions
 - a. To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32° F, the following conditions shall be met:

- i. Geomembrane surface temperatures shall be determined by the CQA Firm at intervals of at least once per 100 feet of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32° F.
- ii. For fusion welding, preheating may be waived by the Project Manager based on a recommendation for the CQA Engineer, if the Installer demonstrates to the CQA Engineer's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
- iii. If preheating is required, the CQA Firm shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.
- iv. Care shall be taken to conform that wind chill does not adversely affect the pre-heat requirements specified for welding. It may be necessary to provide wind protection for the seam area.
- v. All preheating devices shall be approved prior to use by the Project Manager.
- vi. Sheet grinding may be performed before preheating, if applicable.
- vii. Trial seaming, as described in Section 3.04 D, shall be conducted under the same ambient temperature conditions as the production seams. At the option of the CQA Firm, additional destructive tests may be required for any suspect areas.

3.04 NON-DESTRUCTIVE SEAM TESTING

A. Concept

The Installer shall nondestructively test all field seams over their full length using an air pressure test (for double fusion seams only), a vacuum test or other approved method. Air pressure testing and vacuum testing are described in Sections 3.04 B and 3.04 C, respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. For all seams, the CQA Firm shall:

1. Observe nondestructive testing procedures.
2. Record location, data, test unit number, name of tester, and outcome of all testing.
3. Inform the Installer and Project Manager of any required repairs.

B. Air Pressure Testing

1. Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.
 - a. The equipment for air pressure testing shall consist of the following:
 - i. An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.
 - ii. A rubber hose with fittings and connections.
 - iii. A sharp hollow needle or other pressure feed device, approved by Project Manager.
 - b. The following procedures shall be followed:
 - i. Seal both ends of the seam to be tested.
 - ii. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
 - iii. Insert a protective cushion between the air pump and the geomembrane.
 - iv. Pressurize the air channel to a pressure of approximately 30 psi. Close valve, allow two minutes for pressure to stabilize, and sustain pressure for at least five minutes.
 - v. If loss of pressure exceeds the maximum permissible pressure differential as outlined in the project specifications or does not stabilize, locate faulty area and repair in accordance with Section 3.06 C.
 - vi. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seam the cut end of the air channel.
 - vii. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

C. Vacuum Testing

1. Vacuum testing is applicable to extrusion welding and to non-seam areas of the liner.
 - a. The equipment shall consist of the following:
 - i. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
 - ii. A pump assembly equipped with a pressure controller and pipe connections.
 - iii. A rubber pressure/vacuum hose with fittings and connections.
 - iv. A soapy solution. (CQA Firm shall ensure solution makes bubbles when air is passed through. Windshield washer fluid shall be used as anti-freeze in cold weather.)
 - v. A bucket and wide paintbrush, or other means of applying the soapy solution.
 - b. The following procedures shall be followed:
 - i. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.
 - ii. Place the box over the wetted area.
 - iii. Close the bleed valve and open the vacuum valve.
 - iv. Ensure that a leak-tight seal is created.
 - v. Energize the vacuum/venturi pump and reduce the applied pressure to approximately five psi (10 in of Hg) gauge.
 - vi. For a minimum of ten seconds, apply vacuum with the box placed and maintaining a seal, examine the geomembrane through the viewing window for the presence of soap bubbles.
 - vii. If no bubble appears after ten seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three inches overlap, and repeat the process.
 - viii. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.06 C. D. Test Failure Procedures.
2. The Installer shall complete any required repairs in accordance with Section 3.06. For repairs, the CQA Engineer shall:

- a. Observe the repair and testing of the repair.
- b. Mark on the geomembrane that the repair has been made.
- c. Document the repair procedures and test results.

3.05 DESTRUCTIVE SEAM TESTING

A. Concept

1. The purpose of destructive tests is to evaluate seam strength. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

B. Location and Frequency

1. The CQA Firm shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:
 - a. A minimum frequency of one test location per 500 feet of production seam length. This frequency is to be determined as an average taken throughout the entire facility.
 - b. Test locations shall be determined during seaming at the CQA Firm's discretion. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, and offset welds exist.
2. The Installer shall not be informed in advance of the locations where the seam samples will be taken.

C. Sampling Procedures

1. The Installer shall cut samples at locations chosen by the CQA Firm as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The CQA Firm shall:
 - a. Observe sample cutting.
 - b. Assign a number to each sample, and mark it accordingly.
 - c. Record sample location on layout drawing.
 - d. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

2. All holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Section 3.06 C immediately following receipt of successful test results. The continuity of the new seams in the repaired area shall be tested according to Section 3.04 C.

D. Sample Dimensions

1. At each sampling location, two types of samples shall be taken by the Installer. First, two specimens for field-testing should be taken. Each of these samples shall be cut with a one inch wide die, with the seam centered parallel to the width. The distance between these two samples shall be 30 inches. If both samples pass the field test described in Section 3.05 E, a sample for laboratory testing shall be taken.
2. The sample for laboratory testing shall be located between the samples for field-testing. The sample for laboratory testing shall be 12 inches wide by 30 inches long with the seam centered lengthwise. The sample shall be cut into two parts and distributed as follows:
 - a. One 12 inches wide by 18 inches long portion for conformance testing by the CQA Laboratory.
 - b. One 12 inches wide by 12 inches long portion to the CQA Firm.
3. Final determination of the sample sizes shall be made at the pre-construction meeting.

E. Field Testing

1. The three one inch wide specimens mentioned in Section 3.03 D and Section 3.05D shall be tested in the field using a tensiometer for peel and shear and shall not fail according to the criteria in the project specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it is non-conforming, the seam should be repaired in accordance with Section 3.05 G. Final judgment regarding seam acceptability, based on the conformance criteria provided in the project specifications, rests with the CQA Engineer.
2. The CQA Firm shall witness all field tests and mark all samples and portions with their number. The CQA Firm shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

F. Laboratory Testing (on or off-site)

1. Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Firm in a manner, which will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing. The CQA Firm will be responsible for storing the archive samples. Test samples shall be tested by the CQA Laboratory.
2. Testing shall include seam strength and peel adhesion (ASTM D4437). The minimum acceptable values to be obtained in these tests are provided in Section 2.02 D. At least four specimens shall be tested successfully, each in both shear and peel. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A passing test shall meet the minimum acceptable values in at least four of the five specimens tested for each method.
3. The CQA Laboratory shall provide test results within 24 hours of receiving the samples. The CQA Engineer shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

G. Destructive Test Failure

1. When a sample fails a destructive test, whether that test is conducted by the CQA Laboratory or by field tensiometer, the Installer has two options:
 - a. The Installer can repair the seam between any two passing destructive test locations.
 - b. The Installer can trace the welding path to an intermediate location ten feet minimum from the point of the failed test in each direction and take a sample with a one inch wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.
2. All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 3.03 D may be used as a boundary for the failing seam. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which the seam

has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 3.06.

3. The CQA Firm shall document all actions taken in conjunction with destructive test failures.

3.06 DEFECTS AND REPAIRS

A. Identification

1. All seams and non-seam areas of the geomembrane shall be examined by the CQA Firm for identification of defects, holes, blisters, undispersed raw materials, large wrinkles and any sign of contamination by foreign matter. The geomembrane surface shall be cleaned by the Installer prior to examination if the CQA Firm determines that the amount of dust or mud inhibits examination.

B. Evaluation

1. Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 3.04. Each location, which fails the nondestructive testing, shall be marked by the CQA Firm and repaired by the Installer. Work shall not proceed with any materials, which will cover locations, which have been repaired until successful nondestructive and/or laboratory tests are obtained.
2. When seaming of the geomembrane is completed, and prior to placing overlying materials, the CQA Firm shall indicate to the Project Manager any large wrinkles, which should be cut and resealed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation period, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to itself, which is generally a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be nondestructively tested.
3. When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the CQA Firm to ensure that wrinkle formation is minimized and that, in all cases, the geomembrane is not folded over on itself.

C. Repair Procedures

1. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, Designer, and CQA Firm.
 - a. The repair procedures available include:
 - i. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.
 - ii. Spot welding used to repair pinholes, or other minor, localized flaws.
 - iii. Capping, used to repair large lengths of failed seams.
 - iv. Extrusion welding the flap, used to repair areas of inadequate fusion seams which have an exposed edge.
 - v. Removing bad seam and replacing with a strip of new material welded into place.
 - b. For any repair method, the following provisions shall be satisfied:
 - i. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair.
 - ii. All surfaces shall be clean and dry at the time of repair.
 - iii. All seaming equipment used in repairing procedures shall meet the requirements of the project Quality Assurance Plan.
 - iv. Patches or caps shall extend at least six inches beyond the edge of the defect and all corners of patches shall be rounded with a radius of approximately three inches.

D. Repair Verification

1. The CQA Firm shall observe all nondestructive testing of repairs and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the methods described in Section 3.04 as appropriate. Repairs, which pass the nondestructive test, shall be taken as an indication of an adequate repair. Repairs more than 150 consecutive feet long require destructive test sampling. Failed tests require that the repair shall be redone and retested until a passing test result.

3.07 GEOMEMBRANE PROTECTION

- A. The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality assurances of the adjacent materials themselves are covered in separate Sections of this manual.

- B. Soils
 - 1. A copy of the project specifications prepared by the Designer for placement of soils shall be given to the CQA Engineer by the Project Manager. The CQA Engineer shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:
 - a. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32° F nor above 104° F unless otherwise specified.
 - b. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.
 - c. Equipment used for placing soil shall not be driven directly on the geomembrane.
 - d. A minimum thickness of one foot of soil is specified between a light dozer, ground pressure of five-psi or lighter, and the geomembrane.
 - e. In any areas traversed by construction traffic (any vehicles other than deployment equipment approved by the Project Manager) the soil layer shall have a minimum thickness of three feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.
 - 2. The CQA Firm shall measure soil thickness and verify that the required thickness is present. The CQA Firm must also verify that final thickness is consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The CQA Engineer shall inform the Project Manager if the above conditions are not fulfilled.

- C. Sumps and Appurtenances

1. A copy of the plans and project specifications prepared by the Designer for sumps and appurtenances shall be given by the Project Manager to the CQA Firm. The CQA Firm shall review these plans and verify that:
 - a. Installation of the geomembrane in sump and appurtenant areas, and connection of geomembrane to sumps and appurtenances have been made according to project specifications.
 - b. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.
 - c. The geomembrane has not been visibly damaged while making connections to sumps and appurtenances.
 - d. A representative of the CQA Firm shall be present at all times when the Installer is welding geomembrane to appurtenant structures.
2. The CQA Firm shall inform the Project Manager in writing if the above conditions are not fulfilled.

D. Concrete

1. A copy of the project specifications prepared by the Designer for placement of concrete shall be given by the Project Manager to the CQA Firm. The CQA Firm shall verify that these specifications are consistent with the state-of practice, including the use of geosynthetic layers between concrete and geomembrane. The CQA Firm shall verify that geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. The CQA Firm will also verify that construction methods used are not likely to damage the geomembrane.
- E. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test seam. The Geomembrane Installer shall then take more destructive test portions at locations indicated by the CQA Firm and the same laboratory tests required of test seams shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip. The cap-strip shall be non-destructively tested and repaired, as required, until adequacy of the seams is achieved.
- F. A passing non-destructive test of field seams and repairs shall be considered to indicate the adequacy of field seams and repairs.

3.08 ANCHOR TRENCH

Construct as specified in Section 02220.

3.09 DISPOSAL OF SCRAP MATERIALS

On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location approved by the Owner, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

END OF SECTION

SECTION 02278

GEOTEXTILES AND GEOCOMPOSITES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes furnishing and installing geotextile and geocomposite as part of the Landfill final cover system.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 1. ASTM D 413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
 2. ASTM D 7179, Standard Test Method for Determining Geonet Breaking Force.
 3. ASTM D 1505, Standard Test Method for Density of Plastics by the Density Gradient Technique.
 4. ASTM D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
 5. ASTM D 7005, Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.
 6. ASTM D 3786, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.
 7. ASTM D 4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
 8. ASTM D 4354, Standard Practice for Sampling of Geosynthetics for Testing.
 9. ASTM D 4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 10. ASTM D 4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 11. ASTM D 4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

7.5 Acre Partial Closure Technical Specifications

Ash Grove Cement Company ■ Cement Kiln Dust Class 3N Landfill
January 2015 ■ Terracon Project No. 35147187



12. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
13. ASTM D 4716, Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
14. ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
15. ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
16. ASTM D 5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
17. ASTM D 5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

1.03 SUBMITTALS

- A. Submit the following to the CQA Engineer, for review and approval, no later than 14 calendar days prior to scheduled shipment of geotextile and geocomposites:
 1. Documentation of manufacturers' qualifications as specified in subsection 1.04.A of this Section.
 2. Manufacturer's quality control program manual or descriptive documentation.
 3. List of material properties and samples of the material.
 4. Manufacturers' certification that the products to be furnished will comply with all product specifications in this section.
 5. Documentation of installers' qualifications, as specified in subsection 1.04.13 of this Section.
- B. Submit the following to the CQA Engineer for review and approval no later than one calendar day prior to shipment of the products:
 1. The manufacturers' quality control certifications, including results of source quality control testing of the products, as specified in subsection 2.01 of this Section, to verify that the materials supplied for the project are in compliance with all product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or

Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.

- C. No geotextile or geocomposite shall be deployed until the manufacturer's quality control certifications are submitted to and approved by the CQA Engineer. Should the material be deployed prior to CQA Engineer's approval, it shall be at sole risk of the Installer and Contractor, and if the material does not meet project specifications, it shall be removed from the project at the expense of the Contractor.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

- A. **Manufacturer's Qualifications:** The manufacturers shall be specialists in the manufacture of geotextile and/or geocomposite, as applicable. Geotextile and drainage geocomposite manufacturers shall have at least five years experience in the manufacture of such material.
- B. **Installer's Qualifications**
 - 1. The Installer shall be the manufacturer or an approved contractor trained and licensed (if applicable) to install the manufacturer's product.
 - 2. The Installer shall have at least five years experience in the installation of the product. The Installer shall have installed at least 1 million square feet of the product during the last five years or shall provide to the CQA Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the product will be installed in a competent, professional manner.
- C. Owner shall retain the services of independent inspection and testing firms (Geosynthetics Quality Assurance Firm and Geosynthetics Quality Assurance Laboratory) to check conformance of the materials and installation with the specifications.
- D. **Codes and Standards:** Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Store material off of ground, rolled and covered to protect from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
- B. Rolls shall be marked or tagged with the following information:

1. Manufacturer's name
 2. Product identification
 3. Lot number
 4. Roll number
 5. Roll dimensions
- C. Replace defective or torn material at no cost to the Owner.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. The following test methods and frequencies shall be used, at a minimum, by the manufacturer for the quality assurance and control of the geotextiles and geocomposites prior to shipment of each product. Sampling and testing frequency shall conform to ASTM D 4354. Every effort shall be made to minimize the number of lots of each geosynthetic for use in the project.
- B. Geotextile Manufacturing QC
1. Geotextile Tests:
 - a. Mass Per Unit Area - ASTM D 5261
 - b. Grab Tensile Strength and Grab Tensile Elongation - ASTM D 4632
 - c. Thickness – ASTM D5199
 - d. Puncture Resistance - ASTM D 6241
 - e. Apparent Opening Size - ASTM D 4751
 - f. Permeability - ASTM D 4491
 - g. Trapezoid Tear Strength - ASTM D 4533
 - h. Mullin Burst – ASTM D3786

Frequency: Minimum of one test per 100,000 square feet and minimum of one test per lot.

- C. Geocomposite (geotextile/geonet/geotextile) Manufacturing QC
1. Tests for Geonet Component:
 - a. Polymer Density - ASTM D 1505
 - b. Carbon Black Content - ASTM D 4218 or 1603

- c. Transmissivity (at gradient = 0.1 and pressure = 10,000 psf) - ASTM D 4716
- d. Peak Tensile Strength - ASTM D 7179
- e. Thickness – ASTM D5199

Frequency: Minimum of one test per 100,000 square feet and minimum of one test per lot for all except ASTM D 4716, which shall be tested once per 100,000 square feet and minimum of one test per lot.

- 2. Tests for Geotextile Portion of Geocomposite: same as Section 2.01 B, above. Tests shall be run on product prior to adhering to geonet.
- 3. Tests for Finished Product:
 - a. Geotextile Adhesion to Geonet - ASTM D 413
 - b. Transmissivity (at gradient = 0.1 and pressure = 10,000 psf) - ASTM D 4716

Frequency: Minimum of one test per 100,000 square feet and minimum of one test per lot.

- D. For manufacturer's quality control testing of geotextiles and geocomposites, the sample average test results (weaker principle direction for mechanical tests) for a particular property for any individual roll tested within a lot designated as first quality shall meet or exceed the Minimum Average Roll Value indicated in the manufacturer's certification.

2.02 GEOTEXTILE

- A. The geotextile shall be a continuous filament polyester or polypropylene nonwoven needle-punched fabric. The fabric shall be inert to commonly encountered chemicals, biological degradation, hydrocarbons, acids, alkalines and mildew. The fabric shall be resistant to rot, ultraviolet light, insects and rodents.
- B. The polyester or polypropylene filaments shall be formed into a stable network such that the filaments retain their relative position.
- C. Geotextile for leachate collection trenches shall conform to the following minimum requirements:

TABLE 02278-1
 GEOTEXTILE PROPERTIES

Fabric Property	Unit	Test Method	Min. Avg. Roll Value *
Fabric Weight	oz/sq yd	ASTM D 5261	≥ 8
Grab Strength	Lbs	ASTM D 4632	220
Grab Elongation	%	ASTM D 4632	50
Trapezoid Tear Strength	Lbs	ASTM D 4533	90
Puncture Resistance	Lbs	ASTM D 6241	120
Permeability	cm/sec	ASTM D 4491	0.3
AOS (largest opening size)	Sieve Size	ASTM D 4751	80
Thickness	Mils	ASTM D1777	100

*Weakest Principal Direction

- D. Minimum roll width shall be 12.5 feet. The roll length shall be maximized in order to minimize seams.

2.03 GEOCOMPOSITE

- A. Geocomposite shall be composed of a geonet core material with non-woven geotextile attached to each side of the geonet.
- B. The geonet portion of the geocomposite shall be extruded, as a continuous web comprised of two strands of polyethylene to form a three-dimensional structure to provide planar water flow, and conforming to the following minimum requirements:

TABLE 02278-2
 GEONET PROPERTIES

Geonet Properties	Unit	Test Method	Min. Avg. Roll Value
Thickness	mil	ASTM D5199	250 min
Polymer Density	g/cm ³	ASTM D1505	0.94
Peak Tensile Strength ⁽¹⁾	lb/in	ASTM D7179	45
Transmissivity ⁽²⁾	m ² /s	ASTM D4716	2.0 x 10 ⁻³
Carbon Black Content	%	ASTM D1603	2-3 range

- (1) Machine direction.
- (2) Measured using water @ 21 ± 2°C with a gradient of 0.1, between two steel plates, after 15 minutes. Confining pressure 10,000 psf.

- C. Geotextile used as part of the geocomposite shall conform to the following minimum requirements:

TABLE 02278-3
 GEOTEXTILE PROPERTIES

Fabric Property	Unit	Test Method	Min. Avg. Roll Value *
Fabric Weight	oz/sq yd	ASTM D 5261	≥ 8
Grab Strength	lbs	ASTM D 4632	225
Water Flow Rate	gpm/ft ²	ASTM D 4491	100
Trapezoidal Tear Strength	lbs	ASTM D 4533	90
AOS (largest opening size)	Sieve Size	ASTM D 4751	80

* Weakest Principal Direction

- D. The geocomposite shall be manufactured by heat bonding the geotextile continuously to the geonet on both sides. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.
- E. The finished geocomposite product shall conform to the following minimum requirements:

TABLE 02278-4
 GEOCOMPOSITE PROPERTIES

Geocomposite Properties	Unit	Test Method	Min. Avg. Roll Value (1)
Ply Adhesion	Lb/in	ASTM D 7005	1.0
Transmissivity ⁽¹⁾	m ² /s	ASTM D 4716	1 X 10 ⁻⁴

(1) Measured using water @ 20 ± 2°C with a gradient of 0.1, between two steel plates, after 15 minutes. Confining pressure 10,000 psf.

- F. The bond between the geotextile and the geonet shall exhibit minimum average peel strength of one pound per inch, and a typical peel strength of two pounds per inch in accordance with ASTM D 7005.
- G. Minimum roll width of the geocomposite shall be 10 feet.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Conformance Testing for Geotextile and Geocomposite Products:
1. Conformance testing samples shall be taken by the independent testing firm upon delivery of each product to site.
 2. Samples shall be taken at the following frequency: a minimum of one test per 100,000 square feet and minimum of one test per lot.
 3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width.
 4. Each sample shall be identified by manufacturer's name, product identification, lot number, roll dimensions, and roll number. The machine direction shall be noted on the samples with a waterproof marker.
 5. As a minimum, the following tests shall be performed for the geotextile product:
 - a. Fabric Weight - ASTM D 5261
 - b. Grab Strength and Grab Elongation - ASTM D 4632
 - c. Puncture Resistance - ASTM D 6241
 - d. Permeability - ASTM D 4491
 - e. Apparent Opening Size - ASTM D 4751
 - f. Trapezoidal Tear Strength – ASTM D 4533
 - g. Thickness – ASTM D 1777
 - h. Mullen Burst – ASTM D 3786
 6. The following tests shall be performed for the finished geocomposite product:
 - a. Transmissivity (Gradient= 0.1 at 10,000 psf - ASTM D 4716)
 - b. Geotextile Adhesion to Geonet - ASTM D 7005
- B. The CQA Firm shall ensure that the geotextiles and the geocomposite are installed according to manufacturer recommendations and the Contract Documents. The CQA Firm shall observe and document the installation activities.

3.02 PREPARATION

Surfaces to receive geotextile and geocomposites shall be smooth and free of litter, sharp protrusions, and large stones.

3.03 GEOTEXTILE INSTALLATION

A. General

1. All geotextiles shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

B. Installation

1. The geotextile shall be placed where shown on the Drawings, and placed in such a manner that placement of overlying material will not excessively stretch or tear the fabric.
2. On side slopes, the rolls shall be continuous for the full height of slope, without joints.
3. Overlapping of panels without seaming will be allowed in the leachate collection system and leak detection collection system.
4. Overlapped seams shall have a minimum overlap of 12 inches.

C. Seaming

1. Seaming shall be by sewing, adhesives, fusion or other approved bonds. All seams shall be continuously seamed. Spot seaming may only be considered as a measure against wind uplift. Overlaps shall be oriented in the direction of earth filling. No horizontal seaming shall be allowed on slopes steeper than 10 horizontal to 1 vertical.
2. Any sewing shall be done using polymeric thread with chemical properties equal to or exceeding those of the geotextile.

3.04 GEOTEXTILE REPAIR

- #### A. Holes or tears in the fabric shall be repaired as follows:

1. On steep slopes (steeper than 10 to 1): A fabric patch shall be sewn into place using a double sewn lock stitch (1/4 inch to 3/4 inch apart and no closer than one inch from any edge). Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
 2. Flat Areas (flatter than 10 to 1): A fabric patch shall be spot-seamed in place with a minimum of 36 inches of overlap beyond the perimeter of the tear or damage in all directions.
- B. Care shall be taken to remove any soil or other material, which may have penetrated through the torn geotextile.

3.05 GEOCOMPOSITE INSTALLATION

- A. Care shall be taken to keep the geocomposite clean and free from debris prior to installation.
- B. The geonet portion of the geocomposite between adjacent rolls shall be overlapped by at least four inches.
- C. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
- D. The plastic ties shall be installed every five feet along the length at adjacent rolls, every six inches in the anchor trench and every six inches along end-to-end seams.
- E. In general, no horizontal seams shall be allowed on side slopes, except as part of a patch. When horizontal seams are necessary, they shall be offset in adjacent panels and shall be "shingled" downhill.
- F. The top geotextile of the geocomposite shall be overlapped, and sewn or heat-fused along the entire length of joints in accordance with the manufacturer's recommendations, and sufficient to prevent opening by wind action.
- G. At locations where the geocomposite is damaged and soil penetrates the geocomposite material, it shall be removed and replaced with clean, unused geocomposite material.
- H. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- I. During placement of the geocomposite, care shall be taken not to entrap, in or beneath the geotextile portion of the material, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

END OF SECTION

SECTION 02279

GEOTEXTILE USED IN SUBGRADE

1.0 GENERAL

1.1 SECTION INCLUDES

- A. Geotextile to stabilize and reinforce an aggregate cover material (subbase, base, select embankment, etc.) of an unpaved roadway. The stabilization and reinforcement application is appropriate for unpaved roadways constructed over soft subgrade soils with a California Bearing Ratio (CBR) less than 3 (CBR <3) (shear strength less than approximately 90 kPa).

1.2 RELATED SECTIONS

- A. Section 02200 – Earthwork
- B. Section 02505 – Gravel Access Road

1.3 UNIT PRICES

- A. Method of Measurement: See Construction Documents

1.4 REFERENCES

- A. AASHTO Standards:
 - 1. T88 - Particle Size Analysis of Soils
 - 2. T90 - Determining the Plastic Limit and Plasticity Index of Soils
 - 3. T99 - The Moisture-Density Relations of Soils Using a 5.5lb (2.5 kg) Rammer and a 12in (305 mm) Drop.
 - 4. M288-96 - Geotextile Specification for Highway Applications
- B. American Society for Testing and Materials (ASTM):
 - 1. D 123 - Standard Terminology Relating to Textiles
 - 2. D 276 - Test Method for Identification of Fibers in Textiles
 - 3. D 3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics
 - 4. D 4354 - Practice for Sampling of Geosynthetics for Testing
 - 5. D 4355 - Test Method for Deterioration of Geotextiles from Exposure to

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Ultraviolet Light and Water (Xenon-Arc Type Apparatus)

6. D 4439 - Terminology for Geotextiles
 7. D 4491 - Test Methods for Water Permeability of Geotextiles by Permittivity
 8. D 4533 - Test Method for Index Trapezoid Tearing Strength of Geotextiles
 9. D 4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
 10. D 4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles
 11. D 4751 - Test Method for Determining Apparent Opening Size of a Geotextile
 12. D 4759 - Practice for Determining the Specification Conformance of Geosynthetics
 13. D 4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
 14. D 4873 - Guide for Identification, Storage, and Handling of Geotextiles
 15. D 5141 - Test Method to Determine Filtering Efficiency and Flow Rate for Silt Fence Applications Using Site Specific Soils
- C. Federal Highway Administration (FHWA) - Geosynthetic Design and Construction Guidelines, Publication No. FHWA HI-95-038, May 1995.
- D. American Association for Laboratory Accreditation (A2LA).
- E. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP).
- F. National Transportation Product Evaluation Program (NTPEP).

1.5 DEFINITIONS

- A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.6 SUBMITTALS

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A. Submit the following :

1. Certification: The contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns and other pertinent information to fully describe the geotextile. The Certification shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the Manufacturer's quality control program. The Certification shall be attested to by a person having legal authority to bind the Manufacturer.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP)
2. American Association for Laboratory Accreditation (A2LA)

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Geotextiles labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.
- B. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.
- C. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextile.

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2.0 PRODUCTS

2.1 MANUFACTURERS

- A. Mirafi Construction Products
365 South Holland Drive
Pendergrass, GA, USA 30567
1-888-795-0808
1-706-693-2226
1-706-693-2083, fax
www.mirafi.com

2.2 MATERIALS

- A. Geotextile:

1. The geotextile shall be woven from high-tenacity long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.
2. The geotextile shall meet the requirements of Table 1. All numeric values in Table 1 except AOS represent MARV in the specified direction. Values for AOS represent maximum average roll values.

TABLE 1 - SUBGRADE STABILIZATION GEOTEXTILE

Property	Test Method	Units	Required Value	
Reinforcement Properties			MD ¹	CD ¹
Ultimate Tensile Strength	ASTM D 4595	kN/m (lbs/ft)	47.3 (3240)	39.4 (2700)
Tensile Strength @ 2% Strain	ASTM D 4595	kN/m (lbs/ft)	7.9 (540)	7.9 (540)
Tensile Strength @ 5% Strain	ASTM D 4595	kN/m (lbs/ft)	19.8 (1356)	19.8 (1356)
Coefficient of Interaction -Ci (sand)	ASTM D 5321	--	0.8	
Permittivity	ASTM D 4491	sec ⁻¹	0.52	
Apparent Opening Size	ASTM D 4751	mm (U.S. Sieve)	0.6 (30)	
Sewn Seam Strength ²	ASTM D 4884	kN/m (lbs/ft)	24.6 (1688)	
Survivability Index Values			MD ¹	CD ¹
Grab Tensile Strength	ASTM D 4632	N (lbs)	1780 (400)	1100 (250)
Tear Strength	ASTM D 4533	N (lbs)	800 (180)	440 (100)
Puncture Strength	ASTM D 4833	N (lbs)	800 (180)	
Burst Strength	ASTM D 3786	kPa (psi)	5506 (800)	
Ultraviolet Stability (after 500 hrs)	ASTM D 4355	%	70	

¹ MD - Machine, or roll, direction; CD - Cross machine direction

² When sewn seams are required. Refer to **Section 3 - Execution** for overlap / seam requirements.

3. Approved geotextiles are as follows: Mirafi HP370

2.3 QUALITY CONTROL

- A. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP and A2LA for tests required for the geotextile, at frequency meeting or exceeding ASTM D 4354.
- B. Sewn Seam Strength shall be verified based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications and testing of quality assurance samples obtained using Procedure B of ASTM D 4354. A lot size for conformance or quality assurance sampling shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.
- C. Ultraviolet Stability shall be verified by an independent laboratory on the geotextile or a geotextile of similar construction and yarn type.

3.0 EXECUTION

3.1 PREPARATION

- A. The installation site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade. This includes removal of topsoil and vegetation.

3.2 INSTALLATION

- A. The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geotextile rolls shall be overlapped, sewn or joined as required in the plans. Overlaps shall be in the direction as shown on the plans. See table below for overlap requirements.

Soil CBR	Method of Joining
Greater than 3	300 - 450 mm (12 - 18 in) overlap
1 - 3	600 - 1000 mm (24 - 40 in) overlap
0.5 - 1	1000 mm (40 in) overlap or sewn
Less than 0.5	Sewn
All roll ends	1000 mm (40 in) overlap or sewn

- B. On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.
- C. Prior to covering, the geotextile shall be inspected by a certified inspector of the Engineer to ensure that the geotextile has not been damaged during installation. Damaged geotextiles, as identified by the Engineer, shall be repaired immediately. Cover the damaged area with a geotextile patch which extends an amount equal to the required overlap beyond the damaged area.
- D. The subbase shall be placed by end dumping onto the geotextile from the edge of the geotextile, or over previously placed subbase aggregate. On soils with CBR>3, most rubber-tired vehicles can be driven at slow speeds, less than 16 km/h (10 mph) and in straight paths over the exposed geotextile without causing damage to the geotextile. Sudden braking and sharp turning should be avoided. Tracked construction equipment should not be operated directly upon the geotextile. A minimum fill soil thickness of 15cm (6 in) is required prior to operation of tracked vehicles over the geotextile. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and

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damaging the geotextile. Turning of vehicles shall not be permitted on the first lift above the geotextile.

- E. On subgrades having a CBR value of less than 1, the subbase aggregate should be spread in its full thickness as soon as possible after dumping to minimize the potential of localized subgrade failure due to overloading of the subgrade.
- F. Any ruts occurring during construction shall be filled with additional subbase material, and compacted to the specified density.
- G. If placement of the backfill material causes damage to the geotextile, the damaged area shall be repaired as previously described above. The placement procedure shall then be modified to eliminate further damage from taking place.

END OF SECTION

SECTION 02301

FILL PLACEMENT OF CEMENT KILN BRICK (CKB)

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the fill placement and compaction of CKB with cement kiln dust (CKD) as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.
- B. The Contractor shall be prepared to coordinate the fill placement and compaction of CKB with other construction activities and subcontractors at the site.
- C. Notwithstanding the prequalification of any material sources, the Contractor shall be entirely responsible for meeting the requirements of this Section.
- D. The work of this Section shall include, but not necessarily be limited to, fill placement and compaction of CKB with CKD.

1.02 RELATED SECTIONS

- A. Section 02200 – Earthwork

1.03 REFERENCES

- A. *Construction Quality Control Plan*

Latest version of American Society for Testing and Materials (ASTM) standards:

1. ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils.
2. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
3. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water

(Moisture) Content of Soil and Rock.

6. ASTM D 2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D 6938, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. ASTM D 2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
9. ASTM D 4220, Standard Practices for Preserving and Transporting Soil Samples.
10. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 SUBMITTALS

- A. The Contractor shall notify the Owner and CQA Consultant in a minimum of 3 days prior to starting fill placement and compaction the CKB. The notice shall state the source of the material to be used, the equipment to be used, the date and time that placement operations shall start, and the name of the person in the field who shall be in charge of the work.
- B. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and CQA Consultant immediately and provide a plan and schedule for resumption of the work.

1.05 CONSTRUCTION QUALITY ASSURANCE

- A. The fill placement and compaction the CKB shall be monitored by the CQA Consultant 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 activities in the construction schedule.

PART 2 - PRODUCT

2.01 MATERIAL FOR FILL PLACEMENT AND COMPACTIOTN OF CKB

- A. All laboratory testing to evaluate the suitability or conformance of materials for the for fill placement and compaction of CKB shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.

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- B. The materials shall consist of CKB and CKD material from on-site. Materials which do not meet all the requirements of this Section shall be segregated at the source and not be permitted at the work area. Any material which is found by the CQA Consultant to be unsuitable shall be removed from the work area by the Contractor at no extra cost to the Owner.

PART 3 - EXECUTION

3.01 FAMILIARIZATION

- A. Prior to implementing any work of this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section and the CQA Plan.
- B. Inspection:
 - 1. Prior to implementing any work of this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all such work is complete to the point where the installation of this Section may properly commence without adverse impact.
 - 2. If the Contractor has any concerns regarding the installed work of other Sections or the site, the Contractor shall notify the CQA Consultant and Owner in writing within 48 hours of the site inspection. Failure to notify the CQA Consultant and Owner of the fill placement and compaction of the CKB shall be construed as the Contractor's acceptance of the related work of all other Sections.

4.02 FILL PLACEMENT AND COMPACTION OF CKB

- A. The Contractor shall place and compact the CKB to the grades, slopes, and elevations shown on the Drawings and as specified in this Section.
- B. The CKB will be placed on the existing landfill surface in truck load sized pile alternating with truck load sized pile of CKD.
- C. The CKB and CKD mixture shall be placed in a loose lift that results in a compacted lift thickness of no greater than 12 inches.
- D. The final lift of CKB and CKD mixture shall have a minimum of 5-foot separation from the final cover geomembrane.
- E. No frozen or partially thawed compacted CKD material shall be placed, spread or compacted.
- F. No CKB or CKD material shall be placed or spread while the surface on which the material

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is to be placed is frozen or thawing, during unfavorable weather conditions, or during periods of precipitation.

- G. The compacted CKD/CKB surface shall be made smooth and free from ruts or indentations at the end of every working day when precipitation is forecast and/or at the completion of the compaction operations in that area.
- H. The entire area shall be left in a manner to promote runoff at the end of each day.
- I. The Contractor shall not proceed to the next lift until the current lift has been tested and approved by the CQA representative. The Contractor will be held responsible for proceeding to the next lift without prior approval from the CQA Firm.
- J. The compacted CKD and CKB material mixture shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. The moisture condition as necessary to meet the compaction requirements. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 6938 (Method B) at the frequencies presented in the CQA Plan.

4.03 FIELD QUALITY CONTROL AND TESTING

A. Frequency:

- 1. The frequency of quality control testing is outlined below. The Contractor shall take this testing frequency into account in planning his construction schedule.
 - a. The minimum testing frequencies for material evaluation and construction quality evaluation shall be as presented in the CQA Plan.
 - b. Sampling locations shall be selected by the CQA Consultant. If necessary, the location of routine in-place moisture content and dry density tests shall be determined using a non-biased sampling plan.

B. Defective Areas:

- 1. If a defective area is discovered, the CQA Consultant shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet materials or surface desiccation, the CQA Consultant shall define the limits and nature of the defect.

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2. After determining the extent and nature of a defect, the CQA Consultant shall notify the Contractor and schedule appropriate retests when the work deficiency has been corrected.
3. The Contractor shall correct the deficiency to the satisfaction of the CQA Consultant. The cost of corrective actions shall be borne by the Contractor.
4. All retests recommended by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant shall also verify that all installation requirements are met and that all submittals are provided.

4.04 SURVEY CONTROL

- A. The contractor shall be responsible for all layout work. The Contractor shall be responsible for providing certification surveying of the horizontal and vertical extent of the CKB fill area.

4.05 PRODUCT PROTECTION

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

END OF SECTION

SECTION 02505

GRAVEL ACCESS ROAD

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes construction of gravel access roads including grading, testing, and installation of aggregate surface course material.
- B. Related Sections:
 - 1. Section 02200 - Earthwork

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 - 2. ASTM D 1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using Ten-Pound (4.54 kg) Hammer and 18-Inch (457 mm) Drop.
 - 3. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
 - 4. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
 - 5. ASTM D 6938, Standard Test Methods for Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - 6. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- B. Standard Specification for Highway Construction, Oklahoma Department of Transportation (ODOT), 200 N.E. 21st Street, Oklahoma City, OK 73105-3204.
 - 1. OHTD 703, Aggregate Base Course.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Submit written test reports of all specified tests showing conformance of the materials and constructed work with the specifications. Submit test results within three days after samples are obtained.

1.04 QUALITY ASSURANCE/QUALITY CONTROL

Owner will retain the services of an independent inspection and testing firm to determine conformance of earthwork materials and constructed work.

1.05 PROJECT CONDITIONS

- A. Work shall be performed in a manner that does not disturb existing environmental monitoring wells or other site facilities not indicated to be removed within the construction limits.
- B. Provide temporary controls as specified in Sections 01563 and 01565.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

Proposed materials and source of supply shall be approved for use on this project by the Engineer as specified, prior to use of the materials in the construction.

2.02 GENERAL FILL

General Fill shall be as specified in Section 02200.

2.03 AGGREGATE SURFACE COURSE MATERIAL

Naturally or artificially graded mixture of natural or crushed gravel, or crushed stone shall be free of clay balls, organic material and debris. Material shall be graded with 100 percent passing the 1-1/2 inch sieve and between 3 and 10 percent passing the Number 200 sieve (See Table 303-1 in the AHTD Standard Specification for Highway Construction for detailed particle size requirements).

PART 3 EXECUTION

3.01 PREPARATION

Prepare road subgrade to the lines, grades and elevations as shown on the Drawings, and as specified in Section 02200, subsection 3.01.

3.02 PLACEMENT OF AGGREGATE SURFACE COURSE

- A. Place and grade aggregate surface course material to the dimensions shown on the Drawings.

END OF SECTION

SECTION 02930

SEEDING AND MULCHING

PART 1 GENERAL

1.01 SUMMARY

Section includes establishing a stand of grass on all areas disturbed by construction within the construction limits and areas with inactive waste fill.

1.02 QUALITY ASSURANCE/QUALITY CONTROL

Seeding shall be accomplished according to standard local practice and in compliance with requirements of applicable state and federal regulations.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer.
- B. Protect materials from deterioration during delivery, and while stored at site.

1.04 PROJECT CONDITIONS

- A. Perform seedbed preparation and seeding as soon as possible after completion of grading and compaction in each area.
- B. Seeding shall be performed only during the appropriate growing season for the particular seed mix, as recommended by the local agricultural extension office and approved by the Engineer.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. Shall be a standard commercial fertilizer, delivered to the project in bags clearly labeled showing percentages of nitrogen, phosphoric acid, and potash nutrients.
- B. The grade of fertilizer shall be the one of the following:

Di-Ammonium Phosphate

Nutrient	% by Weight
Nitrogen	18
Phosphorous	46
Pottasium	0

Mono-Ammonium Phosphate

Nutrient	% by Weight
Nitrogen	11
Phosphorous	52
Pottasium	0

2.02 LIME

If needed, lime shall be ground limestone containing not less than 85 percent total carbonates and of a fineness so that 90 percent will pass through a No. 20 mesh sieve and 50 percent will pass through a No. 100 mesh sieve.

2.03 SEED

A. The following quantities of grass seed to be planted per acre are as follows:

1. **Spring Planting (March 15 - June 15):**
 - Bermuda Grass (Common) unhulled 10 lbs.
 - Bermuda Grass (Common) hulled 5 lbs.
 - Laspedeza (Korean) 30 lbs.

2. **Summer Planting (June 16 - August 31):**
 - Bermuda Grass (Common) unhulled 10 lbs.
 - Bermuda Grass (Common) hulled 5 lbs.
 - Buffalo Grass 10 lbs.

3. **Fall/Winter Planting (September 1 - March 14):**
 - Annual Rye grass or other Cereal Grasses 100 lbs.
 - Crimson Clover (Dixie) 20 lbs.
 - Bermuda Grass (Common) unhulled 30 lbs.
 - Coreopsis 5 lbs.
 - Laspedeza (Korean) 30 lbs.

B. An alternative seeding program such as that program specified by the Arkansas Highway and Transportation Department (AHTD) or recommended by the local agricultural extension service office may be used in lieu of the seeding mixture above with approval by the engineer.

2.04 WATER

Clean, potable.

2.05 MULCH AND OTHER EROSION CONTROL

- A. Cover material shall be chopped hay mulch generally derived from rice, wheat, oats, barley, or other suitable material free from Johnson grass, weeds, foreign matter detrimental to plant life, and in dry conditions.

PART 3 EXECUTION

3.01 SOIL SAMPLING

- A. An independent testing firm retained by the Contractor shall obtain samples of the soil to be seeded and send the samples to a local agricultural extension office for recommendations on fertilizer, lime and seed mix to be used.
- B. One sample shall be taken at approximately every five (5) acres of area, or as otherwise determined necessary by the Engineer. Each sample shall be a minimum ten-ounce sample.

3.02 PREPARATION

- A. Surface shall be scarified to an approximate depth of three inches to be seeded.
- B. Surface shall be reasonably smooth and free of litter, large clods, roots, sharp protrusions, and large stones.
- C. The seed mixtures specified in paragraph 2.03A shall be applied to areas disturbed from construction activities.

3.03 APPLICATION METHODS

- A. Spread lime (if required) uniformly on soil surface at rate specified in subsection 3.04. Incorporate lime into top three inches of soil.
- B. Seed, fertilizer, and mulch materials shall be placed by the method described below, as approved by the Engineer.
 - 1. Hydraulic Method
 - a. The seed and fertilizer, or seed, fertilizer and mulch shall be mixed in the specified amount of water to produce a slurry. Any of the above combinations may be used, provided that the products are added to the water in the following order as applicable: fertilizer, seed, and mulch.

- b. The slurry shall then be uniformly applied under pressure to the areas and at the rates indicated in subsection 3.04 below.
- c. Areas inadequately covered shall be re-treated as directed by the Engineer.

2. Dry Method

- a. The seed and fertilizer shall be applied uniformly at the specified rate, using power drawn seeders, seed drills, or other mechanical methods approved by the engineer. Hand operated seeding devices may be used on areas which are inaccessible to mechanical seeders.
- b. The seed and fertilizer shall be applied separately. Fertilizer shall be incorporated into the full depth of loosened soil to the seeding operation.

3.04 APPLICATION RATES

- A. Lime: Two tons per acre for pH 4 to 5, one ton per acre for pH 5 to 6, or as otherwise determined based on soil test results.
- B. Fertilizer:
 - 1. Apply at rate of 1,000 pounds of grade 10-20-10 fertilizer per acre or a sufficient quantity of any other acceptable grades of fertilizer that will provide at least 100 pounds of nitrogen, 200 pounds of available phosphoric acid, and 100 pounds of total potash per acre, as computed from the nominal contents of fertilizing ingredients.
 - 2. Other rates of application may be allowed by the Engineer based on soil test results.
- C. Seed mixtures for permanent vegetation shall be applied at the rate of approximately 60 pounds per acre or as otherwise directed by the Engineer.

3.05 APPLICATION TIMES

- A. Seeding for temporary vegetation shall comply with Section 01565.

- B. Seeding for permanent vegetation shall be performed during the first optimum planting season following completion of work in an area. Optimum planting seasons are Spring (March through May) and Fall (September through October).

3.06 MULCHING

- A. Spread mulch uniformly over seeded area in a continuous blanket.
- B. Mulch may be spread by hand or by machinery. Mulch shall be spread not later than 48 hours after seeding.

3.07 ESTABLISHMENT OF GRASS

- A. Begin maintenance immediately after seed placement.
- B. Maintain seeded areas not less than 60 days after substantial completion and longer to establish a good stand of grass. Good stand of grass will consist of a minimum of 80% coverage of grass by area for each 10 yard by 10 yard area (30 ft. x 30 ft. area or 900 square feet).
- C. If seeded in Fall, Contractor shall maintain seeded areas throughout Winter and provide a Spring over-seeding.
- D. Carry out watering as needed during the establishment period to maintain moisture in upper four inches of soil.
- E. Fill, level, and repair washed or eroded areas as necessary.
- F. Re-seed and mulch areas larger than one square foot not having a uniform stand of grass.

3.08 ACCEPTANCE

- A. Seeded areas will be accepted when a full and uniform stand of grass has become established, in accordance with 3.07.B.

END OF SECTION

SECTION 03120

FABRIFORM UNIMAT REVETMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes general information and instructions on how to prepare site and install Fabriform Unimat Revetment.

1.02 REFERENCE STANDARDS

- A. ASTM C-31: Methods of Making and Curing Concrete Test Specimens in the Field
- B. ASTM C-39: Test Method for Compressive Strength of Cylindrical Concrete Specimens

1.03 SUBMITTALS

- A. The Contractor shall furnish records of past successful experience in performing this type of work.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Immediately following receipt of fabric on the job site, fabric shall be inspected and stored in a clean, dry area where it will not be subjected to any mechanical damage or exposure to moisture or direct sunlight.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Fabric shall be Fabriform Unimat – 6-inch (150mm) UM-N, as manufactured by Construction Techniques, Inc., 5353 West 161st Street, Cleveland, Ohio 44142-1609, (216) 267-7310.

1. Fabric-forming material shall consist of double-layer, open-selvage fabric joined in a mat configuration. Fabric shall be woven of 100% nylon of which at least 50% by weight shall be bulk textured fiber.
2. The combined tensile strength and spacing of cords used to control thickness of the finished revetment shall be such as to provide resistance to bursting of the fabric mat during grout injection.

- B. Fabric Porosity

1. At the direction of the Engineer, the Contractor shall demonstrate the suitability of fabric design by injecting proposed grout into 5 ½" (140 mm) diameter sleeves under pressure of 10 to 15 psi (67-100 kPa) which shall be maintained for 10

minutes. The sleeves shall be constructed of a single layer of the same basic fabric material. Test cylinders, 8" (200mm) long, shall be cut from each specimen and tested in accordance with ASTM C-39.

C. Geotextile Cushion

1. Geotextile cushion used for placement underneath Fabriform revetments shall be a non-woven geotextile of Class 2 survivability as provided in Specification 02278.

D. Grout

1. Grout shall consist of a mixture of portland cement, fine aggregate, and water so proportioned and mixed as to provide a readily pumpable slurry.
2. Admixtures and/or pozzolan may be used with the approval of the Engineer.
3. The hardened grout shall exhibit a compressive strength of 2,000 psi (14 MPa) at 28 days when specimens are made and tested according to the provisions of ASTM C-31 and C-39.
4. The average compressive strength of Fabriform cast test cylinders, as described in Paragraph B above, shall be at least 20% higher at 7 days than that of companion test cylinders made in accordance with ASTM C-31, and not less than 2,500 psi (17 Mpa) at 28 days

PART 3 EXECUTION

3.01 INSTALLATION

A. Fabric Placement

1. Prior to grout injection, the dual-walled fabric shall be positioned over a geotextile filter fabric cushion, as specified in Section 2.01 at its approximate design location, making appropriate allowance for contraction of the fabric which will occur as a result of grout injection.
2. Panels of fabric may be factory assembled in predetermined sizes and joined together side-by-side at the job site by field sewing or by means of zipper closures attached to the upper and lower layers of fabric.
3. A single seam in which all four layers of fabric are joined at one point will not be permitted.
4. If required, grout stops may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of the grout. Grout stops shall be designed as to produce full mat thickness along the full length of the grout stop.
5. If any of the above methods are impractical, adjacent panels may be overlapped

a minimum of two feet, subject to Engineer's approval.

6. In no case will simple butt joints between panels be allowed.

B. Grout Injection

1. Following placement of dual-walled fabric over the geotextile filter, grout shall be injected between the top and bottom layers of fabric through small slits in the upper layer of fabric. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap and the burlap pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of the grout on the surface of the revetment. The sequence of the grout injection shall be such as to insure complete filling of the revetment-forming fabric to the thickness specified by the fabric manufacturer.
2. Foot traffic will not be permitted on the freshly pumped mat when such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary. Excessive grout which has been inadvertently spilled on the mat surface shall be cleaned up with a broom and shovel. Use of a water hose to remove spilled grout from the surface of a freshly pumped mat will not be permitted.
3. During grout injection, the mat thickness may be measured by inserting a short piece of stiff wire through the mat at several locations from the crest to the toe of the slope. Any mat measuring less than 90% of the average of all thickness measurements shall be reinjected with grout until average thickness has been attained

END OF SECTION



The FABRIFORM® Process utilizes a double-layer, 100% nylon fabric form, especially woven for optimum strength, stability, adhesion, and filtering characteristics, combined with a highly fluid fine aggregate concrete (grout) to provide an economical hard armor solution for erosion control. Fabriform revetments can be cast underwater as well as in-the-dry.

Fabriform® Unimat Technical Data

DESIGNS BASED ON OVER 40 YEARS OF EXPERIENCE

	Designation Style	CAST-IN-PLACE						
		Cord Spacing	Average Thickness*		Coverage Per		Dry Weight**	
			in.	mm	Y ³ Mortar	M ³ Mortar	lb / ft ²	kg / m ²
	3" UMNN	3" x 3.5"	3	75	100 ft ²	12.14 m ²	34	166
	4" UMNN	3" x 3.5"	4	100	75 ft ²	9.11 m ²	45	220
	6" UMNN	3" x 6"	6	150	50 ft ²	6.07 m ²	68	330
	8" UMNN	3" x 6"	8	200	38 ft ²	4.55 m ²	90	440

* Nominal

** Dry Weight based on a specific weight of 2.1 or 135 lb/cf. Unit Weight may vary with material proportions and source.

Uniform Cross Section (Unimat) revetment fabric is a form for casting in place fine aggregate concrete (grout) revetments. Characterized by a slightly dimpled surface, these rigid revetments exhibit a relatively low coefficient of hydraulic friction. Permeability is equivalent to that of high quality concrete paving. The criterion for selection of Unimat revetment thickness is the same as that employed in determining the thickness of conventional concrete paving.

Unimat revetment fabrics are woven of 100% high-tenacity, multifilament nylon of which at least 50% by weight consists of textured fibers for optimum filtering characteristics and adhesion to the grout. These fibers have an excellent long-term performance record. Nylon yarns also provide a relatively high resistance to ultraviolet light and alkali degradation.

The Unimat revetment fabric is shop-assembled in predetermined panel sizes to fit site topography. The panels are convenient to handle and are joined together side-by-side at the job site by means of sewing or zipper closures attached to both the upper and lower layers of fabric.

The panels will contract when they are injected with grout. Allowance must be made for this contraction when preparing shop drawings of panel assemblies. Contraction will vary with site conditions. For budgetary estimates, a minimum contraction allowance should be made for approximately 8% additional fabric to cover the cast-in-place area.

NOTE:

Information contained in this publication is offered in good faith as a guide to placement of Fabriform® erosion control revetments. It is based on experience obtained under a variety of conditions. However, information contained herein will not apply to every job and dimensions and quantities shown are approximate only and will vary as a result of site conditions and installation procedures. The user is cautioned to obtain from others such professional and technical services as may, in his own judgment, be necessary or desirable to insure effective and economical installations.

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Guide Specifications: Fabriform® Unimat Fabric and Revetment Installation

PAGE 2 OF 4

I. GENERAL

A. Scope of Work

The work shall consist of furnishing all labor, materials, and equipment for installing fabric-formed concrete revetment as indicated in the contract drawings and specified herein.

B. Description

The work shall consist of installing an unreinforced concrete revetment, as indicated in the contract drawings, by positioning a specially woven dual wall, 100% nylon fabric form on the slope or surface to be protected and injecting it with fine aggregate concrete (grout). The surfaces to be protected shall be prepared and graded to such an extent that they are normally stable in the absence of erosive forces.

C. Qualification of Contractor

The Contractor shall furnish records of past successful experience in performing this type of work. The Contractor shall save the Owner harmless from liability of any kind arising from the use of any patented or unpatented invention in the performance of this work.

II. MATERIALS

A. Fiber and Fabric Specifications

Fiber and fabric materials shall meet the minimum requirements, as listed and reported by an independent testing agency, shown below:

PROPERTY	TEST METHOD	UNIT	VALUE
PHYSICAL			
Composition			NYLON
Weight (both layers)	ASTM D-5261	oz/yd (g/m)	13 (440)
Thickness	ASTM D-5199	mils (mm)	30 (0.76)
MECHANICAL			
Grab Tensile Strength	ASTM D-4632	lbf (N)	WARP 400 (1780)
			FILL 250 (1110)
Grab Tensile Elongation	ASTM D-4632	%	WARP 30
			FILL 30
Wide Width Strip Tensile Strength	ASTM D-4595	lbf/in (kN/m)	WARP 300 (52.5)
			FILL 200 (35)
Elongation At Break	ASTM D-4595	%	WARP 15
			FILL 20
Trapezoidal Tear Strength	ASTM D-4533	lbf (N)	WARP 175 (775)
			FILL 150 (665)
HYDRAULIC			
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Standard (mm)	40 (0.425)
Flow Rate	ASTM D-4491	gal/min/sf (l/min/m)	90 (3665)

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B. Fabric Design

Fabric-forming material shall consist of double-layer, open-selvage fabric joined in a mat configuration. Fabric shall be woven of 100% high-tenacity, continuous multifilament nylon of which at least 50% by weight shall be textured fiber. Polyester, staple, and partially orientated yarn shall not be allowed.

Unimat Fabric, designated as _____UMNN on the drawings, shall be woven in such a manner with nylon spacer cords to provide points of attachment on specific centers. (See Note 1 below) The spacer cords shall serve to control the thickness of the revetment without bursting the fabric during fine aggregate injection.

Thickness of the finished revetment shall be measured as described in Section III.D of these specifications.

Note 1: Designer will indicate here the fabric designation required from choice of fabric styles below. Fabric style designates the nominal thickness of the cast-in-place revetment:

3" UMNN, 4" UMNN, 6" UMNN, 8" UMNN

C. Fabric Porosity

Fabric porosity is essential for the successful execution of this work. At the direction of the Engineer, the Contractor shall demonstrate the suitability of fabric design by injecting the proposed grout into 5½" (140 mm) diameter sleeves. The sleeves shall be constructed of a single layer of the same basic fabric material. Test cylinders, 12" (300 mm) long, shall be cut from each specimen and tested in accordance with ASTM C-39. This test will be run once at the start of the project unless otherwise directed by the engineer. (See Item F below)

D. Relief of Hydrostatic Uplift

Where groundwater conditions require provision for relief of hydrostatic uplift, 7/8" (22mm) I.D. weep tube assemblies shall be inserted through the fabric. These weep tube assemblies shall be held in place during grout injection by means of a snap on collar attached to the lower end of the weep tube assembly. If the revetment has not been placed over a geotextile filter cloth, the lower end of the weep tube assembly shall be covered with a piece of filter cloth. The weep tube assemblies shall be located as called for on the plans.

E. Fabric Assembly

The Unimat fabric can be factory sewn into predetermined custom sized panels. The fabric rolls are first cut into the lengths specified on the shop drawings. These fabric pieces are then joined together, top layer to top layer and bottom layer to bottom layer. This will allow for the finished revetment to have the full mat thickness between the top and bottom seam. A single seam in which all four layers of fabric are joined at one point will not be permitted. All factory seams shall face downwards and shall be made using a double-needled machine utilizing the Standard Type 401 stitch. If required, bulkheads (grout stops) may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of fine aggregate concrete. Grout stops shall be designed as to produce full mat thickness along the full length of the grout stop.

F. Fine Aggregate Concrete (Grout)

Fine aggregate concrete (grout) shall consist of a mixture of portland cement, fine aggregate, and water so proportioned and mixed as to provide a readily flowable grout. Admixtures and/or a pozzolan may be used with the approval of the Engineer. Use of super plasticizers requires special precautions; silica fume is not recommended. The hardened fine aggregate concrete shall exhibit a compressive strength of 2,500 psi (17 MPa) at 28 days when specimens are made and tested according to the provisions of ASTM C-31 and C-39. The average compressive strength of fabric cast test cylinders, as described in Paragraph C above, shall be at least 20% higher at 7 days than that of companion test cylinders made in accordance with ASTM C-31, and not less than 3,000 psi (21 MPa) at 28 days.

III. INSTALLATION

A. Fabric Storage

Immediately following receipt of fabric on the job site, fabric shall be inspected and stored in a clean, dry area where it will not be subject to mechanical damage or exposure to moisture or direct sunlight. Fabric allowed to become wet and then dried before installation will be subject to shrinkage.

B. Site Preparation

The surface to be protected shall be constructed to the line and dimensions as shown on the contract drawings. The area shall be free of all obstruction and organic material, such as rocks and roots. Areas below grade shall be brought to grade using engineered fill or a drainage stone as specified by the Engineer. Anchor and flank trench installation will be in accordance with project plans and specifications.

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C. Fabric Placement

The Unimat fabric panels shall be positioned, as specified by the Engineer, at their approximate design location. The factory assembled panels shall be joined in the field by means of sewing or zipper closures. Adjacent panels shall be joined top layer to top layer and bottom layer to bottom layer. The contractor must make the appropriate allowance for approximately 4% contraction of the fabric in each direction, which will occur as a result of grout injection. If joining of panels as described above is impractical, adjacent panels may be overlapped a minimum of 3 feet (900 mm), subject to Engineer's approval. In no case will simple butt joints between panels be allowed. However, a modified butt joint where an underlayment of similar fabric is sewn to one panel and overlapped a minimum of 2 feet (600mm) by the adjacent panel is allowed subject to Engineer's approval.

D. Fine Aggregate Concrete (Grout) Injection

Following placement of the Unimat fabric panels, fine aggregate concrete (grout) shall be injected between the upper and lower layers of fabric through small slits cut in the upper layer of fabric. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap during pumping. First pump the upper edge of the mat which as been placed in the anchor trench followed by injection into the lower edge, working back up the slope. Avoid overpressuring of the fabric. After pumping, the burlap shall be pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of grout on the revetment surface. The burlap seal shall be removed prior to the final set of the fine aggregate concrete and the injection area hand-finished. The sequence of grout injection shall be such as to ensure complete filling of the revetment-forming fabric to the thickness specified by the fabric manufacturer.

Foot traffic will not be permitted on the freshly pumped mat when such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary.

Excessive grout which has been inadvertently spilled on the mat surface shall be cleaned up with a broom and shovel. Use of a water hose to remove spilled grout from the surface of a freshly pumped mat will not be permitted.

During grout injection, the mat thickness may be measured by inserting a short piece of stiff wire through the mat at several locations from the crest to the toe of the slope. Any mat measuring less than 90% of the average of all thickness measurements shall be re-injected until desired average thickness has been attained.

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SECTION 03310

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the manufacture, storage, delivery, and installation of cast-in-place concrete, as specified herein, and as shown on the Drawings.
- B. The work shall include, but not be limited to wingwalls integral to the box culvert road crossing.
- C. The Contractor shall coordinate the installation of the cast-in-place concrete with other construction activities and subcontractors at the site.

1.02 RELATED SECTIONS

- A. Section 02210 - General Fill

1.03 REFERENCES

- A. *Construction Quality Control Plan*
- B. Latest version of American Society for Testing and Materials (ASTM) standards:
 - 1. ASTM A 185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
 - 2. ASTM A 427 Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
 - 3. ASTM A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 4. ASTM C 31 Standard Methods of Making and Curing Concrete Test Specimens in the Field.
 - 5. ASTM C 33 Standard Specification for Concrete Aggregates.
 - 6. ASTM C 39 Standard Method of Compressive Strength of Cylindrical Concrete Specimens.
 - 7. ASTM C 94 Standard Specification for Ready-Mixed Concrete.
 - 8. ASTM C 143 Standard Test Method for Slump of Portland Cement Concrete.

7.5 Acre Partial Closure Technical Specifications

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9. ASTM C 150 Standard Specification for Portland Cement.
10. ASTM C 171 Standard Specification for Sheet Materials for Curing concrete.
11. ASTM C 172 Standard Test Method for Sampling Freshly Mixed Concrete.
12. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
13. ASTM C 260 Specification for Air - Entraining Admixtures for Concrete.
14. ASTM C 494 Specifications for Chemical Admixtures for Concrete.
15. ASTM C 618 Specification for Fly Ash and Raw or Calcined Pozzolans for use in Portland Cement Concrete.

C. Latest version of American Concrete Institute (ACI) standards:

1. ACI 211.1 Selecting Proportions for Normal Weight Concrete.
2. ACI 214 Evaluation of Compression Test Results of Field Concrete.
3. ACI 301 Specifications for Structural Concrete for Buildings.
4. ACI 304 Measuring, Mixing, Transporting and Placing Concrete.
5. ACI 305 Hot Weather Concreting.
6. ACI 318 Requirements for Reinforced Concrete.

1.04 SUBMITTALS

A. The Contractor shall provide the following to the Owner for approval prior to placement of concrete:

1. certifications as required by ASTM C 94;
2. shop drawings for all reinforcing steel;
3. certificates of Compliance for the following items:
 - a. cement;
 - b. aggregates;
 - c. admixtures; and
 - d. reinforcing steel.
4. Design Mixes: At least 30 days prior to start of placing concrete, the Contractor shall submit design mixes for each Class and Type of concrete specified, indicating that the concrete ingredients and proportions will result in a concrete mix meeting the requirements specified.

B. Compression Test Data:

1. Compression test cylinders from all concrete used on the project, except for precast concrete items, will be made by the Owner and tested in accordance with the ACI Code and ASTM C 39.
2. Concrete which does not meet the specifications will be required to be removed and replaced at the Contractor's expense or may be subjected to a load test, also at the Contractor's expense.

C. Batch Tickets:

1. Submit certificate to the Owner before unloading concrete at the site or submit a delivery ticket to the Owner from the concrete supplier for each batch of concrete delivered to the site. The certificate or delivery ticket shall set forth the following information:
 - a. name of supplier;
 - b. name of batching plant and location;
 - c. serial number of ticket or certificate;
 - d. date;
 - e. truck number;
 - f. specific job designation (contract number and location);
 - g. the volume of concrete (cubic yards);
 - h. specific Class and Type of concrete (in conformance with the Specifications);
 - i. time loaded;
 - j. type and brand of cement;
 - k. weight of cement;
 - l. maximum size of aggregates;
 - m. weights of coarse and fine aggregates, respectively;
 - n. amount of water added at the plant and maximum amount of water to be added at the site, if any; and
 - o. kind and amount of admixtures.

D. Following installation, the Contractor shall submit a Placement Log for all cast-in-place concrete items including the following information:

1. date of placement;

2. location and extent of placement;
3. quantity of concrete;
4. air temperature; and
5. tests and samples taken.

1.05 CONSTRUCTION QUALITY ASSURANCE

- A. Ready Mixed Concrete Plant shall be currently certified to comply with approval requirements of one or more of the following:
 1. Concrete Materials Engineering Council;
 2. National Ready Mixed Concrete Association; and
 3. Prestressed Concrete Institute.
- B. Testing and Inspection Agency shall be currently accredited by one or more of the following:
 1. Concrete Materials Engineering Council; and
 2. Other accreditation authority of equivalent standing to the above, on the basis of its compliance with the requirements of ASTM C 1077.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Concrete Mix

Concrete mix shall conform with ASTM C 94, and shall be ready-mixed, normal weight, air entrained, minimum compressive strength 3,500 psi at 28 days. The concrete slump shall be 3 ± 1 inches.

B. Cement

Cement shall conform to ASTM C 150, Type I or II.

C. Aggregate

Aggregate shall conform with ASTM C 33. Maximum size of coarse aggregate shall be the smallest of 1-1/2 inches, 3/4 of the minimum clear spacing between reinforcing bars, or 1/3 the thickness of slabs.

D. Water

Water shall be potable.

E. Reinforcing Steel

All deformed billet steel shall conform to ASTM A 615 Grade 60. All wire fabric shall be welded steel in conformance with ASTM A 185.

2.02 CONCRETE MIXING

- A. The Ready Mix Concretes shall comply with requirement of ASTM C 94 for mixing time and water addition. Total mixing time for concrete shall be determined in accordance with ASTM C 94 for type of mixing equipment used. Concrete that has been in truck for more than 1-1/2 hours after addition of water, or had more than 300 revolutions, or concrete which has become hard or non-plastic, shall not be used. When concrete arrives at the site with a slump below that specified herein, water may be added only if neither the maximum specified water/cement ratio nor the maximum specified slump is exceeded. The additional water should be incorporated into the mix by increasing the mixing time at least 1-1/2 times the total mixing time required by ASTM C 94. However, the Contractor shall bear total responsibility for the effects of adding water on the quality and strength of the concrete.
- B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

2.03 NON-SHRINK GROUT

- A. Non-shrink grout shall conform to Corps of Engineers Specification CRD C621 (588).

PART 3 EXECUTION

3.01 FAMILIARIZATION

- A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with all portions of the work falling within this Section.
- B. Inspection:
1. Prior to implementing any of the work in this Section, the Contractor shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of this Section may properly commence without adverse impact.
 2. If the Contractor has any concerns regarding the installed work of other Sections, the Contractor shall notify the Owner in writing within 48 hours of the site inspection. Failure to inform the Owner in writing or installation of cast-in-place concrete shall be

construed as Contractor's acceptance of the related work of all other Sections.

3.02 EXAMINATION AND PREPARATION

- A. The Owner's Representative shall examine formwork, reinforcing steel, embed inserts, sleeves, and joint materials prior to placement of concrete. Defective material shall be removed and replaced with new material at no cost to the Owner.
- B. The Contractor shall clean all formwork and structural excavations of foreign matter, debris, loose material, and water.
- C. The Owner's Representative shall be notified at least two working days in advance of a scheduled delivery to allow time for adequate observation of the site.

3.03 PLACING REINFORCEMENT

- A. Reinforcement shall be placed to the dimensions shown on the Drawings.
- B. Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness except for bars larger than one inch, in which case the bends shall be made around a pin of eight bar diameters. All bars shall be bent cold.
- C. Reinforcement shall be shipped to the site with bars of the same size and shape securely fastened in bundles with wired metal identification tags containing the bar size. The identification tags shall be labeled with the same designation as shown on submitted bar schedules and shop drawings.
- D. All bars shall be stored off the ground and shall be protected from moisture and kept free from dirt, oil, and other foreign substances.
- E. Unless otherwise shown on the Drawings, splices in reinforcement bars shall be lapped not less than 24 diameters. All bar splices shall be staggered wherever possible. When splicing bars of different diameters, the length of lap is based on the larger bar.
- F. Before placing in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings that may reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.

3.04 PLACING CONCRETE

- A. Formwork and joints shall be erected, and accessories shall be installed in accordance with the Drawings.
- B. Concrete shall not be placed until the forms, reinforcement and other conditions are approved for pouring by the Owner's Representative and until all pipes, conduits, sleeves, thimbles, hangers, anchors, flashing and other work required to be placed in the concrete have been properly installed.
- C. Water shall be removed from the space to be occupied by concrete, and any continuous flows of water shall be diverted to a sump or removed by pumping.
- D. Hardened concrete and foreign materials shall be removed from the inner surfaces of mixing and conveying equipment before concrete is mixed. Before depositing concrete, forms shall be thoroughly wetted and all debris removed.
- E. Concrete Placement:
 - 1. Practices shall comply with ACI 304 and as herein specified.
 - 2. Concrete shall be deposited in horizontal layers not deeper than 24 inches in such a manner as to prevent flow of concrete. Concrete shall be deposited to maintain a plastic surface which is approximately horizontal and in a manner to avoid inclined construction joints.
 - 3. Where placement consists of several layers, each layer shall be placed while the preceding layer is still plastic to avoid cold joints.
 - 4. Concrete shall be consolidated by internal mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping in accordance with ACI 304 during and immediately after placing.
 - 5. Reinforcing, inserts, embeds, and joints shall be maintained in proper position during concrete placement.
 - 6. Pumping placement of concrete shall be done with pumps, pipelines, and accessory equipment provided in accordance with ACI 304 and ACI 304-2R.
- F. Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited against concrete which has hardened. If a section cannot be placed continuously, construction joints may be located at points as provided for in the Drawings or approved by the Owner's Representative. Before depositing new concrete against old concrete, the forms shall be retightened, the hardened surfaces cleaned and covered with a coating of neat cement grout.
- G. In the event of rain during concrete placement, the placement shall be terminated as soon

7.5 Acre Partial Closure Technical Specifications

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as practicable at a point approved by the Owner's Representative and freshly placed concrete shall be protected with a waterproof covering that shall prevent marring or damage of surfaces.

- H. Concrete shall not be placed without consent of the Owner's Representative when the temperature is 50 degrees Fahrenheit or less, or when there is reason to expect a drop in temperature to below 50 degrees Fahrenheit within 12 hours of the conclusion of the pour. Concrete placed at air temperature below 40 degrees Fahrenheit shall have a minimum temperature of 60 degrees Fahrenheit. When the air temperature is below 40 degrees Fahrenheit or near 40 degrees Fahrenheit and falling, the water and aggregates shall be heated before mixing. Accelerating chemicals shall not be used to prevent freezing.
- I. Hot weather placement of concrete shall comply with ACI 305.

3.05 CONCRETE CURING AND PROTECTION

- A. Freshly placed concrete shall be protected from premature drying and excessive cold or hot temperatures.
- B. Curing procedures shall begin immediately after placement in accordance with ACI 301 procedures to provide continuous moist curing above 50 degrees Fahrenheit for at least seven days.
- C. Curing of concrete shall be performed by moist curing and by moisture retaining cover curing, as herein specified. Moisture curing shall be provided by one of the following methods: covering with water, sprinkled with water, continuous water fog spray, and covering concrete surface with specified absorptive cover, thoroughly saturating cover with water, and keeping continuously wet. The Contractor shall submit for approval by the Owner's Representative the methods proposed for use against low temperatures. No salt, manure, or other chemicals shall be used for protection.
- D. Protection of Completed Work:
 - 1. Concrete shall be protected from damaging mechanical disturbances, water flow, loading, shock, and vibration during the entire curing period.
 - 2. Concrete surfaces shall be kept free from all foot and vehicular traffic and all other sources of abrasion for not less than 72 hours after finishing.
 - 3. Any protective coverings shall be maintained continuously during entire curing period, and damage to coverings shall be repaired immediately at no additional expense to the Owner.

4. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.06 REPAIRS

- A. Repair of rock pockets, honeycombs, and sand streaks shall be done by: cutting and removing concrete to at least one inch deep with sides perpendicular to surface; flushing with clean water; coating with neat cement paste; filling with cement drypack mix; curing as specified for concrete; and grinding smooth and flush with adjacent surfaces.

3.07 FIELD QUALITY CONTROL

- A. The Owner shall employ a testing laboratory to perform tests and to submit test reports, except as designated otherwise.
- B. Sampling fresh concrete shall be performed in accordance to ASTM C 172, except modified for slump to comply with ASTM C 94:
 1. Slump test according to ASTM C 143 shall be measured according to:
 - a. one test at point of discharge for each set of compression cylinders taken;
 - b. additional tests when concrete consistency appears to have changed; and
 - c. one test on each truck load of concrete delivered to the site.
 2. Molded concrete compression cylinders shall be sampled in accordance with ASTM C 172, processed and cured in accordance with ASTM C 31, and prepared and tested in accordance with ASTM C 39:
 - a. One set of four cylinders shall be obtained for each 50 cubic yards, or fraction thereof, for each day's placement of each mix design.
 - b. One cylinder shall be tested at age three days or seven days, as required by job conditions, and two cylinders for one valid strength test at 28 days.
 - c. The fourth cylinder shall be cured and held for testing at 42 days if 28-day test indicated deficient results, or as a spare in case of cylinder damage.
- C. Certified written reports shall be promptly submitted with the following additional data:
 1. time concrete batched and time sampled;
 2. water added at site;
 3. strength class;
 4. delivery ticket number;
 5. concrete suppliers mix designation; and

7.5 Acre Partial Closure Technical Specifications

Ash Grove Cement Company ■ Cement Kiln Dust Class 3N Landfill
January 2016 ■ Terracon Project No. 35147187



6. location of concrete in the work.

3.08 PRODUCT PROTECTION

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

END OF SECTION