NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

CONSTRUCTION BID AND CONTRACT DOCUMENTS

NABORS CLASS 1 LANDFILL
AREA 1-3 CELL 2 CONSTRUCTION
BAXTER COUNTY
Permit No. 0249-S1-R2
AFIN: 03-00051

Terracon Project No. 35087025
May 2008

Prepared for:

NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT
1305 Rossi Road
Mountain Home, Arkansas 72653

Prepared by:

Terracon Consultants, Inc.
25809 Interstate 30
Bryant, Arkansas 72022

Terracon

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SECTION 00020
INVITATION TO BID

PART 1 GENERAL

A. Bids will be received by the Northwest Arkansas Regional Solid Waste Management District (NARSWMD) (Owner) until 4:30 p.m. on June 10, 2008 for construction and related site improvements associated with the construction of Area 1-3, Cell 2 at the NABORS Landfill (Site). Bids will be evaluated for construction to be undertaken at the Site which is located in Baxter County, Arkansas. Required construction will be as specified in the Technical Specifications (see Divisions 1, 2, 3, 11, 13, and 16), as shown on the Contract Drawings, and as modified by Addenda, if any. Bids shall be submitted to the following location:

NARSWMD
1305 Rossi Road
Mountain Home, Arkansas

Bids will then be publicly opened and read aloud. Bids received after the bid date and time will not be accepted and will be returned unopened.

B. Sets of the Bid and Contract Documents may be purchased by contacting the NABORS Landfill Office, 1305 Rossi Road, Mountain Home, AR 72653, (870) 425-3213. Documents will be issued upon payment by check of $75.00 for each set requested. No sets will be issued until such payment is received, and sets are non-refundable.

C. The Bid and Contract Documents may be examined at the following locations:

1. **NARSWMD**
   1305 Rossi Road
   Mountain Home, Arkansas 72653

2. **Terracon Consultants, Inc.**
   25809 Interstate 30
   Bryant, AR 72022

D. The Summary of Work for construction associated with the construction of Area 1-3, Cell 2 includes, but is not limited to, providing all labor, materials, tools, equipment, incidentals, and services necessary and required for subgrade preparation, recompacted subgrade placement, compacted clay liner, geosynthetic clay liner (GCL) installation, 60 mil HDPE liner installation, drainage layer installation, protective cover layer installation, leachate collection system installation, leachate tank system connection, seeding, and all related work pursuant to the Bid and Contract Documents including, but not limited to, the Technical Specifications and Contract Drawings. The Summary of Work is detailed in the Technical Specifications, Section 01010 of the Bid and Contract Documents.

E. All equipment, material, and labor must be in accordance with the Bid and Contract Documents on file with the Owner at the address listed above.

F. BIDDERS ARE REQUIRED TO USE THE PRINTED BID FORMS PROVIDED IN SECTION 00300 OF THE BID AND CONTRACT DOCUMENTS.

G. Owner reserves the right to reject any or all Bids or portions of any or all bids and to waive informalities therein to determine the best Bid. The Bidder agrees that such rejection shall be without liability or expense on the part of Owner for any claim brought by Bidder because of such rejection; nor shall the Bidder seek any recourse of any kind against Owner because of such rejection. The filing of the Bid in response to this invitation shall constitute an agreement of the Bidder to the terms and conditions of the Bid and Contract Documents. The Bidder may not withdraw its Bid for a period of ninety (90) calendar days following the Bid Date. Bids may be held by the Owner for up to sixty (60) days from the date of the opening of bids for the purpose of reviewing the bids and investigating the qualifications of bidders prior to awarding of the contract.

H. A certified check or bank draft, payable to the Northwest Arkansas Regional Solid Waste Management District, negotiable U.S. Government bonds (at par value), or satisfactory bid bond executed by the bidder and an acceptable surety in an amount equal to five percent (5%) of the total of bid shall be submitted with the bid.

I. Attention is called to the fact that not less than the minimum salaries and wages as set forth in the contract documents must be paid on this project (reference prevailing wage rate), and that the Contractor must ensure that employees and applicants for employment are not discriminated against because of their race, color, religion, sex, or national origin. Each bidder must be in compliance with the requirements of Act 150 of 1965, effective June 9, 1965, subject to any subsequent amendments, which is the current Arkansas State Licensing Law for Contractors.

J. A pre-bid conference will be held at 10:30 A.M. local time on May 27, 2008 at the NABORS Office located at 1305 Rossi Road, Mountain Home, Arkansas, 72653. Conference will be held at the construction site after the pre-bid meeting. Questions for the construction shall be submitted to the Engineer no later than 4:30 PM local time on June 10, 2008. A transcript of all questions and answers will be available by e-mail, July 8, 2008:

1. **Attn: Mr. David McCormick, P.E. – Senior Project Engineer**
   25809 Interstate 30
   Bryant, AR 72022
   (501) 847-9292

K. Bidder must be properly licensed to perform the work pursuant to all applicable state and local law. An award to contract will not be made to a Bidder who is not so licensed.

Northwest Arkansas Regional Solid Waste District

BY: _____
Purchasing Agent

DATE: _____

SECTION 00100
INSTRUCTIONS TO BIDDERS

1. GENERAL

The purpose of the *Bid and Contract Documents* is to describe the requirements for the furnishing of all equipment, services, materials, and labor to complete the Work as defined and set forth herein. The successful Bidder will be required to furnish equipment, materials, labor, workmanship, and supervision complying fully with the requirements of the Bid and Contract Documents in order to properly perform the Work.

2. TERMS DEFINED

All terms are defined in the *Agreement* which is provided in Section 00500 of the *Bid and Contract Documents* or in *General Conditions, Section 00700*.

3. DIVISION OF THE WORK INTO THE TECHNICAL SPECIFICATIONS

The *Technical Specifications* are divided into a separate section of the Bid and Contract Documents only for the convenience in defining the Work. The specifications shall not require the Contractor to employ any particular craft or skill except as required by the Work, by the *Bid and Contract Documents*, and/or applicable law.

4. INTERPRETATION OF BID AND CONTRACT DOCUMENTS

A. The Bidder shall familiarize itself with the Work and all Site conditions to ensure the fulfillment of the intent of the *Bid and Contract Documents*.

B. If the Bidder is in doubt as to the true meaning of any part of the *Bid and Contract Documents*, it shall promptly request Owner for an interpretation thereof in writing and in any event not less than four (4) calendar days prior to the Bid Date. No response will be provided to a Bidder's oral question if it involves an interpretation of the intent or meaning of the *Bid and Contract Documents*, or the equality or use of products or methods other than those designated or described on the Contract Drawings or in the Technical Specifications. Any information provided to Bidders other than by means of the *Bid and Contract Documents*, including *Addenda* as described below, is given informally for information and the convenience of the Bidder only and is not guaranteed. The Bidder agrees that such information shall not be used as the basis of, nor shall the giving of any such information entitle the Bidder to, assert any claim or demand against Owner arising therefrom.

C. Interpretations of the *Bid and Contract Documents* will be made only by written Addendum, issued by Owner. When an Addendum is issued, two copies of such Addendum will be mailed or delivered to each party that has received the *Bid and Contract Documents*. Receipt of the Addendum must be acknowledged by Bidder's authorized signature in the space designated in the Bid Forms in Section 00300 of the *Bid and Contract Documents* and on the Addendum itself. One copy of the acknowledged Addendum must be returned to Owner with the submission of Bidder's

Bid.

D. No interpretation addenda shall be issued within the last four (4) calendar days before the Bid Date.

5. WITHDRAWAL OF A BID

The Bidder may not withdraw its Bid for a period of ninety (90) calendar days following the Bid Date. The Bid may be withdrawn at any time prior to the Bid Date. Negligence on the part of a Bidder or Bidder's failure to comply with any and all formalities in preparing its Bid confers no right of withdrawal or modification of its Bid after such Bid has been signed and submitted.

6. EXPERIENCE AND FINANCIAL STATUS

A. The only Bids that will be considered will be those which are offered by Bidders who can show evidence of proper completion of work of the type and magnitude comparable to the Work covered by the *Bid and Contract Documents*. A list of such work shall be entered in the appropriate space on the Bid Forms attached in Section 00300.

B. Subsequent to the opening of the Bids, the Bidder may be requested to submit financial statements for the Bidder and its subcontractors together with other such information as requested by Owner to determine that the Bidder is fully qualified. Such statements and information shall be made immediately available to Owner upon request.

7. LAWS AND REGULATIONS

The Bid shall be made and the Work performed in accordance with all applicable federal, state, county, and local laws, regulations, and ordinances including, but not limited to, such laws, regulations, and ordinances concerning appropriate noise levels and hours during which work may be performed.

8. SPECIFICATION OF PARTICULAR MATERIAL OR EQUIPMENT

A. The Bid must be based upon materials and equipment specifically mentioned by name in the *Technical Specifications* and *Contract Drawings* without consideration of possible substitute for "or equal" materials and/or equipment.

B. The Bidder may propose the use of equal or better materials and equipment provided that the requirements of the Work are met. If such proposal is considered before the Bid Date, it must be submitted to Owner at least two (2) calendar days before the Bid Date. Owner's approval will be set forth by an Addendum issued by the Owner to that effect. Otherwise, no such proposal shall be considered until after the award of the contract pursuant to the terms and conditions of the *Agreement*. In either case, Owner reserves the right to accept or reject such proposals at its sole discretion.

9. SUBCONTRACTORS AND SUPPLIERS

A. The Bidder shall submit with its Bid, a list of subcontractors and suppliers of principal items of material and equipment proposed for use in the Work on the Owner's form entitled "Subcontractors/Suppliers Form" which is attached hereto in Section 00300 of the *Bid and Contract Documents*.

B. This list will be considered in the evaluation of the Bids.

C. Such list of the subcontractors and suppliers is deemed to be a condition of the Agreement, and no change will be permitted without prior written approval of Owner.

10. INSURANCE

The Bid shall include a Certificate of Insurance from the Bidder's insurance company(ies) reflecting at a minimum the types and amounts of coverage required in the Agreement. Upon award of contract and upon execution of the Agreement, the Contractor shall provide a certificate of insurance stating that the Owner is named as an Additional Insured on all policies except for Workman's Compensation. The Bidder/Contractor shall provide at least thirty (30) days notice of cancellation or any change in the policies represented thereon all as specified in the Agreement. Contractor shall be solely responsible for payment of all premiums for such insurance. If Contractor intends to charge Owner for such insurance premiums, they shall be included in the Agreement Price (as defined herein).

11. ALTERNATE BID

The Bid shall be consistent with the *Technical Specifications, Contract Drawings*, and other Sections of the *Bid and Contract Documents*. Alternate Bids are not allowed.

12. EXECUTION AND DELIVERY OF THE BID

A. Two copies of the Bid Forms have been included in Section 00300 of the Bid and Contract Documents. The Bidder shall submit its Bid by completing the Bid Forms, signing in ink all copies of the Bid, and shall:

1. Deliver the Bid Forms marked "OWNER'S COPY" to the address designated in the *Invitation to Bid* (Section 00020).

2. Retain the copy of the Bid Forms marked "BIDDER'S COPY".

3. Bids shall be submitted at the time and place indicated in the Advertisement or Invitation to Bid and shall be enclosed in an opaque sealed envelope, marked with the project title and **Bid Identification # 52108** (and, if applicable, the designated portion of the project for which the Bid is submitted) and name and address of the Bidder and accompanied by the Bid security and other required documents. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation “BID ENCLOSED” on the face of it.

4. Prospective Bidders are furnished one copy of the Bidding Documents with one separate copy each of the Bid Form and Bid Bond Form. The Bidding Documents may be retained by the Bidder. The Bid Form marked "Owner's Copy" must be completed and submitted with the Bid Security.

5. Each bid must be submitted on the prescribed form, as well as accompanied by a Bid Bond. All blank spaces for bid prices must be filled in, in ink or typewritten. Each bid must be submitted in three sealed envelopes designated Envelopes "A", "B", and "C".

6. At the time of bid opening, Envelope "A", containing the Bid and Bid Bond, will be opened and read aloud for the purpose of acknowledging the low Bidder. Envelope "B", containing required administrative Contract Documents, will be opened and examined by the Owner at a later time for the purpose of qualifying the Bid. After all bids and required Contract Documents have been thoroughly checked by the Owner, the Successful Bidder will be announced and personally informed. Should a low Bidder fail to execute all required documentation qualifying his/her Bid, the Bid may be rejected and the next lowest Bidder awarded the work if he/she has qualified.

Envelope "A":
Include:

1. **Bid**
2. **Bid Bond**

Envelope "B":
Include:

1. **Certificate of current Arkansas State Contractor's License**
2. **Certificate of Insurance (See II.10)**
3. **Schedule (Proposed)**
4. **Safety History Report**
5. **Principals**
   - Name(s)
   - Home Address, Including City, State, and Zip Code

   Firm
   - Name (d/b/a)
   - Treasury Number
   - Business Address, City, State and Zip Code
   - Business Phone Number (s)

Envelope "C":
(Envelopes "A" and "B" are to be enclosed in Envelope "C")

Envelope "C" will be clearly marked as follows:

FROM: _____
(Name of Concern)

ADDRESS: _____
(Street or P.O. Box)

_____
(City, State, Zip Code)

TO: NARSWMD
1305 ROSSI ROAD
MOUNTAIN HOME, ARKANSAS 72653

PROJECT: NABORS LANDFILL BID #71106
Area 1-3 Cell 2 Construction and Related Site Improvements

To Be Opened: _____
(Date and Time)

B. Partnership Bids shall be signed in the partnership name, by a general partner.

C. Corporate Bids shall be signed in the name of the corporation, by an authorized officer of the corporation who is legally authorized to contractually bind the corporation to the Agreement provided herein.

D. Names and titles of all persons signing shall be typed or printed below their signatures.

E. The Bid must be delivered via mail or delivered in person. Faxed Bids will not be accepted.

F. The Bid shall be accompanied by a letter, executed by an authorized representative of a corporate surety satisfactory to Owner, stating that the Performance and Payment Bonds (described below) will be furnished by the surety company to the Bidder in the event it is awarded the contract. A certified and appropriately dated copy of such representative's currently valid power of attorney shall be attached to such letter.

G. The Bidder to whom the contract has been awarded will be required to execute and deliver two copies of the Agreement on the form provided in Section 00500 of the *Bid and Contract Documents* together with the Performance and Payment Bonds required herein within ten (10) calendar days after the date of mailing, telegraphing, or personal delivery of a written Notice of Award. In case of Bidder's refusal or failure to do so within ten (10) calendar days after the date of mailing, telegraphing, or personal delivery of written Notice of Award, the Bidder will be considered to have abandoned all of its rights and interests in the award and the Bidder's Bid Bond (if applicable) or Certified Check may be declared forfeited to Owner as liquidated damages and the award may then be made to the next best qualified Bidder or the Work re-advertised for Bid as Owner may elect.

H. All spaces on the Bid Form must be completed.

I. Any item on the Bid Forms which is not completed in accordance with the terms and conditions of the *Bid and Contract Documents* may result in rejection of the Bid.

J. Each bid must be accompanied by a Certified check or a “Bid Bond” from a corporate surety satisfactory to Owner, in an amount equal to five percent (5%) of the total Bid Price as the Bidder’s guarantee that it will, if called upon to do so, accept and enter into the Agreement provided herein to perform the Work covered by such Bid at the price stated therein and to furnish a corporate surety to guarantee its faithful and entire fulfillment. All Bid Bond Checks and/or Bonds will be returned promptly after the Owner and the selected Bidder have executed the Agreement, or if no Bid has been selected, within ninety (90) calendar days after the date of the opening of Bids, upon demand of the Bidder at any time thereafter, so long as the Bidder has not been notified of the acceptance of its Bid.

13. AWARD OF CONTRACT

A. Only Bids with firm lump sum and/or fixed unit prices (as appropriate), properly executed and completed will be considered.

B. Bids containing defects, irregularities, or informalities shall be subject to rejection at the discretion of Owner.

C. Owner reserves the exclusive right to determine whether a Bidder is qualified.

D. Owner reserves the sole right to determine which, if any, Bid is best, or to reject any and all Bids. In addition to price, Owner shall consider factors evidencing Bidder's ability to complete its work in a timely manner and in accordance with the standard of workmanship, prudence, care, and skill applicable to a contractor in performing the Work.

E. The successful Bidder, hereafter called Contractor, to whom the award of contract is made, will be notified at the earliest practicable date by a Written Notice of Award from Owner.

F. Owner reserves the right to award the entire contract or portions thereof to any one or more of the Bidders or to none of the Bidders.

G. Owner reserves the right to revoke the award for Owner's convenience at any time after the award is made and prior to complete execution of the Agreement by written notice to Contractor with no liability on Owner's part (including, but not limited to, all expenses or costs incurred by Contractor) because of such revocation.

14. THE AGREEMENT AND PERFORMANCE AND PAYMENT BONDS

A. Upon execution of the Agreement, the *Agreement* and *Contract Documents* shall constitute the entire agreement between the parties thereto, and the Bidder shall not claim any modification thereof resulting from any representation or promise made at any time by any officer, agent, or employee of Owner or any other person.

B. As security for the faithful performance of the Agreement, within ten (10) calendar days from the date of mailing, telegraphing, or personal delivery of a written Notice of Award of the contract, Contractor shall furnish Performance and Payment Bonds (the "Bonds") in a form acceptable to Owner and in an amount equal to one hundred percent (100%) of the total Agreement Price, together with a certificate executed by an officer of the surety issuing the Bonds stating that all premiums for the Bonds have been paid in full. These bonds and certificates shall be attached to, and made a part of, Section 00410 of the Contract Documents. CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR PAYMENT OF ALL PREMIUMS FOR SUCH BONDS. If Contractor intends to charge Owner for such bond premiums, they shall be reflected in the total bid price.

15. TAXES

Contractor shall pay any sales, use, and/or all other federal, state, and/or local taxes of any type applicable to the Work. The Bid Price shall include any and all applicable taxes required by law to be assessed against Owner.

16. DATE OF COMPLETION

All work is to be completed within the time period provided in the Agreement for completion of the Work. Pursuant to these requirements, the time deadline shall be met by Contractor unless specifically changed by Owner pursuant to the terms and conditions of the Agreement.

17. PRICE

The Work shall be bid on a fixed unit and firm lump sum price basis as specified on the Bid Forms, Section 00300 of the *Bid and Contract Documents*.

18. DISQUALIFICATION OF BIDDER

More than one (1) bid from an individual, partnership, corporation, or any combination of the foregoing, under the same or different names, will not be considered. Reasonable grounds to believe that any individual, partnership, corporation, or combination thereof is interested in more than one bid for the proposed work may cause the rejection of all bids in which that individual, partnership, corporation, or combination is interested. Bidders are required to sign a Non-Collusion Affidavit that is attached hereto in Section 00300 of the *Bid and Contract Documents* and which must be submitted with the Bid.

19. SCHEDULE

Contractor must submit a schedule with the Bid reflecting the anticipated progress of the Work based upon a breakdown of the Tasks on the Bid Forms. Each bid item must be represented as an "activity" on the schedule. Additionally, all procurement activities must be indicated on the schedule. Contractor may submit a bar chart, CPM diagram, or other format for this schedule requirement as long as durations of time are reflected for performance of each task and all Work is completed within the Agreement Time indicated in the Agreement.

20. BIDDER'S SAFETY HISTORY REPORT

Bidder shall provide a brief one page summary entitled Bidder’s Safety History Report. The summary shall briefly identify and describe all reported safety incidences and accidents which occurred during construction projects initiated by Bidder. If Bidder has no such violations, Bidder shall indicate the same on the first set of blank lines on the report and submit the report with the Bid.

21. BID AND CONTRACT DOCUMENTS

A. Complete sets of the Bidding Documents may be purchased for the amount and at the location stated in the Invitation to Bid. The purchase price will not be refunded.

B. Complete sets of Bidding Documents must be used in preparing Bids; neither the Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

C. Owner and Engineer, in making copies of Bidding Documents available on the above

terms, do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

22. EXAMINATION OF CONTRACT DOCUMENTS AND SITE

A. It is the responsibility of each Bidder before submitting a Bid, to (a) examine the Contract Documents thoroughly; (b) visit the site to become familiar with the local conditions that may affect cost, progress, performance or furnishing of the Work; (c) consider federal, state and local laws and regulations that may affect cost, progress, performance or furnishing of the Work; (d) study and carefully correlate Bidder's observations with the Contract Documents; and (e) notify Engineer of all conflicts, errors and discrepancies in the Bid and Contract Documents. Complete sets of the Bidding Documents may be purchased for the amount and at the location stated in the Invitation to Bid. The purchase price will not be refunded.

B. Information and data reflected in the Contract Documents with respect to Underground Facilities at or contiguous to the site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities or others, and Owner does not assume responsibility for the accuracy or completeness.

C. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Facilities and other physical conditions, and possible changes in the Bid and Contract Documents due to differing conditions are addressed in the *General Conditions*.

END OF SECTION

SECTION 00300 A
BID FORMS

NABORS Landfill
AREA 1-3 CELL 2 CONSTRUCTION AND RELATED SITE IMPROVEMENTS

(OWNER'S COPY)

Bid Package Title: **"NABORS Landfill – Area 1-3 Cell 2 Construction and Related Site Improvements as prepared by Terracon Consultants, Inc., Dated May 2008**

Name of Bidder:

_____

Address of Bidder:

_____

Bidder's Contractor's License Number (if such is required in order to perform Work in the State in which the Work is designated to be performed):

_____

_____

If Bidder is a corporation, list all shareholders owning five percent or more of the Bidder's stock.

_____, _____,

_____, _____,

_____, _____,

If Bidder is a partnership, list all partners.

_____, _____,

_____, _____,

Pursuant to and in compliance with the Invitation To Bid and the Instructions to Bidder relating hereto, the undersigned as a Bidder proposes and agrees to furnish and complete at the site and services specified in the Contract Documents, in the manner therein prescribed and in accordance with all addenda issued by the Owner prior to the opening of Bids, for the estimated sum of:

_____ $ _____

For Bidding purposes the quantities are fixed. The Owner may modify or delete items, units and estimated quantities in the Bid Form. Changes in the Work may increase or decrease items and quantities. The Owner makes no guarantees or warranties, expressed or implied regarding quantities. Final payment will be based on actual quantities as described in the Detailed Specifications. Contractor is solely responsible for providing sufficient materials, equipment and effort to complete the Work as outlined herein.

BID FORM "A"

NABORS LANDFILL
AREA 1-3 CELL 2 CONSTRUCTION

BID SCHEDULE (Owner's Copy)				
Bid Item	**Quantity**	**Unit**	**Unit Price**	**Item Subtotal**
1. Mobilization/Demobilization: Includes all fees, bonds, taxes, and insurance. Also includes all work required for site preparation and maintenance which includes: clearing and grubbing of areas where excavation is to be performed; all labor, equipment, rental, power, fuel, piping, and materials for establishing and maintaining dewatering system to facilitate excavation operations until it is no longer necessary as determined by the Engineer; temporary measures to control surface water run-on and run-off; and measures to control soil erosion including construction of silt fencing and sediment transport , application, fee payment and acquisition for all necessary permits; establishment of the Contractor's shops, plants, storage areas, field office, temporary water, electrical, telephone, sanitary and other temporary facilities, within the construction limits during and after construction of project.	1	L.S.		
2. Site Preparation and Maintenance: Price shall include and cover the furnishing of all materials, labor, tools, and equipment necessary for site preparation and maintenance, including, project surveying, maintaining field offices and utilities, maintaining temporary access roads for construction vehicles, dust control, erosion and sediment control, perimeter silt fence, clearing and grubbing trees, brush, vegetation, surficial debris, preparing the construction staging/stockpile areas, restoring all access roads and related site features to their original condition, seeding of disturbed areas, and all other activities necessary for site preparation and ongoing maintenance and restoration. Also includes obtaining an NPDES General Construction Stormwater Permit from the ADEQ.	7.5	Acres		
3. Gross Excavation and Fill: Removal and loading/unloading of soil and rock from project area limits to lines and grades specified on the Drawings. Quantity includes excavation to bottom of recompacted subgrade layer. Price to also include transporting excavated soil and rock to borrow area(s) on-site specified by the Owner, all materials, equipment, personnel, labor and all else required. (The client currently uses the soils in this area for site operations and daily cover, therefore these numbers will vary when construction begins.) Rock may only be removed by mechanical operations.	Cut: 19,215 Fill: 34,150 Rock: 50	C.Y. C.Y. C.Y.		

Bid Item	Quantity	Unit	Unit Price	Item Subtotal
4. Recompacted Subgrade Layer: Preparation, excavation, loading/unloading, transport from on-site borrow areas to work area, grading and compacting fill material used to construct the bottom liner system subgrade (not to include side-slopes) in Cell 2. The 24 inch thick cohesive soil layer must meet permeability requirements ($1x10^{-5}$ cm/sec) as specified on Drawings. Permeability will be verified by independent testing firm using soil Proctor information and density/moisture relationship. Price to include all equipment, personnel, labor, and all else required to process and moisture condition the soil as necessary and construct the recompacted subgrade to the elevations and limits shown on the Drawings. (The bid quantity will vary depending on the location of rock ridges and the amount of in-situ material.)	16,610	C.Y.		
5. Compacted Clay Liner Layer (CCL): Excavation, loading/unloading and transport of CCL. Includes the preparation, grading, compaction, and moisture conditioning of the 24-inch thick CCL to the lines and grades shown on the Drawings in Cell 2. The 24 inch thick cohesive soil layer must meet permeability requirements ($1x10^{-7}$ cm/sec) as specified on Drawings. Preparation of, and if necessary repair of, the CCL to render the surface acceptable for deployment of geosynthetic clay liner. (Previously the site material was required to be compacted to 98% compaction and +3% of optimal moisture content to meet permeability.)	16,610	C.Y.		
6. Geosynthetic Clay Liner (GCL): Includes the supply and placement of the GCL within the Cell 2 area limits as shown on the Drawings. (The site has approximately 36,000 s.f. of Claymax 200R remaining from Cell 1 construction that is to be used for this project.) Contractor responsible for unloading geosynthetics.	172,000 136,000	S.F.	_____ Installation _____ Material	
7. Textured HDPE Liner: Includes the supply and placement of textured High Density Polyethylene liner on the bottom and side slopes of the Cell 2 as shown on the Drawings. (The site has approximately 23,000 s.f. of 60 mil textured liner on site remaining from Cell 1 construction that is to be used for this project.) Contractor responsible for unloading geosynthetics.	219,000 196,000 450 Cell ½ Tie-in	S.F. S.F L.F.	_____ Installation _____ Material _____ Installation	
7a. HDPE 60-mil Textured Geomembrane Liner Rub Sheet: Includes the supply and placement of a second layer of geomembrane in the leachate trenches and sumps. Contractor responsible for unloading geosynthetics.	7,500	S.F.	_____ Rubsheet	

Bid Item	Quantity	Unit	Unit Price	Item Subtotal
8. Geocomposite Drainage Layer: Includes the supply, placement of the geocomposite drainage layer above the HDPE liner on the bottom and side slopes within the Cell 2 limits as shown on the Drawings. (The site has approximately 17,500 s.f. of double sided geocomposite remaining from Cell 1 construction that is to be used for this project.) Contractor responsible for unloading geosynthetics.	217,000 199,500	S.F.	_____ Installation _____ Material	
9. Protective Cover Layer – Includes the supply, loading/unloading, transport, and placement of a 12" thick protective cover soil layer above the geocomposite drainage layer within the Cell 2 limits. Price shall include loading, transport, placement, labor, equipment and personnel.	8,305	C.Y.		
9a. Liner Overbuild Area – Install the supply and placement of materials to as required for construction of the liner over-build area as per the drawings. Price shall include loading, transport, material, placement, labor, equipment and personnel.	200	L.F.		
10. Gravel Access Roads: Shall include all materials, equipment, transportation, personnel, labor and all else required to construct access roads to the grades and limits shown on Drawings.	1,535	L.F.		
10a. Storm water Ditch: Shall include all materials, equipment, transportation, personnel, labor and all else required to construct the storm water ditch according to plans. Also, install 24" corrugated HDPE drainage pipe with rip-rap on the northwest corner of Cell 2.	1	L.S.		
11. Geosynthetic Anchor Trenches: Includes all labor, materials, tools, supervision, transportation, equipment excavation of trench, placement of GCL, HDPE and geocomposite material, placement of fill, compaction within the trenches, moisture conditioning, coordination with Geosynthetics installer, as shown on the Drawings.	1,435	L.F.		
12. 6" Perforated Leachate Collection System: Supply and placement of leachate collection piping and clean-out piping. Shall include furnishing all materials, excavation, equipment, transportation, personnel, labor, independent testing, and all else required to construct the leachate collection pipes, including furnishing and installing geotextiles, sewing, perforated and solid wall HDPE pipe, course aggregate, HDPE piping, and associated fittings, elbows, etc.	1,050	L.F.		
13. Leachate Forcemain System: Includes the materials, trenching, supply, bedding, installation, tie-in, pumps, valves, pipe, fittings, bends, joints etc. as shown on the Drawings and described in the Technical Specifications.	1	L.S.		

Bid Item	Quantity	Unit	Unit Price	Item Subtotal
14. Headwall for Leachate Riser Pipe and Clean-out Headwall: Price shall include all materials, trenching, backfill, equipment, labor and all else required to install the Dual 18-inch HDPE riser pipe, cleanout and concrete headwall to dimensions and limits shown on the Drawings.	1	L.S.		
15. Leachate Pump System and Electrical: Includes furnish and install of two submersible leachate pumps, pipe support systems, tank level sensor, electric supply and electrical controls. The pumps and panel equipment shall be manufactured by EPG or equal	1	L.S.		
16. Leachate Storage Tank Area: Preparation, installation of compacted fill, compacted clay material, granular material, 10,000 gallon owner-supplied leachate tank, 8" thick reinforced concrete pad, and installation of discharge piping system as shown on the Drawings.	1	L.S.		
17. Erosion Control Matting and Seeding of Cell 2 construction area and areas disturbed by construction, as shown on the drawings and described in the Technical Specifications.	2	Acres		
Total Bid Amount				

Notes:

All quantities are estimated based on design and 2008 topography.

The Bidder acknowledges, warrants, represents, and agrees with all of the following:

1. The site currently has an NPDES permit. The Contractor is responsible for keeping their construction area in compliance.

2. That the Bid includes all applicable taxes

3. That if conflicts exist between the Owner's Specifications and the Bidder's Bid, the Owner's Specifications shall control.

4. In the case of lump sum items, the Contractor shall furnish to the Owner, upon request, a breakdown of the Contract amount of each significant item used in the compilation of the Bid. The breakdown shall be subject to the approval of the Owner, and shall be used in the compilation of change order prices, as specified herein, when such a breakdown is determined by the Owner to be applicable.

5. Any quantities reflected on the Bid Form are estimates only. The Owner makes no guarantees or warranties, expressed or implied, regarding quantities. The Contractor should perform its own estimates. Contractor's payment will be based on actual whole quantities of completed Work as described in the Specifications and at the unit

Price bid by the Contractor, unless otherwise specified by the Contract. Unit Prices will not be adjusted if actual installed quantities vary from estimated quantities.

6. Separate Contracts may be awarded for different parts of the Work. The Contractor shall afford other Contractors reasonable opportunities for the receipt and storage of their materials and equipment and shall coordinate its Work with theirs.

7. The Owner, in its sole discretion, may modify or delete items, units and estimated quantities in the Bid Form.

8. Contractor is solely responsible to provide sufficient materials, equipment, and effort to complete the Work herein.

9. That it has received Bid Addenda No.s __, __, __, __, to the Bid and Contract Documents;

10. That the Bid is based upon using qualified local labor for all field work done in performance of the Work

11. That it has made careful examination of the Work, (including all subsurface conditions and facilities, as defined in the Construction Agreement) all applicable laws and regulations affecting the Work; that it has determined the amount and character of the Work and the materials and equipment necessary to complete the Work in compliance with the Bid and Contract Documents; that the Bid and Contract Documents are adequate in order for Bidder to perform the Work within the Agreement Time and Bidder's Total Price and Bidder has become acquainted with labor conditions and all other conditions which would affect the Work;

12. That upon submission of the Bid, the Bidder agrees to perform the Work in accordance with all terms and conditions contained in the Contract Documents;

13. That the subcontractors and/or suppliers to be used for the Work are listed in the "Subcontractors/Suppliers Form" which is attached hereto

14. That the Bid shall be submitted with a Certificate of Insurance for the Bidder evidencing at a minimum the types and amounts of coverage required in the Agreement, and that the Owner is named as an additional insured;

15. That the Bid is in all respects is fair and has been made in good faith, without collusion or fraud and that Bidder has submitted as part of this Bid a Non-Collusion Affidavit, which is attached hereto;

IN WITNESS WHEREOF, this Bid and the information represented on these Bid Forms is true, correct, and accurate. I have examined and carefully prepared the Bid and am authorized to prepare and submit such Bid on behalf of Bidder.

BIDDER:	WITNESS:
By: _____	By: _____
_____	_____
Printed Name	Printed Name
_____	_____
Title	Title

NON-COLLUSION AFFIDAVIT

STATE OF _____)

COUNTY OF _____)

_____, being first duly sworn, deposes and says that he/she

is _____ of

_____,
(President, Secretary, Treasurer, etc.)

is authorized to execute this affidavit on behalf of Bidder, is responsible for the prices and the amount of the Bid, is the party who made the foregoing bid; that such Bid is genuine and not collusive; that the Bidder did not collude, conspire, connive, or agree, directly of indirectly, with any bidder, potential bidder, or other entity or person that such other person or entity should refrain from bidding, or submit a sham bid or submit an intentionally high or non-competitive bid or other form of complimentary bid; that Bidder did not in any manner, directly or indirectly, seek by agreement or collusion of communication or conference with any person or entity to fix the bid price of Bidder or any other bidder, or to fix any overhead, profit, or cost element of said bid price, or of that of any other bidder, or to secure any advantage against **Northwest Arkansas Regional Solid Waste Management District**, or any person interested in the proposed contract; and that all statements contained in said Bid are true and further, that the Bidder did not, directly or indirectly, submit this Bid or the contents thereof or divulge information or data relative thereto to any association, entity or person who is a bidder or potential bidder; and that _____ (Bidder), its affiliates, subsidiaries, officers, directors, and employees are not currently under investigation by any governmental authorities or agencies and have not in the last five (5) years been convicted or found liable for any act prohibited by State or Federal Law in any jurisdiction, involving conspiracy with respect to bidding on any contract except as follows:

_____

_____

Bidder:_____

By: _____

Printed Name: _____

Title: _____

Sworn to and subscribed before me this _____ day of _____, 20____.

_____
Notary Public
(seal)

in and for _____ County, _____.

My commission expires _____, 20____.

SUBCONTRACTORS/SUPPLIERS FORM

SCOPE	NAME AND COMPLETE ADDRESS
A.	_____
	_____
	_____
	_____
B.	_____
	_____
	_____
	_____
C.	_____
	_____
	_____
	_____
D.	_____
	_____
	_____
E.	_____
	_____
	_____

** Attach additional sheets as necessary **

SECTION 00300 B
BID FORMS

NABORS Landfill
AREA 1-3 CELL 2 CONSTRUCTION AND RELATED SITE IMPROVEMENTS

(BIDDER'S COPY)

Bid Package Title: **"NABORS Landfill – Area 1-3 Cell 2 Construction and Related Site Improvements as prepared by Terracon Consultants, Inc., Dated May 2008**

Name of Bidder:

_____

Address of Bidder:

_____

Bidder's Contractor's License Number (if such is required in order to perform Work in the State in which the Work is designated to be performed):

_____

_____

If Bidder is a corporation, list all shareholders owning five percent or more of the Bidder's stock.

_____, _____,

_____, _____,

_____, _____,

If Bidder is a partnership, list all partners.

_____, _____,

_____, _____,

Pursuant to and in compliance with the Invitation To Bid and the Instructions to Bidder relating hereto, the undersigned as a Bidder proposes and agrees to furnish and complete at the site and services specified in the Contract Documents, in the manner therein prescribed and in accordance with all addenda issued by the Owner prior to the opening of Bids, for the estimated sum of:

_____ $ _____

For Bidding purposes the quantities are fixed. The Owner may modify or delete items, units and estimated quantities in the Bid Form. Changes in the Work may increase or decrease items and

quantities. The Owner makes no guarantees or warranties, expressed or implied regarding quantities. Final payment will be based on actual quantities as described in the Detailed Specifications. Contractor is solely responsible for providing sufficient materials, equipment and effort to complete the Work as outlined herein.

BID FORM "B"

NABORS LANDFILL
AREA 1-3 CELL 2 CONSTRUCTION

BID SCHEDULE (Bidder's Copy)				
Bid Item	**Quantity**	**Unit**	**Unit Price**	**Item Subtotal**
1. Mobilization/Demobilization: Includes all fees, bonds, taxes, and insurance. Also includes all work required for site preparation and maintenance which includes: clearing and grubbing of areas where excavation is to be performed; all labor, equipment, rental, power, fuel, piping, and materials for establishing and maintaining dewatering system to facilitate excavation operations until it is no longer necessary as determined by the Engineer; temporary measures to control surface water run-on and run-off; and measures to control soil erosion including construction of silt fencing and sediment transport , application, fee payment and acquisition for all necessary permits; establishment of the Contractor's shops, plants, storage areas, field office, temporary water, electrical, telephone, sanitary and other temporary facilities, within the construction limits during and after construction of project.	1	L.S.		
2. Site Preparation and Maintenance: Price shall include and cover the furnishing of all materials, labor, tools, and equipment necessary for site preparation and maintenance, including, project surveying, maintaining field offices and utilities, maintaining temporary access roads for construction vehicles, dust control, erosion and sediment control, perimeter silt fence, clearing and grubbing trees, brush, vegetation, surficial debris, preparing the construction staging/stockpile areas, restoring all access roads and related site features to their original condition, seeding of disturbed areas, and all other activities necessary for site preparation and ongoing maintenance and restoration. Also includes obtaining an NPDES General Construction Stormwater Permit from the ADEQ.	7.5	Acres		
3. Gross Excavation and Fill: Removal and loading/unloading of soil and rock from project area limits to lines and grades specified on the Drawings. Quantity includes excavation to bottom of recompacted subgrade layer. Price to also include transporting excavated soil and rock to borrow area(s) on-site specified by the Owner, all materials, equipment, personnel, labor and all else required. (The client currently uses the soils in this area for site operations and daily cover, therefore these numbers will vary when construction begins.) Rock may only be removed by mechanical operations.	Cut: 19,215 Fill: 34,150 Rock: 50	C.Y. C.Y. C.Y.		

Bid Item	Quantity	Unit	Unit Price	Item Subtotal
4. Recompacted Subgrade Layer: Preparation, excavation, loading/unloading, transport from on-site borrow areas to work area, grading and compacting fill material used to construct the bottom liner system subgrade (not to include side-slopes) in Cell 2. The 24 inch thick cohesive soil layer must meet permeability requirements ($1x10^{-5}$ cm/sec) as specified on Drawings. Permeability will be verified by independent testing firm using soil Proctor information and density/moisture relationship. Price to include all equipment, personnel, labor, and all else required to process and moisture condition the soil as necessary and construct the recompacted subgrade to the elevations and limits shown on the Drawings. (The bid quantity will vary depending on the location of rock ridges and the amount of in-situ material.)	16,610	C.Y.		
5. Compacted Clay Liner Layer (CCL): Excavation, loading/unloading and transport of CCL. Includes the preparation, grading, compaction, and moisture conditioning of the 24-inch thick CCL to the lines and grades shown on the Drawings in Cell 2. The 24 inch thick cohesive soil layer must meet permeability requirements ($1x10^{-7}$ cm/sec) as specified on Drawings. Preparation of, and if necessary repair of, the CCL to render the surface acceptable for deployment of geosynthetic clay liner. (Previously the site material was required to be compacted to 98% compaction and +3% of optimal moisture content to meet permeability.)	16,610	C.Y.		
6. Geosynthetic Clay Liner (GCL): Includes the supply and placement of the GCL within the Cell 2 area limits as shown on the Drawings. (The site has approximately 36,000 s.f. of Claymax 200R remaining from Cell 1 construction that is to be used for this project.) Contractor responsible for unloading geosynthetics.	172,000 136,000	S.F.	_____ Installation _____ Material	
7. Textured HDPE Liner: Includes the supply and placement of textured High Density Polyethylene liner on the bottom and side slopes of the Cell 2 as shown on the Drawings. (The site has approximately 23,000 s.f. of 60 mil textured liner on site remaining from Cell 1 construction that is to be used for this project.) Contractor responsible for unloading geosynthetics.	219,000 196,000 450 Cell ½ Tie-in	S.F. S.F L.F.	_____ Installation _____ Material _____ Installation	
7a. HDPE 60-mil Textured Geomembrane Liner Rub Sheet: Includes the supply and placement of a second layer of geomembrane in the leachate trenches and sumps. Contractor responsible for unloading geosynthetics.	7,500	S.F.	_____ Rubsheet	

Bid Item	Quantity	Unit	Unit Price	Item Subtotal
8. Geocomposite Drainage Layer: Includes the supply, placement of the geocomposite drainage layer above the HDPE liner on the bottom and side slopes within the Cell 2 limits as shown on the Drawings. (The site has approximately 17,500 s.f. of double sided geocomposite remaining from Cell 1 construction that is to be used for this project.) Contractor responsible for unloading geosynthetics.	217,000 199,500	S.F.	_____ Installation _____ Material	
9. Protective Cover Layer – Includes the supply, loading/unloading, transport, and placement of a 12" thick protective cover soil layer above the geocomposite drainage layer within the Cell 2 limits. Price shall include loading, transport, placement, labor, equipment and personnel.	8,305	C.Y.		
9a. Liner Overbuild Area – Install the supply and placement of materials to as required for construction of the liner over-build area as per the drawings. Price shall include loading, transport, material, placement, labor, equipment and personnel.	200	L.F.		
10. Gravel Access Roads: Shall include all materials, equipment, transportation, personnel, labor and all else required to construct access roads to the grades and limits shown on Drawings.	1,535	L.F.		
10a. Storm water Ditch: Shall include all materials, equipment, transportation, personnel, labor and all else required to construct the storm water ditch according to plans. Also, install 24" corrugated HDPE drainage pipe with rip-rap on the northwest corner of Cell 2.	1	L.S.		
11. Geosynthetic Anchor Trenches: Includes all labor, materials, tools, supervision, transportation, equipment excavation of trench, placement of GCL, HDPE and geocomposite material, placement of fill, compaction within the trenches, moisture conditioning, coordination with Geosynthetics installer, as shown on the Drawings.	1,435	L.F.		
12. 6" Perforated Leachate Collection System: Supply and placement of leachate collection piping and clean-out piping. Shall include furnishing all materials, excavation, equipment, transportation, personnel, labor, independent testing, and all else required to construct the leachate collection pipes, including furnishing and installing geotextiles, sewing, perforated and solid wall HDPE pipe, course aggregate, HDPE piping, and associated fittings, elbows, etc.	1,050	L.F.		
13. Leachate Forcemain System: Includes the materials, trenching, supply, bedding, installation, tie-in, pumps, valves, pipe, fittings, bends, joints etc. as shown on the Drawings and described in the Technical Specifications.	1	L.S.		

Bid Item	Quantity	Unit	Unit Price	Item Subtotal
14. Headwall for Leachate Riser Pipe and Clean-out Headwall: Price shall include all materials, trenching, backfill, equipment, labor and all else required to install the Dual 18-inch HDPE riser pipe, cleanout and concrete headwall to dimensions and limits shown on the Drawings.	1	L.S.		
15. Leachate Pump System and Electrical: Includes furnish and install of two submersible leachate pumps, pipe support systems, tank level sensor, electric supply and electrical controls. The pumps and panel equipment shall be manufactured by EPG or equal	1	L.S.		
16. Leachate Storage Tank Area: Preparation, installation of compacted fill, compacted clay material, granular material, 10,000 gallon owner-supplied leachate tank, 8" thick reinforced concrete pad, and installation of discharge piping system as shown on the Drawings.	1	L.S.		
17. Erosion Control Matting and Seeding of Cell 2 construction area and areas disturbed by construction, as shown on the drawings and described in the Technical Specifications.	2	Acres		
Total Bid Amount				

Notes:

All quantities are estimated based on design and 2008 topography.

The Bidder acknowledges, warrants, represents, and agrees with all of the following:

1. The site currently has an NPDES permit. The Contractor is responsible for keeping their construction area in compliance.

2. That the Bid includes all applicable taxes;

3. That if conflicts exist between the Owner's Specifications and the Bidder's Bid, the Owner's Specifications shall control.

4. In the case of lump sum items, the Contractor shall furnish to the Owner, upon request, a breakdown of the Contract amount of each significant item used in the compilation of the Bid. The breakdown shall be subject to the approval of the Owner, and shall be used in the compilation of change order prices, as specified herein, when such a breakdown is determined by the Owner to be applicable.

5. Any quantities reflected on the Bid Form are estimates only. The Owner makes no guarantees or warranties, expressed or implied, regarding quantities. The Contractor should perform its own estimates. Contractor's payment will be based on actual whole quantities of completed Work as described in the Specifications and at the unit Price bid by the Contractor, unless otherwise specified by the Contract. Unit Prices will not be adjusted if actual installed quantities vary from estimated quantities.

6. Separate Contracts may be awarded for different parts of the Work. The Contractor shall afford other Contractors reasonable opportunities for the receipt and storage of their materials and equipment and shall coordinate its Work with theirs.

7. The Owner, in its sole discretion, may modify or delete items, units and estimated quantities in the Bid Form.

8. Contractor is solely responsible to provide sufficient materials, equipment, and effort to complete the Work herein.

9. That it has received Bid Addenda No.s __, __, __, __, to the Bid and Contract Documents;

10. That the Bid is based upon using qualified local labor for all field work done in performance of the Work;

11. That it has made careful examination of the Work, (including all subsurface conditions and facilities, as defined in the Construction Agreement) all applicable laws and regulations affecting the Work; that it has determined the amount and character of the Work and the materials and equipment necessary to complete the Work in compliance with the Bid and Contract Documents; that the Bid and Contract

Documents are adequate in order for Bidder to perform the Work within the Agreement Time and Bidder's Total Price and Bidder has become acquainted with labor conditions and all other conditions which would affect the Work;

12. That upon submission of the Bid, the Bidder agrees to perform the Work in accordance with all terms and conditions contained in the Contract Documents;

13. That the subcontractors and/or suppliers to be used for the Work are listed in the "Subcontractors/Suppliers Form" which is attached hereto;

14. That the Bid shall be submitted with a Certificate of Insurance for the Bidder evidencing at a minimum the types and amounts of coverage required in the Agreement, and that the Owner is named as an additional insured;

15. That the Bid is in all respects is fair and has been made in good faith, without collusion or fraud and that Bidder has submitted as part of this Bid a Non-Collusion Affidavit, which is attached hereto;

IN WITNESS WHEREOF, this Bid and the information represented on these Bid Forms is true, correct, and accurate. I have examined and carefully prepared the Bid and am authorized to prepare and submit such Bid on behalf of Bidder.

BIDDER:	WITNESS:
By:_____	By: _____
_____	_____
Printed Name	Printed Name
_____	_____
Title	Title

NON-COLLUSION AFFIDAVIT

STATE OF _____)

COUNTY OF _____)

_____, being first duly sworn, deposes and says that he/she

is _____ of

_____,
(President, Secretary, Treasurer, etc.)

is authorized to execute this affidavit on behalf of Bidder, is responsible for the prices and the amount of the Bid, is the party who made the foregoing bid; that such Bid is genuine and not collusive; that the Bidder did not collude, conspire, connive, or agree, directly of indirectly, with any bidder, potential bidder, or other entity or person that such other person or entity should refrain from bidding, or submit a sham bid or submit an intentionally high or non-competitive bid or other form of complimentary bid; that Bidder did not in any manner, directly or indirectly, seek by agreement or collusion of communication or conference with any person or entity to fix the bid price of Bidder or any other bidder, or to fix any overhead, profit, or cost element of said bid price, or of that of any other bidder, or to secure any advantage against **Northwest Arkansas Regional Solid Waste Management District**, or any person interested in the proposed contract; and that all statements contained in said Bid are true and further, that the Bidder did not, directly or indirectly, submit this Bid or the contents thereof or divulge information or data relative thereto to any association, entity or person who is a bidder or potential bidder; and that _____ (Bidder), its affiliates, subsidiaries, officers, directors, and employees are not currently under investigation by any governmental authorities or agencies and have not in the last five (5) years been convicted or found liable for any act prohibited by State or Federal Law in any jurisdiction, involving conspiracy with respect to bidding on any contract except as follows:

_____

_____

Bidder:_____

By: _____

Printed Name: _____

Title: _____

Sworn to and subscribed before me this _____ day of _____, 20____.

_____
Notary Public
(seal)

in and for _____ County, _____.

My commission expires _____, 20____.

SUBCONTRACTORS/SUPPLIERS FORM

SCOPE	NAME AND COMPLETE ADDRESS
A.	_____
	_____
	_____
	_____
B.	_____
	_____
	_____
	_____
C.	_____
	_____
	_____
	_____
D.	_____
	_____
	_____
E.	_____
	_____
	_____

** Attach additional sheets as necessary **

SECTION 00410
BID BOND

KNOW ALL MEN BY THESE PRESENTS that we, the undersigned _____

_____

_____

as Principal, and _____

as Surety, are hereby paid and firmly bound unto _____

_____

as owner in the penal sum of_____ ($_____)

for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

Signed: This _____ day of _____ , 2008.

The condition of the above obligation is such that whereas the Principal has submitted to

_____ a certain bid

attached hereto and hereby made a part hereof to enter into a contract in writing for the

NABORS Landfill Area 1-3, Cell 2 Construction and Related Site Improvements.

NOW, THEREFORE:

a) If said bid shall be rejected, or is the alternate;

b) If said bid shall be accepted and the principal shall execute and deliver a contract on the Form of Contract attached hereto (properly completed in accordance with said bid) and shall furnish a bond for his faithful performance of said contract and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said bid;

Then this obligation shall be void; otherwise, the same shall remain in force and effect, it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its bond shall be in no way impaired or affected by any extension of time within which the Owner may accept such Bid; and said Surety does hereby waive notice of any such extension.

In WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year set forth above.

_____ L.S.
(Principal)

_____
(Surety)

By: _____

SEAL

END OF SECTION

SECTION 00500
AGREEMENT

Agreement between Owner and Contractor
on the Basis of Stipulated Price

(Based on EJCDC 1910-8-A-1, 1990 edition)

THIS AGREEMENT is dated as of the _____ day of May in the year 2008 by and between the Northwest Arkansas Regional Solid Waste Management District (hereinafter called "Owner") and _____. (hereinafter called "Contractor").

Owner and Contractor, in consideration of the mutual covenants hereinafter set forth, agree as follows:

PART 1 WORK

A. Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

NABORS Landfill Area 1-3, Cell 2 Construction and Related Site Improvements

PART 2 ENGINEER

A. The Project has been designed by Terracon Consultants, Inc. The Owner will assign an engineer which is hereinafter called "Engineer" to act as the Owner's representative, assume all duties, and responsibilities of the Engineer in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

PART 3 CONTRACT TIME

3.1 The Work included in this contract shall be completed within the agreed upon schedule specified on the Notice to Proceed. Completion includes the satisfactory construction of Area 1-3 Cell 2 and the related site improvements.

3.2 Liquidated Damages. Owner and Contractor recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified in paragraph 3.1 of this Agreement, plus any extensions thereof allowed in accordance with PART 15 of the General Conditions. The Owner and Contractor also recognize the delays, expense and difficulties involved in proving in a legal preceding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay, but not as penalty, Contractor shall pay Owner five hundred Dollars ($500) per day for each day that expires after the time specified in paragraph 3.1 of this Agreement for completion of Work until the Work is complete and

ready for final payment. There shall be no exemptions because of weather conditions if the Owner certifies that work could have proceeded despite the weather. **The Owner has the right to withhold any such sums as liquidated damages from the final payment to the Contractor.**

PART 4 CONTRACT PRICE

4.1 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents in current funds as follows:

A lump sum Contract Price of

_____
(written amount)

PART 5 PAYMENT PROCEDURES

Contractor shall submit Applications for Payment in accordance with PART 19 of the General Conditions. Applications for Payment will be processed as provided in the General Conditions.

5.1 Progress Payments: Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment on or about the 20th day of each month during construction as provided below. All progress payments will be on the basis of the progress of the Work measured by the schedule of values established in PART 3 of the General Conditions, and in the case of Unit Price Work based on the number of units completed, or, in the event there is no schedule of values, as provided in the General Conditions.

A. The Owner shall retain ten percent (10%) of the amount of each progress payment. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below, but, in each case, less the aggregate of payments previously made and less such amounts the Owner may withhold, in accordance with PART 19 of the General Conditions.

1. In accordance with Ark. Code Ann. § 22-9-604, Upon certification by the Engineer that the Work under this contract has been fifty percent (50%) completed, there will be no additional retainage on account of Work completed, in which case the remaining progress payments prior to Substantial Completion will be in an amount equal to one hundred percent (100%) of the Work completed.

2. Subject to the provisions of Section 3.2, upon Substantial Completion, payments will be made in an amount sufficient to increase total payments to Contractor to ninety five percent (95%) of the Contract Price, less such amounts that the Owner may withhold, in accordance with PART 19 of the General Conditions.

3. In accordance with Ark. Code Ann. § 22-9-604, if the Contractor is required by the Contract Documents to purchase and furnish materials or equipment that will be stored on the job site or in a bonded warehouse and used in the Work, no retainage will be withheld on that amount of the submitted progress payment pertaining to the cost of these stored materials or equipment.

5.2 Final Payment. Upon final completion and acceptance of the Work in accordance with PART 19 of the General Conditions, and after the Owner receives ALL lien waivers and ALL other proper documentation from the Contractor, Owner shall pay the remainder of the Contract Price as provided in said PART 19.

PART 6 CONTRACTOR'S REPRESENTATIONS

In order to induce Owner to enter into this Agreement, Contractor makes the following representations:

6.1 Contractor has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and laws and regulations that in any manner may affect cost, progress, performance or furnishing of the Work. Contractor covenants and agrees to comply with all applicable laws, statutes, regulations, ordinances and permits relating to the performance of this contract.

6.2 Contractor has studied carefully all reports of explorations and tests of subsurface conditions and drawings of physical conditions, and accepts the determination of the extent of the technical data contained in such reports and drawings upon which Contractor is entitled to rely.

6.3 Contractor has obtained and carefully studied, or assumes responsibility for obtaining and carefully studying, all such examinations, investigations, explorations, tests, reports and studies, in addition to or to supplement those referred to in paragraph 6.2 above, which pertain to the subsurface or physical conditions at or contiguous to the site or otherwise that may affect the cost, progress, performance or furnishing of the Work as Contractor considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Documents. No additional examinations, investigations, explorations, tests, reports, studies or similar information or data are or will be required by Contractor for such purposes.

6.4 Contractor has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities. No additional examinations, investigations, explorations, tests, reports, studies or similar information or data with respect to said Underground Facilities are or will be required by Contractor in order to perform and furnish the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents.

6.5 Contractor has correlated the results of all such observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents.

6.6 Contractor has given Owner written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents and the written resolution thereof by Owner is acceptable to Contractor.

6.7 Not less than the prevailing hourly rate of wages, as determined by the Arkansas Department of Labor, shall be paid to all workers performing work under the Contract Documents.

PART 7 CONTRACT DOCUMENTS

The Contract Documents which comprise the entire agreement between Owner and Contractor concerning the Work consist of the following:

7.1 This Agreement and Sections of the Construction Bid and Contract Documents dated May 2008, referenced herein.

7.2 Performance and Payment Bonds.

7.3 Notice of Award.

7.4 General Conditions.

7.5 Supplementary Conditions, if any.

7.6 Specifications.

7.7 Drawings.

7.8 Addenda numbers __ to __, inclusive.

7.9 Invitation to Bid, Instructions to Bidders, Bid Form, and Contractor's Bid.

7.10 The following which may be delivered or issued after the Effective Date of the Agreement and are not attached hereto: All written amendments and other documents amending, modifying or supplementing the Contract Documents pursuant to the provisions of this Agreement and the General Conditions, including any written Change Orders and written Field Orders.

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There are no Contract Documents other than those listed above in this PART 7. The Contract Documents may only be amended, modified or supplemented as provided in Subsections 13.1 and 13.2 of the General Conditions and the provisions of this Agreement.

PART 8 MISCELLANEOUS

8.1 Terms used in this Agreement which are defined in PART 1 of the General Conditions will have the meanings indicated in the General Conditions.

8.2 No assignment by a party hereto of any rights under or interests in the Contract

Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation moneys that may become due and moneys that are due may not be assigned without such consent, except to the extent that the effect of this restriction may be limited by law. Unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

8.3 Owner and Contractor each binds themselves, their partners, successors and legal representatives to the other party hereto, their partners, successors, assigns and legal representatives in respect of all covenants, agreements and obligations contained in the Contract Documents.

8.4 Nondiscrimination: Contractor agrees to comply with all applicable federal and state laws and regulations regarding nondiscrimination, and specifically agrees not to discriminate against any individual because of race, religion, sex, national origin or disability, and to require such compliance in contractual agreements with subcontractors and sub-subcontractors.

8.5 Contractor agrees to comply with the Americans with Disabilities Act and the Equal Employment Opportunity Act, as well as regulations promulgated pursuant thereto, and to require such compliance in contractual agreements with subcontractors and sub-subcontractors.

8.6 Modification: Any modification to this contract shall be in writing, signed by all parties to the contract.

8.7 All Change Orders and Field Orders shall be executed by the Owner. Individuals authorized to execute such Change Orders and Field Orders are the Owner's Project Coordinator, or their appointee.

8.8 This contract is governed by the laws of the State of Arkansas.

8.9 Nothing contained in the Contract Documents shall create a contractual relationship with, or cause of action in favor of, a third party against the Owner or Contractor.

8.10 Independent Contractor: It is expressly agreed that Contractor is acting as an independent contractor in performing the services specified herein. The Owner shall carry no workers' compensation insurance, health or accident insurance to cover the Contractor or Contractor's employees for any type of loss which might result to the Contractor or the Contractor's employees in connection with the performance of the Work set forth in this Agreement. The Owner shall not pay any contribution to Social Security, unemployment insurance, federal or state withholding taxes, nor provide any other contributions or benefits which might otherwise be expected in an employer-

employee relationship, it being specifically agreed that the Contractor is not acting herein as an employee of Owner, but shall, at all times, and in all respects, have the rights and liabilities of an independent contractor.

8.11 Severability: In the event any section, subsection, subdivision, paragraph, subparagraph, item, sentence, clause, phrase, or word of the Contract Documents is declared or adjudged to be invalid or unconstitutional, such declaration or adjudication shall not affect the remaining provisions of the Contract Documents, as if such invalid or unconstitutional provision was not originally a part of the Contract Documents.

8.12 The statute of limitation period shall be tolled for any fraudulent act committed by the Contractor that the Owner cannot discover upon due diligence.

8.13 The officials who have executed this contract hereby represent and warrant that they have full and complete authority to act on behalf of the Owner and Contractor, respectively, and that their signatures below, the terms and provisions hereof, constitute valid and enforceable obligations of each.

8.15 This Agreement shall be executed in the original, and any number of copies. Any copy of this Agreement so executed shall be deemed an original, and shall be deemed authentic for any other use.

8.16 Nothing stated within the Contract Documents shall be construed as limiting the Owner's immunity from liability in tort.

8.17 The Owner does not agree with or consent to arbitration or mediation of disputes relating to this Agreement or Project.

8.18 The Contractor agrees that it shall indemnify and save harmless the Owner, its officers, agents, and employees from any claims or losses for services rendered by any subcontractor, person or firm performing or supplying services, materials or supplies in connection with the performance of this Agreement.

8.19 The Contractor shall ensure that the Owner receives lien waivers from all subcontractors and sub-subcontractors before Work begins on the Project. The Contractor shall give Written Notice to the subcontractors and sub-subcontractors providing Work on the Project that states the following: *"According to Arkansas law, it is understood that no liens can be filed against public property if a valid and enforceable payment and performance bond is in place.* The Contractor shall have each subcontractor and sub-subcontractor execute a written receipt evidencing acknowledgment of this statement.

8.20 The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, disability or national origin. The Contractor will take appropriate action to insure that applicants are employed, and that employees are treated during employment without regard to their race, creed, color or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and agrees to post in conspicuous places, available to employees, such notices as may be provided by the Owner setting forth the provisions of this non-discrimination clause. Contractor agrees to comply with the

Americans with Disabilities Act, and regulations promulgated pursuant thereto, as relates to the performance of this contract.

8.21 No Waiver of Enforcement of Contract Provisions: Failure of the Owner to enforce at any time any of the provisions of this Agreement, or to require at any time performance by the Contractor of any of the provisions hereof, shall in no way be construed to be a waiver of such provisions, nor in any way to affect the validity of this Agreement, or any part thereof, or the right of the Owner to thereafter enforce each and every such provision.

8.22 Entire Agreement: The Contract Documents contain the complete and entire agreement of the parties respecting the transactions contemplated herein, and supersede all prior negotiations, agreements, representations, and understandings, if any, among the parties regarding such matters. All prior or contemporaneous agreements, understandings, and statements, oral or written, are merged into the Contract Documents.

8.23 Captions: All captions contained in the Contract Documents are inserted only as a matter of convenience and in no way define, limit or extend the scope or intent of the Contract Documents.

PART 9 INSURANCE AND BONDING

9.1 The Contractor shall provide a Performance Bond, according to Arkansas law, insuring the Owner of the performance of all of the terms, provisions and stipulations of this Agreement. The Contractor shall also provide a Payment Bond, according to Arkansas law. Said Bonds shall be issued by a company duly authorized to transact such business within the State of Arkansas. Said Performance and Payment Bonds shall be acquired and delivered to the Owner prior to the issuance of the Notice to Proceed.

9.2 The Contractor shall furnish the Owner with a certificate of insurance naming the NARSWMD as an insured on a policy of insurance indemnifying and insuring the City in amounts not less than $1,000,000 for personal injury and $1,000,000 for property damage and other liabilities. Such insurance shall be acquired and the certificate delivered to the Owner prior to the issuance of the Notice to Proceed. **The Contractor shall give the Owner thirty (30) calendar days advance written notice of any cancellation, reduction, or modification of such insurance.**

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in duplicate. One counterpart each has been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or identified by Owner and Contractor.

This Agreement will be effective on _____

OWNER:	**CONTRACTOR:**
Northwest Arkansas Regional Solid Waste Management District	_____
By: _____	By _____
_____	_____
Date: _____	Date: _____

ATTEST:

_____

_____

Date:_____

APPROVED AS TO LEGAL FORM:

_____

Address for giving notices:

Employer Identification Number:

END OF SECTION

SECTION 00700
GENERAL CONDITIONS

1. Definitions
2. Additional Instruction & Detail Drawings
3. Schedules, Reports & Records
4. Drawings and Specification
5. Shop Drawings
6. Materials, Services & Facilities
7. Inspection & Testing
8. Substitutions
9. Patents
10. Surveys, Permits & Regulations
11. Protection of Work, Property & Persons
12. Supervision by Contractor
13. Changes in the Work
14. Changes in Contract Price
15. Time for Completion & Liquidated Damages
16. Correction of Work
17. Subsurface Conditions
18. Suspension of Work, Termination & Delay
19. Payments to Contractor
20. Acceptance of Final Payment as Release
21. Insurance
22. Contract Security
23. Assignments
24. Indemnification
25. Separate Contracts
26. Subcontracting
27. Land & Rights of Way
28. Guaranty
29. Taxes
30. Engineer's Authority

PART 1 DEFINITIONS

1.01 Wherever used in the CONTRACT DOCUMENTS, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:

1.02 AGREEMENT - Contract between the OWNER and CONTRACTOR regarding the PROJECT.

1.03 ADDENDA - Written or graphic instruments issued prior to the time of opening the bids which modify or interpret the CONTRACT DOCUMENTS, DRAWINGS and SPECIFICATIONS, by additions, deletions, clarification or corrections.

1.04 BID - The offer or proposal of the BIDDER submitted on the prescribed form setting forth the prices for the WORK to be performed.

1.05 BIDDER - Any person, firm or corporation submitting a BID for the WORK.

1.06 BONDS - Bid, Performance, and Payment Bonds, and other instruments of security, furnished by the CONTRACTOR and his surety in accordance with the CONTRACT DOCUMENTS.

1.07 CHANGE ORDER - A written order to the CONTRACTOR authorizing an addition, deletion or revision of the WORK within the general scope of the CONTRACT DOCUMENTS, or authorizing an adjustment in the CONTRACT PRICE or CONTRACT TIME.

1.08 CONTRACT DOCUMENTS - The contract, including BID, AGREEMENT, Payment Bond, Performance Bond, General Conditions, SUPPLEMENTARY CONDITIONS; NOTICE OF AWARD, NOTICE TO PROCEED, CHANGE and FIELD ORDERS, DRAWINGS, SPECIFICATIONS, and ADDENDA.

1.09 CONTRACT PRICE - The total monies payable to the CONTRACTOR under the terms and conditions of the CONTRACT DOCUMENTS.

1.10 CONTRACT TIME - the number of calendar days stated in the CONTRACT DOCUMENTS for the completion of the WORK.

1.11 CONTRACTOR - The person, firm or corporation with whom the OWNER has executed the Agreement.

1.12 DRAWINGS - The part of the CONTRACT DOCUMENTS which show the characteristics and scope of the WORK to be performed and which have been prepared or approved by the ENGINEER.

1.13 ENGINEER - The person, firm or corporation named as such in the CONTRACT DOCUMENTS.

1.14 FIELD ORDER - A written order effecting a change in the WORK not involving an adjustment in the CONTRACT PRICE, or an extension of the CONTRACT TIME, issued by the ENGINEER and OWNER to the CONTRACTOR during construction.

1.15 NOTICE OF AWARD - The written notice of the acceptance of the BID from the OWNER to the successful BIDDER.

1.16 NOTICE TO PROCEED - Written communication issued by the OWNER to the CONTRACTOR authorizing him to proceed with the WORK and establishing the date of commencement of the WORK.

1.17 OWNER - A public or quasi-public body or authority, corporation, association, partnership, or individual for whom the WORK is to be performed.

1.18 PROJECT - The undertaking to be performed as provided in the CONTRACT DOCUMENTS.

1.19 RESIDENT PROJECT REPRESENTATIVE - The authorized representative of the OWNER who is assigned to the PROJECT site, or any part thereof.

1.20 SHOP DRAWINGS - All drawings, diagrams, illustrations, brochures, schedules and other data which are prepared by the CONTRACTOR, a SUBCONTRACTOR, MANUFACTURER, SUPPLIER or distributor, which illustrate how specific portions of the WORK shall be fabricated or installed.

1.21 SPECIFICATIONS - A part of the CONTRACT DOCUMENTS consisting of written descriptions of a technical nature of materials, equipment, construction systems, standards, and workmanship.

1.22 SUBCONTRACTOR - An individual, firm or corporation having a direct contract with the CONTRACTOR, or with any other SUBCONTRACTOR, for the performance of a part of the WORK at the site.

1.23 SUBSTANTIAL COMPLETION - That date, when the construction of the PROJECT, or a specified part thereof, is sufficiently completed in accordance with the CONTRACT DOCUMENTS, so that the PROJECT, or specified part, can be utilized for the purposes for which it is intended.

1.24 SUPPLEMENTARY CONDITIONS - Modifications to adapt the General Conditions to the specific requirements of the Project and that may be imposed by applicable federal, state, and local laws.

1.25 SUPPLIER - Any person or organization who supplies materials or equipment for the WORK, including that fabricated to a special design, but who does not perform labor at the site.

1.26 WORK - All labor necessary to produce the construction required by the CONTRACT DOCUMENTS, and all materials and equipment incorporated or to be incorporated in the PROJECT. Unless otherwise specified, all materials shall be new, and both workmanship and materials shall be of a good quality. The CONTRACTOR shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

1.27 WRITTEN NOTICE - Any notice to any party of the Agreement relative to any part of this Agreement shall be in writing and considered delivered and the service thereof completed, when posted by certified or registered mail to the said party or his authorized representative.

PART 2 ADDITIONAL INSTRUCTION AND DETAIL DRAWINGS

2.01 The CONTRACTOR may be furnished additional instruction and detail drawings, by the ENGINEER, as necessary to carry out the WORK required by the CONTRACT DOCUMENTS.

2.02 The additional drawings and instruction thus supplied will become a part of the CONTRACT DOCUMENTS. The CONTRACTOR shall carry out the WORK in accordance with the additional detail drawings and instructions.

PART 3 SCHEDULES, REPORTS AND RECORDS

3.01 The CONTRACTOR shall submit to the OWNER, upon request, such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, and other such records pertaining to the PROJECT.

3.02 Prior to the first partial payment estimate, the CONTRACTOR shall submit construction progress schedules showing the order in which he proposes to carry on the WORK, including dates at which he will start the various parts of the WORK, estimated date of completion of each part and, as applicable:

A. The dates at which special detail drawings will be required; and

B. Respective dates for submission of SHOP DRAWINGS, the beginning of manufacture, the testing and the installation of materials, supplies and equipment.

PART 4 DRAWINGS AND SPECIFICATIONS

4.01 The intent of the DRAWINGS and SPECIFICATIONS is that the CONTRACTOR shall furnish all labor, materials, tools, equipment, and transportation necessary for the proper execution of the WORK in accordance with the CONTRACT DOCUMENTS, and all incidental work necessary to complete the PROJECT in an acceptable manner, ready for use, occupancy or operation by the OWNER.

4.02 It is understood and agreed that the CONTRACTOR has, by careful examination, satisfied himself as to the nature and location of the WORK, the conformation of the ground, the character of equipment and facilities needed preliminary to and during the execution of the WORK, the character, quality and quantity of the materials to be encountered, the general and local conditions, and all other matters which can, in any way, affect the WORK under this CONTRACT.

4.03 In case of conflict between the DRAWINGS and SPECIFICATIONS, the SPECIFICATIONS shall govern. Figure dimensions on DRAWINGS shall govern over scale dimensions, and detailed DRAWINGS shall govern over general DRAWINGS.

4.04 Any discrepancies found between the DRAWINGS and SPECIFICATIONS and site conditions, or any inconsistencies or ambiguities in the DRAWINGS or SPECIFICATIONS, shall be immediately reported to the ENGINEER, in writing, who shall promptly correct such inconsistencies or ambiguities in writing. WORK done by the CONTRACTOR after his discovery of such discrepancies, inconsistencies or ambiguities shall be done at the CONTRACTOR'S risk.

4.05 CONTRACTOR acknowledges that, based upon the CONTRACTOR'S examination of the Drawings and Specifications which comprise a part of the Contract Documents, the

CONTRACTOR has not observed anything in the Contract Documents indicating that same are incomplete or inconsistent or otherwise contain any error or omission that would cause the CONTRACTOR to be entitled to make any claim for increases in the CONTRACT PRICE or the CONTRACT TIME.

4.06 The intent of the CONTRACT DOCUMENTS is to include all items necessary for the proper execution and completion of the WORK by the CONTRACTOR. The CONTRACT DOCUMENTS are complimentary, and what is required by one shall be as binding as if required by all; performance by the CONTRACTOR shall be required to the extent inferable from the CONTRACT DOCUMENTS as being necessary to produce the intended results given the CONTRACTOR'S experience in general construction. The SPECIFICATIONS are written in the imperative and abbreviated form. The imperative language is directed to the CONTRACTOR, unless specifically noted otherwise. Any incomplete sentences shall be completed by inserting "shall," "the CONTRACTOR shall," "shall be," and similar mandatory phrases by inference in the same manner as they are applied to notes on the DRAWINGS. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, all indicated requirements shall be performed whether stated imperatively or otherwise. Further, whenever the term "WORK Includes" or "Section Includes" is used as an article or paragraph heading in a SPECIFICATIONS section, it is merely a listing of the significant items described within the section and is not intended to limit the scope of the section or to imply a trade responsibility.

4.07 Conflicts or discrepancies among the Contract Documents shall be resolved in the following order of priority:

A. The AGREEMENT;

B. AMENDMENTS and revisions of later date take precedence over those of earlier date;

C. SUPPLEMENTARY CONDITIONS;

D. The GENERAL CONDITIONS;

E. DRAWINGS and SPECIFICATIONS: DRAWINGS GOVERN SPECIFICATIONS for quantity and location, and SPECIFICATIONS govern for quality and performance. In the event of an ambiguity in quantity or quality, the greater quantity and the better quality shall govern;

F. Figure dimensions govern scale dimensions and large scale DRAWINGS govern small scale DRAWINGS; and,

G. SUBMITTALS; if and only if OWNER concludes, in its sole discretion, that a conflict or discrepancy cannot be otherwise resolved.

PART 5 SHOP DRAWINGS

5.01 The CONTRACTOR shall provide SHOP DRAWINGS as may be necessary for the prompt prosecution of the WORK as required by the CONTRACT DOCUMENTS. The ENGINEER shall promptly review all SHOP DRAWINGS.

5.02 When submitted for the ENGINEER'S review, SHOP DRAWINGS shall bear the CONTRACTOR'S certification that he has reviewed, checked, and approved the SHOP DRAWINGS and that they are in conformance with the requirements of the CONTRACT DOCUMENTS.

5.03 Portions of the WORK requiring a SHOP DRAWING or sample submission shall not begin until the SHOP DRAWING or submission has been reviewed by the ENGINEER. A copy of each processed SHOP DRAWING and each approved sample shall be kept in good order by the CONTRACTOR at the site and shall be available to the ENGINEER AND OWNER.

PART 6 MATERIALS, SERVICES AND FACILITIES

6.01 It is understood that, except as otherwise specifically stated in the CONTRACT DOCUMENTS, the CONTRACTOR shall provide and pay for all materials, labor, tools, equipment, water, sewer, light, utilities, power, transportation, supervision, temporary construction of any nature, and all other services and facilities of any nature whatsoever necessary to execute, complete, and deliver the WORK within the specified time.

6.02 Materials and equipment shall be so stored as to ensure the preservation of their quality and fitness for the WORK. Stored materials and equipment to be incorporated in the WORK shall be located so as to facilitate prompt inspection.

6.03 Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.

6.04 Materials, supplies and equipment shall be in accordance with samples submitted by the CONTRACTOR and approved by the ENGINEER.

6.05 Materials, supplies or equipment to be incorporated into the WORK shall not be purchased by the CONTRACTOR or the SUBCONTRACTOR(S) subject to a chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller.

PART 7 INSPECTION AND TESTING

7.01 All materials and equipment used in the construction of the PROJECT shall be subject to adequate inspection and testing in accordance with generally accepted standards, as required and defined in the CONTRACT DOCUMENTS.

7.02 The OWNER shall provide all inspection and testing services not required by the CONTRACT DOCUMENTS.

7.03 The CONTRACTOR shall provide, at the CONTRACTOR'S expense, the testing and inspection services required by the CONTRACT DOCUMENTS, unless otherwise noted.

7.04 If the CONTRACT DOCUMENTS, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction require any WORK to specifically be inspected, tested, or approved by someone other than the CONTRACTOR, the CONTRACTOR shall give the ENGINEER AND OWNER timely notice of readiness. The CONTRACTOR will then furnish the ENGINEER AND OWNER the required certificates of inspection, testing or approval.

7.05 Inspections, tests, or approvals by the ENGINEER, OWNER or others shall not relieve the CONTRACTOR from his obligations to perform the WORK in accordance with the requirements of the CONTRACT DOCUMENTS.

7.06 The ENGINEER, OWNER and their representatives will, at all times, have access to the WORK. In addition, authorized representatives and agents of any participating federal or state agency shall be permitted to inspect all work, materials, payrolls, records of personnel, invoices of materials, and other relevant data and records. The CONTRACTOR shall provide proper facilities for such access and observation of the WORK and also for any inspection or testing thereof.

7.07 If any WORK is covered contrary to the written instructions of the ENGINEER OR OWNER, it shall, if requested by the ENGINEER OR OWNER, be uncovered for their observation and replaced by the CONTRACTOR at no increase in Contract Price.

PART 8 SUBSTITUTIONS

8.01 Whenever a material, article or piece of equipment is identified on the DRAWINGS or SPECIFICATIONS by reference to brand name or catalogue number, it shall be understood that this is referenced for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality and function shall be considered. The CONTRACTOR may recommend the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the CONTRACT DOCUMENTS by reference to brand name or catalogue number, and if, in the opinion of the OWNER, such material, article, or piece of equipment is of equal substance and function to that specified, the OWNER may approve its substitution and use by the CONTRACTOR. Any cost differential shall be deducted from the CONTRACT PRICE and the CONTRACT DOCUMENTS shall be appropriately modified by CHANGE ORDER. The CONTRACTOR warrants that if substitutes are approved, no major changes in the function or general design of the PROJECT will result. Incidental changes or extra component parts required to accommodate the substitute shall be made by the CONTRACTOR without a change in the CONTRACT PRICE or CONTRACT TIME.

PART 9 PATENTS

9.01 The CONTRACTOR shall pay all applicable royalties and license fees. The CONTRACTOR shall defend all law suits or claims for infringement of any patent rights

and save the OWNER AND ENGINEER harmless from loss on account thereof; however, if the CONTRACTOR has reason to believe that the design, process or product specified is an infringement of a patent, he shall be responsible for such loss unless he promptly gives such information to the OWNER AND ENGINEER.

PART 10 SURVEYS, PERMITS AND REGULATIONS

10.01 The OWNER will furnish all boundary surveys and establish all base lines for locating the principal component parts of the WORK, together with a suitable number of bench marks adjacent to the WORK as shown in the CONTRACT DOCUMENTS. From the information provided by the OWNER, unless otherwise specified in the CONTRACT DOCUMENTS, the CONTRACTOR shall develop and make all detail surveys needed for construction such as slope sheets.

10.02 The CONTRACTOR shall carefully preserve bench marks, reference points and stakes and, in case of willful or careless destruction, the CONTRACTOR shall be charged with the resulting expense and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.

10.03 Permits and licenses of a temporary nature necessary for the prosecution of the WORK shall be secured and paid for by the CONTRACTOR unless otherwise stated in the SUPPLEMENTARY CONDITIONS. Permits, licenses and easements for permanent structures or permanent changes in existing facilities shall be secured and paid for by the OWNER, unless otherwise specified. The CONTRACTOR shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the WORK as drawn and specified. If the CONTRACTOR observes that the CONTRACT DOCUMENTS are at variance therewith, he shall promptly notify the ENGINEER AND OWNER, in writing, and any necessary changes shall be adjusted as provided in Section 13, CHANGES IN THE WORK.

PART 11 PROTECTION OF WORK, PROPERTY AND PERSONS

11.01 The CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR will take all necessary precautions for the safety of, and will provide the necessary protection to prevent damage, injury or loss to all employees on the WORK and other persons who may be affected thereby, all the WORK and all materials or equipment to be incorporated therein, whether in storage on or off the site, and other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

11.02 The CONTRACTOR shall comply with all applicable laws, ordinances, rules regulations and orders of any public body having jurisdiction. The CONTRACTOR shall erect and maintain, as required by the conditions and progress of the WORK, all necessary safeguards for safety and protection. The CONTRACTOR will notify owners of adjacent utilities when prosecution of the WORK may affect them. The CONTRACTOR shall remedy all damage, injury or loss to any property caused, directly or indirectly, in whole or in part, by the CONTRACTOR, any SUBCONTRACTOR or anyone directly or

indirectly employed by any of them or anyone for whose acts any of them be liable, except damage or loss attributable to the fault of the CONTRACT DOCUMENTS or to the acts or omissions of the ENGINEER or OWNER or anyone employed by them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of the CONTRACTOR.

11.03 In emergencies affecting the safety of persons or the WORK or property at the site or adjacent thereto, the CONTRACTOR, without special instruction or authorization from the ENGINEER or OWNER, shall act to prevent threatened damage, injury or loss. The CONTRACTOR shall give the ENGINEER and OWNER prompt WRITTEN NOTICE of any significant changes in the WORK or deviations from the CONTRACT DOCUMENTS caused thereby, and a CHANGE ORDER shall thereupon be issued covering the changes and deviations involved.

11.04 The CONTRACTOR shall confine operations at the PROJECT site to areas permitted by law, ordinances, permits and this AGREEMENT and shall not unreasonably encumber the PROJECT site with materials or equipment.

11.05 The CONTRACTOR shall at all times keep the premises free from accumulation of waste materials or rubbish.

PART 12 SUPERVISION BY CONTRACTOR

12.01 The CONTRACTOR shall supervise and direct the WORK. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction. The CONTRACTOR shall employ and maintain on the WORK a qualified supervisor or superintendent who shall have been designated in writing by the CONTRACTOR as the CONTRACTOR'S representative at the site. The supervisor shall have full authority to act on behalf of the CONTRACTOR, and all communications given to the supervisor shall be as if given to the CONTRACTOR. The supervisor shall be present on the site at all times as required to perform adequate supervision and coordination of the WORK.

PART 13 CHANGES IN THE WORK

13.01 The ENGINEER, UPON the OWNER’s approval, may, at any time, as the need arises, order changes within the scope of the WORK without invalidating the Agreement. If such changes increase or decrease the amount due under the CONTRACT DOCUMENTS, or in the time required for performance of the WORK, an equitable adjustment shall be authorized by a CHANGE ORDER.

13.02 The ENGINEER, UPON the OWNER’s approval, may, at any time, by issuing a FIELD ORDER, make changes in the details of the WORK. The CONTRACTOR shall proceed with the performance of any changes in the WORK so ordered by the ENGINEER and OWNER unless the CONTRACTOR believes that such FIELD ORDER entitles the CONTRACTOR to a change in CONTRACT PRICE or CONTRACT TIME, or both, in which event the CONTRACTOR shall give the ENGINEER and OWNER WRITTEN NOTICE thereof within seven (7) days after the receipt of the ordered change. Thereafter, the CONTRACTOR shall document the basis for the change in CONTRACT

PRICE or CONTRACT TIME within thirty (30) days. The CONTRACTOR shall not execute such changes pending the receipt of an executed CHANGE ORDER or further instruction from the ENGINEER and OWNER.

PART 14 CHANGES IN CONTRACT PRICE

14.01 The CONTRACT PRICE may be changed only by a CHANGE ORDER. The value of any WORK covered by a CHANGE ORDER or of any claim for increase or decrease in the CONTRACT PRICE shall be determined by one or more of the following methods in the order of precedence listed below:

A. Unit prices previously approved.
B. An agreed lump sum.
C. The actual cost for labor, direct overhead, materials, supplies, equipment, and other services necessary to complete the WORK.

PART 15 TIME FOR COMPLETION AND LIQUIDATED DAMAGES

15.01 The date of beginning and the time for completion of the WORK are essential conditions of the CONTRACT DOCUMENTS and the WORK embraced shall be commenced on a date specified in the written NOTICE TO PROCEED.

15.02 The CONTRACTOR shall proceed with the WORK at such rate of progress to ensure full completion within the CONTRACT TIME. It is expressly understood and agreed, by and between the CONTRACTOR and the OWNER, that the CONTRACT TIME for the completion of the WORK described herein is a reasonable time, taking into consideration the average climatic and economic conditions and other factors prevailing in the locality of the WORK.

15.03 If the CONTRACTOR shall fail to complete the WORK within the CONTRACT TIME, or extension of time granted by the OWNER, then the CONTRACTOR shall pay, to the OWNER, the amount for liquidated damages as specified in Section 3.2 of the AGREEMENT for each calendar day that the CONTRACTOR shall be in default after the time stipulated in the CONTRACT DOCUMENTS.

15.04 The CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in completion of the WORK is due to the following, and the CONTRACTOR has promptly given WRITTEN NOTICE of such delay to the ENGINEER and OWNER:

A. To any preference, priority or allocation order duly issued by the ENGINEER or OWNER;

B. To unforeseeable causes beyond the control, and without the fault or negligence of, the CONTRACTOR, restricted to acts of God or of the public enemy, acts of the ENGINEER or OWNER, acts of another CONTRACTOR in the performance of a contract with the OWNER, fires, floods, epidemics, quarantine restrictions, strikes

and freight embargoes; and

C. To any delays of SUBCONTRACTORS occasioned by any of the causes specified in paragraphs 15.4.1 and 15.4.2 of this article.

PART 16 CORRECTION OF WORK

16.01 The CONTRACTOR shall promptly remove from the premises all WORK rejected by the ENGINEER or OWNER for failure to comply with the CONTRACT DOCUMENTS, whether incorporated in the construction or not, and the CONTRACTOR shall promptly replace and re-execute the WORK in accordance with the CONTRACT DOCUMENTS and without expense to the OWNER and shall bear the expense of making good all WORK of other CONTRACTORS destroyed or damaged by such removal or replacement.

16.02 All removal and replacement WORK shall be done at the CONTRACTOR'S expense. If the CONTRACTOR does not take action to remove such rejected WORK within ten (10) days after receipt of WRITTEN NOTICE, the OWNER may remove such WORK and store the materials at the expense of the CONTRACTOR.

PART 17 SUBSURFACE CONDITIONS

17.01 The CONTRACTOR shall promptly, and before such conditions are disturbed, except in the event of an emergency, notify the ENGINEER and OWNER by WRITTEN NOTICE of:

A. Subsurface or latent physical conditions at the site differing materially from those indicated in the CONTRACT DOCUMENTS; or

B. Unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in WORK of the character provided for in the CONTRACT DOCUMENTS.

17.02 The ENGINEER and OWNER will promptly investigate the conditions, and if ENGINEER and OWNER jointly find that such conditions do so materially differ and cause an increase or decrease in the cost of, or in the time required for, performance of the WORK, an equitable adjustment will be made and the CONTRACT DOCUMENTS will be modified by a CHANGE ORDER. Any claim of the CONTRACTOR for adjustment hereunder will not be allowed unless the CONTRACTOR has given the required WRITTEN NOTICE, provided that the ENGINEER and OWNER may, if ENGINEER and OWNER jointly determine the facts so justify, consider and adjust any such claims asserted before the date of final payment.

PART 18 SUSPENSION OF WORK, TERMINATION AND DELAY

18.01 The OWNER may suspend the WORK, or any portion thereof, for a period of not more than ninety (90) days, or such further time as agreed upon by the CONTRACTOR, by

WRITTEN NOTICE to the CONTRACTOR, which notice will fix the date on which WORK shall be resumed. The CONTRACTOR will be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, directly attributable to any such suspension.

18.02 If the CONTRACTOR is adjudged as bankrupt or insolvent, or if the CONTRACTOR makes a general assignment for the benefit of the CONTRACTOR'S creditors, or if a trustee or receiver is appointed for the CONTRACTOR or for any of his property, or if the CONTRACTOR files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or applicable laws, or if the CONTRACTOR repeatedly fails to supply sufficient skilled workmen or suitable materials or equipment, or if the CONTRACTOR repeatedly fails to make prompt payments to SUBCONTRACTORS or for labor, materials or equipment or if he disregards laws, ordinances, rules, regulations or orders of any public body having jurisdiction of the WORK, or if the CONTRACTOR otherwise violates any provision of the CONTRACT DOCUMENTS, then the OWNER may, without prejudice to any other right or remedy and after giving the CONTRACTOR and the CONTRACTOR'S surety a minimum of twenty (20) days' WRITTEN NOTICE, terminate the services of the CONTRACTOR and take possession of the PROJECT and of all materials, equipment, tools, construction equipment and machinery thereon owned by the CONTRACTOR, and finish the WORK by whatever method the OWNER may deem expedient. In such case, the CONTRACTOR shall not be entitled to receive any further payment until the WORK is finished. If the unpaid balance of the CONTRACT PRICE exceeds the direct and indirect costs of completing the PROJECT, including compensation for additional professional services, such excess WILL BE PAID TO THE CONTRACTOR. If such costs exceed such unpaid balance, the CONTRACTOR SHALL PAY THE DIFFERENCE TO THE OWNER. Such costs incurred by the OWNER will be incorporated in a CHANGE ORDER. **The OWNER has the right to withhold any such costs incurred by the OWNER from any payments due the CONTRACTOR.**

18.03 Where the CONTRACTOR'S services have been so terminated by the OWNER, said termination shall not affect any right of the OWNER against the CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of monies by the OWNER due the CONTRACTOR will not release the CONTRACTOR from compliance with the CONTRACT DOCUMENTS.

18.04 After ten (10) days from delivery of a WRITTEN NOTICE to the CONTRACTOR, the OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the PROJECT and terminate the contract. In such case, the CONTRACTOR will be paid for all WORK executed up to the date of termination.

18.05 If, through no act or fault of the CONTRACTOR, the WORK is suspended for a period of more than ninety (90) days by the OWNER, or the WORK is suspended under an order of a court of competent jurisdiction for more than ninety (90) days, or the OWNER fails to pay the CONTRACTOR substantially the sum requested within sixty (60) days of approval and receipt of a request for payment by the OWNER, then the CONTRACTOR may, after thirty (30) days from delivery of a WRITTEN NOTICE to the OWNER, such thirty (30) day WRITTEN NOTICE also giving the OWNER an opportunity to cure any default, terminate the CONTRACT and recover from the OWNER payment for all WORK executed up to the date of termination. In addition and in lieu of terminating the

CONTRACT, if the OWNER has failed to make any payment as aforesaid, the CONTRACTOR may, upon twenty (20) days WRITTEN NOTICE to the OWNER, stop the WORK until the CONTRACTOR has been paid all amounts then due, in which event and upon resumption of the WORK, CHANGE ORDERS shall be issued for adjusting the CONTRACT PRICE or extending the CONTRACT TIME, or both, to compensate for the costs and delays attributable to the stoppage of the WORK.

18.06 If, through no act or fault of the CONTRACTOR, the performance of all or any portion of the WORK is suspended, delayed, or interrupted as a result of a failure of the OWNER to act within the time specified in the CONTRACT DOCUMENTS, including default cure time periods, or if no time is specified, within a reasonable time, an adjustment in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, will be made by CHANGE ORDER to compensate the CONTRACTOR for the costs and delays directly caused by the failure of the OWNER.

PART 19 PAYMENTS TO CONTRACTOR

19.01 At least ten (10) days before each progress payment falls due, but not more often than once a month, the CONTRACTOR shall submit to the ENGINEER a Partial Payment Estimate filled out and signed by the CONTRACTOR covering the WORK performed during the period covered by the Partial Payment Estimate and supported by such data as the ENGINEER or OWNER may reasonably require. If payment is requested on the basis of materials and equipment not incorporated in the WORK but delivered and suitably stored at or near the site, the partial payment estimate shall also be accompanied by such supporting data, satisfactory to the ENGINEER and OWNER, as will establish the OWNER'S title to the material and equipment and protect the OWNER'S interest therein, including applicable insurance. The ENGINEER will, within ten (10) days after receipt of each partial payment estimate, either indicate in writing the ENGINEER'S approval of payment, or return the partial payment estimate to the CONTRACTOR indicating, in writing, the reasons for refusing to approve payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the partial payment estimate. The OWNER will, within thirty (30) days of presentation to the OWNER of an approved partial payment estimate, pay the CONTRACTOR a progress payment on the basis of the approved partial payment estimate. In accordance with Ark. Code Ann. § 22-9-604, the ENGINEER will retain ten percent (10%) of the earned amount of the WORK progress shown on the partial payment estimate, excluding materials and equipment on hand but not installed, and upon certification by the ENGINEER that the WORK progress is fifty percent (50%) complete, based on the adjusted contract price, there will be no additional retainage on account of WORK completed, in which case the remaining progress payments prior to SUBSTANTIAL COMPLETION will be in an amount equal to one hundred percent (100%) of the WORK completed. Further, upon certification of SUBSTANTIAL COMPLETION of the WORK, the retained amount may be reduced to only that amount necessary to assure completion. On completion and acceptance of a part of the WORK on which the price is stated separately in the CONTRACT DOCUMENTS, payment may be made in full, including retained percentages, less authorized deductions.

19.02 The request for payment may also include an allowance for the cost of such major materials and equipment which are suitably stored either at or near the site.

19.03 Prior to SUBSTANTIAL COMPLETION, the OWNER may use any completed or substantially completed portions of the WORK. Such use shall not constitute an acceptance of such portions of the WORK.

19.04 The OWNER will have the right to enter the premises for the purpose of doing work not covered by the CONTRACT DOCUMENTS. This provision shall not be construed as relieving the CONTRACTOR of the sole responsibility for the care and protection of the WORK, or the restoration of any damaged WORK, except such as may be caused by agents or employees of the OWNER.

19.05 Upon completion and acceptance of the WORK, and after the receipt of all lien waivers and other proper documentation from the CONTRACTOR, the OWNER will sign the final payment request as its certification that the WORK has been accepted by the OWNER under the conditions of the CONTRACT DOCUMENTS. The entire balance found to be due the CONTRACTOR, including the retained percentages, but except such sums as may be lawfully retained by the OWNER, will be paid to the CONTRACTOR within thirty (30) days of completion and final acceptance of the WORK by the OWNER.

19.06 The CONTRACTOR shall indemnify and save the ENGINEER and OWNER, or the ENGINEER'S and OWNER'S agents, harmless from all claims growing out of the lawful demands of SUBCONTRACTORS, laborers, workmen, mechanics, material, men, and furnishers of machinery and parts thereof, equipment, tools, and all supplies, incurred in the furtherance of the performance of the WORK. The CONTRACTOR shall furnish the OWNER and ENGINEER satisfactory evidence that all obligations of the nature designated above have been paid, discharged, or waived. If the CONTRACTOR fails to do so, the OWNER may, after having notified the CONTRACTOR, either pay unpaid bills or withhold from the CONTRACTOR'S unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged, where upon payment to the CONTRACTOR shall be resumed, in accordance with the terms of the CONTRACT DOCUMENTS, but in no event shall the provisions of this sentence be construed to impose any obligations upon the ENGINEER or OWNER to either the CONTRACTOR, his Surety, or any third party. In paying any unpaid bills of the CONTRACTOR, any payment, so made by the OWNER shall be considered as a payment made under the CONTRACT DOCUMENTS by the OWNER to the CONTRACTOR and the OWNER will not be liable to the CONTRACTOR for any such payments made in good faith.

19.07 The CONTRACTOR warrants that upon submittal of a request for payment, all work for which payment has been received by the CONTRACTOR shall be free and clear of liens, claims, security interests or encumbrances in favor of the CONTRACTOR, subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials or equipment relating to the work or project.

19.08 Any payment to the CONTRACTOR by the OWNER shall not constitute an acceptance of any WORK not in accordance with the CONTRACT DOCUMENTS.

PART 20 ACCEPTANCE OF FINAL PAYMENT AS RELEASE

20.01 The acceptance by the CONTRACTOR of final payment shall be and shall operate as a release to the OWNER of all claims and all liability to the CONTRACTOR, other than claims in stated amounts as may be specifically excepted by the CONTRACTOR, for all things done or furnished in connection with this WORK and for every act and neglect of the OWNER and others relating to, or arising out of, this WORK. Any payment, however, final or otherwise, will not release the CONTRACTOR or his sureties from any obligations under the CONTRACT DOCUMENTS or the Performance BOND and Payment BOND.

PART 21 INSURANCE

21.01 Contractor's Liability Insurance: CONTRACTOR shall purchase and maintain, in a company or companies licensed to do business in the State of Arkansas, such commercial general liability and other insurance as is appropriate for the WORK being performed and furnished and as will provide protection from claims set forth below which may arise out of or result from CONTRACTOR'S performance and furnishing of the WORK and CONTRACTOR'S other obligations under the CONTRACT DOCUMENTS, whether it is to be performed or furnished by CONTRACTOR, by any Subcontractor, by anyone directly or indirectly employed by any of them to perform or furnish any of the WORK, or by anyone for whose acts any of them may be liable:

A. Claims under workers or workmen's compensation, disability benefits, and other similar employee benefit acts;

B. Claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR'S employees;

C. Claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR'S employees;

D. Claims for damages insured by personal injury liability coverage which are sustained (a) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR, or (b) by any other person for any other reason;

E. Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom;

F. Claims arising out of operation of Laws or Regulations for damages because of bodily injury or death of any person or for damage to property;

G. Claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle;

and

H. Claims involving contractual liability insurance applicable to the Contractor's obligations under Article 24.

21.02 The insurance required by paragraph 21.1 shall include the specific coverages and be written for not less than the limits of liability and coverages provided in the SUPPLEMENTARY CONDITIONS, or required by law, whichever is greater. All such insurance shall remain in effect until final payment and at all times thereafter when CONTRACTOR may be correcting, removing, or replacing defective WORK in accordance with paragraph 28.1. In addition, CONTRACTOR shall maintain completed operations insurance for at least one (1) year after date of final completion and furnish OWNER with evidence of continuation of such insurance at final completion.

21.03 The CONTRACTOR shall purchase and maintain in the name of the ENGINEER and OWNER an Owner's and Contractor's Protective Liability Policy as will protect the ENGINEER and OWNER against claims which may arise from operations under the contract. Coverage shall not exceed coverage of CONTRACTOR'S Commercial General Liability policy.

21.04 The CONTRACTOR shall acquire and maintain, if applicable, Fire and Extended Coverage insurance upon the PROJECT to the full insurable value thereof for the benefit of the OWNER, the CONTRACTOR, and SUBCONTRACTORS as their interest may appear. This provision shall in no way release the CONTRACTOR or CONTRACTOR'S surety from obligations under the CONTRACT DOCUMENTS to fully complete the PROJECT.

21.05 The CONTRACTOR shall procure and maintain, at the CONTRACTOR'S own expense, during the CONTRACT TIME, in accordance with the provisions of the laws of the state in which the WORK is performed, Workers' Compensation Insurance, including occupational disease provisions, for all of CONTRACTOR'S employees at the site of the PROJECT and in case any work is sublet, the CONTRACTOR shall require such SUBCONTRACTOR similarly to provide Workers' Compensation Insurance, including occupational disease provisions for all of the latter's employees unless such employees are covered by the protection afforded by the CONTRACTOR. In case any class of employees engaged in hazardous work under this AGREEMENT at the site of the PROJECT is not protected under Workers' Compensation statute, the CONTRACTOR shall provide, and shall cause each SUBCONTRACTOR to provide, adequate and suitable insurance for the protection of his employees not otherwise protected.

21.06 Certificates of Insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work. These Certificates and the insurance policies required by Paragraph 21.1 shall contain a provision that coverages afforded under the policies will not be canceled or allowed to expire until at least thirty (30) days' prior written notice has been given to the Owner.

PART 22 CONTRACT SECURITY

22.01 The CONTRACTOR shall, within ten (10) days after the receipt of the NOTICE OF AWARD, furnish the OWNER with a Performance BOND and a Payment BOND, each in penal sums equal to the amount of the CONTRACT PRICE, conditioned upon the performance by the CONTRACTOR of all undertakings, covenants, terms, conditions and agreements of the CONTRACT DOCUMENTS, and upon the prompt payment by the CONTRACTOR to all persons supplying labor and materials in the prosecution of the WORK provided by the CONTRACT DOCUMENTS. Such BONDS shall be executed by the CONTRACTOR and a corporate bonding company licensed to transact such business in the state in which the WORK is to be performed and named on the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Treasury Department Circular Number 570. The expense of these BONDS shall be borne by the CONTRACTOR. If, at any time, a surety on any such BOND is declared a bankrupt or loses its right to do business in the state in which the WORK is to be performed or is removed from the list of "Surety Companies Acceptable on Federal Bonds," CONTRACTOR shall, within ten (10) days after notice from the OWNER to do so, substitute an acceptable BOND (or BONDS) in such form and sum and signed by such other surety or sureties as may be satisfactory to the OWNER. The premiums on such BOND shall be paid by the CONTRACTOR. No further payments shall be deemed due nor shall be made until the new surety or sureties shall have furnished an acceptable BOND to the OWNER.

PART 23 ASSIGNMENTS

23.01 Neither the CONTRACTOR nor the OWNER shall sell, transfer, assign or otherwise dispose of this AGREEMENT, the CONTRACT DOCUMENTS, or any portion thereof, or of the right, title or interest therein, or any obligation thereunder, without written consent of the other party.

PART 24 INDEMNIFICATION

24.01 The CONTRACTOR shall indemnify and hold harmless the OWNER, and their agents and employees, from and against all claims, damages, losses and expenses, including attorney's fees, arising out of or resulting from the performance of the WORK, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property, including the loss of use resulting therefrom, and is caused in whole or in part by any negligent or willful act or omission of the CONTRACTOR, any SUBCONTRACTOR, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable.

24.02 In any and all claims against the OWNER, or any of their agents or employees, by any employee of the CONTRACTOR, any SUBCONTRACTOR, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation of benefits payable by or for the CONTRACTOR or any SUBCONTRACTOR under workmen's compensation acts, disability benefit acts or other employee benefits acts.

24.03 The obligation of the CONTRACTOR under this paragraph shall not extend to the liability of the ENGINEER, its agents or employees, arising out of the preparation or approval of maps, DRAWINGS, opinions, reports, surveys, CHANGE ORDERS, designs or SPECIFICATIONS.

PART 25 SEPARATE CONTRACTS

25.01 The OWNER reserves the right to let separate contracts for this PROJECT. The CONTRACTOR shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their WORK, and shall properly connect and coordinate its WORK with theirs. If the proper execution or results of any part of the CONTRACTOR'S WORK depends upon the WORK of any other contractor, the CONTRACTOR shall inspect and promptly report to the ENGINEER and OWNER any defects in such WORK that render it unsuitable for such proper execution and results.

25.02 The OWNER may perform additional WORK related to the PROJECT itself, or the OWNER may let other contracts containing provisions similar to these CONTRACT DOCUMENTS. The CONTRACTOR will afford the other contractors who are parties to such contracts, or the OWNER if the OWNER is performing the additional WORK, reasonable opportunity for the introduction and storage of materials and equipment and the execution of WORK, and shall properly connect and coordinate his WORK with theirs.

25.03 If the performance of additional WORK by other contractors or the OWNER is not noted in the CONTRACT DOCUMENTS prior to the execution of the CONTRACT, WRITTEN NOTICE thereof shall be given by the OWNER to the CONTRACTOR prior to starting any such additional WORK. If the CONTRACTOR believes that the performance of such additional WORK by the OWNER or others involves additional expense to the CONTRACTOR, or entitles the CONTRACTOR to an extension of the CONTRACT TIME, the CONTRACTOR may make a claim therefore as provided in Sections 14 and 15.

PART 26 SUBCONTRACTING

26.01 The CONTRACTOR may utilize the services of specialty SUBCONTRACTORS on those parts of the WORK which, under normal contracting practices, are performed by specialty SUBCONTRACTORS.

26.02 All SUBCONTRACTORS and material suppliers utilized on this Project shall be experienced in the type of work required by the Project, reputable, qualified and shall be acceptable to the OWNER.

26.03 The CONTRACTOR shall be fully responsible to the OWNER for the acts and omissions of the CONTRACTOR’S SUBCONTRACTORS and material suppliers on this PROJECT, and of persons either directly or indirectly employed by them, as the CONTRACTOR is for the acts and omissions of persons directly employed by the CONTRACTOR.

26.04 The CONTRACTOR shall cause appropriate provisions to be inserted in all subcontracts relative to the WORK to bind SUBCONTRACTORS to the CONTRACTOR by the terms of the CONTRACT DOCUMENTS insofar as applicable to the WORK of SUBCONTRACTORS, and to give the CONTRACTOR the same power as regards terminating any subcontract that the OWNER may exercise over the CONTRACTOR under any provision of the CONTRACT DOCUMENTS.

26.05 Nothing contained in the CONTRACT DOCUMENTS will create any contractual relationship between any SUBCONTRACTOR or material supplier and the OWNER.

PART 27 LAND AND RIGHTS-OF-WAY

27.01 Prior to issuance of NOTICE TO PROCEED, the OWNER will obtain all land and rights-of-way necessary for carrying out and for the completion of the WORK to be performed pursuant to the CONTRACT DOCUMENTS, unless otherwise mutually agreed.

27.02 The OWNER will provide to the CONTRACTOR information which delineates and describes the lands owned and rights-of-way acquired.

27.03 The CONTRACTOR shall provide at the CONTRACTOR'S own expense and without liability to the OWNER any additional land and access thereto that the CONTRACTOR may desire for temporary construction facilities, or for storage of materials.

PART 28 GUARANTY

28.01 The CONTRACTOR shall guarantee all materials and equipment furnished and WORK performed for a period of one year(s) from the date of SUBSTANTIAL COMPLETION. The CONTRACTOR warrants and guarantees, for a period of one year(s) from the date of SUBSTANTIAL COMPLETION of the system and PROJECT, that the completed system and PROJECT are free from all defects due to faulty materials or workmanship, and the CONTRACTOR shall promptly make such corrections as may be necessary by reason of such defects, including the repairs of any damage to other parts of the system or PROJECT resulting from such defects. The OWNER will give notice of observed defects with reasonable promptness. In the event that the CONTRACTOR should fail to make such repairs, adjustments, or other WORK that may be made necessary by such defects, the OWNER may do so and charge the CONTRACTOR the cost thereby incurred. The Performance BOND shall remain in full effect throughout the guarantee period.

PART 29 TAXES

29.01 The CONTRACTOR shall pay all sales, consumer, use and other similar taxes required by the law of the place where the WORK is performed.

PART 30 ENGINEER'S AUTHORITY

30.01 The ENGINEER will act as the OWNER'S representative during the construction period. The ENGINEER will jointly decide with the OWNER questions which may arise as to

quality and acceptability of materials furnished and WORK performed. The ENGINEER and the OWNER will jointly interpret the intent of the CONTRACT DOCUMENTS in a fair and unbiased manner. The ENGINEER or OWNER will make visits to the site and determine if the WORK is proceeding in accordance with the CONTRACT DOCUMENTS.

30.02 The CONTRACTOR will be held strictly to the intent of the CONTRACT DOCUMENTS in regard to the quality of materials, workmanship, and execution of the WORK. Inspections may be made at the factory or fabrication plant of the source of material supply.

30.03 The ENGINEER will not be responsible for the construction means, controls, techniques, sequences, procedures, or construction safety.

30.04 The ENGINEER and OWNER will jointly make prompt decisions relative to interpretation of the CONTRACT DOCUMENTS.

END OF SECTION

SECTION 00830
WAGE RATES

PART 1 GENERAL

1.01 PREVAILING WAGE RATES

A. The Arkansas Department of Labor establishes Prevailing Wage Rates for projects that involve public financing. The enclosed regulations and prevailing wage rates shall be strictly adhered to regarding the bidding and execution of this project.

END OF SECTION

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.01 Summary

A. Section Includes:

1. Work Covered by Contract Documents.
2. Work by Others.
3. Work Sequence.
4. Existing Site Conditions.
5. Contractor's Use of Premises.
6. Erosion and Sediment Controls.
7. Temporary and Permanent Seeding.
8. Interim Stormwater Run-on and Run-off Controls.

1.02 Work Covered By Contract Documents

A. The Work consists of, in general, construction of landfill solid waste disposal cell and related site improvements at the NABORS Landfill in Baxter County, Arkansas.

B. The Work includes, but is not necessarily limited to, the following items:

1. Unclassified excavation of soil including removal of rock;
2. Compacted earthen fill;
3. Subgrade establishment;
4. Two feet recompacted subgrade placement;
5. Two feet compacted clay liner;
6. Geosynthetic Clay Liner Installation;
7. 60 mil HDPE liner installation;
8. Geocomposite Drainage Layer Placement;
9. Protective Cover Layer Placement;
10. Leachate Collection System Installation;
11. Seeding and Vegetation Establishment; and
12. Miscellaneous Drainage Improvements.

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.

1.03 Work By Others

A. Related work by others under separate contracts with the Owner consists of:

1. Construction Quality Assurance (CQA)
2. Surveying and preparation of as-built record drawings

1.04 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 Contract Times stated in the Agreement are are complied with.

1.05 Existing Site Conditions

The NABORS landfill is an active solid waste disposal facility. The work associated with this contract is for construction associated with the construction of Cell 2 in Area 1-3.

1.06 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.

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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01019
CONTRACT CONSIDERATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Schedule of Values: and

2. Applications of Payment..

1.02 SCHEDULE OF VALUES

A. Within the time limit indicated in Section 01300, submit to the Engineer and Owner for review a preliminary Schedule of Values for the project.

B. Format: Utilize Bid Schedule as a guide. The Schedule of Values shall include unit cost and quantities for all items noted as Unit Price Items on the Bid Schedule. Include within each line item, a direct proportional amount of Contractor's overhead and profit.

C. Revise schedule to list approved Change Orders with each Application for Payment.

D. The approved Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment, and is not necessarily appropriate for determination of costs for Contract Modifications.

E. Schedule shall list the installed values of the component parts of the Work in sufficient detail to serve as a basis for computing values for progress payments during construction.

1.03 APPLICATIONS FOR PAYMENT

A. Submit three(3) copies of each Application for Payment on form provided in the Contract Documents, or similar form approved by the Engineer and Owner.

B. Submit Applications for Payment in accordance with the General Conditions of the Contract and the Agreement, and as specified herein.

C. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.

D. Preparation of Application for Each Progress Payment

1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.
2. Execute each copy of Application with original signature of a responsible officer of Contractor, and corporate seal of Contractor.

E. Provide substantiating data for Applications for Payment as required by the Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section the Specifications defines the methods that will be used to perform measurement for payment and payment for the work in this Contract.

1.02 DESCRIPTION OF WORK

A. Unless specified as a Lump Sum item, all Contract prices shall be based on a price per unit of measurement for materials or services. The Contract Price shall be adjusted for the actual quantities required as approved by the Owner.

B. The Owner shall take all measurements and compute all preliminary pay quantities, using methods sufficiently accurate to satisfy the Owner and CQA Consultant. The Owner's measurements shall be performed by a professional surveyor registered in the State of Arkansas.

C. The Owner and CQA Consultant shall verify all measurements and determine final pay quantities.

D. Payment shall only be made for Work as specifically described in these Specifications and the Contract Agreement. 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.

E. Payment shall only be made for approved, in-place materials and Work, unless specifically permitted otherwise by these Specifications.

1.03 RELATED SECTIONS

A. All sections of these Specifications.

B. Contract Agreement.

1.04 CONTRACT PAY ITEMS

A. Pay Item 1: Mobilization

1. The Work required for this item will be measured on the basis of satisfactory evidence of mobilization of sufficient labor, equipment and material to adequately advance the Work.

2. Payment will be made at the lump sum price listed in Section 00300, Bid Forms, for this Pay Item. Twenty-five (25) percent of the Lump Sum price bid for Mobilization 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. Fifty (50) percent of the Lump Sum price bid will be paid with the payment request subsequent to the payment request in which the initial payment for this item is made. Twenty-five (25) percent of the Lump Sum price bid will be paid on the following subsequent payment request (i.e., the third routine scheduled payment request).

3. The Lump Sum Price for Mobilization shall be payment in full for all labor, equipment, material and other incidentals of the work. The price shall include and cover the furnishing of all materials, labor, tools, and equipment necessary for the assembling and setting up for the project, including: the initial movement of personnel and equipment to the project site; application, fee payment and acquisition for all necessary permits; the establishment of the Contractor's shops, plants, storage areas, field office, temporary water, electrical, telephone, sanitary and other temporary facilities; establishment of a field office with utilities for the Owner and CQA personnel; and insurance, bonds, and other initial expenses required for the start of work. Clearing and grubbing outside the limits of work (as detailed by the Owner), required by the Contractor for staging areas and parking areas will be paid as part of this item.

B. Pay Item 2: Site Preparation and Maintenance

1. The Work required for this item will be measured on the basis of satisfactory evidence of site preparation activities to adequately advance and protect the Work and ongoing efforts to maintain and protect the site.

2. Payment will be made at the lump sum price listed in Section 00300, Bid Forms, for this Pay Item. Twenty-five (25) percent of the Lump Sum price bid for site Preparation and Maintenance 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. Fifty (50) percent of the Lump Sum price bid will be paid with the payment request subsequent to the payment

request in which the initial payment for this item is made. Twenty-five (25) percent of the Lump Sum price bid will be paid on the final payment request.

3. The price shall include and cover the furnishing of all materials, labor, tools, and equipment necessary for site preparation and maintenance, including: project surveying, maintaining field offices and utilities, constructing and maintaining temporary access roads for construction vehicles, dust control, erosion and sediment control, constructing and maintaining temporary ditches for erosion and sediment control, clearing and grubbing trees, brush, vegetation, surficial debris, preparing the construction staging/stockpile areas, restoring all access roads and related site features to their original condition, seeding of disturbed areas, and all other activities necessary for site preparation and ongoing maintenance and restoration.

C. Pay Item 3: Gross Excavation and Fill

1. Measurement for this Pay Item will be made on a cubic yard basis of soil removed (excavated) from cut and fill areas within the limits of Cell 2, approved and calculated by the Owner based on surveys of the existing topography in the work area before the subject work is executed and the specified grades depicted on the Drawings, or such other means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all materials, equipment, personnel, labor, and all else required to excavate soil to the elevations and limits shown on the Drawings for the subgrade of the Cell 2 liner system, and to transport the excavated soil to approved on-site stockpile areas or fill areas of the project if material is suitable for General Fill. Fill material will be available from onsite borrow areas. No additional payment will be made for over-excavation below the specified grades shown on the Drawings.

4. Unless the Owner has directed in writing that excavation be performed in excess of the quantities shown by the topography and grades on the Drawings, the payment quantity will not exceed the bid quantity.

5. The excavation and fill amounts may vary since the OWNER may use the material for operational purposes.

D. Pay Item 4: Recompacted Subgrade Layer

1. Measurement for this Pay Item will be made on a cubic yard basis of in-place, approved, fill used to construct the liner system subgrade on the bottom of the cell (not including the side-slopes), calculated by the Owner based on surveys of the existing topography in the work area and the specified grades depicted on the drawings, or other such means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all equipment, personnel, labor and all else required to transport structural fill soil from the on-site borrow areas to the work area, process and moisture condition the soil as necessary, and construct the liner system subgrade in the bottom of the cell to the elevations and limits shown on the Drawings. The cohesive fill must meet the permeability specifications on the Drawings. The price shall also include complete preparation (fine grading) of, and if necessary, repair of, the subgrade surface for its upcoming compacted cohesive soil placement and compaction. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, replacement of rejected material, dewatering, preparation or repairs of clay surface, or protection.

4. Unless the Owner has directed in writing that the subgrade fill be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

5. The top of the recompacted Subgrade layer must be at least 2 feet above bedrock or pinnacles. The elevations of this layer will be modified as required to meet this criteria.

E. Pay Item 5: Compacted Clay Liner Placement

1. Measurement for this Pay Item will be made on a cubic yard basis of in-place, approved, compacted cohesive soil, calculated by the Owner based on the actual area of compacted cohesive soil installed, surveyed after the subject work is executed and using the minimum compacted cohesive soil layers' thicknesses (measured perpendicular to the design slope shown on the Drawings), or such other means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all equipment, personnel, labor and all else required to remove overburden soil from above the suitable cohesive soil in the on-site borrow areas, excavate and transport cohesive soil from the on-site borrow areas to the cell, process and moisture condition the soil as necessary, and construct the compacted cohesive soil layers to the elevations and limits shown on the Drawings. The price shall also include complete preparation of, and if necessary, repair of, the compacted cohesive soil liner to render the surface acceptable for deployment of geomembrane by others. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, replacement of rejected material, dewatering, preparation or repairs of clay surface, or protection.

4. Unless the Owner has directed in writing that the compacted cohesive soil be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

F. Pay Item 6: Geosynthetic Clay Liner

1. Price includes all Work necessary to install the geosynthetic clay liner system in the bottom of Cell 2 as shown on the Drawings. Payment quantities will be based on the surveyed surface area as measured from the outside of the anchor trench. The Contractor is responsible for unloading the geosynthetics.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all equipment, personnel, labor, and all else required to place, 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, or wasted material.

4. Unless the Owner has directed in writing that the geosynthetic clay liner should be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

G. Pay Item 7: HDPE 60-mil Textured Geomembrane Liner

1. Price includes all Work necessary to install a 60-mil HDPE textured geomembrane liner system overlying the geosynthetic clay liner on the bottom of the cell and overlying the compacted clay liner on the side-slopes of Cell 2 as shown on the Drawings. Payment quantities will be based on the surveyed surface area. The removal of plywood and the cleaning and welding of the Cell 1

to 2 tie-in will be based off of linear feet. The Contractor is responsible for unloading the geosynthetics.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all equipment, personnel, labor and all else required to place, weld, 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, or wasted material.

4. Unless the Owner has directed in writing that the textured HDPE should be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

H. Pay Item 7A: HDPE 60-mil Textured Geomembrane Liner Rub Sheet

1. Price includes all Work necessary to install a 60-mil HDPE textured geomembrane rub sheet that extends 3 feet outside the leachate collection trench and sump. The rub sheet will be welded and non-destructively tested. Payment quantities will be based on the surveyed surface area. The Contractor is responsible for the unloading the geosynthetics.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all equipment, personnel, labor and all else required to place, weld, 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, or wasted material.

4. Unless the Owner has directed in writing that the textured HDPE should be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

I. Pay Item 8: Geocomposite Drainage Layer

1. Price includes all Work necessary to install the geocomposite system in Cell 2 as shown on the Drawings. Payment quantities will be based on the surveyed surface area as measured from the outside of the anchor trench. The Contractor is responsible for unloading the geosynthetics.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all equipment, personnel, labor and all else required to place, 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.

4. 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.

J. Pay Item 9: Protective Cover Layer

1. Measurement for payment for this Pay Item will be made on a cubic yard basis of in-place, approved protective soil layer, calculated by the Owner based on the actual area of protective soil layer installed, surveyed after the subject work is executed and using the minimum protective cover soil layer thickness (measured perpendicular to the design slope, shown on the Drawings) or such other means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The unit price shall include all equipment; personnel, labor and all else required to transport soil from on-site stockpiles to the cell and construct the protective soil layer to the elevations and limits shown on the Drawings. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, replacement of rejected material, dewatering, or protection.

4. Unless the Owner has directed in writing that the protective soil layer be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

K. Pay Item 9A: Cell 2 Tie-in

1. Measurement for this item will be made on a linear foot basis of approved, in place linear over-build area.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The unit price shall include all equipment; personnel, labor and all else required to transport soil from on-site stockpiles to the cell and construct the protective soil layer to the elevations and limits shown on the Drawings. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, replacement of rejected material, dewatering, or protection.

4. Unless the Owner has directed in writing that the protective soil layer be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

L. Pay Item 10: Gravel Access Road

1. Measurement for this item will be made on a linear foot basis of approved, in-place perimeter access road constructed, calculated by the Owner based on surveys of the work area, or other such means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all materials, equipment, transportation personnel, labor and all else required to construct the perimeter access road to the elevations and limits shown on the Drawings.

4. Unless the Owner has directed in writing that the perimeter access road be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the Bid quantity.

M. Pay Item 10A: Perimeter Stormwater Ditch

1. Measurement for the this item will be made on a lump sum basis for approved, in-place perimeter stormwater ditch constructed, and also the installation of a 24” corrugated HDPE drainage pipe with rip-rap on the northwest corner of Cell 2 per the drawings.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all materials, equipment, transportation personnel, labor and all else required to construct the perimeter access road to the elevations and limits shown on the Drawings.

4. Unless the Owner has directed in writing that the perimeter access road be constructed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the Bid quantity.

N. Pay Item 11: Geosynthetic Anchor Trenches

1. Measurement for this Pay Item will be made on a linear foot basis of in-place, approved geosynthetics anchor trench, calculated by the Owner based on actual linear distance of anchor trench, surveyed after the work is executed.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include and cover the furnishing of all labor, materials, tools, supervision, transportation, and equipment necessary to excavate the geosynthetics anchor trench associated with Cell 2, transport, moisture condition, place and compact soil in the anchor trenches after geosynthetics installation, and coordinate work with Geosynthetics Installer. No additional allowances shall be permitted for unauthorized trenches beyond the depths or limits of anchor trenches as shown on the Drawings.

O. Pay Item 12: Leachate Collection System

1. Measurement for this Pay Item will be made on a linear foot basis of approved, in-place leachate collection piping, clean-out, calculated by the Owner based on the actual linear distance of perforated and solid-wall HDPE piping installed, or such other means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include furnishing all materials, excavation, equipment, transportation, personnel, labor and all else required to construct the leachate collection pipes, including furnishing and installing geotextiles, sewing, perforated and solid wall HDPE pipe, coarse aggregate, HDPE piping, and associated pipe fittings, elbows, etc. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, replacement of rejected material, dewatering, or protection.

4. Unless the Owner has directed in writing that the leachate collection piping be installed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

P. Pay Item 13: Leachate Forcemain System

1. Measurement for this Pay Item will be made on a linear foot basis of installed, approved, dual contained HDPE leachate forcemain pipe, calculated by the Owner based on the actual linear distance of dual contained HDPE forcemain pipe installed, or such other means of measurement that may be agreed to between the Owner and the Contractor.

2. Payment will be made at the unit price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all materials, trenching, backfill, equipment, labor, and all else required to install the HDPE dual contained forcemain pipe, including pipe bedding preparation and material; dual-contained HDPE forcemain pipe, fittings, elbows, bends, joints, and pipe trench backfill material to the dimensions and limits shown on the Drawings. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, shoring and bracing, dewatering, protection, or replacement of rejected material.

4. Unless the Owner has directed in writing that HDPE dual contained forcemain pipe be installed in excess of the quantities shown by the Drawings, the payment quantity will not exceed the bid quantity.

Q. Pay Item 14: Headwall for Leachate Riser Pipe and Clean-out

1. The Work required for this item will be measured on the basis of satisfactory evidence of sufficient labor, equipment, and material to adequately perform the Work.

2. Payment will be made at the lump sum price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all materials, trenching, backfill, equipment, labor, and all else required to install the 18-inch HDPE riser pipes, cleanout, and concrete headwall to the dimensions and limits shown on the Drawings. No additional payment will be made for losses due to settlement, wastage, compaction, erosion, over-excavation, shoring and bracing, dewatering, protection, or replacement of rejected material.

R. Pay Item 15: Leachate Pump System and Electrical

1. The Work required for this item will be measured on the basis of satisfactory evidence of sufficient labor, equipment, and material to adequately perform the Work.

2. Payment will be made at the lump sum price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include furnishing, installing, testing and start-up of leachate pumping unit, including the pump, the wheeled sump drainer, disconnect system, sump level controls, high level alarm and pump cut-off for leachate storage tank, flexible PVC discharge piping, electrical and control lead, electrical control panel, and disconnect.

S. Pay Item 16: Leachate Storage Tank Area

1. The Work required for this item will be measured on the basis of satisfactory evidence of sufficient labor, equipment, and material to adequately perform the Work.

2. Payment will be made at the lump sum price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include all preparation of tank area, installation of compacted general fill material, geotextile Type B, compacted clay material, granular material, relocation of existing owner-supplied leachate tank, and installation of discharge piping system as shown on the Drawings.

T. Pay Item 16: Erosion Control Matting and Seeding

1. The Work required for this item will be measured on the basis of satisfactory evidence of sufficient labor, equipment, and material to adequately complete the Work.

2. Payment will be made at the lump sum price listed in Section 00300, Bid Form A, for this Pay Item.

3. The price shall include placement of seeding to establish vegetation around the construction area and in the stormwater ditch to prevent erosion as shown on the Drawings.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01027
APPLICATION FOR PAYMENT
PART 1

CONTRACTOR: _____ CONTRACT DESCRIPTION:

_____

_____

OWNER: _____

_____ Agreement by and between

_____ and _____as thereafter amended or changed pursuant to the terms and conditions of such Agreement (herein referred to as the "Agreement") for the satisfactory performance of all necessary and/or related Work to properly complete construction of the project at the Site.

PROJECT: _____

_____

PERIOD: From:_____ To: _____

AGREEMENT PRICE SUMMARY:

ORIGINAL AGREEMENT PRICE $ _____

Net change by Change Orders $ _____

REVISED AGREEMENT PRICE $ _____

PAYMENT CALCULATION:

TOTAL COMPENSATION FOR WORK COMPLETED TO DATE $_____
(completed work is detailed on Part 2 of this application)

LESS: RETAINAGE _____ % $ (_____)

TOTAL COMPENSATION AMOUNT $ _____

LESS: AMOUNTS PREVIOUSLY PAID BY OWNER $ (_____)

LESS: PREVIOUS APPROVED PAYMENT APPLICATIONS WHICH HAVE NOT YET BEEN PAID BY OWNER $ (_____)

LESS: DISPUTED AMOUNTS $ (_____)

CURRENT PAYMENT APPLICATION AMOUNT $ _____

CERTIFICATION:

Contractor certifies that the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by Contractor to its subcontractors, material men and suppliers for Work for which previous Applications for Payment were submitted by Contractor.

CONTRACTOR:

By: _____

Printed Name: _____

Title: _____

STATE OF_____

COUNTY OF _____

Subscribed and sworn to before me this _____ day of _____, 20___.

Notary Public:

My commission expires:

APPLICATION FOR PAYMENT
PART 2

ITEMIZED PAYMENT SUMMARY

Item No.	Description of Work	Value of Work Completed	Value of Materials Stored at Site	Total Value

UNCONDITIONAL WAIVER AND RELEASE UPON FINAL PAYMENT

STATE OF ARKANSAS

COUNTY OF _____

The undersigned mechanic and/or materialman has been employed or contracted by _____ (name of party to whom or through whom goods or services were provided) to furnish

_____

_____
(describe materials and/or labor)

in conjunction with the Area 1-3 Cell 2 Construction NABORS Class 1 Landfill.

Upon receipt of the sum of $_____ the undersigned mechanic and/or materialman waives and releases any and all liens or claims of liens or any right against any labor and/or material bond it has upon the foregoing described property.

Given under hand and seal this _____ day of _____, 20___.

_____(SEAL)

_____
(printed name of mechanic/materialman)

_____(SEAL)
(witness)

_____
(printed name of witness)

NOTICE: THIS DOCUMENT WAIVES RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. THIS DOCUMENT IS ENFORCEABLE AGAINST YOU IF YOU SIGN IT, EVEN IF YOU HAVE NOT BEEN PAID. IF YOU HAVE NOT YET BEEN PAID, USE A CONDITIONAL RELEASE FORM.

INTERIM WAIVER AND RELEASE
UPON PAYMENT

STATE OF ARKANSAS

COUNTY OF _____

The undersigned mechanic and/or materialman has been employed or contracted by _____ (name of party to whom or through whom goods or services were provided) to furnish

_____

_____
(describe materials and/or labor)

in conjunction with the Area 1-3 Cell 2 Construction NABORS Class 1 Landfill.

Upon receipt of the sum of $_____ the undersigned mechanic and/or materialman waives and releases any and all liens or claims of liens it has upon the foregoing property through the date of _____ and excepting those rights and liens that the mechanic and/or materialman might have in any retained amounts, on account of labor or materials, or both, furnished by the undersigned to or on account of said party to whom or through whom goods or services were provided for said building or premises.

Given under hand and seal this _____ day of _____, 20___.

_____(SEAL)

_____
(printed name of mechanic/materialman)

_____(SEAL)
(witness)

_____
(printed name of witness)

CHANGE ORDER POLICY

I. Forms

A. Contractor shall break down the Agreement Price regarding the Work properly performed on Application and Certificate for Payment Forms (hereinafter referred to as the "payment forms") in accordance with the tasks reflected on the Schedule. Samples of the payment forms are attached hereto.

B. Each item on such payment forms shall contain overhead and profit. Overhead and profit is not to be added as a separate item. However, Contractor shall submit with these documents supporting documentation reflecting cost, overhead and profit as separate items.

C. Each month Contractor shall submit payment forms to Owner or payment in accordance with the terms and conditions of the Contract Documents.

D. Change Orders shall be submitted and approved on a Change Order form to be supplied to Contractor by Owner. A sample of the Change Order form is attached hereto (as modified).

II. Change Order Policy

Changes in the Work which result in a change in the Agreement Price shall be calculated in accordance with one or more of the following methods as selected by Owner:

A. Firm Lump Sum - If Owner requests, Contractor shall submit a written proposal covering the change, including any reduction in the Work, on a firm lump sum basis. Owner shall review such proposal and upon mutual agreement, a Change Order to the Agreement shall be issued; and/or

B. Fixed Unit Prices - If Owner requests, and fixed unit prices are established in the Contract Documents, then the change in the Agreement Price shall be computed using such prices, except that these fixed unit prices shall apply only for quantities fluctuation of +/-20 percent of the original quantity. Quantity fluctuation in excess of +20 percent will require a re-evaluation of the fixed unit price. If the fixed unit prices are not established in the Agreement or such re-evaluation requires that different prices should apply, then Owner and Contractor shall negotiate and mutually agree upon fixed unit prices to apply to such changed work; and/or

C. Actual Cost - If Owner requests Contractor shall perform the Work covered by any change on the basis of the actual cost incurred plus allowances for overhead and profit as provided herein. The change in price shall be computed as follows:

1. The direct cost of labor to Contractor at the rates set forth in this Attachment and attached hereto as Exhibit 1 shall be used, or, if no rates are attached the effective rates established by any applicable labor agreement, including any surcharges contained in such labor agreement for fringe benefits, payroll taxes, and insurance shall apply. Such labor costs shall include all classifications up to and including General Foreman, but shall not include Contractor's clerical and

supervisory employees, regardless of classification. Contractor shall receive an allowance of ten percent (10%) total for overhead and profit on the cost described in this paragraph;

2. The actual cost of material is incorporated into the Work comprising the change by Contractor shall be used. Contractor must receive written authorization from Owner to furnish such materials prior to incorporation of such materials into the Work. Contractor must establish that it has endeavored to obtain such materials at the lowest available prices and shall verify the cost of all materials by submitting the actual invoice. Material usage shall be subject to verification by Owner. Contractor shall receive an allowance of ten percent (10%) total for overhead and profit on the costs described in this paragraph;

3. The actual cost for the Work subcontracted by Contractor in the performance or completion of such change will be allowed only when each subcontractor has been approved in writing by Owner before Contractor starts work on the change. Only the net cost to Contractor shall be considered a cost hereunder, it being understood that, on any actual cost work by its subcontractor(s), that allowances for tools, supplies, overhead, supervision and profit to the subcontractors shall not exceed ten percent (10%).

4. The actual cost of equipment rented by Contractor from third parties not affiliated with Contractor at no more than published rates (i.e., Bluebook Equipment Rates) plus operating costs, less applicable discount associated with the area where the Work is being performed shall be used. Contractor shall receive an allowance of ten percent (10%) total for overhead and profit on the costs described in this paragraph; and

5. The cost of rental of Contractor-owned equipment shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachment, repairs and maintenance, depreciation, storage and insurance at rates which are attached hereto in Exhibit 1 shall be used. Such costs shall not exceed the rental rates as published in the most current Bluebook Equipment Rate Guide. If rates not attached hereto, then the cost of such equipment shall be at actual cost not to exceed the rental rates published in the most current Bluebook Equipment Rate Guide. Hourly rental charges of equipment on the Site shall be on the basis on 1/176th of monthly rates, Operators of rental equipment shall be paid in accordance with the “labor” provisions of this Attachment [II(C)(1].

6. Exhibit 1, “Contractor’s Time and Materials Rate Provisions” is attached hereto and incorporated by reference into this Agreement as fully as if reproduced in its entirety herein.

D. For all purposes of the Agreement, the profit and overhead allowances provided herein shall be deemed complete compensation to Contractor for all cost attributed to or apportioned to the Work or the Agreement by Contractor. By way of illustration, overhead and profit shall be deemed to include, but not limited to: Contractor’s profit; cost of capital; supervision; clerical and non-manual labor; all tools having a replacement value of less than $200; expendable supplies; warehousing costs; local transportation of material and labor; all expenses of contractor prior to beginning the

Work; work performed by Contractor which does not meet the standards required hereunder, including the cost of correcting or replacing such work, taxes on Contractor's income, profit, franchise, occupational license, or personal property; and fines or assessments against Contractor by any governmental authority.

E. The compensation established herein for any change ordered by Owner shall be the sole and exclusive consideration for such change. Any increased overhead, extension of the Agreement, inefficiencies, and all other costs and profits are incorporated into the compensation established pursuant to this Attachment and are agreed upon by Contractor.

CHANGE ORDER

CONTRACTOR: _____

CHANGE ORDER NUMBER: _____

DATE: _____

CONTRACT DESCRIPTION:

OWNER: _____

_____

Agreement by and between _____

_____and

_____

_____

SITE:

_____

_____

_____

_____

_____

PROJECT:_____

_____

_____

_____

Contractor and Owner; intending to be legally bound hereby, agree to make the following changes to the Agreement:

I. Contractor shall provide all necessary and required labor, materials, tools, services, equipment and incidentals to

_____

_____

_____

_____

II. This Change Order shall incorporate by reference the terms and conditions of the Agreement as fully as if reproduced in its entirety herein.

III. Contractor shall obtain the necessary insurance coverage and Certificates of Insurance as required by the Agreement prior to performing any Work.

IV. All other terms and conditions of the Agreement shall remain the same.

V. Change Order Summary:

A. The original Agreement Price was .....$_____

B. Net change by previously authorized Change Orders .....$_____

C. The Agreement Price prior to this Change Order was .....$_____

D. The Agreement Price for this Change Order is .....$_____

E. The new Agreement Price of the Agreement (including this Change Order) is .....$_____

F. The Agreement Time for proper completion of the Work required pursuant to the Agreement and this Change Order shall (be _____, 20____).

IN WITNESS WHEREOF, the parties hereto set forth their signatures as of the date first set forth above.

WITNESS: CONTRACTOR:

By:_____ By:_____

Printed Name:_____ Printed Name:_____

Title:_____

WITNESS: OWNER:

By:_____ By:_____

Printed Name:_____ Printed Name:_____

Title:_____

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 Pre-construction 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 bi-monthly intervals.

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.

A. Attendance Required: Contractor, Owner, Engineer, and others as appropriate to agenda topics for each meeting.

B. 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.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

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

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

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 01095
DEFINITIONS AND STANDARDS

PART 1 GENERAL

1.01 Description

A. Basic definitions are provided in the General Conditions.

B. Additional technical definitions are provided in appropriate Sections of these Specifications.

C. Abbreviations and acronyms are sometimes used in the Specifications to identify reference standards. Implied words and meanings shall be interpreted as appropriate.

D. When a standard is specified by reference, the Contractor shall comply with requirements and recommendations stated in that standard, except when requirements are modified by the Contract Documents, or when applicable codes established more strict standards.

E. When published standards are referenced, the publication in effect on the date of issue of Contract Documents shall apply unless specified otherwise.

1.02 Abbreviations, Names, and Addresses Or Organizations

The Contractor shall obtain copies of referenced standard direct from the publication source, when needed for proper performance of Work, or when required for submittal by Contract Documents.

AASHTO American Association of State Highway
And Transportation Officials
44 North Capital Street, N.W.
Washington D.C. 20001

AAN American Association of Nurserymen
230 Southern Building
Washington, D.C. 20005

ANSI American National Standards Institute
(Formerly American Standards Association – ASA)
1430 Broadway
New York, New York 10018

AREA American Railroad Engineering Association
2000 "L" Street, N.W.
Washington, D.C. 20036

ASCE American Society of Civil Engineers
345 East 47th Street
New York, New York 10017

ASLA American Society of Landscape Architects
4401 Connecticut Avenue N.W., Fifth Floor
Washington D.C., 2008-2302

ASTM American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

AWWA American Water Works Association
6666 W. Quincy Avenue
Denver, CO 80235

FHWA Federal Highway Administration
Federal Building, U.S. Courthouse
Nashville, TN 37202

FSS Federal Specifications and Standards
General Services Administration
Specifications and Consumer Information
Distribution Section (WFSIS)
Washington, D.C. 20407

1.03 Basic Definitions

A. Agreement: Contract; Contractor Agreement; or Contract Documents: The Contractor Agreement, including exhibits thereto, Contractor's Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when specifically attached as an exhibit to and incorporated in the Agreement, the Notice to Proceed, the Bonds, the General Conditions, the Supplementary Conditions, the Specifications and the Drawings as the same are specifically identified in the Agreement, together with all Written Amendment, Change Orders, Work Change Directives and Field Orders.

B. Application for Payment: The form accepted by Project Manager which is to be used by

Contractor in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

C. *Authorized Representative: An individual or individuals, named in the General Requirements, who have been authorized by the Owner to execute a Change Order on behalf of the Owner.*

D. *Change Order: A document recommended by Technical Representative, which is signed by Contractor and Owner and authorizes an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.*

E. *Owner: The Corporation with whom Contractor has entered into the Agreement and for whom the Work is to be provided.*

F. *Contract Times: The number of days or the dates stated in the Agreement:*

1. *To achieve Substantial Completion; and*
2. *To complete the Work so that it is ready for final payment as evidenced by Project Manger's written recommendation of final payment.*

G. *Contractor: The person, firm or corporation with whom Owner has entered into the Agreement.*

H. *Contractor Resident Superintendent: An individual representing the Contractor for administration of the Agreement. The Contractor Resident Superintendent is named in the Bid Form.*

I. *Defective: An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, in that is does not conform to the Contract Documents, or is of poor quality or workmanship, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to Project Manager's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner) at Substantial Completion.*

J. *Drawings: The drawing which show the scope, extent and character of the Work to be furnished and performed by Contractor and which have been prepared or approved by Engineer and are referred to in the Contract Documents. Shop drawings are not Drawings as so defined.*

K. *Engineer: An individual, firm or corporation responsible for preparation of the Drawings and Specifications. The Engineer is named in the General Requirements.*

L. *Facility: The Owner's or other facility where the Work is to be performed.*

M. *Field Order: A written order issued by Project Manager which orders minor changes in the Work but which does not involve a change in the Contract Price or the Contract*

Times.

N. *General Requirements: Sections of Division 1 of the Specifications.*

O. *Laws and Regulations; Laws or Regulations: Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.*

P. *Milestone: A principle event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of the Work.*

Q. *Project: The total construction of which the Work to be provided under the Contract Document may be the whole or a part as indicated elsewhere in the Contract Documents.*

R. *Project Manager: An individual, firm or corporation representing the Owner for administration of the Agreement. The Project Manager is named in the General Requirements.*

S. *Samples: Physical examples of material, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.*

T. *Shop Drawings: All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepare or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.*

U. *Subcontractor: An individual, firm or corporation having a direct contact with Contractor or with any other subcontractor for the performance of a part of the Work at the site.*

V. *Substantial Completion: The Work (or a specified part thereof) has progressed to the point where in the opinion of Project Manager as evidence by Project Manager's definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by Project Manager's written recommendation of final payment.*

W. *Supplier: A manufacturer, fabricator, distributor, material man or vender having a direct contract with Contractor or with any subcontractor to furnish material or equipment to be incorporated in the Work by Contractor or any subcontractor.*

X. *Technical Representative: An individual, firm or corporation representing the Owner on technical issues related to the Work, including interpretation of Drawings and Specifications (possibly in conjunction with the Engineer), review of Shop Drawings, and Samples, evaluation of proposed Change Orders and other duties as described in the Contract Documents. The Technical Representative is named in the General Requirements.*

Y. Underground Facilities: All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

1.04 Other Definitions

A. Furnish: Supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

B. Install: Operations at the Project Site including unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

C. Provide: To furnish and install, complete and ready for the intended use.

D. Installer: The Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

The term experienced, when used with term Installer, means having a minimum of 5 previous projects similar in size and scope to this Project, being familiar with special requirements indicated, and having compiled with requirements of the authorities having jurisdiction.

E. Project Site: Is the space available for performing construction activities, wither exclusively or in conjunction, with others performing work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

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. Surveyor information and surveyor documents;
4. Independent quality control inspection and testing information.
5. Project Record Documents.
6. Equipment manufacturer's instructions and certificates.
7. All other miscellaneous submittals not mentioned herein and as specified in other individual specification Sections.

1.04 Submittal Procedures

A. Timing of Submittals

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 CONTROL 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 all quality control testing and services required by the Specifications, Drawings, or the Contractor's approved Quality Control Plan. The Contractor shall also provide any additional testing he requires 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 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 Requirements

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

B. The Contractor shall provide and maintain methods, equipment and temporary construction, as necessary to provide controls over environmental conditions at the construction site and related areas under Contractor's control.

C. The Contractor shall remove all temporary facilities at completion of Work or when no longer necessary.

1.02 Dust Control

A. The Contractor shall provide positive methods and apply dust control water to minimize raising dust from construction operation, and provide positive means to prevent airborne dust from dispersing into the atmosphere. **A water truck with a spray nozzle cannon is required to apply water to the lined areas.** Chemical dust suppressant shall not be used unless approved by the Technical Representative prior to use.

1.03 Water Control

A. The Contractor shall provide methods to control surface water to prevent damage to the Project, the site, or adjoining properties. The Contractor shall control fill, grading and ditching to direct surface drainage away from excavations, pits, tunnels and other construction areas; and to direct drainage to proper runoff.

B. The Contractor shall provide operate, and maintain hydraulic equipment or adequate capacity to control surface erosion and prevent ponding of surface water within the Work area.

C. The Contractor shall dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the site or to adjoining areas.

1.04 Debris Control

A. All areas under Contractor's control shall be maintained free of extraneous debris.

B. The Contractor shall initiate and maintain a specific program to prevent accumulation of debris at construction site, storage and parking areas, or along access roads and haul routes.

1. Containers shall be provided for deposit of debris.

2. The Contractor shall prohibit overloading of trucks to prevent spillages on access and haul routes. Traffic areas shall be periodically inspected to enforce requirements.

C. The Contractor shall schedule periodic collection and disposal of debris. Additional collections and disposal or debris shall be provided whenever the periodic schedule is inadequate to prevent accumulation.

1.05 Pollution Control

A. The Contractor shall provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.

B. The Contractor shall provide equipment and personnel to perform emergency measures required to contain any spillages and to remove contaminated soils or liquids; and, shall excavate and dispose of any soil contaminated by the construction operations off-site, and replace with suitable compacted fill and topsoil as directed by the Technical Representative or the Owner.

C. The Contractor shall take special measures to prevent harmful substances from entering public waters; and, shall prevent disposal of wastes, effluents, chemicals, sediments, or other such substances adjacent to streams, or in sanitary or storm sewers.

D. The Contractor shall provide systems for control of atmospheric pollutants and shall:

1. Prevent toxic concentrations of chemicals; and

2. Prevent harmful dispersal of pollutants into the atmosphere.

1.06 Erosion Control

A. The Contractor shall plan and execute construction and earthwork using methods to control surface drainage from cuts and fills from borrow and waste disposal areas in order to prevent erosion and sedimentation; and shall:

1. Hold the number and size of areas of bare soil exposed at one time to a minimum; and

2. Provide temporary control measures such as berms, dikes, silt fence, silt dams, drains, etc., as shown on the Drawings or as direct by the Technical Representative.

B. The Contractor shall construct fills and waste areas by selective placement to eliminate surface silts or clays which will erode.

C. The Contractor shall periodically inspect earthwork to detect any evidence of the start of erosion, and apply corrective measures as required to control erosion.

PART 2 – PRODUCTS

2.01 Materials General

A. Materials may be new or used, suitable for the intended purpose, but must not violate requirements of applicable codes and standards.

2.02 Construction Aids

A. The Contractor shall provide any and all construction aids, equipment and materials required to facilitate execution of the Work, including but not limited to: scaffolds, staging, ladders, stairs, ramps runways, platforms, railings, hoists, cranes, chutes and other facilities and equipment.

PART 3 – EXECUTION

3.01 Preparation

A. The Contractor shall consult with Technical Representative and review site conditions and factors which affect construction procedures and construction aid, including adjacent properties and public facilities which may be affected by execution of the Work.

3.02 General

A. Installation of facilities shall be of a neat and reasonable uniform appearance, structurally adequate for required purposes.

B. The Contractor shall maintain barriers during entire construction period.

C. The Contractor shall relocate barriers as required by progress of construction.

3.03 Tree and Plant Protection

A. The Contractor shall preserve and protect existing trees and plants at the site which are designated to remain, and those adjacent to the site.

B. The Contractor shall consult with Owner and remove agreed-upon roots and branches which interfere with construction. The Contractor shall employ a qualified tree surgeon to remove roots and branches, and to treat cuts.

C. The Contractor shall provide temporary barriers to a height of six feet around each tree or plant or around each group of trees or plants which are designated to remain in the area of the Work.

C. The Contractor shall protect root zones of trees and plants and shall perform the following in areas of protected trees and plants:

1. Not allow vehicular traffic or parking;

2. Not store materials or products;

3. Prevent dumping of refuse or chemically injurious material or liquids; and

4. Prevent puddling or continuous running water.

E. The Contractor shall carefully supervise excavating, grading and filling, subsequent construction operations, to prevent damage.

F. The Contractor shall replace, or suitably repair, tree and plants which have been designated to remain and which are damaged or destroyed due to construction operations.

3.04 Removal

A. The Contractor shall completely remove temporary barriers, materials, equipment, and services:

1. When construction needs can be met by use of permanent construction; or

2. At completion of Project.

B. The Contractor shall protect root zones of trees and plants and shall perform the

following in areas of protected trees and plants:

1. removal of foundations and underground installations for construction aids;

2. grading areas of site affected by temporary installations to required elevations and slopes; and

3. Cleaning of the area.

C. The Contractor shall restore existing facilities used for temporary purposes to specified or original condition.

D. The Contractor shall restore permanent facilities, if any, used for temporary purposes to specified condition.

END OF SECTION

SECTION 01563
CONTROL OF WATER

PART 1 GENERAL

1.01 Section Addresses

A. Controlling surface water runoff.

B. Dewatering trenches, excavations, and other elements.

C. Controlling water of every origin.

1.02 Submittals

A. Contractor shall submit in accordance with Section 01300 – Submittals a dewatering plan including method, installation, and details of dewatering system, to be approved by Engineer and Owner. Contractor's dewatering plan must be approved before any excavation can begin.

PART 2 PRODUCTS

A. Contractor shall 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. Contractor shall 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. Contractor shall dewater and dispose of water in a manner that will not cause injury to public and private property.

C. Dewatering procedures and activities shall not cause a nuisance to the public.

D. Contractor shall keep sufficient pumping equipment and machinery on hand at all times for emergencies, including electric power failures.

E. Contractor shall keep experienced personnel available at all times to operate pumping equipment, machinery, and appliances.

F. Contractor shall not shut down dewatering systems between shifts, on holidays and weekends, nor during Work stoppages.

G. Contractor shall control groundwater (when applicable) to prevent softening of bottoms of excavations or formation of “quick” conditions or “boils.”

H. Contractor shall design and operate dewatering system in a manner that will not remove natural soils.

I. Contractor shall keep excavations free of water during excavation, construction of structures, installation of pipelines, placing of structures, backfill, and placing and curing of concrete (if applicable).

J. Contractor shall control surface water runoff to prevent entry and collection in excavations.

K. Contractor shall draw down static water level a minimum of 1 foot below bottom of excavations (if required) to maintain the undisturbed state of foundation soils and allow placement and compaction of fill and backfill materials to required density.

L. Contractor shall install and operate dewatering system so that groundwater level outside excavations is not lowered to an extent that will damage or endanger adjacent structures or property.

M. Contractor shall not use open or cased pumps as primary dewatering means for excavations more than 3 feet below static water level.

N. Contractor shall release static water level in a manner to maintain the undisturbed state of natural soils; prevent disturbance of compacted backfill; and prevent flotation or movement of structures and pipelines.

O. Contractor shall not obstruct road and ditches and shall provide means of free flow of surface water.

P. Contractor shall provide methods to remove and dispose of surplus water, mud, silt, slickings, or other runoff pumped from excavations or from sluicing or other operations.

Q. Contractor shall not dispose of water from trench, catch basins, pump station, or excavations to nearby surface waters and shall arrange to dispose collected waters to an approved location by the Engineer or the Owner.

R. Contractor shall meet existing facility NPDES permit requirements throughout the duration of the project.

END OF SECTION

SECTION 01565
TEMPORARY SOIL EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 Summary

A. 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

A. Contractor shall submit product data and specifications for approval as required by the Engineer prior to use.

1.04 Quality Assurance

A. Contractor shall comply with the requirements of governmental authorities having jurisdiction.

1.05 Project Requirements

A. Contractor shall 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. Slope Drains: Corrugated polyethylene pipe (as manufactured by Advanced Drainage System, Inc., or equivalent).

D. Silt Fencing: "Envirofence" by Mirafi, "Propex Silt Stop" by Amoco, or equivalent.

E. Check Dams: Shall be constructed of locally available sound crushed stone; size conforming with 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 water courses 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. Contractor shall 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. Contractor shall 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 are 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 operations should be so scheduled and performed so 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. Silt fencing shall be installed 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. Contractor shall 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. Contractor shall excavate four-inch wide by four-inch deep trench along line of posts and upslope from barrier.

D. Contractor shall 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. Contractor shall backfill trench and compact soil over the fabric.

F. Contractor shall 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. Contractor shall replace fabric when it has deteriorated, is torn, loose or no longer effectively performs.

H. Contractor shall replace any silt fence which has been overtopped with two new parallel fences.

3.04 Application of Temporary Grass and Mulch

A. Application of temporary grasses and mulch shall comply with other specifications contained herein.

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. If required, Contractor shall construct check dams across channels within the project limits as shown on the Drawings.

B. Contractor shall inspect check dams after each rainfall event. Contractor shall make required repairs if the check dams have deteriorated to the extent that their effectiveness is reduced.

C. Contractor shall 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. Erosion control measures shall be installed 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 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. In addition to the provisions of Part 8 Substitutions in Section 00700 General Conditions, 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 01655
STARTING OF SYSTEMS

PART 1 GENERAL

1.01 Summary

A. Section Includes:

1. Starting systems;

2. Demonstration and instructions; and

3. Testing, adjusting, and balancing.

1.02 Starting Systems

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Engineer seven days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of responsible manufacturers' representatives in accordance with manufacturers' instructions.

G. When specified in individual specification sections, require manufacturers to provide authorized representatives to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 01400 that equipment or system has been properly installed and is functioning correctly.

1.03 Demonstration and Instructions

A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of final inspection.

B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.

C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manuals with Owners' personnel in detail to explain all aspects of operation and maintenance.

D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

1.04 Testing, Adjusting, and Balancing

A. Contractor shall appoint, employ, and pay for services of manufacturers' representatives or an independent firm to perform testing, adjusting and balancing.

B. The manufacturers' representatives or independent firm shall perform services specified in Divisions 11, 13 and 16.

C. Reports shall be submitted by manufacturers' representatives or independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01700
CONTRACT CLOSE-OUT

PART 1 GENERAL

1.01 Summary

A. Section Addresses:

1. Closeout procedures;
2. Reinspection fees;
3. Contractor's closeout submittals;
4. Final Application for Payment;
5. Project Record Documents;
6. Operation and maintenance data;
7. Warranties;
8. Spare parts and maintenance materials; and
9. Final cleanup and demobilization.

1.02 Closeout Procedures

A. Contractor shall comply with applicable paragraphs of this section and related information in the Agreement, and as herein specified, for substantial completion procedures, final inspection, final application for payment, final payment and acceptance, and related topics.

1.03 Re-inspection Fees

A. Should the Engineer perform more than one reinspection due to failure of the Work to comply with the claims of status of each level of completion made by the Contractor, Owner will deduct the amount of compensation for subsequent inspections, including travel expenses, from the final payment to the Contractor.

1.04 Contractor's Closeout Submittals

A. Contractor shall provide submittals that are required by all governing authorities.

B. Contractor shall submit all documents referenced in this section and related

information in the Agreement, including, but not necessarily limited to:

1. Final Application for Payment (refer to subsection 1.05 below);

2. Project Record Documents (refer to subsection 1.06 below);

3. Operation and Maintenance Data (refer to subsection 1.07 below); and

4. Warranties (refer to subsection 1.08 below).

1.05 Final Application for Payment

A. Contractor shall submit the final Application for Payment, accompanied by all required documentation, in accordance with procedures and requirements stated in the Agreement.

B. Engineer will prepare a final Change Order, reflecting approved adjustments to the Contract Price which were not previously made by Change Orders, if any.

1.06 Project Record Documents

A. Contractor shall maintain at the site one set of the following documents:

1. Contract Documents;

2. Change Orders and other modifications to the Contract;

3. Engineer's Field Orders or written instructions;

4. Approved submittals; and

5. Quality control records (including field test records and laboratory analyses).

B. Contractor shall store Project Record Documents separate from documents used for construction.

C. Contractor shall record information concurrent with construction progress.

D. Contractor shall make Project Record Documents available at all times for review by the Engineer.

E. At Contract close-out, Contractor shall deliver Project Record Documents to the Engineer for the Owner.

1.07 Operation and Maintenance Data

A. Contractor shall submit one bound copy of document 15 days prior to final inspection. The copy will be returned after final inspection with Engineer's comments. Contractor shall then revise the content of the document as required prior to final submittal.

B. Contractor shall submit final revised document within ten days after final inspection.

C. Contents of document shall include:

1. Listing of Engineer, Contractor, subcontractors, and major equipment suppliers; and

2. Operation and maintenance instructions, identifying the following:

   a. List of equipment;
   b. Parts list for each component;
   c. Operating instructions; and
   d. Maintenance instructions for equipment and systems.

1.08 Warranties

A. Contractor shall provide notarized copies of all warranties.

B. Contractor shall execute and assemble documents from subcontractors, suppliers, and manufacturers.

C. Contractor shall submit warranties with final Application for Payment.

1.09 Spare Parts and Maintenance Materials

A. Contractor shall provide products, spare parts, maintenance, and extra materials in quantities specified in individual specification sections.

B. Contractor shall deliver spare parts and maintenance materials to a project site and place in a location as directed by Owner. A receipt shall be obtained to final payment.

1.10 Final Cleanup and Demobilization

A. The Contractor is responsible for final cleanup of the site and demobilization, prior to final acceptance of the Work.

B. Contractor shall remove all equipment, vehicles, excess materials, and debris created by or brought on-site for the purpose of completing the Work described in the Contract Documents.

C. Contractor shall remove all temporary utilities and structures constructed specifically to carry out tasks for this project; they shall be removed as specified in Section 01500.

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
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 storage 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 (By Owner)

Based on Contractor mark-ups and survey data provided by Contractor and Owner's survey, a set of record as-built drawings will be prepared by Owner (or Owner's representative) for inclusion in the project Construction Quality Assurance Certification Report. Final As-built drawings will include:

1. Field changes

2. Details not on original drawings

3. Accepted Recompacted Subgrade Layer

4. Accepted Compacted Clay Liner drawing

5. Location of installed Geosynthetic Clay Liner (GCL)

6. Location of installed geomembrane panels

7. Accepted final grading plan including top of protective cover layer

E. At completion of work:

1. Using data accumulated on blueline prints, Contractor shall submit a set of marked up drawings showing all approved changes and revisions to the Work as authorized by the Owner and Engineer. This information will provide the basis for preparation of the as-built record drawings (by others).

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

PART1 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.

3.02 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.

3.03 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 material obtained from borrow areas when sufficient approved soil 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. Recompacted Subgrade Layer: On site soil or Borrow material free of rock, gravel larger than two inches in any dimension, debris, waste, frozen material, vegetation, and other deleterious material with a maximum particle size of two inches. To be placed in the bottom of Cell 2 (not including side slopes). Must meet permeability of 1X10⁻ 5 cm/sec as specified in section 02224.

C. Compacted Clay Liner: On or off site soil material free of rock, gravel larger than two inches in any dimension, debris waste, frozen material, vegetation and other deleterious matter with a maximum particle size of two inches. To be placed in the bottom and side slopes of cell 2. Must meet permeability requirements of $1X10^{-7}$ cm/sec as listed in section 02224.

2.03 Other Materials

Contractor shall 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. Contractor shall 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. Contractor shall provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties.

3.02 Dewatering

A. Contractor shall prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site surrounding areas.

B. Contractor shall protect subgrade soils from softening and damage by rain or water accumulation.

3.03 Excavation

A. Contractor shall 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. Contractor shall 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. If existing waste is encountered during excavation operations, materials shall be removed from the excavation area and placed within the active working face of the landfill at the direction of the Owner.

5. 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. Ditches shall be cut accurately to the cross sections, grades and elevations shown on the Drawings.

B. Contractor shall 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

Contractor shall comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.07 Approval of Subgrade

A. The engineer shall be notified 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. The contractor 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. Contractor shall stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water and covered to prevent wind-blown dust.

B. Stockpile soil 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, dampproofing, 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. Contractor shall not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Contractor shall 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 ASTMD 698 Standard Proctor:

1. The upper twelve inches of fill below road subgrade shall be compacted to 95% of the soil maximum dry density according to ASTM 698.

2. In all other areas the Contractor shall compact each layer of backfill or fill material at 95% maximum dry density.

3.13 Grading

A. General: Contractor shall 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. Contractor shall cut off soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

B. Site Grading: Contractor shall 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

A. 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. Contractor shall 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 ASTMD 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. Contractor shall 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. Contractor shall 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. The work of this section may pertain in whole or in part to construction of the following: perimeter berm, roads, sedimentation basin, leachate tank area, maintenance area, parking areas, fuel station and access bench. 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 Assurance Plan, NABORS Class 1 Landfill, January 2006, Genesis Environmental Consulting (now Terracon Consultants, Inc.)*

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/ft^3 (600 kN-m/m^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/ft^3 (2,700 kN-m/m^3)).

5. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

6. ASTM D 2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

7. ASTM D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

8. ASTM D 2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

9. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

10. ASTM D 4220, Standard Practices for Preserving and Transporting Soil Samples.

11. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 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 soil 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)

5. A 50-lb sample of each of the proposed soils 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 or 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 soil materials for the structural fill shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.

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 soils 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. 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 2922 (Method B) and ASTM D 3017, respectively.

E. 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.

F. The Contractor shall not place frozen structural fill, nor shall structural fill be placed on frozen ground.

G. 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 disked, 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.

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 02211
LANDFILL SUBGRADE PREPARATION

PART 1 GENERAL

1.01 Summary

A. This section addresses grading of the Landfill Cell to receive soil for the prepared subgrade layer in the bottom and the compacted clay liner (CCL) on the side slopes.

B. Related Sections:

1. Section 02200 – Earthwork; and

2. Section 02220 – Landfill Excavation and Backfilling.

1.02 Submittals

A. Contractor shall submit under provisions of Section 01300.

1.03 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. Contractor shall provide temporary controls as specified in Sections 01563 and 01565.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 General

A. Contractor shall grade subgrade to the lines and grades on the Drawings and in the construction control tables.

B. Subgrade grading shall be to a tolerance of 0.1 feet.

C. Contractor shall maintain grades to provide drainage of any surface water that may affect the Work.

D. Contractor shall prepare subgrade on which the compacted clay liner will be installed in accordance with the *Construction Quality Assurance Plan, NABORS Landfill* **(Attachment A)**.

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 - Washed Gravel

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: Soil materials obtained from borrow areas when sufficient approved soil 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, NABORS* Class 1 Landfill January 2006, Genesis Consultants, Inc. (now Terracon Consultants, Inc.)

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, NABORS* Class 1 Landfill January 2006, Genesis Consultants, Inc. (now Terracon Consultants, Inc.)

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 soils derived from on-site and borrow sources.

C. Soil 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 2.01.

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 02227.

B. Protective Cover material shall be placed on landfill base and side-slopes as shown on the Drawings.

2.04 Washed Gravel

A. Material to conform to the requirements of Section 02225.

B. Shall be installed within the leachate collection pipe trench surrounding the leachate collection pipe, as shown on the Drawings.

2.05 Pipe Bedding Material

A. Material to conform to the requirements of Section 02220, subsection 2.01

B. Shall be installed within the leachate collection pipe trench on the landfill bottom, surrounding the leachate 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 as 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 it deems 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 soils. Proof-roll area with a large rubber-tired vehicle of sufficient weight to reveal unstable areas. Remove all unsuitable soils 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 plus or minus 0.1 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 recompacted 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(Compacted)	95 Standard Proctor	±3% of OMC
Recompacted Subgrade Layer	6 Inches	95 Standard Proctor	±3% of OMC
Compacted Clay Liner	6 inches per section 02224(compacted)	95 Standard Proctor(1)	See note
Protective Cover Layer	12 inches per section 02227	Placed per Section 02227	Not Applicable
Washed Gravel	Uniform lift per section 02229	Placed per section 02229	Not Applicable

Notes:
(1) Previously the compacted clay liner required 98% compaction and +3% of optimum to consistently meet the permeability requirements

3.06 Field Quality Control

A. Tests specified below shall be performed by the CQA Soil 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 recompacted and re-tested at Contractor's expense.

E. Surveying shall be performed to monitor as-built soil layer elevations. Measure on a 50-foot maximum grid pattern at the following locations:

1. Prepared Subgrade, and

2. Top of Protective Cover.

F. Provide topographic survey maps of the as-built surfaces to Engineer for review and approval before proceeding with subsequent construction. Survey maps shall be prepared by a registered 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 have a minimum vertical side 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

2. Section 02715 - Leachate Collection System Piping (HDPE)

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 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock 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

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 2922: 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 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 for Leachate Riser Pipe Trench

A. Place pipe bedding material within trench as shown on the Drawings. Material shall not be compacted.

3.07 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 02224
CLAY LINER

PART 1 GENERAL

1.01 Summary

A. This section addresses placing, compacting, grading, and testing of the Recompacted subgrade layer and the compacted clay layer material.

B. Related Sections:

1. Section 01563 – Control of Water;

2. Section 02200 – Earthwork; and

3. Section 02220 – Excavation and Backfilling.

1.02 References

A. *Construction Quality Assurance Plan*, NABORS Class 1 Landfill **(Attachment A)**.

B. Applicable American Society for Testing and Materials (ASTM) Standards include:

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 Amount of Material in Soils Finer than No. 200 (74μm) Sieve.
4. ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
5. ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.
6. ASTM D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
8. ASTM D 4220, Standard Practices for Preserving and Transporting Soil Samples.
9. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
10. ASTM D 5084, Standard Test Method for Hydraulic Conductivity of Soils Using Flexible-Wall Permeameter.

1.03 Submittals

A. Submittals shall be provided as per 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. Test results shall be submitted within three days after samples are obtained.

1.04 Quality Assurance/Quality Control

A. Testing shall be done in accordance with the most current version of the *Construction Quality Assurance Plan,* NABORS Class 1 Landfill **(Attachment A)**.

B. Owner will retain the services of an independent inspection and testing firm to determine conformance of the materials and constructed work with the specifications, in accordance with Section 01400.

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. Contractor shall provide temporary controls as specified in Section 01563.

PART 2 PRODUCTS

2.01 Recompacted Subgrade Layer And Clay Liner/Barrier Layer Material

A. The recompacted Subgrade layer and Clay liner/Barrier layer material shall be obtained from on-site materials, either from landfill cell excavation, existing on-site stockpiles, or on-site borrow areas.

B. Material shall consist of relative homogeneous natural soils that are free of debris, foreign objects, excess silt or sand, and organics.

C. No particles larger than one inch in any dimension shall be allowed.

D. The soils shall be classified according to the Unified Soil Classification System as CL, CH, or SC material.

E. The recompacted subgrade layer and clay liner/clay barrier layer material shall have a plasticity index in excess of 10.

F. The recompacted subgrade layer and clay liner/barrier layer material shall have greater than 30 percent passing the Number 200 Standard Sieve, and 80 percent shall pass the Number 4 Standard Sieve.

G. The recompacted subgrade layer shall have a remolded permeability less than or equal to 1×10^{-5} cm/sec as determined by ASTM D 5084. The compacted clay layer shall have a remolded permeability less than or equal to 1×10^{-7} cm/sec as determined by ASTM D 5084.

H. The soils shall not be gap-graded or susceptible to piping.

I. Substandard materials shall be segregated at the source and will not be permitted at the work area. Any material that is found by the Soils CQA Monitor to be substandard shall be removed from the work area.

PART 3 EXECUTION

3.01 Preparation

A. Contractor shall examine and prepare surfaces to receive the recompacted subgrade layer and the clay liner/clay barrier layer material as specified in Section 02220, subsection 3.04.

B. The Contractor shall receive subgrade approval by the Engineer prior to beginning initial lift placement.

3.02 Test Fill Construction

A. If required by the Engineer and/or CQA Monitor, a clay liner/clay barrier layer test fill shall be constructed prior to the construction of the clay lined area of the landfill cell unless the Contractor has successfully completed and documented a minimum of 500,000 square feet of clay liner construction during the three previous years. Owner and/or the Project Engineer will determine whether or not a test pad is needed.

B. Clay liner/Clay Barrier Layer test fill (if required) shall be constructed such that the final lift has dimensions of approximately 100 feet long and 60 feet wide to allow construction equipment to achieve normal operating speeds. The test fill shall consist of at least four equal lifts of clay liner material. The total thickness of the test pad shall be at least two feet.

C. Fill Placement for Test Pad (if required): The procedures for construction of each of the four compacted lifts vary to allow for determination of relationships between the compacted fill such as density, moisture content, and permeability. The procedures are

outlined below.

1. First Lift (if required):
   a. Clay liner/Clay Barrier Layer material shall be placed in uniform, loose lifts of six to eight inches in thickness;
   b. Material shall be moisture-conditioned such that the moisture content is in the range of 0 to 4 percent above optimum moisture content (OMC). One half of Test Pad shall have moisture content ranging between 0 to 2 percent above OMC, and the other half shall have a moisture content ranging between 2 to 4 percent above OMC;
   c. Material shall be blended through the use of disc tractor, or similar, to distribute water evenly;
   d. The first lift shall be compacted with two one-way passes using compaction equipment to be used in construction of landfill clay liner;
   e. Contractor shall allow Soils CQA Monitor to perform in-situ density tests using nuclear densometer and to collect samples as outlined in subsection 3.02 D below;
   f. Density testing and sample collection holes shall be repaired or filled with bentonite;
   g. Contractor shall recompact lift (second sequence) with two additional one-way passes of same compaction equipment;
   h. When required, testing, sampling, and repair shall be repeated as outlined above at locations adjacent to the first set of tests;
   i. Contractor shall recompact lift (third sequence) with two additional one-way passes of same compaction equipment;
   j. Testing, sampling and repair shall be repeated as outlined above at locations adjacent to the first two sets of tests; and
   k. Contractor shall continue the sequence of compaction, testing, sampling, and repair until the specified criteria for compaction and permeability are attained.

2. Subsequent Lifts (if required):
   a. Contractor shall place clay liner material in uniform, loose lift of six to eight inches in thickness;
   b. Contractor shall ensure that a good bond exists between two consecutive lifts, and the Soils CQA Monitor shall verify that the two lifts are intermixed;
   c. Adjust moisture as necessary; and
   d. Contractor shall compact, test, sample, and repair similar to the first lift until the specified compaction and permeability of the clay liner is attained.

3. Final Surface Preparation:
   a. The final surface of the test fill shall be rolled with a smooth drum or pneumatic roller so as to be free of irregularities, loose soil, and abrupt

changes in grade. All stones larger than 1-inch in diameter shall be removed.

D. Testing of Fill Material:

1. For the first two lifts, the Soils CQA Monitor shall:
   a. Estimate the thickness of the loose lifts;
   b. Count and record the numbers of compaction equipment passes and monitor the coverage of the test fill area;
   c. After every two passes, perform a minimum of five in-situ moisture and density tests using a nuclear densometer;
   d. Compute the degree of compaction and collect three additional samples for laboratory moisture content determination; and
   e. Monitor the repair of testing and sampling holes.

2. For the remaining two lifts, the Soils CQA Monitor shall:
   a. Verify that the thickness of the loose lift does not exceed the loose thickness determined from testing of the second lift;
   b. 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 fill area; and
   c. Perform a minimum of eight nuclear density tests per lift to verify the adequacy of the construction procedures.

3. For the entire test fill, the Soils CQA Monitor shall:
   a. Collect a total of six undisturbed Shelby tube samples. Samples shall be tested in laboratory for:
      i. Permeability;
      ii. Dry density;
      iii. Grain size distribution;
      iv. Atterberg Limits; and
      v. Moisture content.

3.03 Fill Placement

A. Recompacted Subgrade Layer material shall not be placed until landfill subgrade is approved by the Engineer.

B. Contractor shall construct the recompacted subgrade layer and the compacted clay liner/clay barrier layer to the grades, lines, and elevations on the bottom and slide slopes of the cell as shown on the Drawings and as specified herein. The compacted clay liner shall be constructed overlying the prepared Subgrade layer (24” thick) on the bottom of the cell.

C. The recompacted subgrade layer and the clay liner/clay barrier layer material shall not be placed in areas of standing water, saturated, frozen or unstable soils. Clay liner/Clay barrier layer material shall not be placed, spread, or compacted if frozen or thawing.

D. The recompacted subgrade layer and the clay liner/Clay Barrier Layer material shall be placed in uniform, loose lifts of nine inches or six inches compacted.

E. Clay liner/Clay Barrier Layer material shall be installed using the procedures established in the Test Pad construction, or by methods approved by the Engineer. The length of the pad or foot on the compacting equipment shall equal or exceed the thickness of each lift.

F. Contractor shall moisture adjust to maintain acceptable range of water content of clay liner material specified in this Section or as established in the Test Pad construction.

G. Each lift of the recompacted subgrade layer and the compacted clay liner shall be compacted to 95 percent (or greater) of the maximum dry density with a corresponding moisture content above the OMC as determined by the Standard Proctor test (ASTM D 698), unless otherwise directed by the Engineer.

H. Contractor shall prevent sand or other soil types from becoming incorporated into clay liner, or forming seams.

I. The recompacted subgrade layer and the compacted clay liner/clay barrier layer surface shall be made smooth with a drum roller and free of ruts or indentation at the end of every working day.

J. At the beginning of each working day, the previously placed recompacted subgrade layer and the clay liner shall be inspected by the Soils CQA Monitor to determine any existence of unacceptable areas.

K. No recompacted subgrade layer or clay liner/clay barrier material shall be placed over a previous lift that has not been tested and approved by the Soils CQA Monitor.

L. Contractor shall remove, replace, or re-work unacceptable zones of compacted clay liner until lift conforms to the specifications of this Section.

M. The final surface of the recompacted subgrade layer and compacted clay liner/clay barrier layer shall be made smooth, free of roller marks, holes, depressions, or protrusions greater than one-half inch deep.

N. Final surfaces shall be graded to lines and elevations as shown on the Drawings with a tolerance of 0.1 foot. The different layers will be verified as minimum thickness.

3.04 Field Quality Assurance/Quality Control

A. The recompacted subgrade layer and compacted clay liner/clay barrier layer shall be tested as outlined below.

1. The minimum testing frequencies for material evaluation and construction quality evaluation are presented below in **Table 02224-1 Table 02224-2** for the recompacted subgrade layer and the compacted clay liner.

2. Sampling locations shall be selected by the Soils CQA Monitor. If necessary, the location of routine in-place moisture content and dry density tests shall be determined using a non-biased sampling plan.

3. Undisturbed compacted clay liner/clay barrier layer material samples for laboratory hydraulic conductivity testing shall be taken such that the sample tube is inserted vertically into the compacted clay liner/clay barrier layer with a continuous smooth stroke from the construction equipment used to drive the sampler.

4. A special testing frequency shall be used at the discretion of the Soils CQA Monitor when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas shall be considered when:

    a. The roller slips during operation;
    b. The lift thickness is greater than specified;
    c. The compacted clay liner soil is an improper and/or variable moisture contents;
    d. Fewer than the specified number of roller passes are made;
    e. A dirt-clogged roller is used to compact the material;
    f. The compaction roller does not have optimum ballast; and/or
    g. The degree of compaction is doubtful.

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

    a. Adverse weather conditions;
    b. Breakdown of equipment;
    c. At the start and finish of grading;
    d. If the material fails to meet specifications; and/or
    e. The work area is reduced.

B. Perforations

1. Perforations in the compacted clay liner that must be filled shall include, but not limited to the following:
   a. Nuclear density test probe locations;
   b. Hydraulic conductivity sampling locations; and
   c. Test pit locations.

2. Perforations in the recompacted subgrade layer shall be backfilled with bentonite and compacted to achieve a hydraulic conductivity less than 1×10^{-5} cm/sec.

3. Perforations in the compacted clay liner/clay barrier layer shall be backfilled with bentonite and compacted to achieve a hydraulic conductivity less than 1×10^{-7} cm/sec.

C. Defective Areas:

1. If a defective area is discovered in the recompacted subgrade layer or in the compacted clay liner/clay barrier layer, the Soils CQA Monitor shall immediately determine the extent and nature of the defect. If the defect is indicated by unsatisfactory test results, the Soils CQA Monitor shall determine the extent of the defective area by additional tests, observations, a review of records, or other means that the Soils CQA Monitor deems appropriate. 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.

2. The Contractor shall correct the deficiency to the satisfaction of the Soils CQA Monitor.

3. All retests recommended by Soils CQA Monitor must verify that the defect has been corrected before any additional work is performed in the area of deficiency.

TABLE 02224-1
RECOMPACTED SUBGRADE LAYER
CONSTRUCTION, FIELD, AND PERFORMANCE EVALUATION

TEST	ASTM METHOD	PASSING CRITERIA
Pre-Construction Testing: One test per 50,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Above OMC as determined by ASTM D 698.
Particle Size	D 1140 and D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Max. Particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with P.I. greater than 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory hydraulic conductivity at specified compaction and moisture content	D 5084	1×10^{-5} cm/sec or less
Field Testing: One test per 20,000 square feet of liner constructed per compacted lift.		
In place density and moisture content	D 2922 and D 3017	Minimum 95% Standard Proctor maximum dry density and moisture content greater than OMC.

TABLE 02224-2
CLAY LINER and CLAY BARRIER LAYER MATERIAL
CONSTRUCTION, FIELD, AND PERFORMANCE EVALUATION

TEST	ASTM METHOD	PASSING CRITERIA
Pre-Construction Testing: One test per 20,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Above OMC as determined by ASTM D 698.
Particle Size	D 1140 and D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Max. Particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with P.I. greater than 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory hydraulic conductivity at specified compaction and moisture content	D 5084	1×10^{-7} cm/sec or less
Construction Testing: One test per 5,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Above OMC as determined by ASTM D 698.
Particle Size	D 1140 and D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Max. Particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with P.I. greater than 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density(1)
Laboratory hydraulic conductivity at specified compaction and moisture content	D 5084	1×10^{-7} cm/sec or less
Field Testing: One test per 10,000 square feet of liner constructed per compacted lift.		
In place density and moisture content	D 2922 and D 3017	Minimum 95% Standard Proctor maximum dry density and moisture content greater than OMC.(1)
Performance Testing: One test per 40,000 square feet of liner constructed per compacted lift.		
Laboratory hydraulic conductivity	D 5084	1×10^{-7} cm/sec or less

Note: (1) The soils will be recompacted at moisture and compaction in order to meet the minimum required hydraulic conductivity.

END OF SECTION

SECTION 02225
LEACHATE DRAINAGE LAYER

PART 1 GENERAL

1.01 Summary

A. This section includes description of granular leachate drainage material over the HDPE Geomembrane Liner on the landfill cell floor.

B. Related Sections

1. Section 02220 – Landfill Excavation and Backfilling

1.02 References

A. *Construction Quality Assurance Plan*, NABORS Class 1 Landfill **(Attachment A)**.

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 five days after samples are obtained.

PART 2 PRODUCTS

2.01 Leachate Drainage Layer

A. Material shall be classified as a SW, SP, GW, or GP material in accordance with the Unified Soil Classification System (USCS) and ASTM D 422.

B. Leachate Drainage Layer 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 material shall be clean sand or gravel with a minimum of 95 % passing the 3-inch sieve and less than 5% passing the Number 200 Standard Sieve.

D. The material shall have a maximum calcium carbonate content of 15%.

E. The material shall have a minimum hydraulic conductivity of 1.0×10^{-3} cm/sec as determined by ASTM D 2434.

PART 3 EXECUTION

3.01 General

A. Place material only when HDPE Geomembrane Liner is 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.

D. Finish grade material to a tolerance of 0.2 foot.

E. Do not compact material; only use track vehicles with a ground pressure of five pounds per square inch or less to place material.

3.02 Quality Assurance/Quality Control

A. Leachate Drainage Layer material shall be tested as outlined in **Table 02225-1.**

TABLE 02225-1
LEACHATE DRAINAGE LAYER MATERIAL
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum of 95% passing 3" sieve and less than 5% passing the No. 200 sieve
Calcium Carbonate		Maximum 15%
Permeability	D 2434	1.0×10^{-3} cm/sec
USCS Classification	D 2487	SW, SP, GW, or GP
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum of 95% passing 3/8" sieve and less than 5% passing the No. 200 sieve
Permeability	D 2434	1.0×10^{-3} cm/sec
USCS Classification	D 2487	SW, SP, GW, or GP

END OF SECTION

SECTION 02226
GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.01 Scope

A. This specification covers the technical requirements for the furnishing and installation of the geosynthetic clay liner described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the contract drawings.

1.02 Definitions

A. For the purposes of this specification, the following terms are defined below:

1. *Geosynthetic Clay Liner (GCL). A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetics.*

2. *Geomembrane. An essentially impermeable geosynthetic composed of one or more geosynthetic sheets.*

3. *Geotextile. Any permeable geosynthetic comprised solely of textiles.*

4. *Minimum Average Roll Value. For geosynthetics, the value calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.*

5. *Overlap. Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.*

6. *Typical Value. The mean value calculated from documented manufacturing quality control test results for a defined population obtained from one test method associated with one specific property.*

1.03 Unit Prices

A. Measurement will be made of the total surface area in square feet covered by the GCL as shown on the contract drawings. Final quantities will be based on as-built conditions. Allowance will be made for GCL in anchor and drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the

Contractor. GCL installed and accepted will be paid for at the respective contract unit price in the bidding schedule.

1.04 Submittals

A. With the bid, the Contractor shall furnish the following information:

1. Conceptual description of the proposed plan for placement of the GCL panels over the area of installation;

2. GCL manufacturer's MQC Plan for documenting compliance to Sections 2.1 and 2.2 of these specifications;

3. GCL manufacturer's historical data for reinforced GCL of a) 10,000-hour creep shear testing per Section 2.1 D and b) seam flow data at 2 psi confining pressure per Section 2.1 E; and

4. A copy of GCL manufacturer's ISO quality Certificate of Registration.

B. At the Engineer's or Owner's request the Contractor shall furnish:

1. A representative sample of the GCLs; and

2. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

C. Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.

D. As installation proceeds, the Contractor shall submit certificates of subgrade acceptance, signed by the Contractor and CQA Inspector (see Section 1.7) for each area that is covered by the GCL.

1.05 Qualifications

A. GCL Manufacturer must have produced at least 10 million square feet (1 million square meters) of GCL, with at least 8 million square feet (800,000 square meters) installed.

B. The GCL Installer must either have installed at least 1 million square feet (100,000 square meters) of GCL, or must provide to the Engineer satisfactory evidence,

through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

1.06 Construction Quality Assurance (Cqa)

A. The Owner and Engineer shall provide a third-party inspector for CQA of the GCL installation. The inspector shall be an individual or company who is independent from the manufacturer and installer, who shall be responsible for monitoring and documenting activities, related to the CQA of the GCL, throughout installation. The inspector shall have provided CQA services for the installation of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

B. Testing of the GCL, as necessary to support the CQA effort, shall be performed by a third party laboratory retained by the Contractor and independent from the GCL manufacturer and installer. The laboratory shall have provided GCL CQA testing of the proposed or similar GCL for at least 5 completed projects totaling not less than 1 million square feet (100,000 square meters).

C. CQA shall be provided in accordance with the *GCL CQA Manual* provided by the engineer.

PART 2 PRODUCTS

The GCLs shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Project Engineer.

Reinforced GCL must be used on slopes as designated by the Engineer. Unreinforced GCL may be used on the floor.

2.01 Materials

A. Acceptable reinforced GCL products are Bentomat® ST, as manufactured by CETCO, 1350 West Shure Drive, Arlington Heights, Illinois 60004 USA (847-392-5800), or an engineer-approved equal.

B. Areas requiring reinforced GCL will be furnished with Bentomat® ST. The delineation of these areas shall be agreed by the Installer and the Engineer prior to installation.

C. The reinforced GCL and its components shall have the properties shown in **Table 02226-1**.

D. The reinforced GCL shall have 10,000 hour test data for large-scale constant-load (creep) shear testing under hydrated conditions. The displacement shall be 0.11 in. (2.7 mm) or less at a constant shear load of 250 psf (12 kPa) and a normal load of 500 psf (24 kPa).

E. The reinforced GCL shall have seam test data from an independent laboratory showing that the seam flow with a grooved cut in the nonwoven geotextile is less than 1×10^{-8} $m^3/m^2/s$ at 2 psi hydraulic pressure.

F. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 feet (21 m) but less than a full-length roll)] may be supplied at a rate no greater than 3 per truckload or 3 rolls every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

G. A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

2.02 Product Quality Documentation

A. The GCL manufacturer shall provide the Contractor or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

1. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the parameters swell index and fluid loss shown in tables TR404-st and TR404-200r;

2. Manufacturer's test data for finished GCL product(s) of bentonite mass/area, GCL tensile strength and GCL peel strength (reinforced only) demonstrating compliance with the index parameters shown in **Table 02226-1**; and

3. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

B. Manufacturer's test data for finished GCL product(s) including GCL index flux, permeability and hydrated internal shear strength data demonstrating compliance with the performance parameters shown in **Table 02226-1** is available upon request of the manufacturer.

Table 02226-1
Reinforced GCL
BENTOMAT® ST CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY $ft^2(m^2)$	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24mL/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18mL max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000ft^2 (4,000m^2)	0.75lb/ft^2 (3.6kg/m^2)
GCL Grab Strength[3]	ASTM D 6768	200,000ft^2 (20,000m^2)	30 lbs/in (53 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000ft^2 (4,000m^2)	3.5lbs/in (6.1N/cm)min.
GCL Index Flux[4]	ASTM D 5887	Weekly	1 x $10^{-8}$$m^3$/$m^2$/sec max.
GCL Permeability[4]	ASTM D 5887	Weekly	5 x 10^{-9}cm/sec max.
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321 ASTM D-6243	Periodic	500psf (24kPa) typical @ 200 PSF.

Bentomat ST is a reinforced GCL consisting of a layer of sodium bentonite between a woven and a nonwoven geotextiles, which are needlepunched together.

Notes

1. Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.
2. Bentonite mass/area reported at 0 percent moisture content.
3. All tensile testing is performed in the machine direction, with results as minimum average roll values unless otherwise indicated.
4. Index flux and permeability testing with deaired distilled/deionized water at 80psi (551kPa) cell pressure, 77psi (531kPa) headwater pressure and 75psi (517kPa) tailwater pressure. Reported value is equivalent to 925gal/acre/day. This flux value is equivalent to a permeability of 5x10^{-9}cm/sec for typical GCL thickness. This flux value should not be used for equivalency calculations unless gradients used represent field conditions. A flux test using gradients that represent field conditions must be performed to determine equivalency. The last 20 weekly values prior to end of the production date of the supplied GCL may be provided
5. Peak value measured at 200psf (10 kPa) normal stress. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

2.03 Product Labeling

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand product code);

2. Lot number and roll number; and

3. Roll length, width and weight.

2.04 Packaging

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

2.05 Accessory Bentonite

A. The granular bentonite sealing clay used for overlap seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. Seaming of GCLs shall be conducted in accordance with the manufacturer's guidelines for each particular GCL.

PART 3 EXECUTION

3.01 Shipping And Handling

A. The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling and storage of the GCL are the responsibility of the Contractor, Installer or other designated party.

B. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

C. The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

3.02 Storage

A. Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

3.03 Earthwork

A. Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation;
2. Construction Debris;
3. Sticks;
4. Sharp rocks;
5. Void spaces;
6. Ice;
7. Abrupt elevation changes;
8. Standing water;
9. Cracks larger than one-quarter inch (6 mm) in width; and

10. Any other foreign matter that could contact the GCL.

B. Subgrade surfaces consisting of granular soils or gravel may not be acceptable due to their large void fraction and puncture potential. *In high head applications, such as ponds and wastewater lagoons, subgrade soils should possess a particle size distribution such that at least 80 percent of the soil is finer than a #60 sieve (0.250 mm).*

C. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

D. On a continuing basis, the project CQA inspector shall certify acceptance of the subgrade before GCL placement.

E. It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

F. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA Inspector. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

3.04 GCL Placement

A. Unreinforced GCL shall be placed on the flatter areas (the floor) of the site; reinforced GCL shall be placed on the side slopes (if needed). The Installer and Project engineer shall review and agree upon which GCL shall be placed on these areas prior to installation.

B. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) should be in accordance with the Engineer's recommendations.

C. Equipment, which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

D. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

E. The GCL panels shall be placed parallel to the direction of the slope.

F. All GCL panels should lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels.

G. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The project Engineer, CQA inspector, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

3.05 Anchorage

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope or an equivalent runout design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

3.06 Seaming

A. The GCL seams are constructed by overlapping their adjacent edges. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

B. The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). If the GCL is manufactured with a grooved cut in the nonwoven geotextile that allows bentonite to freely extrude into the longitudinal overlap then no supplemental bentonite is required for this overlap. If the GCL does not have a grooved cut in the nonwoven geotextile longitudinal overlap, then bentonite-enhanced seams are

required as described below. End-of-roll overlapped seams should be constructed with a minimum overlap of 24 inches (600 mm). End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

C. Bentonite-enhanced seams are constructed between the overlapping adjacent panels as follows. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150-mm) line. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m). A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

3.07 Detail Work

A. The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.08 Damage Repair

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

3.09 Cover Placement

A. Cover soils shall be free of angular stones or other foreign matter that could damage the GCL. Cover soils should be approved the project Engineer with respect to particle size, uniformity and chemical compatibility. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

B. Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1foot (300 mm) of cover should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently

trafficked areas or roadways, for which a minimum thickness of 2 feet (600 mm) is required.

C. Soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones. Cover soil shall be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

D. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

E. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

END OF SECTION

SECTION 02227
PROTECTIVE COVER LAYER

PART 1 GENERAL

1.01 Summary

A. Section includes description of soil protective cover layer over leachate collection blanket layer on landfill floor and above geomembrane liner and geocomposite drainage net on side-slopes and floor of landfill cell.

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,* Waste Management – Two Pine Class 1 Landfill (May 2006), Terracon Consultants, Inc.

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 relatively homogeneous sand (or equivalent 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.

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.

3.02 Quality Assurance/Quality Control

A. The protective cover layer material shall be tested as outlined in **Table 02227-1** below.

TABLE 02227-1
PROTECTIVE COVER LAYER MATERIAL
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Classification Permeability	D 2487 D 2434	GW, GP, SW, SP, SM, ML 1×10^{-5} cm/sec or greater
Construction Testing: Minimum of one test per source		
Classification Permeability	D 2487 D 2434	GW, GP, SW, SP, SM, ML 1×10^{-5} cm/sec or greater

END OF SECTION

SECTION 02228 A
BALLAST STONE

PART 1 GENERAL

1.01 Summary

A. Section includes description of granular material placed in leachate collection sump in landfill cell floor.

B. Related Sections:

1. Section 02220 – Landfill Excavation and Backfilling;

2. Section 02225 - Leachate Drainage Layer;

3. Section 02277 – Geomembrane; and

4. Section 02715 - Leachate Collection System Piping.

1.02 References

A. *Construction Quality Assurance Plan*, NABORS Class 1 Landfill **(Attachment A).**

B. American Society for Testing and Materials (ASTM):

1. ASTM D 422, Standard Method for Particle-Size Analysis 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.

PART 2 PRODUCTS

2.01 Ballast Stone

A. Ballast Stone shall be hard, durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

B. The stone shall be graded from five inches to two inches in diameter.

C. The material shall have a maximum calcium carbonate content of 15%.

PART 3 EXECUTION

3.01 General

A. Place material only when underlying geosynthetics are completed.

B. Place to the lines and grades shown on the Drawings.

C. Place material in single uniform lifts. Do not operate any equipment closer than 12 inches to underlying geosynthetics.

D. Do not compact material.

E. Only use track vehicles with ground pressures of five pounds per square inch (psi) or less to place material when operating over installed geosynthetics.

F. Restrict rubber-tired vehicles (10,000-pound axle loads maximum) to areas with three feet of cover over underlying geosynthetics.

3.02 Quality Assurance/Quality Control

Ballast Stone shall be tested as outlined in **Table 02228 A-1**.

TABLE 02228 A-1
BALLAST STONE
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis Calcium Carbonate	D 422	Approximate Range between 5” to 2” in diameter Maximum 15%
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Approximate Range between 5” to 2” in diameter

Note: Permeability will be calculated off of gradation.

END OF SECTION

SECTION 02228 B
WASHED GRAVEL

PART 1 GENERAL

1.01 Summary

A. Section includes description of granular material placed in leachate collection trench and sump in landfill cell floor.

B. Related Sections:

1. Section 02220 - Excavation and Backfilling
2. Section 02225-Leachate Drainage Layer
3. Section 02277-Geomembrane: and
3. Section 02715 - Leachate Collection System Piping(HDPE)

1.02 References

A. *Construction Quality Assurance Plan,* NABORS Class 1 Landfill (**ATTACHMENT A**)

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 Washed Gravel

A. Washed Gravel material 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 material shall be washed gravel 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 02228 B-1**.

TABLE 02228 B-1
WASHED GRAVEL
PRE-CONSTRUCTION AND CONSTRUCTION TESTING REQUIREMENTS

TEST	ASTM METHOD	PASSING CRITERIA
Pre-construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum 95% larger than pipe perforations (typically 3/8" sieve) Less than 5% passing a number 200 sieve. Maximum particle size of 3 inches
Calcium Carbonate		Maximum 15%
USCS Classification	D2487	GW or GP
Permeability	D 2434	1×10^{-2} cm/sec
Construction Testing: Minimum of one test per source		
Grain Size Analysis	D 422	Minimum 95% larger than pipe perforations (typically 3/8" sieve) Less than 5% passing a number 200 sieve. Maximum particle size of 3 inches
Permeability[(1)]	D 2434	1×10^{-2} cm/sec

Notes: [(1)] Permeability will be determined off of the gravels gradation.

END OF SECTION

SECTION 02230
COMPACTED CLAY / RECOMPACTED SUBGRADE

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 clay 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 clay with other construction activities and subcontractors at the site.

C. Notwithstanding the prequalification of any material sources for the compacted clay, 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 clay component of the lining system.

1.02 Related Sections

A. Section 02200 – Excavation and Subgrade Preparation

B. Section 02277 – Geomembrane

C. Section 02278 – Geotextile and Geocomposite

D. Section 02279 – Geocomposite

1.03 References

A. *Construction Quality Assurance Plan,* NABORS Class 1 Landfill (**ATTACHMENT A**)

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/ft^3 (600 kN-m/m^3)).
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 Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
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 2922 Standard Test Methods for Density 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 3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
11. ASTM D 4220 Standard Practices for Preserving and Transporting Soil Samples.
12. ASTM D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D 5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter.
14. 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 clay. 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 clay.

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 clay 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 Clay

A. All laboratory testing to evaluate the suitability or conformance of soil materials for the compacted clay shall be carried out in accordance with the test methods indicated in Part 1.04 of this Section.

B. The compacted clay shall consist of relatively homogeneous, natural soils which are substantially free of debris, foreign objects, large rock fragments, roots, and organics. More than 30% passing a number 200 sieve and less than 20% greater than a number 4 sieve. No particles larger than one inch shall be allowed. The soil shall be classified according to the Unified Soil Classification System (USCS) as CL, CH, or SC material with a PI greater than 10. Regardless of the classification requirements, 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 clay shall have a plasticity index (PI) in excess of seven, and the percent passing the No. 200 sieve shall be greater than 30 percent.

D. The compacted clay shall have an in-situ (i.e., after compaction) hydraulic conductivity less than 1.0×10^{-7} cm/sec as measured in the laboratory.

E. Soil testing shall be provided by the Owner through the CQA Consultant.

F. A test pad shall be constructed for each source of compacted clay to verify that the proposed material and procedures shall result in a product complying with this Section. Test pad construction shall be as detailed in Part 3 of this Section.

G. The requirements for a test pad detailed in Part 3 of this Section may not be performed if the conditions of Reg.22.428(c)(11) are met:

1. The proposed materials for the compacted clay:

2. The compacted clay and recompacted subgrade layer shall be constructed using an adequate compactive effort. The Contractor shall demonstrate that adequate compactive effort shall be applied by providing the required testing from **Table 2230-1 and 2**

PART 3 - TEST PAD

3.01 Regulatory Requirements

A. Unless the requirements of Reg.22.428(c)(11) are met, a test pad shall be constructed and tested prior to construction of the full-scale compacted clay.

B. A test pad shall be constructed each time:

1. the dry unit weight of the proposed material changes by at least five pcf, based on a moisture-density relation test results;

2. construction equipment is changed; or

3. construction practices are changed.

3.02 Test Pad Materials

A. The soil materials to be used for construction of the test pad shall be approved by the Engineer, and it shall be verified by the CQA Consultant that the materials conform to all design specifications. The test pad materials shall meet the requirements of Part 2.01 of this Section. Soil clods shall be broken up so that no clods exceed three inches in maximum size.

3.03 Test Pad Construction

A. Subgrade Preparation:

1. The area within the limits of the test pad shall be cleared and grubbed of all trees, debris, stumps, and any other vegetation. After clearing and grubbing, the area shall be stripped of topsoil and/or organic materials.

2. The surface of the subgrade shall be proof-rolled to eliminate soft zones, irregularities, and abrupt changes in grade. The finished subgrade surface shall be sloped to promote drainage. No standing water or excessive moisture shall be allowed to accumulate on the surface of the subgrade. The surface of the subgrade shall be examined by the CQA Consultant prior to commencement of construction of the test pad. The CQA Consultant shall document the condition of the subgrade.

B. Configuration:

1. The test pad shall be constructed with a width at least four times wider than the widest piece of construction equipment, not counting side slopes.

2. The test pad shall be long enough to allow the construction equipment to achieve normal operating speed before reaching the area within the test pad that shall be used for testing, but not less than approximately 100 ft long.

3. The test pad shall consist of at least four lifts of soil. Each lift shall be of uniform thickness, however different lifts may vary in thickness. The total thickness of the test pad shall be a minimum of two ft.

C. Test Pad Placement

1. The test pad shall be constructed using equipment similar to that intended for use in full-scale construction. Each lift of the test pad shall be compacted using a wedge foot compactor, such as a Caterpillar 815C or 825C.

2. First Lift:

   a. the Contractor shall, by trial and error, determine the loosely-placed soil lift thickness which shall result in a maximum compacted lift thickness of approximately nine in. (225 mm), and upon determining this, place the first lift of soil;

   b. the soil moisture content shall be adjusted by the Contractor, as required, to 0 to +4.0 percent above the optimum moisture content as determined by ASTM D 698 (Note: the moisture content for compaction to meet a density criterion shall normally be lower than the moisture content for compaction to meet a permeability criterion, depending on the PI of the soil);

   c. the soil shall be compacted with two one-way passes, using the same compaction equipment intended for the construction of the full-scale compacted clay;

   d. the CQA Consultant shall perform in-situ density tests using the nuclear device, and collect samples for hydraulic conductivity tests as outlined in Part 3.03-C.4.d. of this Section and the CQA Plan;

   e. all holes made as a result of sampling or testing shall be repaired in accordance with procedures outlined in the CQA Plan;

   f. the lift shall be recompacted (second sequence) by applying two additional one-way passes with the same equipment;

g. the testing, sampling, and repair outlined above shall be repeated at locations adjacent to the first set of tests;

h. the lift shall be recompacted (third sequence) by applying two additional one-way passes with the same equipment;

i. the testing, sampling, and repair outlined above shall be repeated at locations adjacent to the first two sets of tests; and

j. additional sequences of compaction, testing, sampling, and repair shall be carried out until the specified criteria for compaction and permeability are attained.

3. Subsequent Lifts

a. the Contractor shall place a soil lift which shall result in a compacted lift thickness of the target lift thickness;

b. the Contractor shall ensure that a good bond exists between two consecutive lifts, and the CQA Consultant shall verify that the two lifts are intermixed; and

c. additional sequences of compaction, testing, sampling, and repair shall be carried out until the specified criteria for compaction are attained.

4. Final Surface Preparation

a. After compaction of the final lift, the surface of the test pad shall be rolled with a smooth drum or pneumatic wheel compactor so as to be free of irregularities, loose soil, and abrupt changes in grade;

b. All stones projecting more than 0.4 in. from the surface shall be removed;

c. One-half of the prepared soil surface shall be protected against drying. The protective material shall be placed immediately after the completion of surface preparation. Monitoring and documentation of the condition of the surface (e.g., desiccation cracking) shall be performed by the CQA Consultant on the uncovered section of the test pad; and

d. The CQA Consultant shall conduct in-situ hydraulic conductivity testing on the protected portion of the test pad. The in-situ hydraulic conductivity test shall consist of one of the following test methods:

i. sealed double-ring infiltrometer (SDRI), per ASTM D 5093; or
ii. Shelby-tube (carved block) samples for laboratory testing, per ASTM D 5084, using a 12-in. (300-mm) diameter tube, with a minimum of three tests required.

PART 4 - EXECUTION

4.01 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 clay shall be construed as the Contractor's acceptance of the related work of all other Sections.

4.02 Compacted Clay Placement

A. The Contractor shall construct the compacted clay to the grades, slopes, and elevations shown on the Drawings and as specified in this Section.

B. No frozen or partially thawed compacted clay material shall be placed, spread or compacted.

C. No compacted clay 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 clay 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 compacted clay shall be compacted using the equivalent equipment to that used for construction of the Test Pad. The final surface of the compacted clay shall be compacted using a smooth drum or pneumatic wheel compactor. The equipment shall operate only over previously placed compacted clay material.

G. The compacted clay material shall be placed in loose lifts which result in a maximum compacted lift thickness of 6 in. The total thickness of the compacted clay layer shall not be less than the minimum thickness shown on the Drawings.

H. The compacted clay material shall be compacted to at least 95 percent of the maximum dry unit weight as measured according to ASTM D 698. In all cases the moisture content shall be maintained at 0 to +6 percent of the optimum moisture content as measured according to ASTM D 698. The dry unit weight and moisture content shall be measured in place in accordance with ASTM D 2922 (Method B) and ASTM D 3017, respectively, at the frequencies presented in the CQA Plan.

I. The compacted clay 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 clay 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 clay 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 clay 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 clay that must be filled shall include, but not be limited to, the following:

a. nuclear density test probe locations

b. hydraulic conductivity sampling locations

c. test pit locations

2. Perforations in the compacted clay shall be backfilled with similar clay material and compacted to achieve a hydraulic conductivity less than 1×10^{-7} cm/s. Alternatively, bentonite chips or pellets may be used.

C. Defective Areas:

1. If a defective area is discovered in the compacted clay, 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 survey the location and elevation of the compacted clay. Final elevations of the compacted clay surface shall be 0 to +0.1 ft. compared to the grades shown on the Drawings.

B. The Owner may supply surveying for quality assurance purposes and Record Drawings.

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.

TABLE 02230-1
RECOMPACTED SUBGRADE LAYER
CONSTRUCTION, FIELD, AND PERFORMANCE EVALUATION

TEST	ASTM METHOD	PASSING CRITERIA
Pre-Construction Testing: One test per 50,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Above OMC as determined by ASTM D 698.
Particle Size	D 1140 and D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Max. Particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with P.I. greater than 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory hydraulic conductivity at specified compaction and moisture content	D 5084	1×10^{-5} cm/sec or less(1)
Field Testing: One test per 20,000 square feet of liner constructed per compacted lift.		
In place density and moisture content	D 2922 and D 3017	Minimum 95% Standard Proctor maximum dry density and moisture content greater than OMC.(1)

Note:

(1) The minimum percent compaction and moisture will be based off of what is required to meet the minimum hydraulic conductivity.

TABLE 02230-2
CLAY LINER and CLAY BARRIER LAYER MATERIAL
CONSTRUCTION, FIELD, AND PERFORMANCE EVALUATION

TEST	ASTM METHOD	PASSING CRITERIA
Pre-Construction Testing: One test per 20,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Above OMC as determined by ASTM D 698.
Particle Size	D 1140 and D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Max. Particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with P.I. greater than 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory hydraulic conductivity at specified compaction and moisture content	D 5084	1×10^{-7} cm/sec or less(1)
Construction Testing: One test per 5,000 cubic yards, or more frequently if visual observation indicates change in material.		
Moisture Content	D 2216	Above OMC as determined by ASTM D 698.
Particle Size	D 1140 and D 422	More than 80% passing No. 4 sieve and more than 30% passing No. 200 sieve. Max. Particle size of 1 inch. Soil clod size less than 4 inches in diameter.
Atterberg Limits	D 4318	CL, CH or SC with P.I. greater than 10
Laboratory Compaction	D 698	Minimum 95% Standard Proctor maximum dry density
Laboratory hydraulic conductivity at specified compaction and moisture content	D 5084	1×10^{-7} cm/sec or less(1)
Field Testing: One test per 10,000 square feet of liner constructed per compacted lift.		
In place density and moisture content	D 2922 and D 3017	Minimum 95% Standard Proctor maximum dry density and moisture content greater than OMC. (1)
Performance Testing: One test per 40,000 square feet of liner constructed per compacted lift.		
Laboratory hydraulic conductivity	D 5084	1×10^{-7} cm/sec or less(1)

Note:

(1) The minimum percent compaction and moisture will be based off of what is required to meet the minimum hydraulic conductivity.

END OF SECTION

SECTION 02270
RIPRAP

PART 1 GENERAL

1.01 Summary

A. Section includes description of riprap stone and geotextile material placed in stormwater outlet locations as shown on the Drawings.

B. Related Sections

1. Section 02200 - Earthwork

2. Section 02720 - Stormwater Drainage Systems

1.02 References

A. American Society for Testing and Materials (ASTM):

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 Riprap

A. The stone shall be hard, sound, and durable. It shall be free from seams, cracks, and other defects tending to destroy its resistance to weather.

B. The stone shall have at least 50 percent by weight consisting of pieces measuring between seven inches and ten inches in any direction. Larger pieces may be used if approved by the Engineer.

C. Dust or fines less than 1/2 inches in maximum cross section accumulated from quarrying or loading operations shall not exceed five percent by weight.

D. Nominal 12 inches graded down.

2.02 Geotextile Filter

A. Geotextile Filter used with riprap shall be needlepunch non-woven geotextile, woven geotextile with monofilament yarn or woven geotextile with monofilament and fibrillated yarn meeting the following requirements:

1. Min permittivity ASTM D4491: 0.2 sec.

2. Survivability (AASHTO M288-9G): Class 2 - woven monofilaments, Class 1 -all other geotextiles.

3. Max. AOS ASTM D4751: 0.25mm.

4. U.V. retardant required.

PART 3 EXECUTION

3.01 General

A. Riprap shall be provided at all locations shown on the Drawings or as directed by the Engineer. Prior to placing the riprap, install geotextile filter on the prepared subgrade as shown on the Drawings.

B. Key upper geotextile after placement of riprap on slopes. Prepare subgrade to the lines and grades as specified. Provide intimate contact of geotextile with smooth slope. Fill depressions or holes to avoid development of a geotextile bridge.

C. Riprap shall be placed from the bottom up on the geotextile filter in such manner as to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids and shall be constructed to the lines and grades shown. Maximum drop height of stones should not exceed one foot.

D. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified. The finished riprap layer shall be free from objectionable pockets of small stones and clusters of larger stones.

E. Placing riprap layers will not be permitted. Placing of riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source; controlled dumping of successive loads during final placing or by other methods of

placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above.

F. Riprap shall be maintained in a satisfactory condition, as determined by the Engineer, until completion of the project. Damage before completion from any cause shall be repaired or replaced at no cost to the Owner.

G. Articulated concrete mats or other flexible revetment systems may be used in place of stone riprap as approved by the engineer.

END OF SECTION

SECTION 02273
EROSION CONTROL MATTING

PART 1 GENERAL

1.01 Summary

Section includes furnishing and installing erosion control blanket (ECB) to provide surface stabilization of drainage ditches and slopes as directed by the Engineer.

1.02 Submittals

Manufacturer's certificates of compliance with the specifications.

PART 2 PRODUCTS

2.01 Erosion Control Blanket (ECB)

A. Shall be a wood machined mat of curled wood excelsior, CURLEX I, with standard polypropylene netting, as manufactured by American Excelsior Company, 850 Avenue H East, Arlington, Texas 76011, (888) 352-9582 or (800) 777-7645, or approved equal.

B. 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.

3.03 Installation Of ECB

A. Distribute lime, fertilizer and seed over prepared soil surface as specified in Section 02930 prior to placement of ECB.

B. Place ECB in areas as directed by the Engineer.

C. Secure ECB on the slopes as shown on the Drawing.

D. Roll ECB over the prepared soil surface using sequence, arrangement, and overlapping of adjacent sections, as shown on the Drawing.

E. Installed ECB 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 ECB.

END OF SECTION

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 4437, 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.
   12. ASTM D 1004, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

B. FTM Standard Number 101C, Method 2065, Puncture Resistance and Elongation Test (1/8 inch Radius Probe Method).

C. NSF International Standard 54-1993, “Flexible Membrane Liners”.

D. Geosynthetic Research Institute (GRI) Test Method GM6, "Pressurized Air Channel Test for Dual Seamed 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 (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.

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
   c. Carbon Black Dispersion - ASTM D 5596
   d. Thickness - ASTM D 5994
   e. Tensile Properties (Yield Strength, Break Strength, Elongation at Yield and Elongation at Break) - ASTM D 6693, Type IV, as modified by NSF 54 1991 or GRI-GM-13
   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, high-density polyethylene (HDPE) 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 60-mil HDPE (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	60-mil HDPE Textured
Thickness	Mils	ASTM D 5994	57 min / 60 Ave
Resin Density	g/cm^3	ASTM D 1505/792	0.940 min
Carbon Black Content	%	ASTM D 1603	2.0 – 3.0
Tensile Strength at Yield	ppi	ASTM D 638, GRI-GM-13	132 min
Tensile Strength at Break	ppi	Same as above	132 min
Elongation at Yield	%	Same as above	13
Elongation at Break	%	Same as above	200
Tear Resistance	Lbs	ASTM D 1004	42
Dimensional Stability	%	ASTM D 1204 (100 ° C, 1 hour)	+/- 2
Puncture Resistance	Lbs	ASTM D 4833	90
Carbon Black Dispersion	Category	ASTM D 5596	1, 2

TABLE 02277-2
GEOMEMBRANE SEAM SPECIFICATIONS

Type of Material	ASTM Method	Peel Extrusion	Peel Fusion	Shear Extrusion	Shear Fusion
60-mil HDPE Textured	ASTM D 4437 (as modified by NSF 54-1993)	78 PPI and FTB(1)	90 PPI and FTB(1)	120 PPI	120 PPI

Note:
(1) Peel greater than 24% is considered a non-FTB

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.

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, or 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 or other markers approved by the Engineer.

3.03 Field Seaming

A. Seam Layout

1. Before installation begins, the Installer shall provide the Project Manager and the CQA Firm 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 ¼ 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 use 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 area 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. Two specimens shall be cut from the sample with one-inch wide die. The Installer shall cut the specimens at a location selected randomly along the trial seam sample by the CQA Firm.

3. The specimens shall be tested in peel 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 hall 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
        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 1,000 feet of production seam length performed by each welding machine. 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, offset welds exists.

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 two 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 adhesion 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 reseamed 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 non-destructively 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

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 bottom liner and leachate collection construction.

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 Busting 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.
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 4833
e. Apparent Opening Size - ASTM D 4751
f. Permittivity - ASTM D 4491
g. Trapezoid Tear Strength - ASTM D 4533
h. Tear Strength – ASTM D 4632
i. 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 = 1.0 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 lot and minimum of one test per 100,000 square feet for all.

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. Thickness - ASTM D 5199
   c. Mass per Unit Area - ASTM D 5261

Frequency: Minimum of one test per 40,000 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
Thickness	Mils	ASTM D 5199	100
Grab Strength	lbs	ASTM D 4632	230
Grab Elongation	%	ASTM D 4632	50
Trapezoid Tear Strength	lbs	ASTM D 4533	90
Puncture Resistance	lbs	ASTM D 4833	130
Permittivity, T	sec^{-1}	ASTM D 4491	1.26
Permeability	cm/sec	ASTM D 4491	0.30
Mullen Burst Strength	psi	ASTM D 3786	425
Water Flow	gpm/ft^2	ASTM D 4491	100
AOS (largest opening size)	Sieve Size	ASTM D 4751	80
UV Resistance	%/hrs	ASTM D 4355	70/500

*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
Weight	lb/ft^2	ASTM D 5261	0.16
Thickness	mil	ASTM D 5199	200
Polymer Density	g/cm^3	ASTM D 1505	0.94
Peak Tensile Strength (1)	lb/in	ASTM D 7179	40
Transmissivity (2)	m^2/s	ASTM D 4716	1.5×10^{-3}
Carbon Black Content	%	ASTM D 1603	2 to 3

Notes:
(1) Machine direction.
(2) Measured using water @ 20° C with a gradient of one, between two steel plates, after one hour. Confining pressure 4,000 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	$\geq$ 6
Thickness	Mils	ASTM D 5199	75
Grab Strength	lbs	ASTM D 4632	160
Water Flow Rate	gpm/ft^2	ASTM D 4491	110
Trapezoid Tear Strength	lbs	ASTM D 4533	80
AOS (largest opening size)	Sieve Size	ASTM D 4751	70

* 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
Thickness	Inch	ASTM D 5199	0.225
Ply Adhesion	lb/in	ASTM D 7005	2.0
Tensile Strength[(1)]	lbs	ASTM D 4632	500
Transmissivity[(2)]	m^2/s	ASTM D 4716	5×10^{-5}

Notes:

(1) Machine direction.

(2) Measured using water @ 20° C with a gradient of one, between two steel plates, after one hour. Confining pressure 10,000 psf.

F. The bond between the geotextile and the geonet shall exhibit a 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 (not part of geocomposite):

a. Fabric Weight - ASTM D 5261
b. Grab Strength and Grab Elongation - ASTM D 4632
c. Puncture Resistance - ASTM D 4833
d. Permittivity - ASTM D 4491
e. Apparent Opening Size - ASTM D 4751

6. The following tests shall be performed for the finished geocomposite product:

a. Transmissivity (Gradient= 1.0 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 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,
2. Section 02210 - Grading.

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 2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D 3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
7. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

B. Standard Specification for Highway Construction, Arkansas State Highway and Transportation Department (AHTD), P.O. Box 2262, Little Rock, Arkansas 72203.

1. AHTD 303, Aggregate Base Course.
2. AHTD 303, Aggregate Surface 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 at least 95 percent passing the 1-1/2 inch sieve and not more than eight percent passing the Number 200 sieve unless other material is approved by the Owner.

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

Place and grade aggregate surface course material to the dimensions shown on the Drawings.

END OF SECTION

SECTION 02631
POLYETHYLENE PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 Summary

A. Section includes installation of dual-contained high-density polyethylene (HDPE) pressure pipe and fittings.

B. Related Sections:

1. Section 02223 – Trenching Backfilling and Compacting;
2. Section 02715 - Leachate Collection System Piping (HDPE); and
3. Section 03300 – Cast-in Place Concrete

1.02 References

A. American Society for Test

1. ASTM D 1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
2. ASTM D 2657, Standard Practice for Heat-Joining Polyolefin Pipe and Fittings.
3. ASTM D 3035, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
4. ASTM D 3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
5. ASTM D 3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
6. ASTM F 714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

1.03 Submittals

A. Submit under provisions of Section 01300.

B. Submit manufacturer's certificates of conformance with the specifications and product data for specified pipe and fittings.

C. Submit certification of personnel training in heat fusion procedures, as specified in subsection 1.04.13 of this Section.

1.04 Quality Assurance/Quality Control

A. Pipe manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings specified.

B. Heat fusion of polyethylene piping shall be performed by personnel trained in the pipe manufacturers recommended procedures. Training shall have been received not more than 12 months prior to start of construction.

1.05 Delivery, Storage and Handling

A. During loading, transporting, and unloading, exercise care to prevent damage to materials.

B. Pipe shall be marked with manufacturer's identification symbol, size, date of manufacture, material classification, pressure rating, standard dimension ration, and other applicable product specification identification numbering.

C. All materials shall be inspected by the Contractor upon delivery to the site. The Contractor shall notify the Engineer of any loss or damage. Damaged or defective materials shall be rejected and shall be replaced with new materials at the supplier's or Contractor's expense.

PART 2 PRODUCTS

2.01 Dual Containment Polyethylene Pipe And Fittings

A. Piping shall be a dual containment system as shown on the Drawings and as specified herein.

B. Materials used for the manufacture of polyethylene pipe and fittings shall be as follows:

1. PE3408 high density polyethylene, with a cell classification of PE345434C in compliance with ASTM D 3350, and material classification Type III, Class C, Category 5, Grade P34 in compliance with ASTM D 1248.

C. Carrier pipe and containment pipe shall be manufactured in accordance with ASTM F 714 or ASTM D 3035. Carrier pipe shall be SDR 11 with an inside diameter of two inches, and containment pipe shall be SDR 26 with an inside diameter of four inches.

D. Molded fittings shall be manufactured in accordance with ASTM D 3261. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe,

sheet stock, or molded fittings. Each fabricated fitting shall be rated for internal pressure service equivalent to the full service pressure rating of the pipe to which it is joined.

E. Manufacturer's standard flange adapters, back-up rings and flange bolts shall be provided for a complete system.

F. The dual containment system shall consist of factory pre-fabricated components.

G. Pre-fabricated pipe and fittings shall provide a continuous annular space between the carrier and the containment piping to allow unrestricted passage of possible flow of fluid from the carrier pipe.

H. The carrier pipe shall be factory installed within the containment pipe, with support spacers secured to the carrier pipe at standard intervals. Support spacers shall be manufactured from non-metallic, corrosion resistant material.

I. Pipe shall be provided in nominal lengths of 20 feet or 40 feet, and shall allow for field adjustment of pipe length.

J. Dual containment fittings shall have the carrier-fitting factory installed within the containment fitting, with all necessary support spacers installed.

2.02 Identification Tape

Shall be a three-inch or six-inch wide detectable direct burial identification tape with Caution - Pipe Buried Below.

2.03 Pipe Bedding And Trench Backfill Materials

Specified in Section 02223.

PART 3 EXECUTION

3.01 Preparation - Excavation

A. Excavate trenches as specified in Section 02223.

B. Examine areas to receive pipe for adherence to specified line and grade.

C. Install pipe only when acceptable conditions exist.

3.02 Dual Containment Polyethylene Pipe Installation

A. Examine pipe and fittings before installation and assure no defective materials are incorporated. Keep inside of pipes and fittings free of dirt and debris.

B. Installation of all pipe and fittings shall be subject to the review of the Engineer.

C. Install piping as shown, as recommended by the manufacturer, in conformance with reference standards, and as specified herein.

1. Carrier to carrier joints and containment to containment joints shall be made using thermal butt fusion procedures recommended by the manufacturer.

2. Carrier joints and containment joints should be made independently of each other. However, simultaneous fusion of carrier joints and containment joints are permitted if the installer can demonstrate tight joints with no leakage when subjected to hydrostatic test pressures specified below. The Engineer shall observe jointing.

D. Field cutting of piping, where required, shall be made with a plastic pipe cutter, hack saw or other suitable tools as recommended by the manufacturer. Cuts shall be carefully done, without damage to piping, so as to leave a square end at right angles to the axis of the piping. Piping damaged by improper or careless methods of cutting shall be replaced or repaired at Contractor's expense.

E. Pipe and fittings shall be joined by heat fusion (butt fusion) or with approved mechanical fittings.

F. Only equipment approved by the pipe and fitting manufacturer(s) shall be used to make heat fusion joints.

G. Joints of plain end pipes, and joints between plain end pipes and fittings of the same material, shall be made by butt heat fusion in conformance with ASTM D 2657 and manufacturer's recommendations. When making a butt fusion joint, the equipment shall hold the heating element square to the ends of the pipe, compress the heated ends of the pipe, and hold the pipe in proper alignment while the plastic hardens.

H. Heat fusion equipment shall be kept in good working conditions at all times. Faces of the cleaning elements shall be cleaned properly after each use.

I. Polyethylene pipe and fittings shall be joined to other materials by means of flanged connections (flange adapters and back-up rings) or mechanical couplings specially designed for polyethylene pipe connections. Mechanical couplings and flange

connections shall be installed in accordance with the pipe manufacturer's recommendations, and shall be pressure rated and fully thrust restrained.

J. Pipe connections to structures shall be made as shown on the Drawings.

K. Anchorage and Blocking for Buried Pipe

1. Provide suitable concrete thrust blocking, anchors, joint connections, as shown on Drawings, and as otherwise required to prevent movement of piping causing by internal pressure in all piping tees, plugs, or bends.

2. Concrete thrust blocking shall be as specified below.

a. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms.

b. Blocking shall be placed so that the fitting joints will be accessible for repair.

L. Employ partial backfilling and cradling to hold pipe in secure position during backfilling operations.

M. Request instructions from Engineer before proceeding if there is a conflict between the manufacturer's recommendation and the Drawings or Specifications.

N. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, and other foreign matter from entering the piping.

3.03 Field Quality Control

A. Butt Fusion Trial Testing

1. On every day that butt heat fusions are to be made, a trial fusion shall be performed prior to the start of construction fusion joining.

2. The trial fusion shall be performed under the same conditions and with the same equipment as for construction fusion.

3. After allowing the fusion to cool completely, one fusion test strap shall be cut out at the joint. The test strap dimensions shall be 12 inches minimum in length, with the fusion at the center; and one inch minimum in width.

4. The test strap shall be bent until the ends of the strap touch. If the fusion fails at the joint, fusion procedures and machine setup shall be changed as necessary, and a new trial fusion shall be prepared and tested.

5. Construction butt fusion shall not commence until a trial fusion has passed the bent strap test.

B. Visually inspect completed piping to assure joints are intact. This shall include inspection of fusion beads at each joint. The size and shape of the fusion beads shall comply with the manufacturer's recommendations.

C. Hydrostatic Testing for Dual-Containment Piping

1. After the piping is laid, the joints completed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping shall, unless otherwise specified, be subjected to hydrostatic pressure testing as specified below.

2. Pressure/leak testing shall be conducted in accordance with the pipe manufacturer's recommendations. Only hydrostatic testing is allowed. Pneumatic pressure testing shall not be used.

3. Hydrostatic testing shall be performed in the presence of the Engineer.

4. Furnish all labor, materials, equipment and services required for making tests as specified, including pumps, gauges, thrust protects, temporary bulkheads and other miscellaneous items required.

5. Testing shall be performed in such a manner as to avoid injury to personnel or damage to other equipment, work, or surrounding territory.

6. The carrier pipe of the dual containment piping shall be tested in place at 150 percent of the rated operating pressure of the pipe.

7. Devices, which could be damaged by the test pressure, shall be isolated or removed from the system during the testing periods. If the device cannot be removed or isolated, then the limiting section test pressure shall be the maximum allowable test pressure for that device.

8. The initial pressure test shall be applied and allowed to stand without makeup pressure for a sufficient time (approximately 2 to 3 hours) to allow for pipe expansion and for stretching to stabilize.

9. After the equilibrium period, return the test section to the test pressure and hold the pressure for a minimum of one to three hours. Water shall be added, and accurately measured, to maintain the pressure for the specified time period.

10. Allowable amounts of makeup water to account for normal pipe expansion during the test period is as follows:

    a. For two-inch diameter pipe: 0.10 gallons per 100 feet of pipe per hour.

    b. For four-inch diameter pipe: 0.30 gallons per 100 feet of pipe per hour.

11. Exposed pipe, joints, and fittings shall be carefully examined during the pressure testing.

12. Any leakage or defective piping disclosed by the testing shall be replaced or repaired by the Contractor at his own expense. Defective piping shall be repaired in a manner acceptable to the Engineer. The Engineer shall have the option to reject any repaired pipe if he feels the repair is unsatisfactory.

13. Pipe installation shall not be considered completed until all tests have been made, and all defects corrected to meet the requirements of the specified test, and all piping proves tight. No caulking of defective piping or joints shall be permitted.

END OF SECTION

SECTION 02714
HDPE PIPING

PART 1 GENERAL

1.01 Description of Work

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of all high density polyethylene (HDPE) pipe, fittings, and appurtenances 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 install HDPE pipe and fittings in conjunction with the earthwork and other components of the liner system.

1.02 References

A. CQA Plan, NABORS Class 1 Landfill **(Attachment A)**.

B. Latest version of the American Society for Testing and Materials (ASTM) standards:

1. ASTM D 1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
2. ASTM D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
3. ASTM D 1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
4. ASTM D 2657, Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings.
5. ASTM D 2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
6. ASTM D 3350, Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
7. ASTM F 714, Standard Specification for Polyethylene (PE) Plastics Pipe (SDR-PR) Based on Outside Diameter.

1.03 Warranty

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

1.04 Submittals

A. The Contractor shall submit to the Owner or Owner's Authorized Representative for approval within 14 days after signing of the Contract and at least 28 days before the start of work, complete, detailed shop drawings of all HDPE pipe and fittings, a list of materials to be furnished, the names of the suppliers and the proposed dates of delivery of the materials to the site.

B. The Contractor shall submit to the Owner or Owner's Authorized Representative the HDPE pipe Manufacturer's certification of compliance with this Section for all materials delivered to the site, and shall comply with the HDPE pipe Manufacturer's recommendations for handling, storing and installing HDPE pipes and fittings.

C. The Contractor shall submit to the Owner or owner's Authorized Representative in writing the following documentation from the HDPE pipe Manufacturer on the raw materials used to manufacture the HDPE pipe and fittings prior to transporting any HDPE pipe or fittings to the site:

1. Certificate stating the specific resin, its source and the information required by ASTM D 1248.
2. Certification that no recycled compound has been added to the resin except that generated in the Manufacturer's own plant from resin of the same specification from the same raw material.

D. The Contractor shall submit certification from the HDPE pipe Manufacturer that stress regression testing has been performed on the specific product in accordance with ASTM D 2837. The Manufacturer shall supply HDPE pipe having a minimum Hydrostatic Design Basis (HDB) of 1,500 psi at 23^{o}C, as determined in accordance with ASTM D 2837.

1.05 Construction Quality Assurance

A. The installation of HDPE pipe and fittings shall be monitored as outlined in the Construction Quality Assurance (CQA) Plan.

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

PART 2 PRODUCTS

2.01 High Density Polyethylene (Hdpe) Compound

A. The HDPE pipe and fittings shall be manufactured from new, high performance, high

molecular weight, high density polyethylene resin conforming to ASTM D 1248 (Type III, Class C Category, Grade P 34), ASTM D 3350 (Cell Classification PE 345434C), and having a Plastic Pipe Institute (PPI) Rating of PE3408. Material specifications for the HDPE pipe and fittings are presented in **Table 02714-1**.

B. The resin shall be pre-compounded. In plant blending of non-compounded resins shall not be permitted. The polyethylene compound shall contain a minimum of 2% carbon black.

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

2.02 High Density Polyethylene (Hdpe) Pipes And Fittings

A. All HDPE pipe and fittings shall comply with the ASTM D 714.

B. All HDPE pipe and fittings shall have a minimum Standard Diameter Ratio (SDR) of 17 unless otherwise stated on the Drawings. HDPE pipe and fittings and the embedment shall be designed to ensure that external loads will not subsequently cause a decrease in the vertical cross-section dimension (deflection) greater than the percentages listed below:

SDR	ALLOWABLE RING DEFLECTION (percent)
26.0	6.5
21.0	5.2
19.0	4.7
17.0	4.2
15.5	3.9
13.5	3.4
11.0	2.7

C. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 feet.

D. HDPE pipe shall be furnished non-perforated or perforated as specified on the Drawings.

1. Perforations shall be drilled into the pipe after manufacture, prior to delivery to the

site. Perforations shall consist of the number of rows of holes and size of holes as indicated on the Drawings.

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

F. Fittings at the ends of pipes shall consist of HDPE end caps unless indicated otherwise on the Drawings.

G. Pipe boots shall be fabricated by the Geomembrane Manufacturer to the dimensions shown on the Drawings. The pipe boots shall be fabricated from the same resin as the polyethylene geomembrane to which they are welded.

H. Leachate collection pipe (within the leachate collection system corridor) shall be 8-in. diameter perforated SDR 11 HDPE. Leachate gravity main pipe shall be sized compatible with existing leachate gravity main pipe and shall be solid SDR 17 HDPE.

2.03 Identification

A. The following shall be continuously indent printed on the pipe, or spaced at intervals not exceeding 5 feet:

1. Name and/or trademark of the pipe manufacturer;
2. Nominal pipe size;
3. Standard dimension ratio (SDR);
4. The letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design basis in 100's of psi (e.g., PE 3408);
5. Manufacturing Standard Reference (e.g., ASTM F-714-1); and
6. A production code from which the date and place of manufacture can be determined.

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; and

2. If the Contractor has any concerns regarding the installed work of other Sections, the Contractor shall notify the Owner of Owner's Authorized Representative in writing within 48 hours of his site inspection. Failure to inform the Owner or Owner's Authorized Representative in writing or installation of the polyethylene pipes and fittings will be construed as Contractor's acceptance of the related work of all other Sections.

3.02 Handling And Placement

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

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

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

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

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

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

G. Where pipes penetrate through geomembranes, an effective seal shall be established in accordance with Parts 2.02.G and 3.04.B of this Section and the details shown on the Drawings.

3.03 Installation

A. General:

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

3.04 Joints And Installation

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

B. Mechanical connections of HDPE pipe to auxiliary equipment such as valves, flow meters, pumps and tanks shall consist of the following unless otherwise specified by the Owner or Owner's Authorized representative:

1. An HDPE flange connection, called a stub end, shall be butt-fused to the HDPE pipe. Outside diameter and drillings shall comply with ANSI B16.1;
2. A 316 stainless steel back-up flange. Outside diameter and drillings shall comply with ANSI B16.6;

3. A flange of the convoluted design and cost from ASTM A 351 CF8M passivated stainless steel, cast equivalent of 316 SS. The flange shall be marked with size, bolt hole template, material and type of flanges. The flange shall mate with ANSI B16.5, B16.1, AWWA C207 and MSS-SP 43;
4. Other mechanical couplings, such as 360 degree full circle clamps, shall only be used if approved by the Owner or Owner's Authorized Representative; and
5. Pipe boot connections shall be made in the field using vitron rings and stainless steel clamps, as shown on the Drawings. The vitron ring material shall have a thickness of 3/16-inch and shall have an inner diameter equal to the outer diameter of the pipe on which the vitron ring is to be placed. The stainless steel clamps shall be made of 3/16-inch thick, ½-inch wide, Type 316 stainless steel. The clamps shall be joined around the pipe using a Type 316 stainless steel clasp, not thicker than 3/8-inch; the clasp shall be chosen by the Contractor and approved by the Owner or Owner's Authorized Representative.

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

3.05 Testing Of Hdpe Pipe And Fittings

A. General:

1. All nonperforated pipe and fittings shall be tested prior to placing fill over the pipe;
2. The Owner or Owner's Authorized Representative shall be notified a minimum of 24 hours in advance of any testing;
3. The Contractor shall provide all testing apparatus, including pumps, hoses, gauges, taps, plugs, drains, temporary connections, and fittings;
4. All tests shall be performed in the presence of the Owner or the Owner's Authorized Representative or CQA Consultant;
5. HDPE pipe with thermal butt-fusion type joints shall be tested at 1 ½ times the working pressure; and
6. Test duration shall be twelve hours.

B. Repair:

1. Installed pipes that leak, according to the test results, shall be either repaired to the satisfaction of the Owner or Owner's Authorized Representative or replaced at no cost to the Owner. Repaired or replaced pipe shall be successfully pressure-tested prior to filling over the pipe; and
2. Visible leaks shall be repaired and re-tested.

3.06 Product Protection

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

B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Owner or Owner's Authorized Representative and at no additional cost to the Owner.

TABLE 02714-1
HDPE PIPE AND FITTINGS PROPERTIES

PROPERTIES	UNITS	SPECIFIED VALUES	TEST METHOD
Density	g/cm^3	0.941 - 0.955	ASTM D 1505
Melt Flow	g/10 min	< .015	ASTM C 1238 Condition E
Flex Modulus	psi	110,000 - 160,000	ASTM D 790
Tensile Strength at Yield	psi	3,000 - 5,000	ASTM D 638
Environmental Stress Cracking	hrs	> 5,000	ASTM D 1693 Condition C
Hydrostatic Design Basis	psi	1,500 @ 23^{o}C	ASTM D 2837

END OF SECTION

SECTION 02715
LEACHATE COLLECTION SYSTEM AND RISER PIPING

PART 1 GENERAL

1.01 Summary

A. Section includes furnishing and installing 6-inch diameter high density polyethylene leachate collection system piping (perforated piping, solid piping, and fittings) and leachate riser pipes.

B. Related Sections:

1. Section 02223 – Trenching, Backfilling and Compacting
2. Section 02278 – Geotextiles and Geocomposite
3. Section 02631 – polyethylene Pressure Pipe and Fittings
4. Section 03300 – Cast-in-Place Concrete

1.02 References

A. American Society for Testing and Materials (ASTM):

1. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
2. ASTM D 2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
3. ASTM D 3035, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
4. ASTM D 3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
5. ASTM D 3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
6. ASTM F 714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

1.03 Submittals

A. Submit under provisions of Section 01300.

B. Submit manufacturer's certificates of conformance with specifications, and product data, for the leachate collection piping, fittings and accessories and the leachate riser pipes.

C. Submit shop drawings for fabrication of leachate piping, riser pipe, and fittings.

D. Submit certification of personnel training in heat fusion procedures, as specified in subsection 1.04.B of this Section.

1.04 Quality Assurance/Quality Control

A. Pipe manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings specified.

B. Heat fusion of polyethylene piping shall be performed by personnel trained in the pipe manufacturer's recommended procedures. Training shall have been received not more than 12 months prior to start of construction.

1.05 Delivery, Storage And Handling

A. During loading, transporting, and unloading, exercise care to prevent damage to materials.

B. Pipe shall be marked with manufacturer's identification symbol, size, date of manufacture, class of pipe and applicable product specification identification number.

C. All materials shall be inspected by the Contractor upon delivery to the site. The Contractor shall notify the Engineer of any loss or damage. Damaged or defective materials shall be rejected and shall be replaced with new materials at the supplier's or Contractor's expense.

PART 2 PRODUCTS

2.01 Perforated Leachate Collection Pipe

A. Materials used for the manufacture of polyethylene pipe and fittings shall be as follows:

1. PE3408 high density polyethylene, with a cell classification of PE345434C in compliance with ASTM D 3350, and material classification Type III, Class C, Category 5, Grade P34 in compliance with ASTM D 1248.

B. Pipe shall be manufactured in accordance with ASTM F 714 or ASTM D 3035. Pipe shall have a standard dimension ratio (SDR) of 17 and an inside diameter of six inches.

C. Molded fittings shall be manufactured in accordance with ASTM D 3261 or ASTM D 2683. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, sheet stock, or molded fittings. Each fabricated fitting shall be rated for internal pressure service equivalent to the full service pressure rating of the pipe to which it is joined.

D. Size and arrangement of perforations shall be as shown on the construction drawing.

2.01 Leachate Riser Pipes

A. Materials used for the manufacture of polyethylene riser pipe shall be as follows:

1. PE3408 high density polyethylene, with a cell classification of PE345434C in compliance with ASTM D 3350, and material classification Type III, Class C, Category 5, Grade P34 in compliance with ASTM D 1248.

B. Pipe shall be manufactured in accordance with ASTM F 714 or ASTM D 3035. Pipe shall have a standard dimension ratio (SDR) of 11 and a nominal pipe size of 18 inches.

C. Perforations shall be 3/8” diameter holes equally spaced at 6” each way. Perforations shall extend approximately 7’ from edge of 3’ wide by 6’ long by 2” thick HDPE sheet stock.

D. Sheet stock (3’ wide by 6’ long by 2” thick HDPE) shall be extrusion welded to 18” riser pipe to match the 3:1 side slope.

E. Molded fittings shall be manufactured in accordance with ASTM D 3261 or ASTM D 2683. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, sheet stock, or molded fittings. Each fabricated fitting shall be rated for internal pressure service equivalent to the full service pressure rating of the pipe to which it is joined.

2.03 Washed Gravel Backfill For Leachate Collection Systems

Specified in Section 02227.

2.04 Geotextile for Leachate Collection

Geotextile as specified in Section 02278.

PART 3 EXECUTION

3.01 Preparation

A. Excavate and grade trenches for leachate collection piping to the width, depth, grade and alignment shown on the Drawings, and as specified in Section 02223.

3.02 Geotextile Installation For Leachate Collection Systems

A. Place geotextile on the bottom and sides of the pipe trenches as shown on the Drawings.

B. Place geotextile in such a manner that placement of overlying material will not stretch or tear the fabric.

C. Overlaps of adjacent rolls of geotextile and at the top of the gravel backfill shall be approximately three feet, or as otherwise shown on the Drawings.

3.03 Leachate Collection Pipe Installation

A. Examine pipe and fittings before installation and assure no defective materials are incorporated. Keep inside of pipes and fittings free of dirt and debris.

B. Lay piping on firm bedding for entire length of alignment.

C. Installation of all pipe, and fittings shall be subject to the review of the Engineer.

D. Polyethylene pipe and fittings shall be joined by heat fusion (butt fusion, saddle/sidewall fusion, socket fusion or electrofusion) as specified in Section 02631.

E. Install piping accurately to line and grade as shown on Drawings unless otherwise approved by the Engineer.

F. Place stone backfill around and over the pipe in trenches and in sumps as indicated on the Drawings.

G. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, and other foreign matter from entering the piping.

H. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

END OF SECTION

SECTION 02720
STORMWATER DRAINAGE - HDPE

PART 1 GENERAL

1.01 Summary

A. Section includes furnishing and installing 24-inch diameter high density polyethylene riser outlet structure (including piping and fittings) and 6-inch piping and fittings for floating skimmer discharge.

B. Related Sections:

1. Section 02223 – Trenching, Backfilling and Compacting

1.02 References

A. American Society for Testing and Materials (ASTM):
1. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
2. ASTM D 2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
3. ASTM D 3035, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
4. ASTM D 3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
5. ASTM D 3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
6. ASTM F 714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

1.03 Submittals

A. Submit under provisions of Section 01300.

B. Submit manufacturer's certificates of conformance with specifications, and product data, for the riser outlet structure, piping, fittings and accessories.

C. Submit shop drawings for fabrication of the riser outlet structure, piping, fittings and accessories.

D. Submit certification of personnel training in heat fusion procedures, as specified in subsection 1.04.B of this Section.

1.04 Quality Assurance/Quality Control

A. Pipe manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings specified.

B. Heat fusion of polyethylene piping shall be performed by personnel trained in the pipe manufacturer's recommended procedures. Training shall have been received not more than 12 months prior to start of construction.

1.05 Delivery, Storage And Handling

A. During loading, transporting, and unloading, exercise care to prevent damage to materials.

B. Pipe shall be marked with manufacturer's identification symbol, size, date of manufacture, class of pipe and applicable product specification identification number.

C. All materials shall be inspected by the Contractor upon delivery to the site. The Contractor shall notify the Engineer of any loss or damage. Damaged or defective materials shall be rejected and shall be replaced with new materials at the supplier's or Contractor's expense.

PART 2 PRODUCTS

2.01 Riser Outlet Structure And Pipes

A. Materials used for the manufacture of polyethylene riser outlet structure and pipe shall be as follows:

1. PE3408 high density polyethylene, with a cell classification of PE345434C in compliance with ASTM D 3350, and material classification Type III, Class C, Category 5, Grade P34 in compliance with ASTM D 1248.

B. Pipe shall be manufactured in accordance with ASTM F 714 or ASTM D 3035. Pipe shall have a standard dimension ratio (SDR) of 11 and a nominal pipe size of 18 inches.

C. Perforations shall be 3/8” diameter holes equally spaced at 6” each way. Perforations shall extend approximately 7’ from edge of 3’ wide by 6’ long by 2” thick HDPE sheet stock.

D. Sheet stock (4’ wide by 4’ long by 1” thick HDPE) shall be extrusion welded to 36” riser pipe.

E. Molded fittings shall be manufactured in accordance with ASTM D 3261 or ASTM D 2683. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, sheet stock, or molded fittings. Each fabricated fitting shall be rated for internal pressure service equivalent to the full service pressure rating of the pipe to which it is joined.

3.01 Preparation

A. Excavate and grade trenches for discharge piping to the width, depth, grade and alignment shown on the Drawings, and as specified in Section 02223.

3.03 Pipe Installation

A. Examine pipe and fittings before installation and assure no defective materials are incorporated. Keep inside of pipes and fittings free of dirt and debris.

B. Lay piping on firm bedding for entire length of alignment.

C. Installation of all pipe, and fittings shall be subject to the review of the Engineer.

D. Polyethylene pipe and fittings shall be joined by heat fusion (butt fusion, saddle/sidewall fusion, socket fusion or electrofusion) as specified in Section 02631.

E. Install piping accurately to line and grade as shown on Drawings unless otherwise approved by the Engineer.

F. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, and other foreign matter from entering the piping.

G. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

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 following:

Nitrogen	10 percent
Phosphoric Acid	20 percent
Water Soluble Potash	10 percent

2.02 Lime

Shall be ground limestone containing not less than 85 percent total carbonates and of 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 types and 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.
Weeping Love Grass (Eragrostis Curvula)	10 lbs.

3. *Fall/Winter Planting (September 1 - March 14):*

Annual Rye grass or other Cereal Grasses	30 lbs.
Crimson Clover (Dixie)	20 lbs.
Bermuda Grass (Common) unhulled	20 lbs.
Laspedeza (Korean)	30 lbs.

2.04 Water

Clean, potable.

2.05 Mulch And Other Erosion Control

Cover material shall be chopped hay mulch generally derived from rice, wheat, oats, barley, or other suitable material.

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 least for approximately every five 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.

3.04 Application Rates

A. Lime: Three tons per acre, 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.

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 as per the Engineer.

C. If seeded in Fall, Contractor shall maintain seeded areas throughout Winter and provide a Spring 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 mulch areas larger than one square foot not having a uniform stand of grass.

END OF SECTION

SECTION 03300
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 the building pad.

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 - Structural Fill

1.03 References

A. *Construction Quality Assurance Plan*, NABORS Class 1 Landfill, January 2006, Genesis Environmental Consulting, Inc. (now Terracon Consultants, Inc.)

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.
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 pre-cast 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. Pre-stressed 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, except concrete for anti-flotation collars, buttresses, and pipe encasement shall have a minimum compressive strength of 2,500 psi. 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 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
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

SECTION 11305
LEACHATE PUMPING UNIT

PART 1 GENERAL

1.01 Summary

A. Section includes furnishing, installing, testing and start-up of leachate pumping unit, including the pump, the wheeled sump drainer, disconnect system, sump level controls, high level alarm and pump cut-off for leachate storage tank, flexible PVC discharge piping, electrical and control lead, electrical control panel, and disconnect.

1.02 System Description

A. The leachate pumping unit shall be provided by the Contractor complete and shall consist of the following:

1. Submersible pump with motor and electrical cable;
2. Level control and mounting hardware;
3. Flexible PVC discharge hose, quick disconnects and accessories;
4. Pump control panel and mounting hardware;
5. Stainless steel pump lifting cable; and
6. Tank level sensor system and mounting hardware.

1.03 Submittals

A. Submit the following items under the provisions of Section 01300:

1. Pump system arrangement Drawings;
2. Pump catalog information, specifications and certified pump curves;
3. Pump manufacturer's parts lists, schematic and wiring diagrams;
4. Complete lubrication, maintenance, and operating instructions including initial startup instructions;
5. Control panel submittals including wiring diagrams, panel layout and catalog information for each control system component;
6. Interconnection wiring diagrams showing field wiring;
7. Other technical, installation and maintenance data as applicable;
8. Listing of special tools required for repair and maintenance; and
9. Factory Test report.

1.04 Manufacturer's Services

A. Unless otherwise instructed by the Engineer or the Owner, a manufacturer's representative for the equipment specified shall be present at the job site for installation assistance, inspection and certification of the installation, and equipment testing.

1.05 Guarantee

A. The manufacturer shall guarantee in writing that the submersible sump pump system will meet the performance requirements specified in this section, provided that the manufacturer's operations and maintenance procedures are followed. The manufacturer shall guarantee the system, parts and labor included, for one year from the first day the system is placed in operation.

Part 2 Products

2.01 Acceptable Manufacturers

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Submersible leachate pumps, controls and accessories:
   a. EPG Companies 800-443-7426
   b. The Reich Company, Inc. (EPG pumps locally) 888-502-7756 (toll free)

B. Submit requests for substitution in accordance with Specification Section _____

2.02 Materials

A. Furnish unit component meeting or exceeding the following material specifications:

1. Pump case: 304 Stainless Steel
2. Motor housing: 304 Stainless Steel
3. Impeller: 304 Stainless Steel
4. Shaft: Stainless Steel, ANSI Series 300 or 400
5. Wear ring: Corrosion and wear resistant materials
6. Bearings & O-rings: E-GlideTM
7. Bolts and nuts: Stainless Steel
8. Seal metal parts: Stainless Steel

2.03 Equipment

A. Performance Requirements:

1. Submersible Leachate Pump (LP-1)

   a. Design condition: 43 gpm at 53 ft TDH
   b. Nameplate horsepower: 1.0 HP
   c. Drive type: constant speed

2.04 Accessories

A. Wheeled Drainers:

1. Pump shall be EPG WSDPT 8-3 installed in a (patented) 300 series stainless steel, wheeled, sump drainer for use in an 18" HDPE riser pipe with a constant diameter set at a 3:1 slope.
2. The sump drainer shall be supplied as a sealed unit which draws all liquid past the motor. A vent valve shall be provided to assist with the evacuation of air from the sump drainer.
3. The pump shall be designed to allow easy removal of unit should it be required.
4. Provide a retrieval cable of 300 series stainless steel complete with stainless steel clamps and associated hardware.
5. A submersible level sensor mount shall be located at the center bottom of the sump drainer for liquid level monitoring and pump control.

B. Discharge Fittings:

1. Fittings provided should be suitable for use intended.
2. Provide 300 Series stainless steel right angle slip fit taper lock discharge adapter with Viton O-ring seal. To be installed near top of riser or sump to allow easy connection and separation of pump discharge from force main. Discharge adapter to be designed for gas tight seal to riser or sump wall.

C. Control Panel

1. The control panel shall be supplied by the same manufacturer as the pumps and will provide level control, pump operation, and motor protection. Control panel power shall be 230V, 1- phase, grounded.
2. Control panel shall be EPG Model L925 and consist of a NEMA 4 coated metal enclosure with a rain guard and lockable outer cover. The door shall open a

minimum of 180 degrees.

3. The inner door shall be painted steel. The inner door shall contain cut outs for the mounted equipment and operator accessible equipment and provide protection of personnel from live internal wiring.
4. Operator accessible components mounted on the dead front door shall include the following:

    a. H-O-A switch.
    b. POWER ON indicating light (amber)
    c. RUN indicating light (green)
    d. Digital read out level indicator
    e. Fused type main disconnect switch
    f. Pump fuse
    g. Fused type control switch

5. The back plate shall consist of 12 gauge sheet steel and finished with a primer coat and two coats of baked on enamel. All hardware mounted to the subpanel shall be accomplished with machine thread tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified by labels.
6. The panel power distribution shall include all necessary components and shall be completely wired with standard copper conductors rated at 90 degrees C. Control wiring shall be a minimum of 16 gauge and installed in Panduit type wiring trays.
7. Individual fuses shall be provided for main power, pump and control circuits.
8. A control transformer shall be used to provide the 120VAC power for control circuits. Provide primary and secondary fusing for the circuit.
9. Surge protection and voltage protection shall be provided.
10. A transducer simulator, to check transducer operation for both leachate pump & underdrain pump, shall be provided.
11. A thermostat controlled heater shall be provided to control the inside temperature below the dew point and alleviate the buildup of condensate in the control enclosure.
12. A corrosion inhibitor shall be provided within the enclosure.
13. A top-mounted, rotating, red visual high level alarm beacon which shall be weatherproof shall be provided for the leachate pumping system. Light shall be Federal Signal Model 225. Provide high level contact closure for wiring to the alarm dialer.
14. A storage tank full shutdown circuit for the leachate pumping system shall be provided.
15. All control panel lights shall be “Push to Test”.

D. Level Control

1. A panel mounted controller digital readout displays, one each for the leachate system and underdrain system shall provide level indication of the sideslope sumps. The pump "ON-OFF-HIGH LEVEL" selection shall be through setpoint current relays located on inner door. The digital controller shall be equipped with a "HIGH-HIGH" shutdown feature which will lock out the pump(s) if the level exceeds 150 inches.
2. A submersible transducer shall be provided with a suitable cable for the leachate pump. The transducer shall be all 316 stainless steel and shall be mounted in the center axis of the pump carriage at the suction end. The unit shall provide a 4-20 mA signal output to the control unit over the entire range at levels encountered in the sump. Static accuracy rating shall be no less than 1.0%.
3. A filter dryer with seal pressure/temperature compensation diaphragm shall be provided to be mounted in the control panel or junction box to prevent moisture in the level sensor vent tube. Unit shall extend the operating life of the desiccant filter.

E. Break Out Junction Boxes

1. Breakout boxes, for power leads, level sensor leads, flow sensor leads, and float leads shall be provided for installation near the top of the riser pipe and adjacent to the leachate tank.
2. Breakout boxes to be NEMA 4X fiberglass and include proper sized cord restraint and ½" conduit gastight seal fitting.

F. Flow Meter System

1. An EPG Flow Meter System shall be provided to register liquid flow rate and to record total flow and shall operate from a 115V, 60H, single-phase power supply.
2. Sensor shall be linear with a repeatability factor of +/-0.5% and will incorporate the following features:
   a. Dual magnet drum design to assure unimpeded operation of the paddlewheel.
   b. Sensor shall be supplied in flow spool pieces, sized for specified flow rate range to maximize system accuracy.
   c. Line Size shall be 1.5".
   d. Flow velocity shall be between 1.5 and 27 fps.
3. Meter shall include a bi-directional, eight digit flow rate display and eight digit flow totalizer display.

4. Meter shall be front panel programmable for ease of calibration to line size and change in units.
5. Meter shall include a non-volatile memory to retain programmed settings and totalized flow when power is disconnected.
6. Meter shall include a two line, eight digit, 1/3 inch high display showing flow rate and totalized flow.
7. Meter programming shall be menu driven to simplify setup.
8. Meter shall maintain full function in temperatures between 0 degrees and 55 degrees C, with ability to extend low temperature range with optional meter heater.
9. Flow meter shall be scalable in a variety of engineering units.

G. Storage Tank Level Control

1. A float switch with 40’ lead and breakout junction box, to monitor tank level, shall be provided.

2.05 Fabrication

A. General:

1. Provide pumps capable of handling primary landfill leachate.
2. Design pump to allow for removal without entering the wet well and without removal of bolts, nuts or other fastenings.

B. Impeller:

1. Provide closed impeller in accordance with Hydraulic Institute Standards.
2. Provide wear ring as necessary to assure efficient sealing between volute and impeller.

C. Shaft:

1. Design pump shaft of sufficient size to transmit full driver output.
2. Use shaft which is accurately machined and constructed with sufficient materials.

D. Bearings:

1. Support shaft on upper and lower and between end stage with E-GlideTM product lubricated bearings.

E. Motors:

1. Provide motor of totally submersible design, constructed with epoxy encapsulated windings and Kingsbury type thrust bearings, rated for continuous duty operation.
2. Motor shall be 1-PH, 230V.

2.06 Source Quality Control

A. Secure from the pump manufacturer the following inspections and tests on each pump before shipment from factory:

1. Check impeller, motor rating and electrical connections for compliance with Specification.
2. Test motor and cable insulation for moisture content or insulation defects.
3. Run pump for a minimum of 15 minutes submerged.
4. After operational test #3, perform insulation Test (#2) again.

B. Factory Authorized Installation

1. Pumping system shall be installed and started up by a factory trained installer.

C. System Ground

1. Factory trained installer shall ground system, measuring impedance to ground, to less than or equal to 1.0 Ohms using 780 Series Ground Resistance Tester, Model #61-781, as manufactured by Ideal Industries, Inc., Sycamore, IL.

2.07 Equipment Warranty

A. Wheeled Sump Drainer, Control Panel and accessories manufactured by EPG and installed as a complete system will be warranted for a period of thirty (30) months from date of manufacture.

PART 3 EXECUTION

3.01 General

A. A minimum buffer distance of 14 feet shall be maintained between the liner system anchor trench and the landfill operations road in order to provide sufficient space for the valve box system, concrete retaining structure and surface water control conveyance.

B. The pump field control panel shall be completely shop fabricated. Field work shall be limited to mounting, connections, testing and start-up.

C. The control panel should be constructed with the interface facing the landfill.

3.02 Piping

A. The types and sizes of pipes to be used shall be as specified.

B. Pipe shall be installed as closely as indicated on the Drawings. Major adjustments, if required, shall be approved by the Engineer.

C. The interior of piping shall be cleaned before assembly and connection.

D. Flanged joints shall be square with even pressure upon the gaskets and shall be airtight.

3.03 Pumping Unit

A. Pumping unit shall be installed as specified and as recommended by the manufacturer. The Contractor shall protect the integrity of the power lead to pump motor connection and shall be responsible for keeping the connection watertight. Power leads shall not be used to lift or position the pumping unit.

B. Level sensors shall be positioned as recommended by the manufacturer.

3.04 Control Equipment

A. Control equipment shall be installed in accordance with manufacturer's printed instructions.

3.05 Testing

A. All major system components shall be factory tested for compliance with the construction and functional requirements specified herein, and a certification of the results of these tests shall be submitted to the Owner.

B. Prior to system start-up, all system components shall be inspected for proper alignment, noise levels, proper connection and satisfactory performance. The manufacturer's representative shall provide a written certification for all system components to the Owner that the furnished equipment has been installed in accordance with the

manufacturer's instructions and is ready for permanent operation.

C. Operational acceptance tests shall be performed for a minimum of three days to demonstrate that the systems furnished perform in accordance with all provisions of these specifications. In the case of a non-conforming system, the Owner may, at his option, withhold final payment to the manufacturer until the system is reclassified as conforming.

END OF SECTION

SECTION 13205
ABOVE-GROUND LEACHATE STORAGE TANK

PART 1 GENERAL

1.01 Summary

A. Section includes disconnection, transportation and installation procedures for Owner-supplied above-ground 10,000-gallon leachate storage tank.

B. Related Sections:

1. Section 02200 – Earthwork;

2. Section 02210 – Grading;

3. Section 02631 – Polyethylene Pressure Pipe and Fittings; and

4. Section 11305 – Leachate Pumping Unit.

1.02 Delivery, Storage and Handling

A. Contractor shall be responsible for packing tank to prevent normal installation and handling damage to the tank.

B. Flange faces shall be protected from damage. All openings are to be securely covered to prevent entrance of dirt, water and debris.

PART 2 PRODUCTS

2.01 Tank

A. Above-ground, 10,000-gallon poly tank shall be supplied by Owner.

2.02 Piping and Fittings

A. All piping and fittings shall be HDPE as shown on the Drawings and as specified in Section 02631.

2.03 Accessories

A. Top mounted indicator lights as specified in Section 11305.

PART 3 EXECUTION

3.01 Preparation

A. Leachate Storage Tank Area: Prepare leachate storage tank area as shown on the Drawings and as specified in Section 02200.

B. Storage Tank: Flush tank to remove dirt and debris. Clean piping and fittings.

3.02 Tank Installation

A. Install tank on 8-inch thick, reinforced concrete pad. Pad shall be reinforced with # 4 rebar at 12-inches on center as shown on the Drawings.

B. Connect leachate transmission piping to tank.

C. Install pumping control system, including tank level sensor system and indicator lights.

3.03 Field Testing

A. After installation of tank, piping and control system is complete, connecting pipe and fittings shall be field tested by Contractor by filling tank with water. The tank and fittings shall hold water for a period of 72 hours with no evidence of leaking.

END OF SECTION

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 Summary

A. This section addresses basic electrical requirements specifically applicable to Division 16 sections in addition to applicable Division 1 sections of the Specifications.

1.02 Coordination

A. The electrical work shall be installed in cooperation with other trades installing inter-related work.

1.03 Submittals

A. Deviation from the Drawings and Specifications shall be called to the attention of the Engineer in writing at the time of submission of the Shop Drawings. The Engineer's checking of any drawing shall not release the subcontractor from responsibility for such deviations.

B. The Contractor shall furnish seven complete sets of certified Shop Drawings. Submittals must be one installment in bound manual with title sheet and numbered index at the beginning. Piecemeal submittals will be returned without consideration. Thermofax copies are not acceptable; only permanent type prints will be allowed. Shop Drawings are required even though the equipment is as specified. All submittals shall give complete catalog data for every manufactured item of equipment and all components to be used. Partial list of submittals as follows: wire and cable, devices, panels with circuit number shown, ballasts, disconnect switches, fixtures, conduit, and fire alarm.

C. Where equipment requiring different arrangement of connections from those shown is approved, it shall be the responsibility of the subcontractor to install the equipment to operate properly and in harmony with the intent of the Contract Documents, and to make all changes in the work required by the different arrangement of connections and pay all charges resulting from changes.

1.04 Codes, Ordinances, Inspections, and Permits

A. Contractor shall obtain and pay for required fees, permits, and inspections for electrical work.

B. Contractor shall perform Work in accordance with N.E.C., N.F.P.A., U.L., and N.E.C.A. (latest version).

1.05 Delivery, Storage and Handling

A. Contractor shall place stored materials on clean, hard surfaces above ground and keep covered at all times to ensure protection from paint, plaster, dust, water, and other construction debris or operations.

1.06 Accuracy of Data

A. The data given herein and on the Drawings are as exact as could be secured, but their absolute accuracy is not guaranteed. Exact locations, distances, levels, etc., will be governed by the building, and the Contractor shall use the data contained herein with this understanding.

1.07 Intent of Drawings and Specifications

A. The intent of the Electrical Drawings and Specifications is that the subcontractor shall furnish all labor and materials, equipment and transportation necessary for the proper execution of the work. This subcontractor shall thoroughly examine the Drawings and Specifications relating to other trades in order to include all necessary work in his bid. No additional payments shall be considered for failure to properly interpret the responsibilities to other trades. The subcontractor shall do all the work shown on the Drawings and described in the Specifications and all incidental work necessary to complete the work ready for use, occupancy, and operation by the Owner. The Engineer reserves the right to make any reasonable changes up to six feet in the locations indicated without additional cost to Owner.

1.08 Operating and Maintenance Manuals

A. Contractor shall deliver to the Engineer for the Owner's use, two complete operating and maintenance manuals covering all equipment and systems installed by this Division.

B. Contractor shall include approved equipment and material submittals, parts lists, wiring diagrams, and operating instructions for all operating equipment.

C. Contractor shall bind brochures in hard back three ring binder and tab indexed with front cover and back spine labeled to indicate project name. Contractor shall also include page showing data and local responsible vendors with addresses and telephone numbers and furnishing parts and information on equipment.

1.09 Observation of Work

A. General: Refer to Agreement.

B. The Engineer will make final on site review of the Work of this division, prepare punch list, and visit the job site to check the punch list.

C. The Contractor shall furnish assistance and information as required by the Engineer.

D. If additional trips are required to the job because the Contractor did not perform the work as shown and called for on the punch list, then the Contractor shall reimburse the Engineer for charges at the rate of $125.00 per hour plus 65 cents per mile for travel expenses.

E. The Contractor shall allow the Engineer access to all parts of the Work and shall furnish assistance and information as required by the Engineer.

1.10 Project Record Drawings

A. The Contractor shall store the Project record drawings on the project site. Each day, Contractor shall make corrections and additions with colored pencil with date and authorization of change. Contractor shall locate all underground and concealed work. Project record drawings shall be complete in every detail.

B. The Contractor shall transfer information from Project record drawings to tracings or mylars of original drawings so Owner may reproduce copies as required. Contractor shall pay for tracings or mylars. Project record drawings must be submitted to the Engineer before project will be accepted.

1.11 Inspection of Sites

A. Refer to Section II – Instructions to Bidders and to Section IV – Waste Management Agreement and Contract Documents.

B. Contractor shall inspect the site and become thoroughly familiar with conditions to be met and the work to be accomplished. At existing building sites, Contractor shall verify, prior to bid, all conditions shown affecting work.

1.12 Safety and Work Methods

A. Refer to General Conditions.

B. The Electrical Subcontractor is completely responsible for performance of his work; safety, in, on, or about the job site; methods of performance; and timeliness in such performance. In the event he is unsatisfied with the performance of other trades, he shall set forth such complaints in writing for the Owner's review. In no event shall this subcontractor expect to be specifically directed in the protection of personnel or material by the Owner or Engineer.

1.13 Painting

A. Contractor shall repair finish surfaces damaged by Work of the section.

B. Contractor shall paint equipment and material furnished and installed under this section that has only a prime coat of paint, using color and brand of paint selected by Engineer.

1.14 Temporary Construction Power

A. This Contractor shall furnish and install temporary construction power wiring as required. Temporary electrical service shall be obtained in the name of the General Contractor, and it will be the General Contractor's responsibility to pay all power company charges. The temporary service shall be obtained from the local utility company. Provide temporary lighting as required for adequate illumination for construction and safety purpose.

PART 2 PRODUCTS

2.01 Material and Equipment

A. In order to establish standards of quality, the Engineer has referred to certain products by name and catalog number. This procedure is not to be construed as eliminating from competition other products of equivalent or better design. Where multiple manufacturing sources are shown on the Drawings or herein specified, the subcontractor shall limit his bid to one of those manufacturers.

B. The subcontractor shall abide by the Engineer's judgment when proposed substitute materials or items of equipment are judged to be unacceptable and shall furnish the specified material or item of equipment in such case. All proposals for substitution shall be submitted in writing by the General Contractor and not by the Electrical Subcontractor or material suppliers. The Engineer will approve or disapprove

proposed substitutions in writing. If any request for a substitution is rejected, the Contractor shall automatically furnish material specified. All materials shall be new and shall bear the manufacturer's name and the Underwriters Laboratory label. Materials of the same general type shall be the same throughout the job to provide uniform appearance, operation, and maintenance.

2.02 Labeling

A. Electrical equipment, safety switches, time clock, starters, panels and transformers shall have black and white laminated bakelite nameplates securely fastened to device with screws, and be exposed. Edge of plates shall be beveled. Letters shall be white with black field. Letters shall be 3/8-inch upper case. Nameplate shall state its purpose and the voltage of the equipment. 120 or 240 volt equipment shall have black.

PART 3 EXECUTION

3.01 Clearances

A. Clearances in front of electrical equipment shall be maintained as required by code. Discrepancies shall be reported to Engineer.

3.02 Excavating, Trenching and Backfilling

A. Perform as specified in Section 02223.

3.03 Connection to Equipment Not Specified In This Division

A. Provide necessary materials and make connections to equipment requiring electrical power.

B. Rough-in for connection of this equipment according to shop drawings furnished with the equipment or by actual measurements taken from equipment on site. Provide junction boxes, disconnect switches, etc., required to properly connect each piece of equipment unless specifically stated otherwise.

3.04 Utilities Locations, Meters, and Connections

A. Arrange with proper authorities and utility companies for service connections, verifying locations and arrangements. Pay all costs of service as shown and provide all required conduits, meter bases wiring for indicated service. Contact the serving utility prior to bid and include all cost in bid.

B. When connections to existing lines, rerouting of utility lines, modifications to services, etc., would interrupt service or interfere with normal use of the buildings, arrange work such that outages are minimized and schedule outages to occur at times satisfactory to the Owner.

C. Before ordering equipment and proceeding with Work, verify with the utility company existing or available voltages shown on Drawings. If voltage differs from that noted on the Drawings and in the Specifications; notify the Engineer immediately.

3.05 Appearance of Work

A. Contractor shall arrange and install exposed portions on Work specified under this division such as devices, fixtures, panels and safety switches to fit in and harmonize with Work specified in other divisions.

B. Contractor shall run conduits concealed in chases, attics or cable trenches unless indicated otherwise. Run conduit exposed to view in mechanical rooms and electrical equipment rooms.

C. Run conduit panel parallel or perpendicular to building lines.

3.06 Tests

A. Test panel feeders, motor circuits, and conductors larger than #6 with a 600 volt Megger to prove insulation resistances.

B. Record readings on Contractor's letterhead and submit three copies of tabulated results to Engineer prior to final inspection.

C. Upon completion of installation of equipment, work with other trades to start equipment and make necessary tests and adjustments to place systems in first-class operating condition.

D. Test grounding electrode system to verify compliance with N.E.C. requirements. Submit results to Engineer.

3.07 Guaranty Period

A. Electrical Contractor shall warrant equipment furnished and work performed for a period of one year from date of written acceptance of work. This guarantee shall cover patching, refinishing, etc., required to restore faulty condition at no additional expense to Owner.

3.08 Cleaning

A. Cleaning during construction: Refer to Agreement

B. At completion of work, clean and polish fixtures, equipment, and materials.

3.09 Conflict

A. If there is conflicting variance between Drawings and Specifications, provisions of most stringent shall control. Drawings and Specifications are complementary. Work required by one, but not required by other, shall be performed as though required by both.

3.10 Motor Connections

A. Whenever equipment requiring electrical connection is specified, power wiring shall be furnished and installed under applicable sections of Electrical Division of Specifications. Starting switches, protective devices, and other means for operation and control of equipment shall be furnished under applicable equipment sections but shall be installed under applicable electrical section, unless specifically noted otherwise on Drawings. Additional disconnects required by National Electrical Code shall be furnished, installed and connected by Electrical Contractor. Motor terminals or equipment connections shall terminate in a junction box or disconnect adjacent to equipment.

END OF SECTION

SECTION 16111
CONDUIT

PART 1 GENERAL

1.01 Summary

A. This section addresses:

1. Rigid metal conduit and fittings;
2. Electrical metallic tubing and fittings;
3. Flexible metal conduit and fittings;
4. Liquid-tight flexible metal conduit and fittings; and
5. Non-metallic conduit and fittings.

PART 2 PRODUCTS

2.01 Rigid Conduit and Fittings

A. Rigid Steel Conduit: ANSI C80.1.

B. PVC Externally Coated Conduit: NEMA RN1: rigid steel conduit with external 20 mil PVC coating and internal galvanized surface.

C. Fitting and Conduit Bodies: ANSI/ NEMA FB 1; threaded type, material to match conduit.

2.02 Electrical Metallic Tubing (EMT) and Fittings

A. EMT: ANSI C80.3. galvanized tubing.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1: steel compression type.

2.03 Flexible Metal Conduit and Fittings

A. Conduit: FS WW-C-566; steel.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1.

2.04 Liquid-Tight Flexible Conduit and Fittings

A. Conduit: Flexible metal conduit with PVC jacket.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1.

2.05 Plastic Conduit and Fittings

A. Conduit: NEMA TC 2; Schedule 40 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.06 Armored Cable

A. Armored cable shall not be permitted.

PART 3 EXECUTION

3.01 Conduit Sizing, Arrangement, and Support

A. Size conduit for conductor type installed, minimum size ¾-inch. Conduit sizes shown on Drawings are based on THWN.

B. Arrange conduit to maintain headroom and present a neat appearance.

C. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

D. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.

E. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

F. Do not fasten conduit with wire or perforated pipe straps or caddie clamps, remove all wire used for temporary conduit support during construction before conductors are pulled.

3.02 Conduit Installation

A. Cut conduit square using saw; de-burr cut ends.

B. Bring conduit to the shoulder of fittings and couplings and fasten securely.

C. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes, and for fastening conduit to sheet metal boxes in damp or wet locations.

D. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pans.

E. Maximum Size Conduit in Slabs Above Grade: ¾-inch. Do not route conduits to cross each other in slabs above grade.

F. Use PVC-coated rigid steel factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs that have more than two bends regardless of length. Use rigid steel conduit to turn up out of concrete.

G. Install four spare ¾-inch conduits from each flush mounted power panel to an accessible point above ceiling and cap off.

H. Use long radius elbows on telephone conduit over 1-inch size.

3.03 Conduit Installation Schedule

A. Galvanized rigid steel: Minimum ¾-inch size may be used in all areas.

B. Electrical Metallic Tubing: Minimum ¾-inch size may be used in indoor dry locations where it is:

1. Not subject to damage;
2. Not in contact with earth;
3. Not in concrete slabs on grade; and
4. In compliance with other qualifications in this section.

C. Schedule 40 PVC may be run for underground branch circuits and feeders. Utilize rigid steel where conduits exit the ground. Bury conduits 30 inches below finished grade.

D. Liquid-tight flexible steel conduit:

1. Use for outdoor final connections to mechanical equipment, length not to exceed three feet.

END OF SECTION

CONSTRUCTION DRAWINGS

FOR THE

NABORS LANDFILL

AREA 1-3 CELL 2

PERMIT NO. 249-S1-R2

MAY 2008

PROJECT NO. - 128-001-35087025

PREPARED FOR:

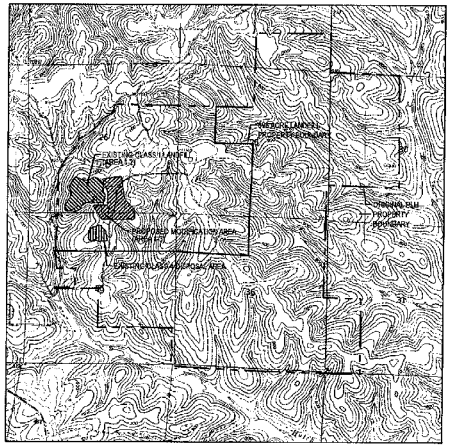
NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT
NABORS LANDFILL

1320 RLH LANDFILL ROAD
THREE BROTHERS, AR. 72653
(870) 425-3213

VICINITY MAP
N.T.S.

PREPARED BY

Terracon
Consulting Engineers and Scientists
25809 I-30 BRYANT, AR 72022
PH (501) 847-9292 FAX (501) 847-9210



SITE LOCATION MAP
SCALE: 1" = 2000'±

INDEX OF DRAWINGS

DRAWING NO.	TITLE
	COVER SHEET
1	INDEX SHEET
2	EXISTING SITE CONDITIONS
3	GRADING PLAN - SUBGRADE
4	GRADING PLAN - CLAY LINER
5	LEACHATE COLLECTION SYSTEM DETAILS
6	LINER DETAILS
7	MISCELLANEOUS DETAILS
8	LEACHATE TRANSMISSION DETAILS
9	LEACHATE TRANSMISSION DETAILS - SHEET 2

ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

AFG	ABOVE FINISHED GRADE
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BLDG	BUILDING
CB	CATCH BASIN
CF	CUBIC FEET
CFS	CUBIC FEET PER SECOND
CO	CLEANOUT
CONC	CONCRETE
℄	CENTERLINE
C TO C	CENTER TO CENTER
DIA	DIAMETER
DWG	DRAWING
ELEV	ELEVATION
EXIST	EXISTING
FT	FEET
GAL	GALLONS
GPM	GALLONS PER MINUTE
HDPE	HIGH DENSITY POLYETHYLENE
HORZ	HORIZONTAL
ID	INSIDE DIAMETER
IN	INCHES
INV	INVERT
LB	POUNDS
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
MSL	MEAN SEA LEVEL
NOM	NOMINAL
NTS	NOT TO SCALE
OD	OUTSIDE DIAMETER
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE (PLASTIC)
RAD	RADIUS
SCHED	SCHEDULE
SDR	STANDARD DIMENSION RATIO
SPEC	SPECIFICATION
TYP	TYPICAL
VERT	VERTICAL

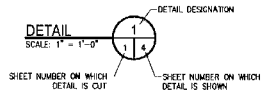
SYMBOLS

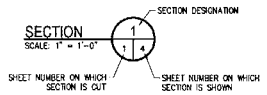
- PROPERTY LINE
- EXISTING FENCE
- EXISTING BUILDING
- EXISTING GRAVEL ROAD
- EXISTING ASPHALT
- DRAINAGE WAY
- 320 EXISTING INDEX CONTOUR
- 318 EXISTING INTERMEDIATE CONTOUR
- 320 PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- LEACHATE LINE
- GAS LINE
- OHE OVERHEAD ELECTRIC
- RAILROAD TRACK
- FILL-SLOPE INDICATOR
- CUT-SLOPE INDICATOR
- PROPOSED ACCESS ROAD (GRAVEL)
- WATERLINE
- WS=1294.6 WATER SURFACE ELEVATION
- X 325.8' EXISTING SPOT ELEVATION
- BM-1 PERMANENT SURVEY BENCHMARK
- SITE GRID MARKER (1000 FT INTERVALS)
- MW-1A GROUNDWATER MONITORING WELL
- B-15 GEOTECHNICAL BORING
- P-5 GROUNDWATER PIEZOMETER
- BM-1 SURVEY CONTROL POINT
- CP-1 SURVEY COORDINATE SYSTEM CONVERSION POINT
- EC-1 EXPLOSIVE GAS MONITORING PROBES
- LEACHATE SYSTEM CLEAN-OUT
- FIRE HYDRANT
- POWER POLE
- DRAINAGE CULVERT
- LANDFILL GAS COLLECTION WELL
- MANHOLE INVERT=X OUTLET=X
- CATCH BASIN INLET
- BOLLARD OR GUARD POST CP

GENERAL NOTES

1. EXISTING CONTOURS SHOWN ON THESE PLANS WERE PROVIDED BY AMI ENGINEERING INC AND ARE BASED ON AN AERIAL SURVEY PERFORMED BY WESTERN AIR MAPS ON FEBRUARY 9 2008
2. EXISTING FACILITIES AND FEATURES ARE SHOWN LIGHT-LINED AND/OR SCREENED NEW FACILITIES AND FEATURES ARE SHOWN SOLID AND HEAVY-LINED
3. SLOPES AND GRADES ARE IN UNITS OF FT/FT UNLESS OTHERWISE NOTED
4. THE EROSION CONTROL FACILITIES REQUIRED BY THESE PLANS ARE THE MINIMUM FACILITIES REQUIRED ADDITIONAL FACILITIES MAY BE REQUIRED TO CONTROL EROSION
5. OWNER IS RESPONSIBLE FOR OBTAINING NPDES CONSTRUCTION PERMIT WITH ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY AS REQUIRED CONTRACTOR IS RESPONSIBLE FOR WORKING WITH THE OWNER TO KEEP THIS CONSTRUCTION AREA IN COMPLIANCE

SECTION/DETAIL KEY





OWNER:
NORTHWEST ARKANSAS REGIONAL
SOLID WASTE MANAGEMENT DISTRICT
NABORS LANDFILL
1320 R.H. LANDFILL ROAD
THREE BROTHERS, ARKANSAS 72653
PHONE: (870) 425-3213

ENGINEER:
TERRACON CONSULTS, INC
ATTENTION: DAVID McCORMICK P.E. PROJECT ENGINEER
25609 I-30
BRYANT, AR 72022
PHONE: (501) 847-9292
FAX: (501) 847-9210

REGULATORY AUTHORITY:
ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY
SOLID WASTE MANAGEMENT DIVISION
ATTENTION: SOLID WASTE MANAGEMENT DIVISION CHIEF
5301 NORTHSHORE DRIVE
NORTH LITTLE ROCK, ARKANSAS 72118-5317
PHONE: (501) 682-0600
FAX: (501) 682-0611

5/21/08

REV	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No. 223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No. 9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25609 I-30 BRYANT, AR 72022
PH (501) 847-9292 FAX (501) 847-9210

INDEX SHEET

CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY ARKANSAS

DRAWING 1

DESIGNED BY:	DCM
DRAWN BY:	JDW
APPVD. BY:	KEB
SCALE:	N.T.S.
DATE:	04/28/08
JOB NO.	126-001-35087025
ACAD NO.	002
SHEET NO.:	1 OF 9

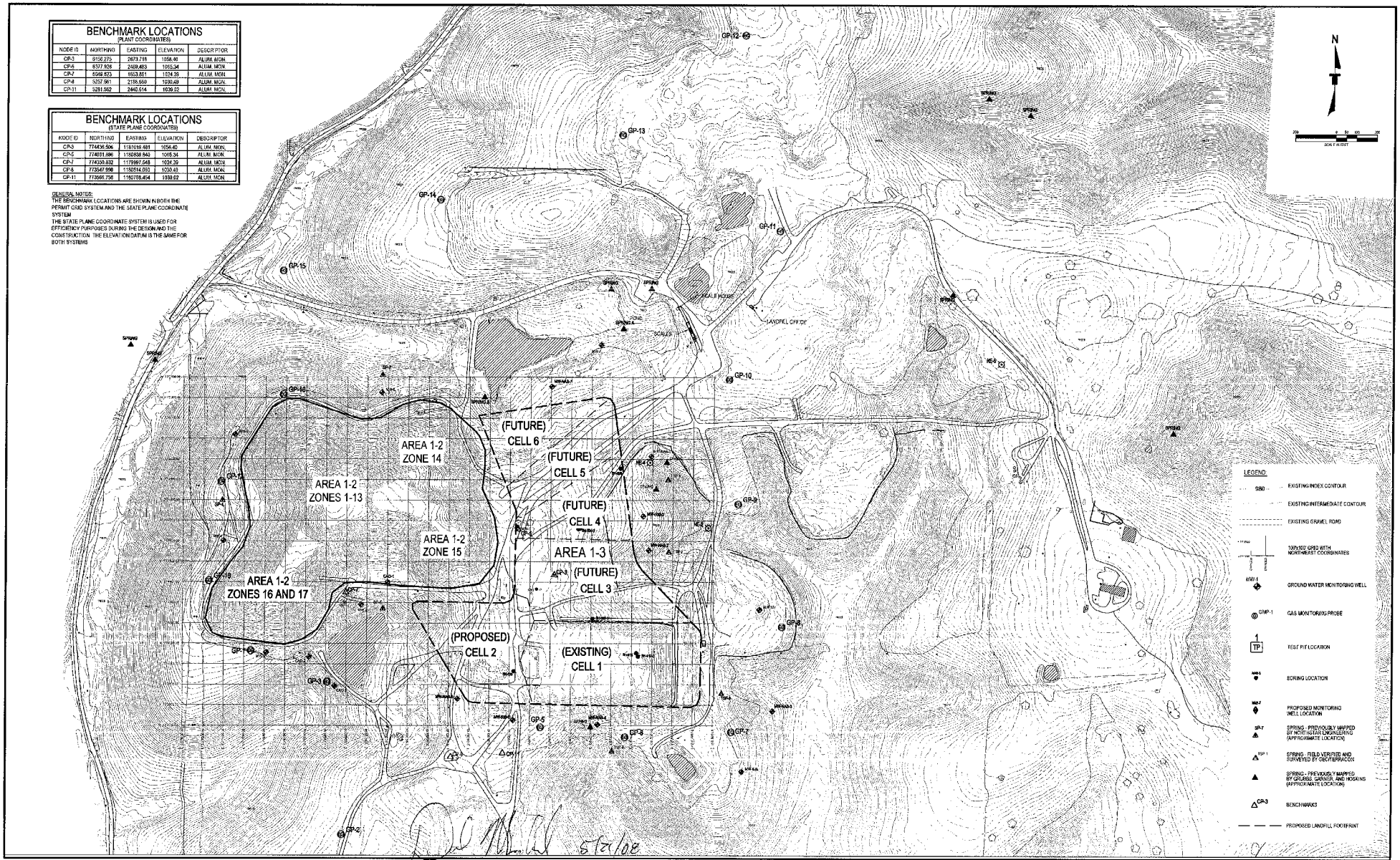
BENCHMARK LOCATIONS
(PLANT COORDINATES)

NODE ID	NORTHING	EASTING	ELEVATION	DESCRIPTION
CP-3	8150.275	2879.718	1056.40	ALUM. MON.
CP-5	8377.926	2459.483	1055.34	ALUM. MON.
CP-7	8049.823	1653.851	1034.39	ALUM. MON.
CP-8	7257.961	2159.569	1030.49	ALUM. MON.
CP-11	7281.562	2442.514	1039.02	ALUM. MON.

BENCHMARK LOCATIONS
(STATE PLANE COORDINATES)

NODE ID	NORTHING	EASTING	ELEVATION	DESCRIPTION
CP-3	774436.506	1181018.481	1056.40	ALUM. MON.
CP-5	774661.686	1180838.840	1055.34	ALUM. MON.
CP-7	774330.832	1179997.548	1034.39	ALUM. MON.
CP-8	773547.598	1180514.053	1030.49	ALUM. MON.
CP-11	773565.758	1180765.454	1039.02	ALUM. MON.

GENERAL NOTES:
THE BENCHMARK LOCATIONS ARE SHOWN IN BOTH THE PERMIT GRID SYSTEM AND THE STATE PLANE COORDINATE SYSTEM.
THE STATE PLANE COORDINATE SYSTEM IS USED FOR EFFICIENCY PURPOSES DURING THE DESIGN AND THE CONSTRUCTION. THE ELEVATION DATUM IS THE SAME FOR BOTH SYSTEMS.



5/21/08

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION TERRACON CONSULTANTS, INC. No. 223 ARKANSAS

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No 9199 DAVID C. McCORMICK

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EXISTING SITE CONDITIONS

CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

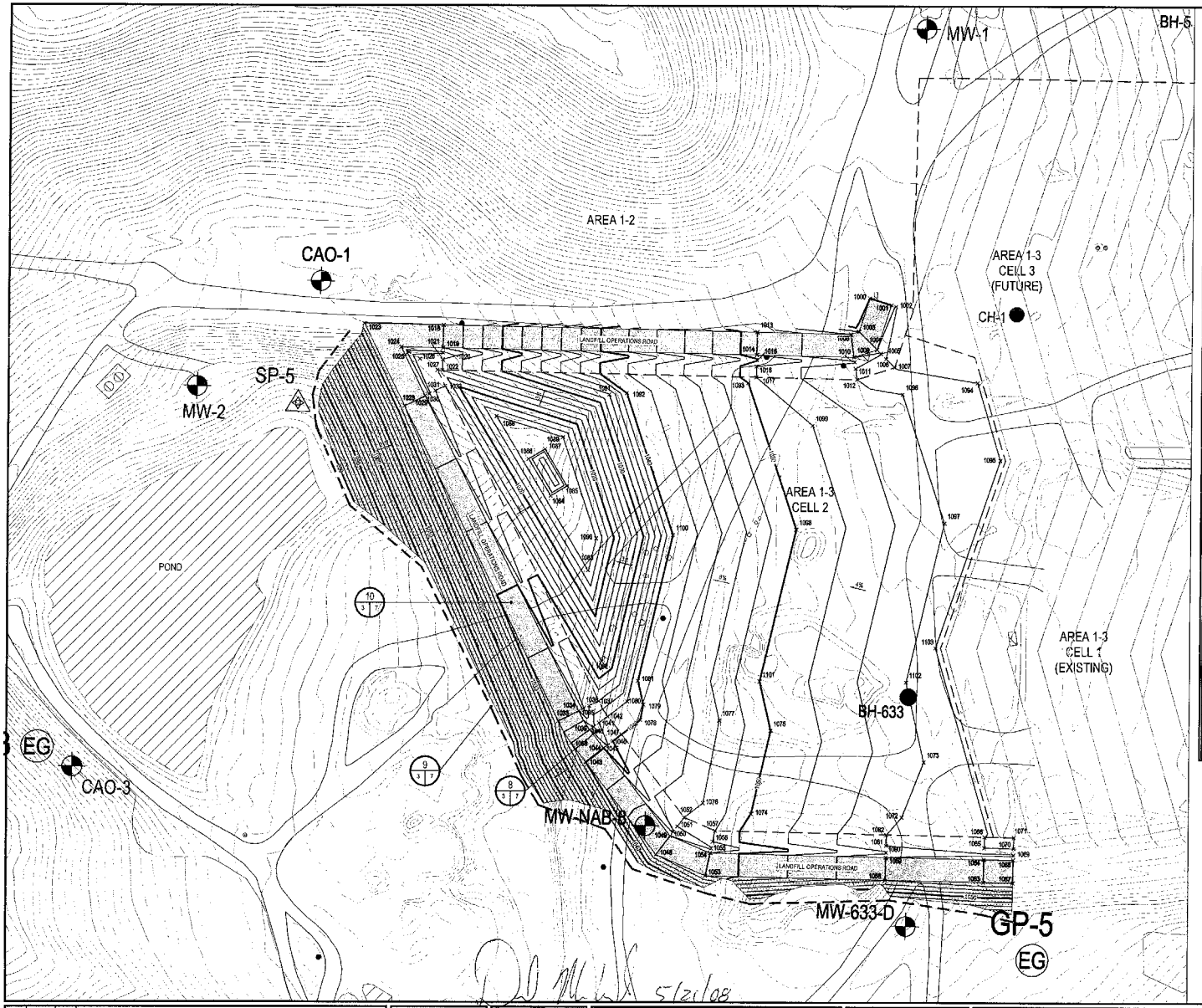
NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY ARKANSAS

DRAWING 2

DESIGNED BY:	DCM
DRAWN BY:	JDW
APPVD. BY:	DCM
SCALE:	1" = 200'
DATE:	04/29/08
JOB NO.	126-001-35081025
ACAD NO.	003
SHEET NO.:	2 OF 9



CONTROL POINT TABLE				
POINT NO.	NORTHING	EASTING	DESCRIPTOR	ELEVATION
1000	774383.31	1180777.62	ROAD	1066.00
1001	774316.02	1180630.39	ROAD	1060.00
1002	774314.59	1180623.15	DITCH	1058.00
1003	774348.31	1180756.36	ROAD	1058.00
1004	774329.27	1180785.48	ROAD	1058.00
1005	774325.36	1180789.46	DITCH	1056.00
1006	774319.75	1180795.54	SUBGRADE	1050.00
1007	774310.74	1180804.08	SUBGRADE	1056.00
1008	774349.83	1180767.75	ROAD	1056.00
1009	774321.45	1180761.29	ROAD	1056.00
1010	774316.43	1180767.03	DITCH	1054.00
1011	774369.41	1180765.07	SUBGRADE	1058.00
1012	774298.02	1180764.74	SUBGRADE	1056.00
1013	774347.52	1180659.92	ROAD	1060.00
1014	774353.53	1180659.43	ROAD	1062.00
1015	774316.53	1180659.33	DITCH	1056.00
1016	774311.53	1180659.19	SUBGRADE	1050.00
1017	774300.13	1180658.96	SUBGRADE	1052.00
1018	774354.26	1180529.90	ROAD	1024.00
1019	774320.27	1180329.41	ROAD	1024.00
1020	774325.27	1180329.30	DITCH	1022.00
1021	774316.27	1180329.15	SUBGRADE	1024.00
1022	774292.99	1180328.63	SUBGRADE	1024.00
1023	774355.06	1180248.68	ROAD	1023.50
1024	774331.86	1180228.74	ROAD	1023.50
1025	774325.99	1180253.69	DITCH	1021.50
1026	774318.76	1180353.28	SUBGRADE	1023.50
1027	774307.03	1180333.77	SUBGRADE	1023.50
1028	774269.52	1180258.52	ROAD	1024.00
1029	774280.16	1180311.62	ROAD	1024.00
1030	774282.38	1180315.50	DITCH	1022.00
1031	774285.48	1180321.76	SUBGRADE	1024.00
1032	774295.53	1180331.94	SUBGRADE	1024.00
1033	773946.50	1180452.59	ROAD	1034.00
1034	773951.16	1180474.10	ROAD	1034.00
1035	773953.38	1180478.58	DITCH	1032.00
1036	773958.49	1180484.85	SUBGRADE	1034.00
1037	773951.58	1180405.02	SUBGRADE	1034.00
1038	773917.34	1180469.40	ROAD	1038.00
1039	773931.55	1180455.74	ROAD	1038.00
1040	773934.51	1180469.77	DITCH	1036.00
1041	773958.66	1180481.42	SUBGRADE	1038.00
1042	773945.36	1180454.57	SUBGRADE	1038.00
1043	773897.56	1180481.78	ROAD	1040.00
1044	773912.23	1180503.65	ROAD	1040.00
1045	773915.29	1180504.64	DITCH	1038.00
1046	773919.57	1180510.18	SUBGRADE	1040.00
1047	773926.51	1180519.16	SUBGRADE	1040.00
1048	773901.12	1180556.32	ROAD	1046.00
1049	773920.80	1180571.41	ROAD	1046.00
1050	773924.90	1180574.56	DITCH	1044.00
1051	773930.84	1180578.97	SUBGRADE	1046.00
1052	773938.95	1180586.12	SUBGRADE	1046.00

CONTROL POINT TABLE				
POINT NO.	NORTHING	EASTING	DESCRIPTOR	ELEVATION
1053	773979.03	1180608.89	ROAD	1048.00
1054	774002.91	1180614.80	ROAD	1048.00
1055	773997.58	1180615.80	DITCH	1046.00
1056	773944.85	1180618.56	SUBGRADE	1048.00
1057	773906.14	1180619.00	SUBGRADE	1048.00
1058	773774.05	1180798.17	ROAD	1056.00
1059	773758.84	1180798.05	ROAD	1056.00
1060	773803.84	1180798.75	DITCH	1054.00
1061	773810.84	1180798.80	SUBGRADE	1056.00
1062	773822.19	1180799.12	SUBGRADE	1056.00
1063	773772.87	1180801.29	ROAD	1058.00
1064	773756.87	1180801.75	ROAD	1058.00
1065	773808.87	1180801.87	SUBGRADE	1058.00
1066	773802.42	1180802.18	SUBGRADE	1058.00
1067	773772.29	1180832.18	ROAD	1060.00
1068	773798.29	1180832.63	ROAD	1060.00
1069	773981.23	1180832.72	DITCH	1056.00
1070	773988.23	1180832.85	SUBGRADE	1058.00
1071	773819.64	1180833.06	SUBGRADE	1058.00
1072	773940.48	1180815.10	SUBGRADE	1056.00
1073	773858.26	1180837.77	SUBGRADE	1058.00
1074	773843.91	1180656.47	SUBGRADE	1050.00
1075	773870.68	1180676.44	SUBGRADE	1052.00
1076	773855.16	1180605.37	SUBGRADE	1048.00
1077	773941.47	1180622.57	SUBGRADE	1046.00
1078	773947.72	1180539.00	SUBGRADE	1040.00
1079	773957.68	1180542.00	SUBGRADE	1040.00
1080	773981.08	1180525.06	SUBGRADE	1038.00
1081	773992.59	1180536.29	SUBGRADE	1040.00
1082	774003.04	1180497.96	SUBGRADE	1026.00
1083	774068.05	1180452.06	SUBGRADE	1014.00
1084	774175.67	1180442.93	SUBGRADE	1012.00
1085	774185.98	1180463.07	SUBGRADE	1012.00
1086	774214.23	1180419.73	SUBGRADE	1012.00
1087	774224.54	1180436.87	SUBGRADE	1012.00
1088	774258.92	1180395.66	SUBGRADE	1014.00
1089	774237.02	1180405.81	SUBGRADE	1014.00
1090	774131.28	1180491.20	SUBGRADE	1014.00
1091	774281.90	1180504.29	SUBGRADE	1034.00
1092	774293.35	1180522.56	SUBGRADE	1040.00
1093	774294.16	1180650.75	SUBGRADE	1050.00
1094	774294.57	1180661.40	SUBGRADE	1058.00
1095	774213.57	1180815.92	SUBGRADE	1058.00
1096	774282.56	1180612.82	SUBGRADE	1056.00
1097	774148.07	1180867.84	SUBGRADE	1056.00
1098	774149.93	1180702.04	SUBGRADE	1050.00
1099	774249.69	1180718.37	SUBGRADE	1052.00
1100	774154.66	1180672.22	SUBGRADE	1046.00
1101	773982.20	1180664.62	SUBGRADE	1056.00
1102	773961.73	1180818.63	SUBGRADE	1056.20
1103	774017.56	1180940.33	SUBGRADE	1058.00

NOTE
THE CONTROL POINTS ON THE TOP OF CLAY LINER ON FLOOR ARE FOR GUIDANCE PURPOSES ONLY. THE TOP OF CLAY LINER WILL BE MODIFIED SUCH THAT THERE WILL BE A MINIMUM OF FOUR FEET BETWEEN THE TOP OF COMPETANT BEDROCK AND THE TOP OF THE CLAY LINER

LEGEND

- CELL BOUNDARY LINES
- 950 EXISTING INDEX CONTOUR
- EXISTING ROADS
- 1020 PROPOSED SUBGRADE INDEX CONTOUR
- PROPOSED RIPRAP LETDOWN STRUCTURE
- PROPOSED CULVERTS
- EROSION CONTROL MATTING
- CONSTRUCTED ROADS IN THIS CONTRACT

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No. 223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No. 9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25909 I-30 — BRYANT, AR 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

GRADING PLAN - SUBGRADE

CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

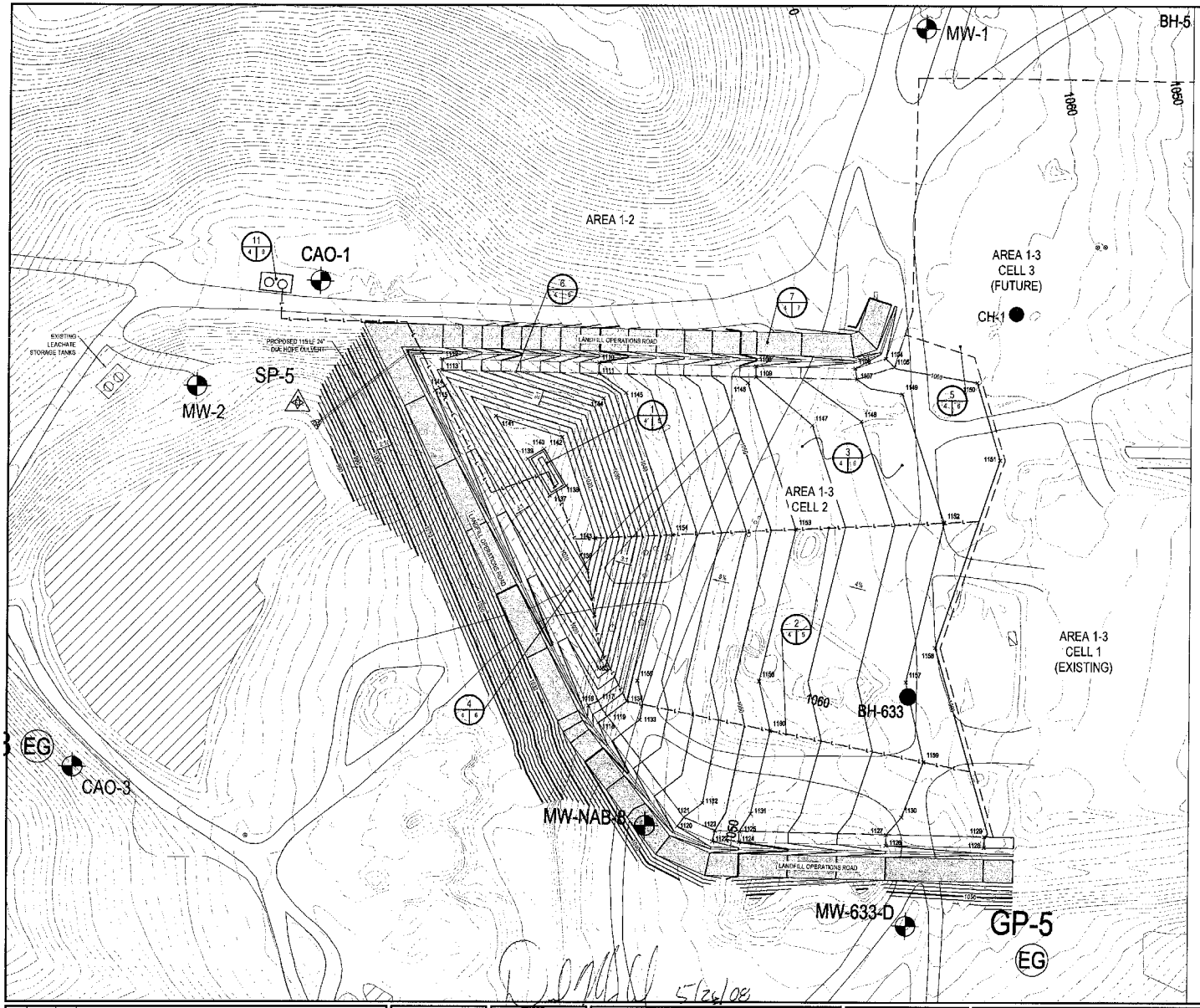
NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY — ARKANSAS

DRAWING 3

DESIGNED BY:	DCM
DRAWN BY:	JDW
APPVD. BY:	DCM
SCALE:	1" = 50'
DATE:	04/30/08
JOB NO.	128-041-30967025
ACAD NO.	004
SHEET NO.:	3 OF 9



CONTROL POINT TABLE

POINT NO.	NORTHING	EASTING	DESCRIPTOR	ELEVATION
1104	774319.75	1180705.04	CLAY	1058.00
1105	774390.74	1180804.98	CLAY	1058.00
1106	774369.41	1180763.07	CLAY	1058.00
1107	774298.02	1180764.74	CLAY	1058.00
1108	774311.53	1180859.19	CLAY	1054.00
1109	774302.18	1180959.56	CLAY	1054.00
1110	774314.90	1180464.23	CLAY	1042.00
1111	774303.95	1180663.99	CLAY	1042.00
1112	774318.27	1180329.16	CLAY	1025.00
1113	774358.52	1180359.93	CLAY	1026.00
1114	774290.53	1180331.94	CLAY	1026.00
1115	774285.48	1180321.78	CLAY	1026.00
1116	773956.40	1180484.85	CLAY	1036.00
1117	773961.53	1180495.02	CLAY	1036.00
1118	773938.65	1180485.42	CLAY	1040.00
1119	773945.38	1180504.57	CLAY	1040.00
1120	773930.64	1180578.97	CLAY	1048.00
1121	773938.95	1180586.12	CLAY	1048.00
1122	773814.85	1180815.58	CLAY	1050.00
1123	773826.14	1180819.06	CLAY	1050.00
1124	773814.34	1180844.58	CLAY	1052.00
1125	773825.48	1180844.77	CLAY	1052.00
1126	773810.84	1180798.89	CLAY	1058.00
1127	773822.19	1180799.12	CLAY	1058.00
1128	773809.87	1180991.97	CLAY	1060.00
1129	773802.22	1180992.18	CLAY	1060.00
1130	773648.46	1180845.18	CLAY	1058.00
1131	773843.51	1180856.47	CLAY	1052.00
1132	773855.16	1180805.97	CLAY	1040.00
1133	773841.72	1180538.09	CLAY	1042.00
1134	773991.08	1180525.09	CLAY	1040.00
1135	774003.04	1180497.99	CLAY	1028.00
1136	774097.20	1180483.17	CLAY	1016.00
1137	774175.87	1180442.30	CLAY	1014.00
1138	774185.98	1180460.07	CLAY	1014.00
1139	774214.23	1180419.73	CLAY	1014.00
1140	774224.54	1180438.87	CLAY	1014.00
1141	774258.92	1180385.06	CLAY	1016.00
1142	774237.92	1180455.81	CLAY	1016.00
1143	774131.28	1180491.20	CLAY	1016.00
1144	774277.81	1180499.10	CLAY	1034.00
1145	774293.35	1180522.56	CLAY	1042.00
1146	774284.16	1180550.75	CLAY	1052.00
1147	774249.69	1180718.37	CLAY	1054.00
1148	774254.61	1180709.65	CLAY	1056.00
1149	774262.56	1180592.52	CLAY	1058.00
1150	774204.67	1180881.49	CLAY	1060.00
1151	774213.57	1180915.82	CLAY	1060.00
1152	774149.07	1180857.84	CLAY	1058.00
1153	774140.80	1180732.84	CLAY	1052.00
1154	774134.99	1180577.22	CLAY	1042.00
1155	773962.59	1180536.29	CLAY	1042.00
1156	773962.20	1180954.62	CLAY	1057.90
1157	773981.73	1180818.53	CLAY	1058.00
1158	774017.56	1180849.33	CLAY	1060.00
1159	773898.25	1180837.77	CLAY	1058.00
1160	773630.66	1180676.44	CLAY	1052.00

NOTE:
THE CONTROL POINTS ON THE TOP OF CLAY LINER ON FLOOR ARE FOR GUIDANCE PURPOSES ONLY. THE TOP OF CLAY LINER WILL BE MODIFIED SUCH THAT THERE WILL BE A MINIMUM OF FOUR FEET BETWEEN THE TOP OF COMPETANT BEDROCK AND THE TOP OF THE CLAY LINER.

LEGEND

- 950 — EXISTING INDEX CONTOUR
- EXISTING ROADS
- 1020 — PROPOSED CLAY LINER INDEX CONTOUR
- PROPOSED RIPRAP LETDOWN STRUCTURE
- PROPOSED CULVERTS
- L — L — PROPOSED LEACHATE COLLECTION LINES

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No.222 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No.9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25809 I-30 BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

GRADING PLAN - CLAY LINER

CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

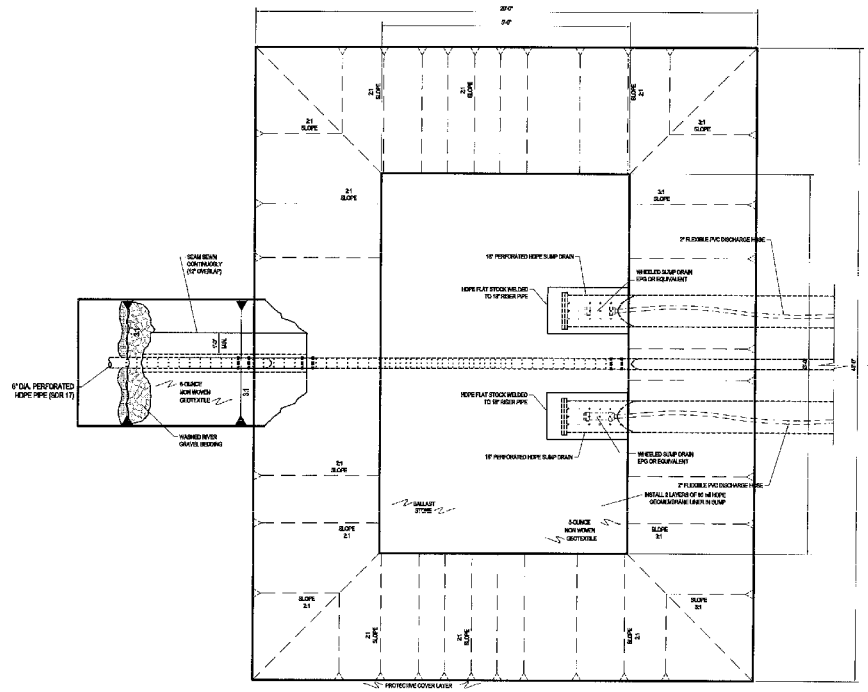
NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY ARKANSAS

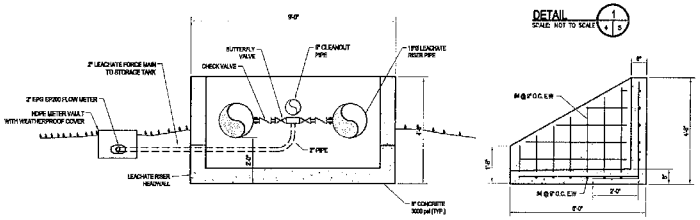
DRAWING 4

DESIGNED BY:	DGM
DRAWN BY:	KNV
APPVD. BY:	DGM
SCALE:	1" = 50'
DATE:	04/06/09
JOB NO.	129.961.35947035
ACAD NO.	005
SHEET NO.:	4 OF 9



LEACHATE COLLECTION SUMP PLAN

DETAIL (1/5) SCALE: NOT TO SCALE

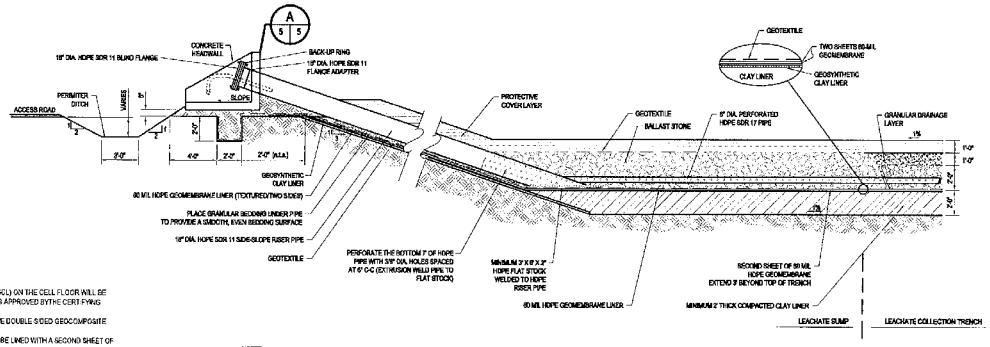


FRONT VIEW

SIDE VIEW

HEADWALL @ LEACHATE RISER PIPE

DETAIL (A/5/5) SCALE: 1/8" = 1'-0"



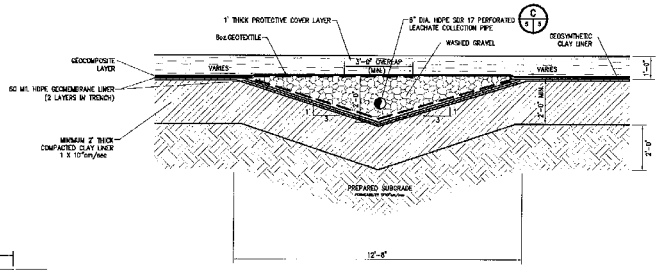
NOTES:

1. THE GEOSYNTHETIC CLAY LINER (GCL) ON THE CELL FLOOR WILL BE CLAYMAX 200R OR EQUIVALENT AS APPROVED BY THE CERTIFYING ENGINEER.
2. ALL AREAS OF THE CELL WILL HAVE DOUBLE SIDED GEOCOMPOSITE PLACED ABOVE IT (8 OZ/SQ.YD.).
3. THE TRENCH AND THE SUMP WILL BE LINED WITH A SECOND SHEET OF 60-MIL HDPE. THIS SECOND LAYER OF 60 MIL HDPE WILL BE SEAMED AND NON-DESTRUCTIVELY TESTED.

NOTES:
1) A SECOND SHEET OF 60-MIL HDPE GEOMEMBRANE SHALL BE PLACED WITHIN THE LIMITS OF THE LEACHATE SUMP AND RISER TRENCH.
2) UPSLOPE LEACHATE CLEANOUT RISER PIPE NOT SHOWN FOR CLARITY.
3) LEACHATE CLEANOUT RISER PIPE SHALL HAVE 3/4#/LAR END CAP ARRANGEMENT (6" DIA SDR 17) AS LEACHATE SIDE-SLOPE RISER PIPE.

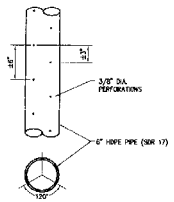
SECTION THROUGH SIDE-SLOPE RISER (ALTERNATE 1)

SECTION (B/5/5) SCALE: 1/4" = 1'-0"



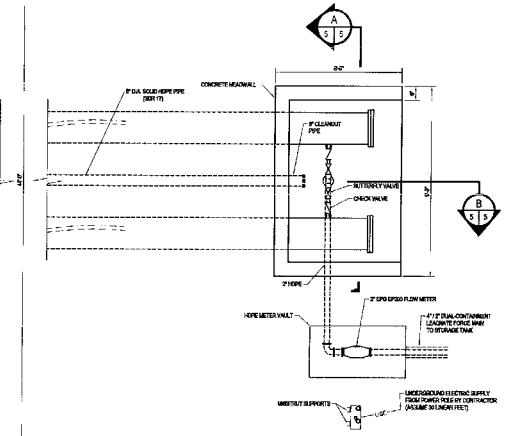
LEACHATE COLLECTION TRENCH DETAIL

DETAIL (2/5/4) SCALE: 1/2" = 1'-0"



LEACHATE COLLECTION PIPE PERFORATION

DETAIL (C/5/5) SCALE: 1-1/2" = 1'-0"



NOTE: CONTRACTOR RESPONSIBLE FOR PROVIDING ALL ELECTRICAL AND CONTROLS BETWEEN METER AT POWER POLE AND LEACHATE TANK SYSTEM. CONTRACTOR WILL WORK WITH OWNER ON THE LOCATION OF THE CONTROL PANEL.

D.C. McC 5/12/08

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No. 223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No. 9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25809 I-30 — BRYANT, AR 72022
PH. (501) 847-9292 — FAX. (501) 847-9210

LEACHATE COLLECTION SYSTEM DETAILS

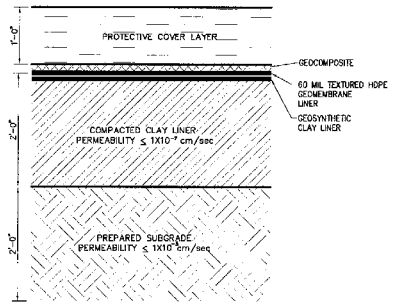
CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

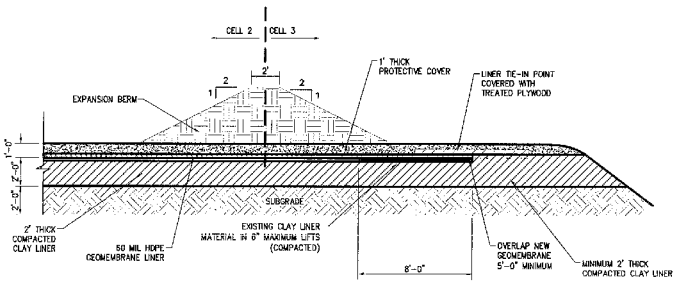
BAXTER COUNTY — ARKANSAS

DRAWING 5	
DESIGNED BY:	DCM
DRAWN BY:	JDW
APPVD. BY:	DCM
SCALE:	AS SHOWN
DATE:	04/00/08
JOB NO.:	128-001-38087025
ACAD NO.:	007
SHEET NO.:	5 OF 9



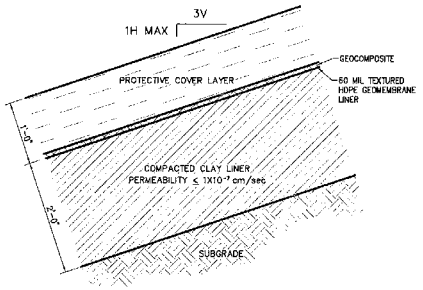
SECTION THROUGH LINER ON BOTTOM OF LANDFILL

DETAIL 3 (4 | 6)
SCALE: 1" = 1'-0"



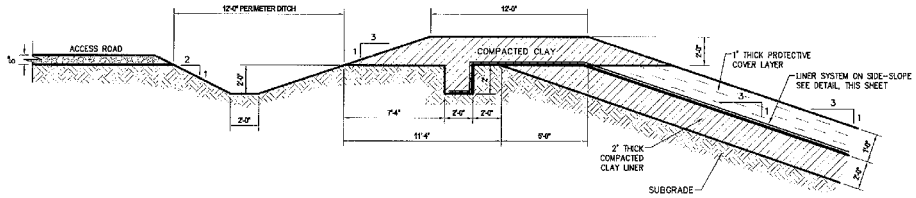
LINER OVER-BUILD AREA

DETAIL 5 (4 | 6)
SCALE:1/4" = 1'-0"



SECTION THROUGH LINER ON SIDE-SLOPE

DETAIL 4 (4 | 6)
SCALE:1" = 1'-0"



SIDE-SLOPE ANCHOR TRENCH

DETAIL 6 (4 | 6)
SCALE:1/4" = 1'-0"

5/12/08

REV	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION TERRACON CONSULTANTS, INC. No.223 ARKANSAS

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No 9199 DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25809 I-30 BRYANT, AR 72022
PH (501) 847 9292 FAX (501) 847-9210

LINER DETAILS

CONSTRUCTION DRAWINGS AREA 1-3 CELL 2

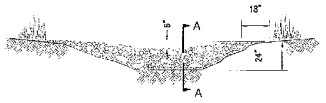
NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY ARKANSAS

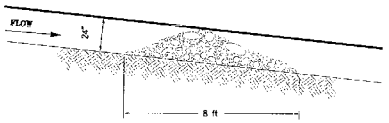
DRAWING 6

DESIGNED BY:	DCM
DRAWN BY:	JDW
APPVD. BY:	DCM
SCALE:	AS SHOWN
DATE:	04/28/08
JOB NO.	128-01-35087025
ACAD NO.	008
SHEET NO.:	6 OF 9



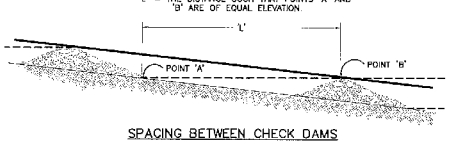
VIEW LOOKING UP STREAM

NOTE:
KEY STONE INTO THE DITCH BANKS AND EXTEND IT BEYOND THE ABUTMENTS A MINIMUM OF 18" TO PREVENT OVERFLOW AROUND DAM



SECTION A–A

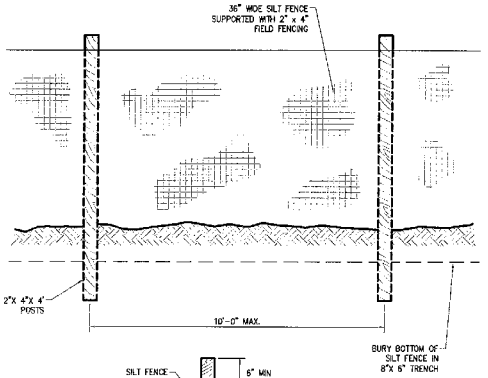
'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION

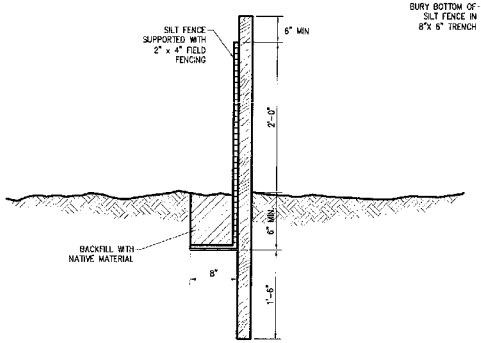


SPACING BETWEEN CHECK DAMS

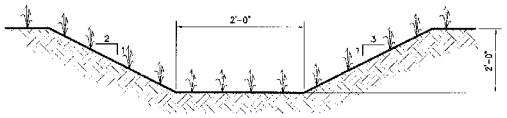
NOTE: PLACE RIPRAP CHECK DAMS ON 200 FOOT CENTERS ALONG ENTIRE LENGTH OF ALL CONSTRUCTED STORMWATER DITCHES

CHECK DETAIL 7 (4 | 7)
SCALE: N.T.S

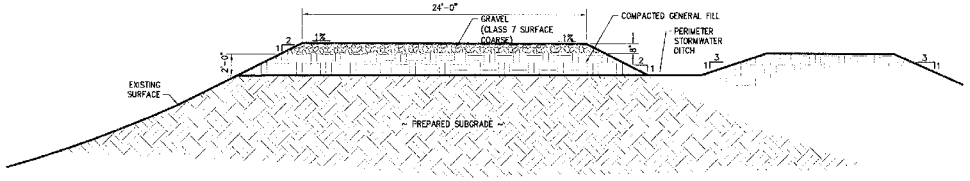




SILT FENCE
DETAIL 9 (3 | 7)
SCALE: N.T.S



PERIMETER STORMWATER DITCH
DETAIL 8 (3 | 7)
SCALE: 3/4" = 1'-0"



TYPICAL SECTION PERIMETER GRAVEL ACCESS ROAD
DETAIL 10 (3 | 7)
SCALE: N.T.S.

5/21/08

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION — TERRACON CONSULTANTS, INC. — No. 223 — ARKANSAS

STATE OF ARKANSAS — REGISTERED PROFESSIONAL ENGINEER — No 9199 — DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25309 I-30 BRYANT, AR 72022
PH (501) 847-9292 FAX (501) 847-9210

MISCELLANEOUS DETAILS

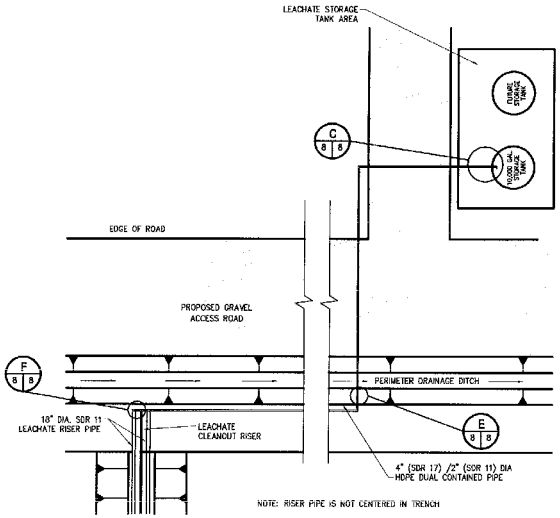
CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

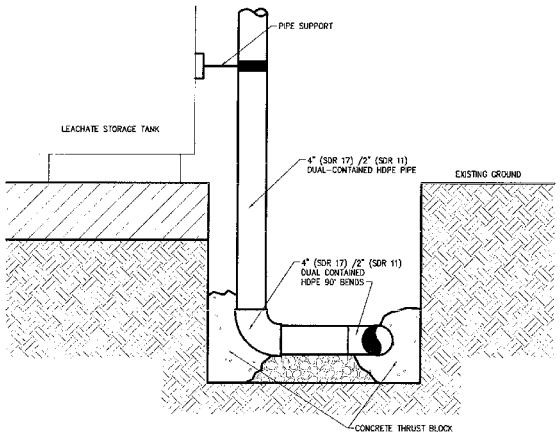
NABORS LANDFILL

BAXTER COUNTY ARKANSAS

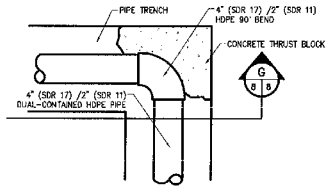
DRAWING 7	
DESIGNED BY:	DCM
DRAWN BY:	JDW
APP'VD. BY:	DCM
SCALE:	AS SHOWN
DATE:	04/30/08
JOB NO.	126-001.35087035
ACAD NO.	009
SHEET NO.	7 OF 9



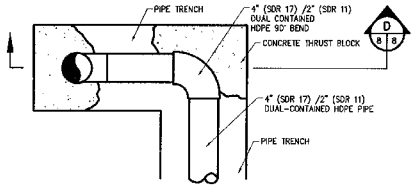
PLAN VIEW - LEACHATE PRESSURE PIPELINE
SCALE: 3/32" = 1'-0"



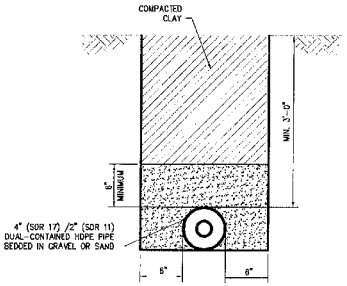
LEACHATE TRANSMISSION LINE NEAR STORAGE TANK
SECTION D
SCALE: 1" = 1'-0"



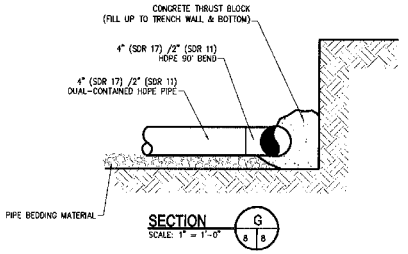
CONCRETE THRUST BLOCK FOR 90° HORIZONTAL BEND
DETAIL F
SCALE: 1" = 1'-0"



LEACHATE TRANSMISSION LINE NEAR STORAGE TANK
DETAIL C
SCALE: 1" = 1'-0"



LEACHATE FORCEMAIN TRENCH
DETAIL E
SCALE: 1-1/2"=1'-0"



SECTION G
SCALE: 1" = 1'-0"

5/2/08

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION TERRACON CONSULTANTS, INC. No.220 ARKANSAS

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No. 9199 DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
25609 I-30 BRYANT, AR 72022
PH (501) 847-9292 FAX (501) 847-9210

LEACHATE TRANSMISSION DETAILS

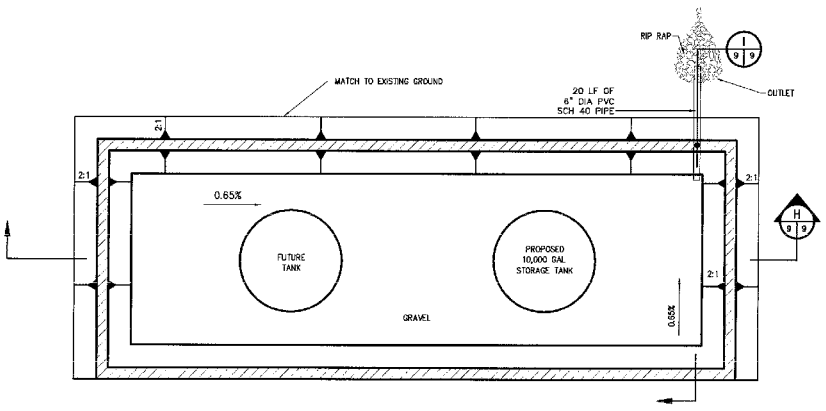
CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY ARKANSAS

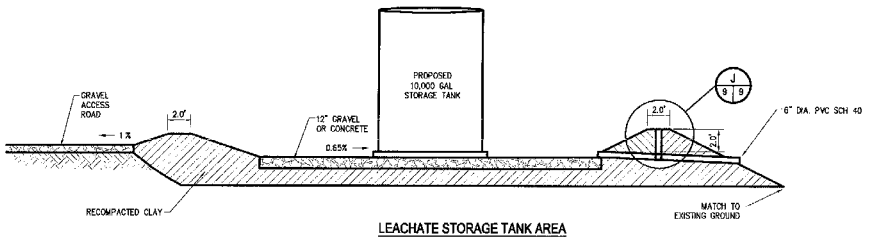
DRAWING 8	
DESIGNED BY:	DCM
DRAWN BY:	JDW
APPVD. BY:	DCM
SCALE:	AS SHOWN
DATE:	5/2/2008
JOB NO.:	128-001-35087025
ACAD NO.:	010
SHEET NO.:	8 OF 9



NOTE:
LEACHATE TANK AREA TO BE APPROXIMATELY 20'x40'. CONTRACTOR TO WORK WITH OWNER ON FINAL SETUP FOR EASE OF OPERATION

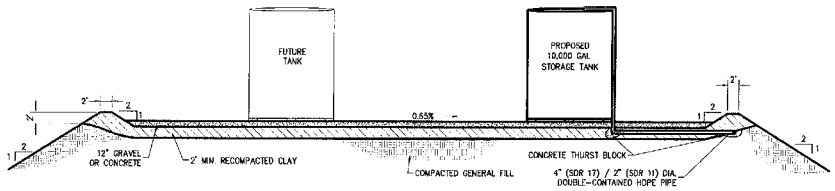
PLAN VIEW - LEACHATE STORAGE TANK AREA

DETAIL 11 (4 | 9) SCALE: 1" = 10'



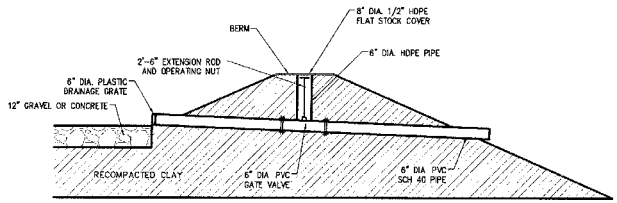
LEACHATE STORAGE TANK AREA

SECTION I (9 | 9) SCALE: 1" = 5'



LEACHATE STORAGE TANK AREA

SECTION H (9 | 9) SCALE: 1" = 10'



LEACHATE TANK AREA OUTLET

DETAIL J (9 | 9) SCALE: 3/8" = 1'-0"

5/2/08

REV.	DATE	BY	DESCRIPTION

CERTIFICATE OF AUTHORIZATION TERRACON CONSULTANTS, INC. No.225 ARKANSAS

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No.9199 DAVID C. McCORMICK

Terracon
Consulting Engineers and Scientists
2569 I-30 BRYANT, AR 72022
PH (501) 847-9292 FAX (501) 847-9210

LEACHATE TRANSMISSION DETAILS - SHEET 2

CONSTRUCTION DRAWINGS FOR AREA 1-3 CELL 2

NORTHWEST ARKANSAS REGIONAL SOLID WASTE MANAGEMENT DISTRICT

NABORS LANDFILL

BAXTER COUNTY ARKANSAS

DRAWING 9

DESIGNED BY:	DCM
DRAWN BY:	JCW
APPVD. BY:	DCM
SCALE:	AS SHOWN
DATE:	05/14/08
JOB NO.	108-001-25087025
ACAD NO.	011
SHEET NO.:	9 OF 9

CONSTRUCTION QUALITY ASSURANCE PLAN

NABORS CLASS 1 LANDFILL

NABORS CLASS 1 LANDFILL

PREPARED FOR:

NABORS LANDFILL
1320 RLH LANDFILL ROAD
THREE BROTHERS, ARKANSAS 72653
(870) 425-3213

PREPARED BY:

Genesis Environmental Consulting, Inc.
11400 West Baseline Road
Little Rock, Arkansas 72209

JANUARY 2006

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SECTION #1
GENERAL

1.0 INTRODUCTION

Arkansas Regulation Reg.22.428 requires all Class 1 municipal solid waste landfills in Arkansas to develop a written 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 Lining and Cover Systems (Geosyntec, 1992*). The NABORS Class 1 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 for earthworks, low-permeability soil liners, and granular drainage systems 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); February 17, 2005;

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. **APPENDIX A** defines terminology commonly used in this document and in the field of CQA.

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.

Detailed definitions of terminology used in this plan is provided in **APPENDIX A** of this document.

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 NABORS Class 1 Landfill facility. **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 NABORS Class 1 Landfill facility. Where applicable, the NABORS Class 1 Landfill facility 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.

3.1.1 Owner

The Owner owns, and/or is responsible for, the facility including components constructed within the scope of this document. Unless otherwise noted, the NABORS Class 1 Landfill facility will be the owner of any liner/final cover system constructed in association with the Landfill. The NABORS Class 1 Landfill facility 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. 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. 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 or not 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 shall be a 3rd Party firm or agency with no direct corporate ties to the Owner, which could be construed as a conflict of interest. The Design Engineer will review periodic CQA reports and will review and seal the Certification Report prior to submittal to the ADEQ.

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 Manager 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 3rd 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 earthworks at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geomembranes, geotextiles, geogrids, and geonets. 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 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 earthworks at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geomembranes, geotextiles, geogrids, and geonets.

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 earthworks at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geomembranes, geotextiles, geogrids, and geonets.

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 CQA Firm may be retained by the Owner or the General Contractor.

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 CQC field testing may be performed by the geosynthetics installer if deemed acceptable by the CQA consultant. 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. This analysis shall be conducted by a firm independent of the geosynthetics installer.

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, geomembrane, 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 fibers.

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 or factory panels of geomembranes, geotextiles, geogrids, 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 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/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. 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, to the Owner before entering into contractual agreements with the Owner:

1. Corporate background and information
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 geomembranes, geonets, geogrids, and geotextiles;
   - a summary of the firm's experience in quality assurance, including installation quality assurance of geomembranes, geonets, geogrids, 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 Geosynthetics CQA Consultant shall provide the following, in writing, to the Project Manager 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 (or ability to be registered) in the project state of the engineer to be designated the CQA Certifying Engineer, as well as proof of B.S., M.S., or Ph.D. engineering degree; and
3. Proof of quality assurance experience of the CQA personnel with emphasis on geomembranes, as well as geonets, geotextiles, geogrids, and GCL's.

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 – Construction quality assurance (CQA) shall be provided by an independent third party. If the certifying firm or individuals have any relationship with the owner or operator of the facility which could 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 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 earthworks 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 Contractors Bid to the Project Manager.

3.2.6 Resin Supplier

Qualifications of the Resin Supplier are specific to the Manufacturer's requirements. The Resin Supplier shall have a demonstrated history of providing resin with consistent properties.

3.2.7 Geosynthetics Manufacturer

The Geosynthetics manufacturer shall be able to provide sufficient production capacity and qualified personnel to meet the demands of the project. The Geomembrane Manufacturer, in particular, shall be pre-qualified and approved by the Engineer and Owner. The qualifications presented by the Geomembrane Manufacturer shall, at a minimum include:

1. Corporate background and information
2. Manufacturing capabilities:
   - information on plant size, equipment, personnel, number of shifts per day and capacity per shift;
   - daily production quantity available for this contract;
   - quality control manual for manufacturing; and
   - list of material properties including certified test results, to which are attached geomembrane samples.
3. A list of at least ten completed facilities, totaling a minimum of 9,290,304 m^2 (100,000,000 ft^2), for which the Geomembrane Manufacturer has manufactured a geomembrane of the type to be used for this project. For each facility, the following information shall be provided:
   - name and purpose of facility, its location, and date of installation;
   - name of owner, project manager, designer, fabricator (if any), and installer;
   - thickness of geomembrane and surface area of geomembrane manufactured; and
   - available information on the performance of the lining system and the facility.

3.2.8 Geosynthetics Installer

The Geosynthetics Installer shall be trained and qualified to install geosynthetics. The Geomembrane Installer, in particular, shall be approved and/or licensed by the Geomembrane Manufacturer and/or the Geomembrane Fabricator. A copy of the approval letter or license shall be submitted by the Geomembrane Installer to the Project Manager. Prior to confirmation of any contractual agreements, the Geomembrane 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; and
6. Samples of field seams and certified test results.

7. A list of at least five completed facilities, each totaling a minimum of 185,807 m^2 (2,000,000 ft^2), for which the Geomembrane Installer has installed a polyethylene geomembrane. For each installation, the following information shall be provided:
   - name and purpose of facility, its location, and date of installation;
   - name of owner, project manager, designer, manufacturer, and fabricator (if any);
   - name and qualifications of the supervisor(s) of the Installer's crew(s),
   - thickness of geomembrane and surface area of the installed geomembrane,
   - type of seaming and type of seaming apparatus used;
   - duration of installation; and
   - available information on the performance of the lining system and the facility.

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 464,500 m^2 (5,000,000 ft^2) of polyethylene geomembrane using the same type of seaming apparatus as to be used for this project. The most experienced seamer, the "master seamer", shall provide direct supervision, as required, over less experienced seamers. No field seaming shall take place without the master seamer being present.

The Geomembrane Installer shall provide the Project Manager with a list of proposed seaming personnel and their professional records. All quality control technicians shall have a minimum 5,000,000 ft^2 of experience installing polyethylene lining systems. All other seaming personnel shall have a minimum of 1,500,000 ft^2 of experience installing geomembranes. This document shall be reviewed by the Project Manager/Design Engineer and the Geosynthetics CQA Consultant. Any proposed seaming personnel deemed insufficiently experienced will not be accepted or shall be invited to pass a seaming test.

The Installer shall designate one representative as his Superintendent, who shall represent the Installer at all site meetings and be responsible for acting as the Installer's spokesman on site. This Superintendent shall be pre-qualified for this role, on the basis of experience, management ability, and authority. His appointment will be approved by the Project manager and the Geosynthetics CQA Consultant.

3.2.9 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 insure 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 who are located at the site.

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. Attends all CQA-related meetings, i.e., 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. Verifies the calibration and condition of on-site CQA equipment;

7. Oversees collection and shipping of all laboratory test samples;
8. Reviews results of laboratory testing and makes appropriate recommendations;
9. Reviews all CQA Monitors' daily reports and logs;
10. Reports to the Project Manager, and logs in his daily field report any relevant observations reported by the CQA Monitors;
11. Prepares daily report;
12. Prepares weekly summary of CQA activities;
13. Delegates responsibilities to a senior CQA Monitor whenever absent from the site while operations are ongoing;
14. Reports any unresolved deviations from the CQA Plan to the CQA Manager; and
15. Prepares the final CQA report with the CQA Manager.

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; and
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.

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. On-site conformance testing to verify thickness of geomembranes and geonets;
4. Marking samples for conformance testing;
5. Sampling for conformance testing by the Geosynthetics CQC Firm;
6. All placement operations;
7. Condition of panels as placed;
8. All joining and/or seaming operations;
9. Repair operations;
10. Trial seams;
11. Seam preparation;
12. Seaming;
13. Nondestructive seam testing;
14. Sampling for destructive testing;
15. Field tensiometer testing; and
16. Laboratory sample marking.

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.

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.

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;
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 spare seaming units for geomembranes to be maintained on site by the Installer (this number depends on the number of seaming crews and on the type of seaming equipment);
10. Decide the number of soil density testing units to be maintained on site;
11. Establish work area security and safety protocol;
12. Select testing equipment and review protocols for testing and placement of soil materials;
13. Confirm the methods for documenting and reporting, and for distributing documents and reports; and
14. Confirm the lines of authority and communication.

The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

4.2 Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. At a minimum, the meeting shall be attended by the Owner, Project Manager, Design Engineer, CQA Manager, Earthwork Contractor, and Geosynthetics Installer. 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;
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. Establish rules for writing on the geomembrane, i.e., who is authorized to write, what can be written and in which color;
9. Outline procedures for packaging and storing archive samples;
10. Review panel layout and numbering systems for panels and seams;
11. Establish procedures for use of the extrusion welding apparatus;
12. Establish procedures for use of the fusion welding apparatus, if applicable;
13. Finalize field cutout sample sizes;
14. Review seam testing procedure;
15. Review repair procedures;
16. Conduct a site walk-around to verify that earthwork construction is proceeding on schedule, and to review material storage locations;
17. Establish soil stockpiling locations; and
18. Review precautions to be taken against clay deterioration, due to wetting or desiccation.

The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

4.3 Progress Meetings

A weekly progress meeting 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 week, 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 meeting shall be attended by the affected contractor(s), the Project Manager, and the appropriate CQA Manager(s). 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.

The meeting shall be documented by a person designated at the meeting and minutes shall be transmitted to affected parties.

4.5 Project Control Visits

4.5.1 Periodic Visits

Periodically, the construction site shall be visited by the CQA Manager, and the Certifying Engineer(s). 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. State regulatory officials may also be informed of these designated inspection dates if deemed appropriate by the Project Manager and/or Owner.

4.5.2 Manufacturing Plant Visits

A geomembrane manufacturing plant visit may be carried out by a representative of the Owner, Project Manager, Design Engineer, or CQA Manager in order to verify manufacturing practices or quality control procedures. These visits will be arranged on a "as needed" basis if deemed appropriate by the Project Manager. Project specific plant visits for the manufacture and fabrication of the geomembrane, as well as the other geosynthetics (geotextiles, geogrids, GCLs, and geonets) are optional. 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 liner system, 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 benchmark will be established for the project in a location convenient for reference during construction. The reference datum will be consistent with State Plane Coordinates and/or 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 are either 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 PRECISION AND ACCURACY

A wide variety of survey equipment is available for use in projects of this type. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.1 feet and with a setting accuracy of $\pm$ 0.8 sec. (2.2×10^{-3} degrees).

4.0 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
   - finished grade surface
2. For the compacted soil liners
   - original contours
   - prepared subgrade surface

- finished compacted soil liner surface

3. For the soil cover materials
   - prepared surface
   - finished soil cover surface

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

5.0 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 spacings 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.

6.0 DOCUMENTATION

Copies of all field survey notes should be retained by the Surveying CQA Managing Engineer. 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:

    1. Layout of Prepared Area in Relation to Permitted Boundaries;
    2. Property boundaries and/or corners;
    3. Monitoring wells and piezometers (if scale permits);
    4. Leachate risers, manholes and collection piping related to the specific cell and/or construction;
    5. Limits of existing/future refuse disposal areas and limits of liner or final cover barrier;
    6. Any gas monitoring facilities or wells in the area;
    7. Labeling and Miscellaneous Information
        - Descriptions of what each line style represents
        - Drawing scale
        - Legend
        - North Arrow
    8. Existing Contours (prior to construction activity corresponding to this project);
    9. 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; and
    10. 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
    11. 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;
    12. Any other features deemed significant.

2. Subgrade Drawing showing:

    1. Prepared Subgrade Surface (Plan View);
    2. The limits of excavation including all slopes;
    3. The location of slope breaks, leachate sump and trenches, berms; and
    4. Any other features deemed significant.

3. Top of Compacted Clay Liner System (or GCL) showing:

    1. The top and bottom of liner or final cover elevations referenced to the site grid coordinate system at 50’ elevations;
    2. 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;

3. Any other features deemed significant.

4. Top of Drainage Layers or Liner Protection Layers showing:

    1. If a granular blanket is utilized in the design, top of blanket elevation should be identified at 50' intervals;
    2. The location of slope breaks, leachate sump and trenches, berms; and trenches, berms; and any other features which are material to the disposal area construction;
    3. Any other features deemed significant.

The Contractor will be responsible for submitting these record drawings (as built) to the CQA Consultant for review. The 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

1.0 INTRODUCTION

This CQA document covers five types of soil that are used in the construction of a MSW 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 NABORS Class 1 Landfill facility.

1. Subgrade Surface;
2. Compacted Clay Liners and/or Compacted Clay Barrier 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. 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 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 there compaction criteria. Since 100% standard proctor is assumed under natural soil conditions the subgrade is assumed to be as such if undisturbed. 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 composite 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;
3. Other tests identified in TABLES 2 and 3;

The main requirement for the subgrade is it must have sufficient compaction and strength to enable the placement and compaction of the clay liner. The subgrade also must be stable to prevent large differential settlements that would be conducive to damage of the liner system or the pooling of leachate. 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.

2.2 Compacted Clay Liners

The soil components of the composite liner system shall consist of the following specifications. This includes compacted clay liners for bottom liner systems and compacted clay barrier 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);
2. The soil must be classified as either CL, CH or SC and should have a Plasticity Index (PI) greater than 10;
3. Material greater than #4 sieve must compose less than twenty percent (20%) of soil by weight with no particle sizes greater than 1.0inch per diameter;
4. Soil clod size must be less than four (4) inches in diameter;
5. The soil component of the composite liner system and final cover barrier layers must have a hydraulic (K) of $1x10^{-7}$ cm/sec or less measured by undisturbed hydraulic conductivity test, installed and compacted at a minimum of 90% Standard Proctor maximum dry density at a moisture content 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 constructed 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 indicate a change in material characteristics. Tests shall be conducted in a manner to correlate compaction effort to permeability. Tests shall include:
    (i) Moisture Content (ASTM D854)
    (ii) Particle Size (ASTM D1140, D422)
    (iii) Atterberg Limits (ASTM D4318)
    (iv) Laboratory Compaction (ASTM D698)
    (v) Laboratory Hydraulic Conductivity at a specified compaction (ASTM D5084)
7. Construction testing on soil hauled for linear or final cover placement shall be conducted at a rate of one test set every 5,000 cubic yards of material used in the construction of the liner, or more frequently if visual observation indicates a change in material or if otherwise indicated herein. In addition to the test shown below, the liner shall be monitored to insure bonding between lifts and that the specified lift thickness is being achieved. Tests shall include:
    (i) Moisture Content (ASTM D854)
    (ii) Particle Size (ASTM D1140, D422)
    (iii) Atterberg Limits (ASTM D4318)
    (iv) Laboratory Compaction (ASTM D698)
    (v) 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 ft^2 of liner constructed per compacted lift and shall include:

   Moisture Content (ASTM D854)

9. Performance testing on undisturbed field samples shall be conducted at the rate of one test every 40,0000 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 H, 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 liners and/or clay barrier layers shall not exceed 1.0×10^{-7} cm/s;

14. The soil must be compacted to the appropriate density and moisture content as per the Specifications and as determined by ASTM D698;

15. Maximum soil clod size, soil classifications, Atterberg Limits, and other physical properties shall be as specified;

16. Any moisture conditioning that is required shall be conducted in such a manner as to preserve the homogeneity of the soil and insure that moisture contents throughout the soil mass are relatively uniform;

Regardless of the properties of the soil materials comprising the soil components of the clay liner and clay barrier layers, the hydraulic conductivity shall be verified by sampling and laboratory testing. The clay liner 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 determined utilizing the Hydrologic Evaluation of Landfill Performance (HELP, Version 3.0) Model. This value should 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 #4 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;
   - 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 D-6). See **TABLE 1** for typical minimum thickness used for the ground pressure exerted by the equipment.
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.

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

TABLE 1
Required Lift Thickness of Sand/Gravel Layer Based on Equipment Ground Pressure

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

2.4 Liner Protective Cover Layers

The protective cover materials above the lining system and primary leachate collection system components are addressed herein. In some instances, the Liner Protective Layer also serves as the Lateral Drainage Layer. The protective cover materials used to protect either the primary geomembrane and/or the leachate collection system, shall consist of fine grained sandy soils or gravels with a minimum hydraulic conductivity as per the Project Specifications. If the Protective Cover Layer is also to act as a lateral drainage layer as part of the leachate collection system design then the material chosen shall demonstrate a minimum hydraulic conductivity as generated using the Hydrologic Evaluation of Landfill Performance (HELP, Version 3.0). This value should be determined by the Design Engineer and included in the Project Specifications.

Shredded tires and/or tire chips may be used for the protective cover layer. In no case shall tire chips or shredded tires be placed directly above or in contact with the geomembrane.

2.5 Soils Testing

2.5.1 Test Methods

All testing used to evaluate the suitability or conformance of soils 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 2, 3,** and **4** are to be utilized for evaluating soils materials (when applicable) for adherence to the project specifications and the materials standards specified in this CQA Plan.

TABLE 2:
TEST REQUIREMENTS FOR PRECONSTRUCTION TESTING OF CLAY LINER AND/OR CLAY COVER MATERIALS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]
Soil Classification	ASTM D 2487	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
Atterberg Limits	ASTM D4318	1 test per 20,000 yd^3 or change of material or borrow area
Percent Passing No. 200 Sieve	ASTM D1140	1 test per 20,000 yd^3 or change of material or borrow area
Moisture	ASTM D854	1 test per 20,000 yd^3 or change of material or borrow area
Permeability	ASTM D5084	3 tests per 20,000 yd^3 or change of material or borrow area; Tests are to be run at a compaction and moisture content that simulates the standards outlined in the technical specifications.

TABLE 3:
TESTING REQUIREMENTS FOR CONSTRUCTION TESTING OF CLAY LINER AND/OR CLAY BARRIER LAYER

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]
In-Place Field Density/Moisture (Subgrade)	ASTM D2922	1 test per 10,000 ft^2
In-Place Field Density/Moisture (Clay Liner)	ASTM D2922	1 test per 10,000 ft^2 per lift of liner placed (minimum of six per lift)
Soil Classification	ASTM D2487	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
Atterberg Limits	ASTM D4318	1 test per 5,000 yd^3 or change of material or borrow area
Percent Passing No. 200 Sieve	ASTM D1140	1 test per 1,000 yd^3 or change of material or borrow area
Permeability	ASTM D5084	1 test per 40,000 ft^2 per lift

All construction and preconstruction testing for sand/gravel layers shall be performed at the frequency given in the tables below. All tests are to be performed in accordance with the latest version of the ASTM test listed.

TABLE 4
REQUIRED TESTING FOR PRECONSTRUCTION TESTING OF SAND AND GRAVEL

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]
Gradation	ASTM D422	1 test per source or change in material
Permeability	ASTM D2434	1 test per source or change in material

TABLE 5
REQUIRED TESTING FOR CONSTRUCTION TESTING OF SAND AND GRAVEL

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1,2]
Gradation	ASTM D422	1 test per 5,000 yd^3 or change of material or borrow area
Permeability	ASTM D2434	1 test per 5,000 yd^3 or change of material or borrow area

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. Any conflict over the results shall be resolved by the Soils CQA Consultant and/or CQA Manager.

The test frequencies presented in **TABLES 2, 3, 4,** and **5** are specified as minimum test frequencies. The actual frequency of testing required can be increased by the CQA Manager or Soils CQA Consultant 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 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 Contractor must prepare a test pad in accordance with this section unless it can be demonstrated that the Contractor successfully constructed a minimum of 2,000,000 square feet of compacted clay liner systems in the past two years for the containment of waste or water systems using similar soils, equipment, and installation methods. Demonstrations of Earthworks Qualification shall be made to the Project Manager and/or Design Engineer prior to mobilization.

The Project Manager, CQA Manager, or other 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 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
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. 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 or 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 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
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 clay 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
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 following criteria as outlined below. The following criteria for each lift is 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.
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;
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
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 synthetic liner is placed on the clay liner and/or compacted clay barrier layer.

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
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
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

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 ASTM Test D5093 - 90 "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. 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 5084.

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
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 1×10^{-7} cm/sec or less;
   - 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 (sheepsfoot penetration, pumping, cracking, etc.);
3. Noting the liner material for any change is 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 be the CQA Soils monitor.

4.3 Field and Laboratory Tests

The field and laboratory test methods and testing frequencies presented in **TABLES 2 and 3** shall apply to all clay liner and clay barrier layer systems constructed associated with the NABORS Class 1 Landfill facility. 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 this area is determined by the Soils CQA Monitor. 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 or as directed by the Project Manager and/or CQA Manager. Testing methods, as previously identified, shall be observed by the Soils CQA Monitor. 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 2**.

Sampling locations shall be selected by the Soils CQA Consultant. 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. 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. 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 to be 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 any additional work is performed by the Contractor in the area of the deficiency. 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, summarizing discussions between the Soils CQA Monitor and Contractor. At a minimum, the memorandum 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 the following information:

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 reduced-scale 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

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, 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 for 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 any revision to procedures or specifications shall be approved by the Owner and the Design Engineer.

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, shall be cross-referenced with observation and testing data sheet(s), and/or construction problems and solution data sheet(s). These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in

chronological order. These records shall be presented to the Project Manager upon completion of the project.

5.4 Design and/or Specifications 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 specifications 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 each week, or at time intervals established at the pre-construction meeting. As a minimum, this report shall include the following 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 scale 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, AND 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 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 shall be tested by the Manufacturer for the following specifications:

TABLE 6
TESTING REQUIREMENTS
FOR POLYETHYLENE GEOMEMBRANE RAW MATERIALS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]
Specific Gravity	ASTM D1505	per batch
Melt Index	ASTM D1238 Condition E 190^{o}C/2.16 kg	per batch

1 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, provided that 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 E, 190^{O}C/2.16 kg).
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 6 and 7** provide the frequency of testing for the geomembrane. The CQA Monitor shall verify that the specifications include at least all properties listed in **TABLES 6 and 7**, measured with the same methods or equivalent.

If the specifications do not fulfill the above conditions, the required alterations of the specifications shall be completed by the Design Engineer. 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 7
CONFORMANCE TESTING REQUIREMENTS
FOR POLYETHYLENE GEOMEMBRANE

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING[1]
Density	ASTM D792	1 test per 100,000 ft^2
Tensile Strength at Yield	ASTM D638	1 test per 100,000 ft^2
Tensile Strength at Break	ASTM D638	1 test per 100,000 ft^2
Elongation at Yield	ASTM D638	1 test per 100,000 ft^2
Elongation at Break	ASTM D638	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 D3015	1 test per 100,000 ft^2
Average Thickness	ASTM D1503	1 test per 100,000 ft^2

1. Or as dictated by the project plans and project specifications; Manufacturer's quality control testing shall be completed at a frequency of one test per roll.

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. The quality control certificate shall be signed by a responsible party employed be the Geomembrane Manufacturer, such as the production manager. 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
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 ineligible 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 which 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 were the geomembrane will not be damaged or in the way of daily operations of the sanitary 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 are 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 7** 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 ft^{2} whichever is greater). Material lots found not in conformance will be rejected.

    (i) Density (ASTM D1505) or Specific Gravity (ASTM D792, Method A)
    (ii) Carbon Black Content (ASTM D1603)
    (iii) Carbon Black Dispersion (ASTM D3015)
    (iv) Thickness (ASTM D1593)
    (v) Tensile Properties (ASTM D638)
    (vi) Tear Resistance (ASTM D1004, Die C)
2. Seam Testing
    (i) Trail seams tested in field tensiometer or at testing laboratory at the beginning of everyday and every four working hours.
    (ii) Air pressure and vacuum testing of all field seam lengths

1.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three lineal 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 7**.

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 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 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 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 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 is repaired.

At any time before and during the geomembrane installation, the Geosynthetics CQA Monitor shall indicate to the Project Manager locations which 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. This identification code shall be agreed upon by the Project Manager, Installer and CQA Monitor. 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 pounded 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 if 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); and
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.

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 form 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 ft^2 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. This document shall be reviewed by the Project Manager and the Geosynthetic CQA Monitor.

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;
4. The geomembrane is protected from damage in heavily trafficked areas; and
5. An insulating plate or fabric is placed beneath the hot welding apparatus.

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;
4. The geomembrane is protected from damage in heavily trafficked areas; and
5. An insulating plate or fabric is placed beneath the hot welding apparatus.

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 "fishmouths".

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. 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.
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. Also, 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 at test properly; this is usually 3” for extrusion welding and 4” for fusion welding.
3. 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 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.
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
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
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 which 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 are 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 or not 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 8**. 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 8
GEOMEMBRANE SEAM
TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Peal Adhesion	ASTM D4437	1 test per 500 feet seam length
Bond Seam Strength	ASTM D4437	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 tow 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 CQC Firm shall be selected by the Geosynthetics CQA Consultant 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 that test was conducted by the Geosynthetics CQC Firm, the Installer's laboratory, or the gauged tensiometer.

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 which 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 Manger, 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 on 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 an 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
- Certification, including "as built" drawing(s), sealed by a registered professional engineer has been received by the Project Manager.

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

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

2.7.2 Concrete

A copy of the specifications prepared by the Design Engineer for placement of concrete shall be given by the Project Manager 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

A copy of the specifications prepared by the Design Engineer for sumps and appurtenances shall be given by the Project Manager 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 Monitor.

The Geosynthetics CQA Manager shall review the daily reports submitted by the Geosynthetics CQA Monitors, and incorporate summary of their reports into his own daily 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 the day following the report date.

3.2 Destructive Test Reports

The destructive test reports from all sources shall be collated by the Geosynthetics CQA Monitor. 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, 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 for occurring in the future; and
8. The signature of the CQA Manager/Monitor and signature indicating concurrence 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 any revision to procedures of specifications shall be approved by the Owner and Design Engineer.

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. The survey should be performed by a third party independent surveyor. 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 permit
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. 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:

1. Personnel involved with the project;
2. Scope of work;
3. Outline of project;
4. Construction quality assurance methods;
5. Test results (destructive and non-destructive, including laboratory tests);
6. Sealed and signed by a registered professional engineer; and
7. 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 document originals shall be stored by the owner/operator in a manner that will allow for easy access. An additional copy should also be kept at the facility.

SECTION #5
OTHER

1.0 GEONETS AND GEOCOMPOSITES

1.1 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
5. Results of quality control testing
   - Polymer-specific gravity
   - Mass per unit area
   - 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.

Quality assurance tests shall be performed by the in accordance with the test methods specified in **TABLE 9** for every 100,000 $ft.^2$ of geonet and/or geocomposite produced for the project. The manufacturer shall also 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.

The CQA Consultant shall examine all manufacturer's certifications to insure that the property values listed on the certifications meet or exceed those specified and the measurements of properties by the manufacturer are properly documented, test methods 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 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
5. Roll dimensions

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

1.3 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 Quality Assurance 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.

1.4 Conformance Testing

1.4.1 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 tests presented in **TABLE 9** shall be performed 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
Density	ASTM D1505	1 test per 100,000 ft^2
Thickness	ASTM D1777	1 test per 100,000 ft^2
Transmissivity	ASTM 4716	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 job.

1.4.2 Sampling Procedures

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

1.4.3 Test Results

The CQA Monitor shall examine all results form 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.

1.5 Installation of the Geonet

1.5.1 Handling and Placement

The Installer shall take steps necessary to insure that any underling 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, and/or stones that could damage the adjacent geomembrane, 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 of 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). Such locations shall be identified by the Designer in 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 transitivity.

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.
5. Unless otherwise specified, geonets and/or geocomposite shall not be welded to geomembranes.

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

1.5.2 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.

1.5.3 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. Geonets may be butt-joined or lapped if specified. Nylon/plastic cable ties will be applied to the net edge at five foot intervals along the edge. End splices will be made as follows:

1. On slopes, the ends will overlap two feet with the uphill panel on top with two rows of cable ties applied
2. 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.

1.5.4 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 1.5.3. 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 1.5.3.

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

2.0 GEOTEXTILES

2.1 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. 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:

1. mass per unit area;
2. grab strength;
3. tear strength;
4. burst strength;
5. puncture strength;
6. wide strip tensile strength;
7. thickness; and
8. permeability and apparent opening size.

Quality assurance tests shall be performed in accordance with the test methods specified in **TABLE 10** for every 100,000 ft^2 of geotextile produced for the project. The geotextile manufacturer shall also provide a written certification that the nonwoven, needle-punched geotextiles are continuously inspected and found to be needle-free.

The CQA Consultant shall examine all manufacturer certifications to insure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile and the measurements of properties by the Manufacturer are properly documented, test methods 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 geotextile manufacturer and the geogrid manufacturer shall identify all rolls of geotextile and geogrid 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.

2.3 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.

2.4 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. As a minimum, the following tests shall be performed on geotextiles:

1. mass per unit area;
2. grab strength;
3. tear strength;
4. burst strength;
5. puncture strength;

6. wide strip tensile test;
7. thickness; and
8. permeability and apparent opening size.

These conformance tests shall be performed in accordance with the tests methods specified in the project specifications. Other conformance tests may be required by the specifications. Testing frequency for the geotextiles is presented in **TABLE 10**. 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.

TABLE 10
GEOTEXTILE CONFORMANCE
TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Mass per Unit Area	ASTM D3776	1 test per 100,000 ft.^{2}
Puncture Resistance	ASTM D4833	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 D4362	1 test per 100,000 ft.^{2}
Mullen Burst	ASTM D3786	1 test per 100,000 ft.^{2}

Note: Testing shall be carried out at a frequency of one per lot or at listed frequency, whichever is less.

2.4.1 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear three 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 ft^2, whichever is least, as indicated in **TABLE 10** for geotextiles.

2.4.2 Test Results

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

2.5 Handling and Placement

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

1. On slopes, the geotextiles and the geogrids 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 geogrid sheet in tension.
2. In the presence of wind, all geotextiles and geogrids 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 shall be cut using an approved geotextile cutter only. Geogrids shall be cut using scissors 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 or the geogrids.
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile or the geogrid.

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 damage the geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
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.

2.6 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.

On bottom and slopes shallower 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.

2.7 Defects and Repairs

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

1. On slopes: A patch made form 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 form 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.

2.8 Placement of Soil Materials

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

1. no damage of the geotextile or geogrid;
2. minimal slippage of the geotextile or geogrid on underlying layers;
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	Minimum Loose Lift Thickness
psi	inches
< 9	9
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 geogrid are exposed, the CQA Consultant shall periodically place two (or more, at his discretion) marks on the geotextile or the geogrid 3 m (10 ft.) apart along the slope and measure the elongation of the geotextile or the geogrid during the placement of soil. This elongation shall be related by the Designer to the tensile stress in the geotextile or the geogrid.

3.0 GEOSYNTHETIC CLAY LINERS

3.1 Manufacturing

The Geosynthetic Clay Liner (GCL), shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Reinforced GCL must be used on slopes as designated by the Engineer. Unreinforced GCL may be used on slopes not exceeding 10H: 1V.

Acceptable reinforced GCL products are Bentomat® ST, as manufactured by CETCO, 1350 West Shure Drive, Arlington Heights, Illinois 60004 USA (847-392-5800), or an engineer-approved equal. Acceptable unreinforced GCL products are Claymax 200R, as manufactured by CETCO, or an engineer-approved equal.

The reinforced GCL and its components shall be tested for the properties shown in **TABLE 11**. The unreinforced GCL and its components shall be tested for the properties shown in **TABLE 12**.

The reinforced GCL shall have 10,000 hour test data for large-scale constant-load (creep) shear testing under hydrated conditions. The constant shear load shall be 0.56 kN and the normal load shall be 1.1 kN.

The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 feet (21 m) but less than a full-length roll)] may be supplied at a rate no greater than 3 per truckload or 3 rolls every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

The GCL manufacturer shall provide the Project Manager or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

1. Certificates of analysis for the bentonite clay used in GCL production stating the parameters swell index and fluid loss.

2. Manufacturer's test data for finished GCL product(s) of bentonite mass/area, GCL tensile strength and GCL peel strength (reinforced only).

3. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

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.

Manufacturer's Quality control tests must be performed in accordance with the test methods and frequency's specified in **TABLE 11 and TABLE 12**.

TABLE 11
REINFORCED GCL MANUFACTURER'S QUALITY CONTROL TESTING REQUIREMENTS

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2
GCL Grab Strength[3]	ASTM D 4632	200,000 ft^2
GCL Peel Strength[3]	ASTM D 4632	40,000 ft^2
GCL Index Flux[4]	ASTM D 5887	Weekly
GCL Permeability[4]	ASTM D 5887	Weekly
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321	Periodic

Reinforced GCL consists of a layer of sodium bentonite between a woven and a non-woven geotextile, which are needle punched together.

TABLE 12
UNREINFORCED GCL MANUFACTURER'S QUALITY CONTROL TESTING REQUIREMENTS

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2
GCL Grab Strength[3]	ASTM D 4632	200,000 ft^2
GCL Index Flux[4]	ASTM D 5887	Weekly
GCL Permeability[4]	ASTM D 5887	Weekly
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321	Periodic

Unreinforced GCL consists of a layer of sodium bentonite between two geotextiles which are continuously adhered together.

Notes

[1] Bentonite property tests shall be performed at Manufacturer's bentonite processing facility before shipment to GCL production facilities.

[2] Bentonite mass/area reported at 0 percent moisture content.

[3] All tensile testing shall be performed in the machine direction, with results as minimum average roll values unless otherwise indicated.

[4] Index flux and permeability testing with desired distilled/deionized water at 80-psi (551 kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of $5x10^{-9}$ cm/sec for typical GCL thickness. This flux value should not be used for equivalency calculations unless the gradients used represent field conditions. A flux test using gradients that represent field conditions must be performed to determine equivalency. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.

[5] Peak value measured at 200-psf (10 kPa) normal stress. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

The CQA Consultant shall examine all manufacturer's certifications to insure that the property values listed on the certifications meet or exceed those specified by the project specifications and the measurements of properties by the manufacturer are properly documented, test methods 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.

3.2 Roll Label Requirements

The GCL manufacturer shall identify all rolls with the following:

1. Manufacturer's name
2. Product identification
3. Lot number

4. Roll number
5. Roll length,, width, and weight

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

3.3 Shipping, Handling, and Storage

The GCL rolls should be wrapped in polyethylene sheets or otherwise protected against dust and dirt during shipping and storage. The wrapping should be removed just prior to the deployment of the rolls. The CQA Consultant shall verify that geonets are free of dirt and dust just before installation. The Quality Assurance Consultant shall report the outcome of this verification to the Project Manager, and if the geonets are judged dirty, dusty, they shall be cleaned by the Installer prior to installation.

The manufacturer shall be responsible for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling and storage of the GCL are the responsibility of the Contractor, Installer or other designated party.

A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four). All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

3.4 Conformance Testing

3.4.1 Testing Requirements

Upon delivery of the rolls of GCL, the CQA Consultant shall take conformance samples of the GCL, to ensure conformance to both the design specifications and the list of Manufacturer guaranteed properties. **TABLE 13** presents the conformance testing requirements.

3.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear meter (three feet). The geosynthetic testing laboratory shall be contacted to determine the sampling size necessary for laboratory testing of the GCL.

3.4.3 Test Results

The CQA Monitor shall examine all results form 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.

3.5 Installation of the GCL

3.5.1 Earthwork

The Installer shall take whatever steps are necessary to insure that any underling layers are not damaged during the placement of the geonet or that the geonet is damaged in any way, which shall include but is not limited to the following conditions.

Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of:

1. Vegetation.
2. Construction Debris.
3. Sticks.
4. Sharp rocks.
5. Void spaces.
6. Ice.
7. Abrupt elevation changes.
8. Standing water.
9. Cracks larger than one-quarter inch (6 mm) in width.
10. Any other foreign matter that could contact the GCL.

TABLE 13
GCL CONFORMANCE TESTING REQUIREMENTS

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY
Bentonite Mass/Area	ASTM D 5993	100,000 ft^2
GCL Grab Strength	ASTM D 4632	100,000 ft^2
GCL Peel Strength	ASTM D 4632	100,000 ft^2
GCL Permeability	ASTM D 5887	100,000 ft^2

Subgrade surfaces consisting of granular soils or gravel may not be acceptable due to their large void fraction and puncture potential. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface

with a smooth-drum compactor. On a continuing basis, the project CQA inspector shall certify acceptance of the subgrade before GCL placement.

It shall be the Installer's responsibility thereafter to indicate to the Design Engineer changes in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA Inspector. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

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

3.5.2 GCL Placement

Unreinforced GCL shall be placed on the flatter areas of the site; reinforced GCL shall be placed on the more steeply sloped areas. The Installer and Design Engineer shall review and agree upon which GCL shall be placed on these areas prior to installation.

GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) should be in accordance with the Design Engineer's recommendations.

Equipment, which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

The GCL panels shall be placed parallel to the direction of the slope.

All GCL panels should lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to

remove and replace the hydrated material. The Design Engineer, CQA inspector, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

3.5.3 Anchorage

As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope or an equivalent run out design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

3.5.4 Seaming

The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required for reinforced GCL.

The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 24 inches (600 mm).

Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150-mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m).

3.5.5 Detail Work

The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.5.6 Damage Repair

If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

3.5.7 Cover Placement

Cover soils shall be free of angular stones or other foreign matter that could damage the GCL. Cover soils should be approved the Design Engineer with respect to particle size, uniformity and chemical compatibility. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1 foot (300 mm) of cover should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 2 feet (600 mm) is required.

Soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones. Cover soil shall be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

4.0 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, geosynthetic clay liners, 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 site specific quantity assurance plan.

APPENDIX 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 waster'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 a s 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 form 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.

GeosyntheticsThe 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 filed 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./yd^2 or g/m^2). Often incorrectly called "weight" or "basis weight."

Melt bounded*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 shopping 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 allklys and transition metal salts.

Chlorosulfonated polyethylene (CSPE) Family of polymers that is produced y 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 posses 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 norminal 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., E_{50} and E_{100}).

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, $CONH_2$. 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 modules 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. Scrims 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, pounds, 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) of 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 asses 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.