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**MESA COUNTY LANDFILL CELL PROJECT – IFB-20-PS-7B-7C**

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ADVERTISEMENT FOR BIDS

The County of Mesa, Colorado, is requesting bids for the Landfill Cell Project (IFB-20-PS-7B-7C) at the Mesa County Public Works Department, 200 South Spruce, Grand Junction, Colorado, until 10:00 A.M. February 21, 2020. All bids will be publicly opened and read aloud at this location at 10:00 A.M. February 21, 2020.

The pertinent features of this project includes excavation to achieve design subgrades grades; construction of a 12-inch thick compacted clay liner; placement of geosynthetics; construction of an access road and culvert; and installation of stormwater controls.

This IFB is available starting February 3, 2020, by going to the following web pages: http://www.mesacounty.us/publicworks/bids/ or www.rockymountainbidsystem.com

All necessary documents including bids sets, specifications, addendum and any additional information will be placed on these web pages. It shall be the responsibility of all firms and contractors to check the web pages and download the appropriate documents including all addendums. Any questions or problems with the Mesa County web page should be directed to Pam Hawkins at 970-244-1765.

A mandatory (on site) pre-bid Conference will be held at the Mesa County Solid Waste Management Campus located at 3071 US 50, Grand Junction, CO, 81503 at the administrative office located just south of the scale house, 11:00 A.M. on February 12, 2020.

The Contract will be awarded to the lowest qualified bidder, as determined by the statement of qualifications and the bid, which is deemed to be in the best interest of the County. The County reserves the right to accept the bid or any portion of the bid by a competent bidder that will result in the lowest cost to the County. The County reserves the right to accept or reject any portion or all bids without disclosing the reason therefore.

A Certified Check or Bank Draft on a responsible bank, or a satisfactory Bid Bond executed by the bidder and a recognized Colorado Licensed Surety Company payable to Mesa County, in an amount equal to five percent (5%) of the total bid, shall be submitted with each bid as security that the bidder to whom the contract may be awarded will enter into a contract in accordance with this notice, and give bond as hereinafter provided.

No bids may be withdrawn after the opening of bids, without consent of Mesa County, for a period of sixty (60) days after the scheduled time of opening of bids. The successful bidder or bidders will be required to furnish satisfactory performance bonds equal to the full amount of each bid or bid.

All bids must be signed by the bidder or his duly authorized agent.

Published February 2nd and 5th, 2020
1. TERMINOLOGY

1.1 The OWNER is the County of Mesa, Colorado. John Justman, Scott McInnis, Rose Pugliese, or designated representative.

1.2 The OWNER’S DESIGNATED REPRESENTATIVE is Jennifer Richardson, Waste Management Division Director, 3071 Highway 50, Grand Junction, CO 81503, 970.254.4158, jennifer.richardson@mesacounty.us

1.3 The ENGINEER’S REPRESENTATIVE is Michael Pretti, P.E., Souder, Miller & Associates, 5610 Ward Road, Suite 130 – 303.239.9011 mike.pretti@soudermiller.com

1.4 The CONTRACT ADMINISTRATOR is Connie Hahn, P.O. Box 20,000, Grand Junction, CO 81502, 970.244.1812, connie.hahn@mesacounty.us

1.5 Terms used in the Instructions to BIDDERS shall have the meanings assigned to them in the Special Provisions.

2. BID PERIOD AND OPENING

2.1 BIDS will be received by the OWNER at the Mesa County Public Works Department, 200 South Spruce, Grand Junction, Colorado, until 10:00 A.M. February 21, 2020. All bids will be publicly opened and read aloud at this location at 10:00 A.M. February 21, 2020.

3. PROJECT EVALUATION

3.1 Mesa County is now making all bidding documents available on the following web pages: http://www.mesacounty.us/publicworks/bids/ and www.rockymountainbidsystem.com All necessary documents including bid sets, specifications, addendum and any additional information provided will be placed on the web pages. It shall be the responsibility of all firms and contractors to check the web page and download the appropriate documents including all addendums. This is the responsibility of the individual firms and/or contractors.

3.2 The OWNERS assumes no responsibility for the accuracy of project information (Plans and Specifications) obtained from outside sources (Plan Rooms) other than the OWNER. Be aware, if the BIDDER chooses to pick plans and specification from a Plans Room rather than signing up with the OWNER, they may not be included in all Addenda, which could result in having a non-responsive BID.

3.3 BIDDERS must satisfy themselves as to the accuracy of the estimated quantities in the BID SCHEDULE by examination of the site and a review of the drawings
and specifications including Addenda. After BIDS have been submitted, the BIDDER shall not assert that there was a misunderstanding concerning the quantities of WORK or the nature of the WORK to be done.

3.4 The OWNER shall provide BIDDERS prior to bidding, all information pertinent to, delineates, and describes the land owned and rights of way acquired or to be acquired.

3.5 The CONTRACT DOCUMENTS contain the provisions required for the performance of the Project. Information obtained from an officer, agent, or employee of the OWNER or any other person shall not affect the risks or obligations assumed by the CONTRACTOR or relieve him from fulfilling any of the conditions of the CONTRACT.

3.6 All applicable laws, ordinances, and rules or regulations of all authorities having jurisdiction over performance of the project shall apply to the WORK described by the CONTRACT DOCUMENTS. The BIDDER shall be responsible for compliance with these statutes.

3.7 Each BIDDER is responsible for inspection of the site, the reading and being thoroughly familiar with the CONTRACT DOCUMENTS. The failure or omission of a BIDDER to do any of the foregoing shall in no way relieve a BIDDER of obligations with respect to the BID.

3.8 Command type sentences are used in the CONTRACT DOCUMENTS. These refer to and are directed to the CONTRACTOR. Modifications, as stated in the special conditions, shall be given precedence over related language in other parts of the CONTRACT DOCUMENTS.

3.9 Questions regarding documents, discrepancies, omissions, or intent of the specifications or drawings on a technical level shall be communicated in writing to the ENGINEER REPRESENTATIVE, Michael Pretti, 303.239.9011 mike.pretti@souldermiller.com or the OWNERS DESIGNATED REPRESENTATIVE, Jennifer Richardson, 970.254.4158, jennifer.richardson@mesacounty.us during business hours 8:00 a.m. to 5:00 p.m. Monday through Friday at least 7 days prior to the BID opening to provide time to issue an Addendum. Addenda will be issued, if in the opinion of the OWNER and the ENGINEER REPRESENTATIVE, it is necessary. The OWNER and the ENGINEER REPRESENTATIVE will not be responsible for oral interpretations of the specifications and drawings. All other questions, especially as they pertain to the Agreement shall be communicated in writing to the CONTRACT ADMINISTRATOR, Connie Hahn, 970.244.1812, connie.hahn@mesacounty.us during business hours 8:00 a.m. to 5:00 p.m. Monday through Friday at least 7 days prior to the BID opening to provide time to issue an Addendum.
3.10 The BIDDER shall carefully examine the site of the WORK, the drawings, and the specifications. The submission of a BID will be conclusive evidence that the BIDDER has investigated and is satisfied as to the conditions to be encountered, with respect to character, quality, and quantity of WORK to be performed. Submission of a BID will also be seen as evidence of the BIDDER's understanding of the materials required for completion of the WORK, completion time, and the authority that the OWNER and the ENGINEER REPRESENTATIVE will exercise over the CONTRACT during its tenure.

3.11 Investigation of the subsurface conditions, if performed, were made for the purposes of the OWNER and ENGINEER REPRESENTATIVE. The OWNER and ENGINEER REPRESENTATIVE will make all of the subsurface data in their possession available to the BIDDER, at the request of the BIDDER, as a courtesy to the BIDDER. The OWNER assumes no responsibility whatever with respect to sufficiency or accuracy of bores, test pits, logs or interpretations within. The OWNER gives no guarantee, either expressed or implied, that the subsurface data available is representative of those existing throughout the WORK or any part thereof, or that unforeseen developments may not occur. If the BIDDER elects to rely on this data, any interpretations made by the BIDDER shall be the responsibility of the BIDDER. The BIDDER shall be free to make his own investigations of the subsurface conditions on which to base the BID.

3.12 A mandatory (on site) pre-bid Conference will be held at the Mesa County Solid Waste Management Campus located at 3071 US 50, Grand Junction, CO, 81503 at the administrative office located just south of the scale house, 11:00 A.M. on February 12, 2020. All written question will be due no later than 12:00 P.M. February 13, 2020.

4. SUBSTITUTION OR APPROVAL OF ALTERNATIVE MATERIALS

4.1 To obtain approval during the BID period to use unspecified, “or equal”, or “as approved” materials, BIDDERS shall submit written requests at least 7 days prior to BID opening. Requests received later than this time will be considered at the discretion of the ENGINEER REPRESENTATIVE. Requests shall clearly describe the product for which approval is asked, including all necessary data to demonstrate its acceptability. The ENGINEER REPRESENTATIVE will make recommendations on acceptability and an Addendum will be issued if the product is acceptable.

5. BID FORMAT

5.1 BIDS will be received by the OWNER at the Mesa County Public Works Department, 200 South Spruce, Grand Junction, Colorado, until 10:00 A.M. February 21, 2020. All bids will be publicly opened and read aloud at this location at 10:00 A.M. February 21, 2020.
5.2 All BIDS must be made on the BID form included in the CONTRACT DOCUMENTS. All blank space for BID prices must be filled out in ink or typewritten, and the BID form must be completed in its entirety. Only one copy of the BID form is required.

5.3 The BIDDER shall supply the names and addresses of major material suppliers and SUBCONTRACTORS on the BID forms where requested.

5.4 The full name, business address, zip code and business telephone number with the area code of the individual, partnership, joint venture, or corporation submitting the bid shall be legibly printed on the BID forms. The BIDDER shall sign the form with his usual signature.

5.5 A partner shall sign for the partnership. The names of all partners with addresses shall be given.

5.6 An officer shall sign for a corporation, the corporate existence shall be attested by the corporate seal, and the names and titles of all officers of the corporation shall be given.

5.7 Any signature other than that of a corporate officer, partner, or the BIDDERS legally authorized agent or representative will be accepted only if an authenticated power of attorney is attached to the BID forms. All signatures shall be handwritten with the name printed or typewritten below the signature.

5.8 The BIDDER shall state for each item on the BID form the unit price and item total or lump sum in clearly legible figures. Prices shall be represented on the BID form with both numerals and words in the spaces provided for each. In case of conflict, words will take precedence.

5.9 In case of errors or uncertainty in pricing of any item, or if such pricing is omitted, then either unit prices or total price for the same item may be used, at the OWNERS discretion, to arrive at a total project BID cost. If the OWNER is unable to resolve ambiguities with respect to BID prices, the BID may be disregarded.

5.10 The BID shall contain the Statement of Bidders Qualifications and Notification of Immigration Compliance Requirements and Certification by Contractor. No Notice of Award shall be given until these documents are completed and signed.

5.11 The BID shall contain acknowledgment of receipt of all Addenda in the space provided in the BID forms.
6. BONDS

6.1 Each BID must be accompanied by a BID BOND payable to the OWNER for five percent of the total amount of the BID. As soon as the BID prices have been evaluated and a CONTRACT has been approved, the OWNER will return the Bonds to the remaining unsuccessful BIDDERS. The BID BOND of the successful BIDDER will be returned after the PERFORMANCE, PAYMENT and MAINTENANCE BOND has been executed and approved. A certified check may be used in lieu of a BID BOND.

6.2 A PERFORMANCE BOND and a PAYMENT AND MAINTENANCE BOND, each in the amount as specified in the Agreement, Article 7, with a corporate surety approved by the OWNER, will be required for the faithful performance of the CONTRACT.

6.3 Attorneys-in-fact who sign BID BONDS, or PERFORMANCE, PAYMENT and MAINTENANCE BOND must file with each BOND a certified and effective dated copy of their power of attorney.

7. EVALUATION OF BIDS

7.1 The OWNER may waive any informality or minor defects, or reject any and all BIDS. Any BID may be withdrawn prior to the BID opening. Any BID received after the time and date specified for the BID opening shall not be considered. No BIDDER may withdraw a BID within 60 days after the BID opening. Should there be reasons why the CONTRACT cannot be awarded within the specified period, the time within which the BID shall remain valid may be extended by mutual agreement between the OWNER and the BIDDER.

The OWNER, or the OWNERS Representative, may make such investigations, as he deems necessary to determine the ability of the BIDDER to perform the WORK. The BIDDER shall furnish the OWNER with all such information and data for this purpose as the OWNER may request. The OWNER reserves the right to reject any portion of a BID or the entire BID if, based on submitted evidence or the OWNERS investigation, said BIDDER fails to satisfy the OWNER that he is properly qualified to carry out the obligations of the CONTRACT and to complete the WORK as presented by the CONTRACT DOCUMENTS. The OWNER reserves the right to reject any portion or the entire complete bids without disclosing the reason therefore.

The OWNER reserves the right to disqualify any BIDDER who is not in good standing with Mesa County. Items that constitute “not in good standing” can include, but not limited to, lack of insurance, lack of performance on prior projects, or un-completed work.
7.2 All BIDDERS should be aware of Mesa County Purchasing Policy section 5.9 titled “Bid Preference for Mesa County Resident Bidder”. Complete Mesa County Purchasing Policy’s can be obtained by visiting the County web page: http://www.mesacounty.us/purchasing/.

7.3 A Conditional or Qualified BID will not be accepted.

8. NOTICE OF AWARD

8.1 The OWNER shall issue a Notice of Award along with the necessary CONTRACT and BOND forms to the lowest acceptable BIDDER that will result in completion of the WORK within the time allotted by the CONTRACT DOCUMENTS.

9. EXECUTION OF CONTRACT

9.1 The BIDDER, to whom the CONTRACT is awarded, will be required to execute the CONTRACT and obtain a PERFORMANCE, PAYMENT AND MAINTENANCE BOND and furnish INSURANCE CERTIFICATES within 10 calendar days from the date when the Notice of Award is delivered to the BIDDER. In case of failure of the BIDDER to execute the CONTRACT or provide the required bond and insurance certificates the OWNER may consider the BIDDER in default, and the BID BOND accompanying the bid shall become the property of the OWNER.

10. NOTICE TO PROCEED

10.1 The OWNER, within 20 calendar days of receipt of acceptable PERFORMANCE, PAYMENT AND MAINTENANCE BOND, INSURANCE CERTIFICATES and CONTRACT signed by the BIDDER to whom the CONTRACT was awarded, shall sign the Agreement and return to said BIDDER an executed duplicate of the CONTRACT. Should the OWNER not execute the CONTRACT within such period, the BIDDER may by written notice withdraw his signed CONTRACT. Such notice of withdrawal shall be effective upon receipt of the notice by the OWNER.

10.2 The Notice to Proceed shall be issued within 10 calendar days of the execution of the Contract by the Owner. Should there be reasons why the Notice to Proceed cannot be issued within such period, the time may be changed by mutual agreement between the OWNER and CONTRACTOR. If the Notice to Proceed is not issued within the 10-day period or within the period mutually agreed upon, the CONTRACTOR may terminate the CONTRACT without further liability on the part of either party.
11. LOCATION AND ACCESS

11.1 Encroachment on private property, outside the construction easements or right-of-way, by the CONTRACTOR or the WORK is prohibited unless special arrangements are made in writing with the property owner and agreed to by the ENGINEER REPRESENTATIVE or the OWNER. Damage to private property, both within and outside the delineated easements, must be minimized by the CONTRACTOR. The location of the project is as shown on the location map.

12. OWNERS RIGHT TO REJECT BIDS

12.1 The OWNER reserves the right to reject any or all bids and/or to waive technical defects as the interests of the OWNER may require. The OWNER proposes to award a CONTRACT to a single successful BIDDER as soon as possible after BIDS have been opened.

13. PRICES AND PAYMENTS

13.1 The quantities and portions of the WORK listed in the BIDDING SCHEDULE for which unit prices are asked, have been selected by the OWNER as the method of payment for the entire PROJECT as outlined in the drawings and described in the Specifications. Payments of these unit prices will be in full for the completed WORK and will cover materials, supplies, labor, tools, equipment and all other expenditures necessary to satisfactory compliance with the CONTRACT, unless specifically otherwise provided.
MESA COUNTY, COLORADO

BID
LANDFILL CELL PROJECT (IFB-20-PS-7B-7C)

CONTRACTOR NAME:________________________________________________

ADDRESS:__________________________________________________________

PHONE:____________________________________________________________

To:  Mesa County
    Grand Junction, Colorado 81501

The undersigned bidder, having examined the plans, specifications, and other Contract Documents as designated, and any addenda hereto, having investigated the location of, and conditions affecting the proposed work; and being acquainted with and fully understanding the extent and character of the work covered by this Bid and all factors and conditions affecting or which may be affected by the work;

HEREBY PROPOSES, pursuant to the Requirements for Bids as specified in the Bid Package entitled Landfill Cell Project – IFB-20-PS-7B-7C, to furnish all required materials, tools and equipment to perform all necessary labor and superintendence; and to undertake and complete the work required in Mesa County, Colorado in full accordance with plans, specifications and Contract Documents hereto attached or by reference made a part thereof at, and for the following prices:
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Units</th>
<th>Unit Rate</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobilization/Demobilization</td>
<td>1</td>
<td>LS</td>
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<tr>
<td>2</td>
<td>Clearing and Grubbing</td>
<td>1.74</td>
<td>acres</td>
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<td>3</td>
<td>Excavation to Subgrade (cut, haul to stockpile)</td>
<td>3,624</td>
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<td>4</td>
<td>Excavation to Subgrade (fill)</td>
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<td>5</td>
<td>Fertilize, Seed, and Mulch</td>
<td>0.07</td>
<td>acres</td>
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<td>6</td>
<td>12-inch Clay Liner Construction</td>
<td>2,693</td>
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<tr>
<td>7</td>
<td>60-mil HDPE Geomembrane (Agru Microspike® or equivalent)</td>
<td>72,706</td>
<td>sf</td>
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<tr>
<td>8</td>
<td>250-mil Geocomposite with 6 oz/yd² Geotextile on Both Sides</td>
<td>72,706</td>
<td>sf</td>
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<td>9</td>
<td>12-inch Operations Layer Construction</td>
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<td>10</td>
<td>Installation of Interim Liner Termination Berm</td>
<td>791</td>
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<td>11</td>
<td>Installation of Interim Liner Termination Berm Plastic Barricade Fencing</td>
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<td>Stormwater Control Berm</td>
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<td>15</td>
<td>Excavation to Subgrade (cut, haul to stockpile)</td>
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<td>16</td>
<td>Excavation to Subgrade (fill)</td>
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<td>17</td>
<td>Non-Granular Subgrade, Scarify, Replace and Compact 6-inches</td>
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<td>18</td>
<td>Class 6 Road Base, Place and Compact 6-inch Layer</td>
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<td>19</td>
<td>Fertilize, Seed, and Mulch</td>
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<td>acres</td>
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<td>20</td>
<td>Supply and Install 30-inch Culvert</td>
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<td>21</td>
<td>Supply and Install Type II Bedding</td>
<td>16</td>
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<td>Supply and Install Riprap Type VL</td>
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# Mesa County Solid Waste Management Campus
## Phase 7B & 7C Bid

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Units</th>
<th>Unit Rate</th>
<th>Cost</th>
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<tr>
<td>23</td>
<td>Stormwater Controls:</td>
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<td>23a</td>
<td>Supply and Install Waddles on Road Cut Slope</td>
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<td>Is</td>
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<td>23b</td>
<td>Installation of Check Dams in Access Road Drainage Ditches</td>
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<tr>
<td>23c</td>
<td>Installation of Riprap Run Down Channel</td>
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<td>Is</td>
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<td>24</td>
<td>Geomembrane Electronic Leak Location Surveys</td>
<td>1.67</td>
<td>acres</td>
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<tr>
<td>25</td>
<td>Excavation of Dense Shale Material and boulders larger than 4-feet dia.</td>
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<td>LS</td>
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<td>26</td>
<td>Force Account</td>
<td>1</td>
<td>LS</td>
<td>$50,000.00</td>
<td>$50,000.00</td>
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**GRAND TOTAL:**

- $50,000.00
The BIDDER acknowledges receipt of the following ADDENDA:
________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________
The undersigned BIDDER proposes to sublet the following work:

1. Work Description: _____________________________________________
   _____________________________________________________________
   Name of Proposed Sub-Contractor: _______________________________
   _____________________________________________________________
   Address of Proposed Sub-Contractor: _____________________________
   _____________________________________________________________

2. Work Description: _____________________________________________
   _____________________________________________________________
   Name of Proposed Sub-Contractor: _______________________________
   _____________________________________________________________
   Address of Proposed Sub-Contractor: _____________________________
   _____________________________________________________________

3. Work Description: _____________________________________________
   _____________________________________________________________
   Name of Proposed Sub-Contractor: _______________________________
   _____________________________________________________________
   Address of Proposed Sub-Contractor: _____________________________
   _____________________________________________________________
4. Work Description: ______________________________________________________________

Name of Proposed Sub-Contractor: ________________________________________________

Address of Proposed Sub-Contractor: ______________________________________________

5. Work Description: ______________________________________________________________

Name of Proposed Sub-Contractor: ________________________________________________

Address of Proposed Sub-Contractor: ______________________________________________

The undersigned BIDDER acknowledges the right of the County to reject any portion of the
BIDDER’S bid or the entire complete bid submitted and to waive informalities therein.

By submission of the BID each BIDDER certifies, and in the case of a joint BID each party
thereof certifies as to his own organization, that this BID has been arrived at independently,
without consultation, communication, or agreement as to any matter relating to this BID with any
other BIDDER or with any competitor.

The submission of a BID will constitute an incontrovertible representation by the BIDDER that
he is familiar with conditions of the site together with the work required.

BIDDER agrees to perform all work described in the Contract Documents for unit prices or lump
sum as shown on the Bid Schedule. The BIDDER further agrees that no bid may either be
changed or withdrawn, without consent of the County for a period of sixty (60) days after the
scheduled time for opening the bids.

The undersigned BIDDER hereby agrees to be ready and to appear at the office of the Mesa
County Clerk to execute the attached Agreement in conformity with this bid and also to have
ready and furnish the required bond, executed by a Surety Company acceptable to the County
Attorney, and the insurance certificates at any time within ten (10) days from the date of a Notice of Award, mailed to the address hereinafter given.

The ________________________________________________________________________, a corporation of the State of __________________________________________, is hereby offered as Surety on said Bond. If such surety is not approved by the Engineer, another and satisfactory surety company will be furnished.

Enclosed herewith is Bid Security as defined in the attached Instructions to Bidders in the amount of _______________________, which Bid Security the undersigned BIDDER agrees is to be paid to and become the property of the County, as liquidated damages and not as a penalty, for the delay and extra work caused hereby, should the BIDDER prevent an award as defined in the Instructions to Bidders, or should the Bid be accepted and contract awarded him and he fails to enter into Agreement in the form prescribed and to furnish the required bond and insurance certificates within ten (10) days as stipulated.

All participating BIDDERS, by their signature hereunder, shall agree to comply with all conditions, requirements, and instructions of this IFB as stated or implied herein. Print the words “NO Exceptions” here _____________________ if there are no exceptions taken to any of the terms, conditions, or specifications of these quotation documents. If there are exceptions taken to any of these terms, conditions, or specifications of these quotation documents, they must be clearly stated on a separate sheet of paper, attached to this quotation sheet and returned with your quotation. Should Mesa County omit anything from this IFB package, which is necessary to a clear understanding of the requirements, or should it appear that various instructions are in conflict, then the BIDDERS shall secure instructions from Jennifer Richardson, Owners Designated Representative, in the Mesa County Public Works Department, telephone number 970-254-4158 or email at jennifer.richardson@mesacounty.us prior to the date and time of the quote closing date shown in the IFB.

Dated at ________________ this ________ day of __________________________, 20_____.

Signatures of Bidders:

If an individual: ___________________________________________________________ doing business as

________________________________________________________________________

If a partnership: ___________________________________________________________ by

________________________________________________________________________ member of firm.

If a corporation: ___________________________________________________________ by

________________________________________________________________________
Corporate Seal:

**ATTEST:**

Title:

Business Address of Bidder  ______________________________________

____________________________________

____________________________________
Bidder is required to submit

NOTIFICATION OF IMMIGRATION COMPLIANCE REQUIREMENTS AND CERTIFICATION BY CONTRACTOR

_________________________, ("Contractor" herein) acknowledges that Contractor has been notified of the immigration compliance requirements of C.R.S. § 8-17.5-101, et.seq. (House Bill 06-1343), and hereby CERTIFIES that:

1. The Contractor shall not knowingly employ or contract with an illegal alien to perform work under the public contract for services; or

2. Enter into a contract with a subcontractor that fails to certify to the Contractor that the subcontractor shall not knowingly employ or contract with an illegal alien to perform work under the public contract for services;

3. The Contractor has verified or attempted to verify through participation in the basic pilot program that the Contractor does not employ any illegal aliens and, if the Contractor is not accepted into the basic pilot program prior to entering into a public contract for services, that the Contractor shall apply to participate in the basic pilot program every three months until the Contractor is accepted or the public contract for services has been completed, whichever is earlier. This provision shall not be required or effective in a public contract for services if the basic pilot program is discontinued;

4. The Contractor acknowledges that the Contractor is prohibited from using basic pilot program procedures to undertake preemployment screening of job applicants while the public contract for services is being performed;

5. If the Contractor obtains actual knowledge that a subcontractor performing work under the public contract for services knowingly employs or contracts with an illegal alien, the Contractor shall be required to:

   (A) Notify the subcontractor and the contracting state agency or political subdivision within three days that the Contractor has actual knowledge that the subcontractor is employing or contracting with an illegal alien; and

   (B) Terminate the subcontract with the subcontractor if within three days of receiving the notice required pursuant to subparagraph (A) of this Section 5 the subcontractor does not stop employing or contracting with the illegal alien; except that the Contractor shall not terminate the contract with the subcontractor if during such three days the subcontractor provides information to establish that the subcontractor has not knowingly employed or contracted with an illegal alien.

6. Contractor is required to comply with any reasonable request by the State
Department of Labor and Employment ("Department" herein) made in the course of an investigation that the Department is undertaking pursuant to the authority established in C.R.S. § 8-17.5-102(5).

7. If Contractor violates a provision of the public contract for services required herein may terminate the contract for a breach of the contract. If the contract is so terminated, the Contractor shall be liable for actual and consequential damages to the County.

8. The County is obligated to notify the office of the secretary of state if a contractor violates a provision of this Addendum and the County terminates the contract for such breach. Based on this notification, the secretary of state shall maintain a list that includes the name of the Contractor, the state agency or political subdivision that terminated the public contract for services, and the date of the termination. A contractor shall be removed from the list if two years have passed since the date the contract was terminated, or if a court of competent jurisdiction determines that there has not been a violation of the provision of the public contract for services required pursuant to Section I. An agency or political subdivision shall notify the office of the secretary of state if a court has made such a determination. The list shall be available for public inspection at the office of the secretary of state and shall be published on the internet on the website maintained by the office of the secretary of state.

9. The Department may investigate whether a contractor is complying with the provisions of a public contract for services required pursuant to Section I. The Department may conduct on-site inspections where a public contract for services is being performed, request and review documentation that proves the citizenship of any person performing work on a public contract for services, or take any other reasonable steps that are necessary to determine whether a contractor is complying with the provisions of a public contract for services required pursuant to Section I. The Department shall receive complaints of suspected violations of a provision of a public contract for services (this Addendum) and shall have discretion to determine which complaints, if any, are to be investigated. The results of any investigation shall not constitute final agency action. The Contractor is hereby notified that the Department is authorized to promulgate rules in accordance with article 4 of title 24, C.R.S., to implement the provisions of C.R.S. § 8-17.5-101, *et. seq.*

Dated this _______ day of __________________, ________.

[CONTRACTOR]

By

_____________________________________[Printed Name]
Bidder is required to submit

**STATEMENT OF BIDDERS QUALIFICATIONS**

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The Bidder may submit any additional information he desires.

1. Name of Bidder:

2. Permanent main office address, email and phone number:

3. When organized:

4. If a corporation, where incorporated:

5. How many years have you been engaged in contracting business under your present trade name?

6. Contracts on hand: (schedule these, showing amount of each contract and the appropriate anticipated dates of completion.)

7. Have you ever failed to complete any work awarded to you?
   
   If so, where and why?

8. Have you ever defaulted on a contract?
   
   If so, where and why?
9. List the more important similar projects recently completed by your company, stating the name and phone number of the Owner of the project, approximate cost for each, and the month and year completed:

10. List your major equipment available for this contract.

11. Describe your experience in construction work similar in importance to this project:

12. Give bank references:

13. Will you, upon request, fill out a detailed financial statement and furnish any other information that may be required by the County?

14. Quality personnel are a key component to the successful completion of a project. Provide a list of key personnel who will be assigned to this project indicating their function and experience.

15. List all previous experience on Mesa County Capital Improvement Projects. Previous experience on Mesa County Capital Improvement Projects will be considered a project reference and could positively or negatively impact the decision by Mesa County to accept any particular bid.
The undersigned hereby authorizes and requests any person, firm or corporation to furnish any information requested by the County in verification of the recitals comprising this Statement of Bidder’s Qualifications:

Dated at:

This _____________ day of __________________, 20___.

Name of Bidder

By: ___________________________

Title: _________________________

State of ______________________________)  
County of ____________________________) ss.

Being duly sworn deposes and says that he/she is ____________________________________ of ______________________________________ and that the answers to the foregoing questions and all statements therein contained are true and correct.

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

_____________________________
Notary Public

_____________________________
Address

(seal)

My Commission Expires: ________________
PERFORMANCE, PAYMENT AND MAINTENANCE BOND

KNOW ALL MEN BY THESE PRESENT:

That we the undersigned, _______________________________________________________as Principal, and ______________________________________________a Corporation, organized and existing under and by virtue of the laws of the State of Colorado and Surety, are held and firmly bound unto the County of Mesa, Colorado in the penal sum of Dollars ($                         ) lawful money of the United States of America, for the payment of which, will truly be made the said Principal and the said Surety do hereby bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these present, as follows:

The condition of the above obligation is such that; whereas, the said Principal has entered into a written Contract with the County of Mesa, Colorado for the performance of the work designated ________________________________________________, in Mesa County, in the State of Colorado in conformity with the drawings, plans, and General Conditions, and specifications are hereby referred to and made a part hereof, the same to all intents and purposes as if written at length herein, in which Contract the said Principal has contracted to perform the work specified in said Contract in accordance with the terms thereof;

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH THAT if the above bonded Principal shall well, truly and faithfully perform said contract and any alterations in and additions thereto and comply with all of the terms and provisions thereof, and satisfy all claims and demands incurred by the Principal in the performance of said Contract, and shall fully indemnify and save harmless the County of Mesa, Colorado all costs, damages, and expenses which they may incur in making good any default by the Principal, including any default based upon the failure of the Principal to fulfill his obligation to furnish maintenance, repairs, or replacements for the full guarantee period provided in the specifications contained herein and in compliance with Title 38, Article 26, Section101 (et seg) of the Colorado Revised Statutes of 1973 as a condition of this bond shall be that the Contractor shall at all times promptly make payments of all amounts lawfully due to all persons supplying or furnishing him or his subcontractors with labor and materials used or performed in the prosecution of work provided for in the above contract and that the undersigned will indemnify and save harmless the County of the extent if any and all payments in connection with carrying out of such contract, then this obligation shall be null and void, otherwise, it shall remain in full force and effect.

PROVIDED, FURTHER, that Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration, or addition to the terms of the Contract or to the work to be performed thereunder, or the specifications accompanying the same shall in any wise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the Contract, or to the work or to the specifications.
IN WITNESS WHEREOF, said Principal and Surety have set their hands and seals at
___________________________________________, this ______ day of ___________________, 20__.

___________________________________
Principal Contractor
(Seal)
By: ________________________________
Attest: ______________________________

___________________________________
Surety
(Seal)
By: ________________________________
Attest: ______________________________
INSURANCE CLARIFICATION

1. Contractor agrees to procure and maintain, at its own cost, a policy or policies of insurance/bonds sufficient to insure against all obligations assumed by Contractor pursuant to this agreement and shall not start work under this agreement until such insurance coverage has been obtained and approved in writing by the Board’s Contract Administrator.

2. Contractor shall require all subcontractors and sub-subcontractors to maintain during the term of this agreement, Commercial General Liability insurance, Comprehensive Automobile Liability insurance, and Workers' Compensation and Employers' Liability insurance, in the same manner as specified for Contractor. Contractor shall furnish subcontractors' certificates of insurance to the Board, with a copy to the Board’s Contract Administrator, immediately upon request.

3. All insurance policies required hereunder shall include a written thirty (30) day notification of cancellation. In that notice the Board and the Board’s Contract Administrator will be notified of any material changes in the insurance policy(s) such as; cancellation, non-renewal, or reduction in coverage or alteration of coverage.

4. Nothing herein shall be deemed or construed as a waiver of any of the protections to which the Board or Mesa County shall be entitled pursuant to the Colorado Government Immunity Act, sections 24-10-101, C.R.S., as amended.

5. All required insurance coverages must be acquired from insurers authorized to conduct business in the State of Colorado and acceptable to the Board and Mesa County. The insurers must also have policyholders' rating of "A-" or better, and financial class size of "Class VII" or better in the latest edition of Best's Insurance Reports, unless the Board grants specific approval for an exception.

6. Contractor shall procure and continuously maintain the minimum insurance coverage listed below, and additional coverage as may apply, with forms and insurers acceptable to the Board. In the case of any claims-made policy, the necessary retroactive dates and extended reporting periods shall be procured to maintain such continuous coverage.

   a. Workers' Compensation and Employer's Liability Including Occupations Disease Coverage in accordance with scope and limits as required by the State of Colorado of $100,000 each accident; $100,000 disease each employee; $500,000 disease policy limit.

   b. Commercial General Liability, "occurrence form," with minimum limits of ONE MILLION ($1,000,000) combined single limit, per occurrence for bodily injury, personal injury and property damage. In addition Contractor must either:
1) Agree to provide certificates of insurance evidencing the above coverage for a period of two years after the final payment for the contract

OR

2) Purchase an extended (minimum two years) reporting period endorsement for the policy or policies in force during the term of this contract and evidence the purchase of this extended reporting period endorsement by means of a certificate of insurance or a copy of the endorsement itself.

c. Comprehensive Automobile Liability insurance with minimum limits for bodily injury and property damage of not less than ONE MILLION ($1,000,000) combined single limit per accident.

d. PROFESSIONAL LIABILITY INSURANCE with an endorsement for work under this Agreement, and coverage of no less than ONE MILLION ($1,000,000) per claim, and ONE MILLION ($1,000,000) aggregate for all Design/Build, Professional Service and Design Contracts.

e. EXCESS LIABILITY/UMBRELLA INSURANCE with a limit no less than ONE MILLION ($1,000,000) per occurrence/ONE MILLION ($1,000,000) aggregate, and coverage at least as broad as the primary Commercial General Liability policy.

7. The policies required by paragraphs (B) and (C) above shall be endorsed to specify: "Mesa County, their officers, officials, employees and volunteers as INSUREDs, as respects liability, on behalf of Contractor, arising out of this Contract." All certificates of insurance are to be submitted on standard "ACCORD 25-S" form.

8. Depending on the nature and scope of the services to be provided under this Contract, additional insurance requirements may be specified by the Board. Items listed below, which have been marked with an "X" are required of Contractor by the Board as a condition of this Contract. Contractor initial, placed by the corresponding "X", shall acknowledge the Contractor compliance in meeting the specific insurance requirement(s).

Your
Initial X

BUILDERS RISK INSURANCE must be in an amount equal to the aggregate total of the initial contract prices in the contracts, as well as any subsequent modifications. The policy must be in Completed Value Form, insuring the entire project for, at least Broad Form coverage including theft. Such Insurance shall remain in effect until 12:00 noon on the day following the date of final acceptance of the entire project, whether or not the building or some part thereof is occupied in any manner prior to final acceptance of the project.
BID BONDS AND/OR PERFORMANCE BONDS. Bid bond coverage to be determined as a percentage of the total bid. Performance Bond in the amount of 100% of the project contract.

Other insurance as required. If other insurance is required it will be included and referred to as "EXHIBIT E."
COUNTY OF MESA, COLORADO

AGREEMENT

CONTRACTOR’S NAME

This Agreement made and entered into this <__> day of _______________, by and between the MESA COUNTY, COLORADO, a political subdivision of the State of Colorado, referred to as the “County” or “Owner,” and <__________>, a Colorado corporation (or limited liability company, etc., or if the contractor is not a Colorado entity, then it should read "a Texas, Delaware, etc., corporation authorized to do business in Colorado"), hereinafter referred in the Contract Documents as the “Contractor.

WITNESSETH, that the County advertised that sealed bids would be received for furnishing all labor, tools, supplies, equipment, materials and everything necessary and required for the construction project.

WHEREAS, the Agreement has been awarded to the above named Contractor by the County, and said Contractor is now willing and able to perform all of said work in accordance with said advertisement and his bid.

NOW THEREFORE, in consideration of the compensation to be paid the Contractor, the mutual covenants hereinafter set forth and subject to the terms hereinafter stated, it is mutually covenanted and agreed as follows:

ARTICLE I

Contract Documents: It is agreed by the parties hereto that the following list of installments, drawings, and documents which are attached hereto, bound herewith, or incorporated herein by reference constitute and shall be referred to either as the Contract Documents or the Agreement, and all of said instruments, drawings, and Documents taken together as a whole constitute a Contract between the parties hereto, and they are as fully a part of this Agreement as if they were set out verbatim and in full herein.

- Advertisement for Bids
- Bid
- Performance, Payment and Maintenance Bond
- Notification of Immigration Compliance
- Agreement
- Notice to Proceed
- Change Order
- Certificate of Substantial Completion
- Project Special Provisions
- Plans and Drawings (Bearing the same Project name)
- Mesa County Landfill Construction Assurance/Quality Control Plan
- Addenda (If Any)
- Instruction to Bidders
- Statement of Bidders Qualifications
- Insurance Clarification
- Notice of Award
- Field Order
- Application for Payment
- Lien Waiver
- Mesa County Project Specials
- Additional Special Provisions (If Any)

In the event there is a conflict in the terms and conditions of the Contract Documents, they shall govern in the following order:
1. Agreement
2. Mesa County Landfill Construction Assurance/Quality Control Plan
3. Mesa County Project Specials

For clarification, the remaining documents shall be utilized.

**ARTICLE 2**

Definitions: The definitions provided in the IFB apply to the terms used in the Agreement and all Contract Documents, unless specifically modified by this Agreement.

**ARTICLE 3**

Statement of Work: The Contractor agrees to and shall furnish all labor, tools, supplies, equipment, materials, and everything necessary for and required to do, perform and complete all of the work described, drawn, set forth, shown, and included in said Contract Documents.

**ARTICLE 4**

Contract Time: The Contractor agrees to undertake the performance of the Work under the Agreement within ten (10) calendar days after the date of the Notice to Proceed and agrees to fully complete said Work within the stipulated working days noted hereinafter unless an extension of time is granted by the County. The Contract Time for Substantial Completion of all required Work shall be **DAYS OR DATE**.

**ARTICLE 5**

Liquidated Damages: It is understood and agreed by and between the County and the Contractor that should the completion of the entire project be delayed beyond the stipulated day herein specified, the County will suffer substantial damages, which damages it would be difficult to accurately determine. The parties hereto have considered the possible limit of damages and have agreed that a delay in completion of this work will cost the following:

<table>
<thead>
<tr>
<th>Original Contract Amount ($)</th>
<th>Liquidated Damages Per Calendar Day ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>150,000</td>
<td>1,000</td>
</tr>
<tr>
<td>500,000</td>
<td>1,600</td>
</tr>
<tr>
<td>1,000,000</td>
<td>2,300</td>
</tr>
<tr>
<td>2,000,000</td>
<td>4,100</td>
</tr>
<tr>
<td>4,000,000</td>
<td>5,800</td>
</tr>
<tr>
<td>10,000,000</td>
<td>7,000</td>
</tr>
</tbody>
</table>

If the Contractor shall fail to pay such liquidated damages promptly upon demand, therefore, the Surety on the Performance Bond shall pay such damages. Also, the County may hold all or part of such liquidated damages from payments due the Contractor.
ARTICLE 6

Terms of Payment: The Contractor agrees to accept as his full and only compensation for the performance of all the work required under this price or prices set forth in the Contractor’s Document, attached hereto and made a part hereof for Contract items numbered through , for total estimated cost thereof to be SPelled OUT, ($). Partial payments will be made for Work completed during the previous month and certified by the Engineer as well as for materials (invoice cost only) delivered to the Project site and suitably stored.

Application for partial payments for stored materials must be accompanied by certified invoices showing all pertinent data that may be required by the Engineer to verify the accuracy of the invoices and their relation to the stored materials. Failure to provide certified invoices will disqualify the materials, in question, from consideration for partial payment. Partial payments for Work completed during the previous month will be made based on the Contractor’s Applications for Payment (with the exception of the first submitted payment) and shall be accompanied by partial waivers of lien for the Major Contract Items and stored materials that were allowed partial payment during the prior month.

Failure of the Contractor to provide partial waivers of lien for previous partial payments, will be just cause for reducing subsequent partial payments by an amount equal to the sum of any and all outstanding partial waivers of lien until such time as the outstanding waivers are provided.

All partial waivers of lien shall be sworn to and notarized by the party (s) granting the waiver.

All lien waivers shall show whether any or all of the amount being waived is under dispute. Any amounts under dispute will not be eligible for partial payment until said dispute has been resolved and the Engineer has been so notified in writing.

All material and work covered by partial payments made shall thereupon become the sole property of the County, but this provision shall not be construed as relieving the Contractor from the sole responsibility for all materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the County to require the fulfillment of all the terms of the Agreement.

The Owner will retain, from partial payments, five percent (5%) of the total amount due the Contractor based on the Contractor’s Application for Payment and the Owners Representatives recommendation of the work required by the Agreement has been performed. Thereafter, the Owner may pay any of the remaining installments without retaining additional funds if, in the opinion of the Owner, satisfactory progress is being made in the work. The Owner may, at his sole discretion, at any time during the Contract Time, reduce the percentage of the total amount due which is retained when it appears that such retainage is not necessary to adequately protect the Owner.

Upon completion of the Work under the Agreement, and prior to the payment, the Engineer and Owner shall publish, in the newspaper published in the County the Notice of Contractor’s Settlement, which shall state that they have accepted said Work as completed according to the
Contract Documents and that the Contractor is entitled to final settlement and that, upon thirty days notice following the date of first publication, specifying the exact date, the County will pay the full balance due under the Agreement, and that persons having claims for labor or material furnished the Contractor shall present the same to the County prior to said date specified for such payment. Nothing contained herein shall be construed as relieving the Contractor and the Sureties on the Contractor’s Bond from any claim or claims for work or labor done or materials or supplies furnished in the execution of the Agreement it is the intent of the Owner, to make payment for partial payments in at timely manner as follows:

1) The Contractor shall submit his Application for Payment not later than the first day of the month.

2) The Owners Representative will, within 30 calendar days after receipt, submit the Application for Payment to the Owner for payment along with his Recommendation of Payment, noting any changes.

CHANGE OF CONTRACT PRICE

The Contract Price constitutes the total compensation (subject to authorized adjustments) payable to Contractor for performing Work. All duties, responsibilities and obligations assigned to or undertaken by Contractor shall be at his expense without change in the Contract Price.

The Contract Price may only be changed by a Change Order. Any claim from the Contractor for a change in the Contract Price shall be based on written notice delivered to Owner Representative within fifteen (15) days of the occurrence of the event, giving rise to the claim. Notice of the amount of the claim with supporting data shall be delivered within forty-five (45) days of such occurrence unless Owner Representative allows an additional period of time to ascertain accurate cost data. Any change by the Owner Representative shall be described on a Change Order and issued to the Contractor.

All claims for adjustment in the Contract Price shall be determined by Public Works Director, if Owner and Contractor cannot otherwise agree on the amount involved. Any change in the Contract Price resulting from any such claim for adjustment shall be incorporated in the Change Order.

The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined as defined in section 109.04 of the Mesa County Special Provisions, and section 105.03 of the CDOT Revised Standard Special Provisions and CDOT Standard Specifications for Road and Bridge Construction contained and/or referenced herein.

CHANGE OF THE CONTRACT TIME

The Contract Time may only be changed by a Change Order. Any claim from Contractor for an extension in the Contract Time shall be based on written notice delivered to Owner Representative within fifteen (15) days of the occurrence of the event, giving rise to the claim. Notice of the extent of the claim with supporting data shall be delivered within forty-five (45)
days of such occurrence unless Owner Representative allows and additional period of time to ascertain more accurate data.

All claims for adjustment in the Contract Time shall be determined by Owner Representative if an agreement cannot be reached. Any change in the Contract Time resulting from any such claim shall be incorporated in a Change Order. Any change by the Owner Representative shall be described on a Change Order and issued to the Contractor.

The Contract Time may be extended in an amount equal to time lost due to delays beyond the control of Contractor if a claim is made therefore as provided in the previous paragraph. Such delays shall include, but not be limited to fires, floods, epidemics, abnormal weather conditions, or acts of God.

All time limits stated in the Contract Documents are of the essence of the Agreement. The provisions of this Section shall not exclude recovery for damages (including compensation for additional professional services) for delay by either party.

**ARTICLE 7**

**Bonds and Insurance:** The Contractor furnishes currently herewith the bonds and insurance required by the Contract Documents, said bonds and insurance having been approved by the County and attached hereto. The Performance Bond will be in an amount not less than one-hundred percent (100%) of the estimated aggregate payments to be made under the Agreement but, in any event, shall provide for the completion of the project in accordance with the Contract Documents, without additional cost to the County. The Payment Bond will be in an amount not less than the aggregate total of all materials, labor and subcontracted work, exclusive of the Contractors overhead and profit, or one-hundred percent (100%) of the estimated aggregate payments to be made under the Agreement, whichever is greater. The Maintenance Bond will be so conditioned as to provide for the correction of workmanship for a period of one year following final acceptance of the project, and shall cover not only the material but also costs of removal, correction, re-construction and any other costs incurred in the repair of defective portions of the Work.

If notice of any change affecting the general scope of the Work or change in the Contract Price is required by the provisions of any Bond to be given to the Surety, it will be Contractor’s responsibility to so notify the Surety, and the amount of each applicable Bond shall be adjusted accordingly. Contractor shall furnish proof of such adjustment to Owner.

**The Contractor's insurance policies shall be endorsed to include, for the benefit of County, a 30-day advance written notice of cancellation, non-renewal, or reduction in policy limits of liability by endorsement.** Additionally it shall specifically state on the Commercial General Liability and Auto Liability policies the following: “Mesa County, its officers, officials, employees and volunteers as INSURED, as respects liability, on behalf of Contractor, arising out of this Contract.” All certificates of insurance are to be submitted on standard “ACCORD 25-S” form. A Certificate of such insurance coverage naming Mesa County, its officials,
officers, employees and agents as insured, shall be supplied to Mesa County upon signing of this Contract. Failure to obtain or maintain such insurance shall constitute a breach of the Contract.

Contractor shall require all subcontractors and sub-subcontractors to maintain during the term of this agreement, Commercial General Liability insurance, Comprehensive Automobile Liability insurance, and Workers' Compensation and Employers' Liability insurance, in the same manner as specified for Contractor. Contractor shall furnish subcontractors' certificates of insurance to the Board, with a copy to the Board's Contract Administrator, immediately upon request.

ARTICLE 8

1) Any other work, materials, equipment or machinery not specifically described or expressly covered herein, but which is required or necessary to perform or complete the work, which is contemplated, shall be deemed to be, and is, covered by this Agreement.

2) The Contractor shall perform its work hereunder in accordance with sound and acceptable industry or professional practices and standards and in accordance with all codes, standards, regulations, and laws applicable to the work; and prior to beginning work, shall secure, at Contractor's expense, all necessary permits required by any governmental agency with jurisdiction.

3) In the performance of work under this Agreement, the Contractor shall be deemed to be, and is, an independent Contractor with the authority to control and direct the performance and details of its work; the County being interested only in the results obtained. As an independent contractor, Contractor shall be responsible for payment of all taxes including federal, state and local taxes arising out of the activities under this Agreement, including by way of illustration but not limitation, federal and state income tax, Social Security tax, unemployment insurance taxes, and any other taxes or license fees required.

4) Precautions shall be exercised at all times for the protection of all persons (including County employees) and property. The safety provisions of all applicable laws, regulations, and codes shall be observed. Hazards arising from the use of vehicles, machinery, and equipment shall be guarded or eliminated in accordance with the highest accepted standards of safety practice. The Contractor and any subcontractors shall comply fully with all requirements of the Occupational Safety and Health Act, and any other pertinent Federal, State or Local Statutes, rules or regulations. The Contractor and any subcontractors shall bear full responsibility for payment of any fines or other punishments resulting from violation of any such statutes, rules or regulations.

5) This Agreement may not be assigned or subcontracted without the prior express written consent of the County and specifically the Contractor shall not assign any money due or to become due without prior written consent of the Owner. Any attempt to assign this Agreement or any portion of this Agreement without the prior express written consent of the County shall render the Agreement null and void with respect to the attempted assignee.

6) The County reserves the right, without notice and at reasonable times, to inspect the work accomplished by the Contractor under this Agreement. The right of inspection reserved in
the County is for the protection of County in assuring that the work is proceeding in a timely and satisfactory manner and does not relieve the Contractor from responsibility for selecting appropriate means of fulfilling its obligations hereunder.

7) The County, or its designee, may, at reasonable times, during the term of this Agreement or for two years after its termination or expiration, audit the Contractor’s books with regard to this Agreement, and the Contractor shall retain its books and records for the required period.

8) This is not an exclusive Agreement. The County may, at its sole discretion, contract with other entities for work similar to that to be performed by the Contractor hereunder. Contractor may contract to perform similar work for others, and is not expected to work exclusively for County.

9) This Agreement is and shall be deemed to be performable in the County of Mesa, Colorado, and venue for any dispute hereunder shall be in the District Court of the County of Mesa, Colorado. In the event of dispute concerning performance hereunder, the parties agree that the Court may enter judgment in favor of the prevailing party for costs and reasonable attorneys’ fees.

10) Contractor agrees that any information received by Contractor during any furtherance of the Contractor’s obligations hereunder will be treated by the Contractor as confidential and will not be revealed to other persons, firms or organizations unless required by state, federal or local law.

11) **(This paragraph applies if the work performed is a “public work”)**: In discharge of this Agreement, Contractor shall employ Colorado labor to perform not less than 80% of each type or class of labor in each of the several classifications of skilled and common labor employed on this project. A “public work” is any construction, alteration, repair, demolition, or improvement of any building, road, street, bridge, drain, park, or other structure suitable for and intended for use by the public.

12) This agreement constitutes the entire agreement between the parties, and no changes or modifications shall be effective unless reduced to writing and signed by the party to be charged.

13) Persons signing as or on behalf of Contractor represent by their signature that the person signing is fully authorized to so sign this Agreement and that the Contractor has taken all steps necessary that the signature is binding upon the Contractor.

14) The provisions of this Agreement shall be severable; and the invalidity of any provisions shall not invalidate the remaining provisions hereof.

15) Contractor shall indemnify, and hold harmless the County, its agents, officials and employees, against all loss or damages, including penalties, charges, professional fees, interest, costs, expenses and liabilities of every kind and character arising out of, or relating to, any and all claims and causes of actions of every kind and character, in connection with,
directly or indirectly, this Agreement, whether or not it shall be alleged or determined that
the harm was caused through or by the Contractor or the subcontractor, if any, or their
respective employees and agents, or a party indemnified hereunder. Contractor further
agrees that its obligations to the County under this paragraph include claims against the
County by Contractor’s employees whether or not such claim is covered by workers
compensation. Contractor expressly understands and agrees that any insurance or bond
protection required by this contract, or otherwise provided by Contractor, shall in no way
limit the responsibility to indemnify, keep and save harmless and defend the County as
herein provided, and such obligation exists even if the claim is fraudulent or groundless.

16) Contractor assures that where activities supported by this Agreement produce any discovery
or invention, original computer programs, writing, sound recordings, pictorial reproductions,
drawing or other graphical representation and works of any similar nature, the County has the
right to use, duplicate and disclose, in whole or in part in any manner for any purpose
whatsoever and authorize others to do so. If the material or invention is copyrightable, the
Contractor may copyright such, but the County reserves the royalty-free non-exclusive and
irreversible license to practice, reproduce, publish and use such materials in whole or in part,
and authorize others to do so.

17) Conformance with Law: The Contractor shall at all times during the performance period
strictly adhere to all applicable federal and state laws and implementing regulations as they
currently exist and may hereafter be amended. Contractor shall also require compliance with
these statutes and regulations in subcontract and sub-grant agreements, if any permitted
under this Agreement. Without limitation, these federal and state laws and regulations
include:

- Age Discrimination Act of 1975, 42 USC Sections 6101 et seq and its implementing
  regulation, 45 CFR Part 91;
- Age Discrimination in Employment Act of 1967, 29 USC 621-634;
- Americans with Disabilities Act of 1990 (ADA), 42 USC 12101 et seq;
- Drug Free Workplace Act of 1988, 41USC 701 et seq;
- Equal Pay Act of 1963, 29 USC 206(d);
- Immigration Reform and Control Act of 1986, 8 USC 1324b;
- Pro-Children Act of 1994, 20 USC 6081 et seq;
- Section 504 of the Rehabilitation Act of 1973, 29 USC 794, as amended, and
  implementing regulation 45 CFR Part 84;
- Titles VI and VII of the Civil Rights Act of 1964, 42 USC 2000d and e;
- Title IX of the Education Amendments of 1972, 20 USC 1681 et seq;
- Section 24-34-302, et seq, Colorado Revised Statutes 1993, as amended;
- The “Uniform Administrative Requirements of Grants and Cooperative Agreements to
  State and Local Governments (Common Rule)”, at 49 CFR, Part 18;
- Office of Management an Budget Circulars A-87, A-21, or A-22, and A-102 or A-110,
  whichever are applicable;
- The Hatch Act (5 USC 1501-1508 and PL 95-454 Section 4728). These statutes state that
  federal funds cannot be used for partisan political purposes of any kind by any person or
  organization involved in the administration of federally assisted programs.
18) Non-discrimination: Contractor shall not discriminate against any person on the basis of race, color, national origin, age, sex, religion and disability, including Acquired Immune Deficiency Syndrome (AIDS) or AIDS related conditions, in performance of work and provision of services under this Agreement.

19) Survival of Certain Agreement Provision: Notwithstanding anything herein to the contrary, the parties understand and agree that all terms and conditions of this Agreement, and the exhibits and attachments hereto, which may require continued performance or compliance beyond the termination date of this Agreement shall survive such termination date and shall be enforceable as provided herein in the event of a failure to perform or comply by a party to this Agreement. Examples of some provisions surviving termination include but are not limited to Agreement Article 7 and 8, subparagraphs 2, 3, 4, 7, 9, 10, 12, 13, 14, 15, 16, 17, 18 and 21 shall survive expiration or any termination of this Agreement.

20) Termination: The Owner reserves the right, regardless of satisfactory or non-satisfactory performance hereunder, to terminate this Agreement without liability by giving written notice of such termination to the Contractor. A written notice to terminate must be delivered to the Contractor ten (10) days prior to the date of final service delivery. In the event of such termination, the Contractor shall be paid for all satisfactory work accomplished pursuant to this Agreement. Any final settlement of compensation shall take into full consideration all work which has been properly performed by the Contractor and all payments which have or have not been made.

21) Availability of Funds: Both parties agree that payments pursuant to this Contract are subject to and contingent upon the continuing availability of funds for the purposes herein. If such funds become unavailable, the Board may terminate this Contract immediately without further liability.

22) Agreement Binding: The Owner and the Contractor each binds himself, his partners, successors, assigns and legal representatives to the other party hereto in respect to all covenants, Contracts and obligations contained in the Contract Documents.

IN WITNESS WHEREOF, The County of Mesa, Colorado has caused this Agreement to be subscribed by its County commissioners and sealed and attested by its County Clerk in its behalf; and the Contractor, second party, has signed this Agreement the day and the year first mentioned herein.

This Agreement is executed in three counterparts, each deemed to be an original.

THE COUNTY OF MESA, COLORADO ATTEST

BY: ___________________________ BY: ___________________________
, Chair , Clerk to the Board
Mesa County Commissioners
NOTICE OF AWARD

Project:

To:

The County has considered the Bid submitted by you for the above-described work in response to its Advertisement for Bids dated

You are hereby notified that your Bid has been accepted for items in the amount of $ contingent upon an acceptable contract signed by the Contractor and final approval by the Board of County Commissioners for Mesa County. You are required by the Instructions to Bidders to execute the Agreement and furnish the required Contractor's Performance Bond, Payment and Maintenance Bond and Certificates of Insurance within ten (10) calendar days from the date of this Notice to you.

If you fail to execute said Agreement and to furnish said Certificates of Insurance and Bonds within ten (10) calendar days from the date of this Notice, said Owner will be entitled to consider all your rights arising out of the Owner's acceptance of your Bid as entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of the NOTICE OF AWARD to the Owner.

Dated this day of,

By:
Title:

Address: P.O. Box 20,000
(200 South Spruce)
Grand Junction, Colorado 81502-5013

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE OF AWARD is hereby acknowledged by:

________________________________________. This _____ day of ______________, 20__.

By:
Title:

Telephone:
NOTICE TO PROCEED

To:

Date:

Project:

You are hereby notified to commence Work in accordance with the Contract dated ____________, on or before ______________, and you are to fully complete said Work on or before __________, and to complete other specified items of work in accordance with the dates specified in Article 4 of the Agreement.

Please prepare and make available for the preconstruction meeting on __________ the Initial Project Schedule under SECTION 108, the Project Traffic Control Plan required for Mesa County and a draft of the Project Storm Water Management Plan required by Section 208.

By:

Title:

Address:  P.O. Box 20,000
          200 South Spruce Street
          Grand Junction, Colorado  81502-5013

Telephone:  (970) 244-1686

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE TO PROCEED is hereby acknowledged

By ______________________________________________________

This the ________________ day of _________________________, 20____.

By: _____________________________________

Title: ____________________________________

Telephone: ________________________________
FIELD ORDER

FIELD ORDER NO: _____________________
DATED: _______________________________

Project:

County Project Number:

Contractor:

Attention:

You are directed to make the changes as defined below and on any attached pages.

Description of Required Changes:

Changes Ordered By: _______________________________________________________
Mesa County Engineering, Project Engineer
Dated: _____________, 20___

Changes Accepted By: _______________________________________________________
Contractor or Authorized Representative
Dated: _____________, 20___
CHANGE ORDER

CHANGE ORDER NO.

Date:
Project:
CPN:
Contractor:
Contract For:
Contract Date:
To:

You are directed to make the changes noted below in the subject Contract:

Mesa County
By:

Dated:

NATURE OF CHANGES:

<table>
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<tr>
<th>BID ITEM #</th>
<th>CDOT REF #</th>
<th>DESCRIPTION</th>
<th>BID QUAN.</th>
<th>CO 1 QUAN.</th>
<th>CHANGE</th>
<th>UNITS</th>
<th>UNIT $</th>
<th>TOTAL COST</th>
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TOTAL CHANGE ORDER COST
These changes result in the following adjustment of Contract Price and Contract Time:

**Contract Price:**

- Prior to Change Order: $ 
- Decrease/Increase: $ 
- Current Contract Price: $ (Including Change Order)

**Contract Time:**

- Prior to Change Order: 60 days from Notice to Proceed issued 
- Decrease/Increase: 
- Current Contract Time: 

**The Above Changes are Approved:**

Mesa County Public Works

By: ________________________________

Date: ________________________________

The foregoing Change Order No. 1 is satisfactory and is hereby accepted. In accepting this Change Order No. 1, the Contractor acknowledges that he has no unsatisfied claim against the County arising out of or resulting from this Order, and the Contractor hereby releases and discharges the County from any and all claims or demands whatsoever arising out of or resulting from this Order.

**The Above Changes are Accepted:**

Contractor:

By: ________________________________

Date: ________________________________
**SUMMARY OF CHANGE ORDERS**

These Change Orders to date have resulted in the following adjustment of Contract Price and Contract Time:

Original Contract Price: $  
Original Contract Time: 60 days from Notice to Proceed

<table>
<thead>
<tr>
<th>Change Order No.</th>
<th>Date</th>
<th>Amount (+ or -)</th>
<th>Time (+ or -)</th>
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Net Change of ALL Change Orders (+ or -)  
Net Change this Change Order (+ or -)  
New Contract Price  
Time if this Change Order is Executed
APPLICATION FOR PAYMENT

Number <>

To:

Project:

Contractor:

Contract Date:

County’s Project Number:

For Work Accomplished Through:

**CONTRACTORS SCHEDULE OF WORK (See Attached)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Amount</th>
<th>Previous Applications</th>
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Totals $ $
Original Contract Amount: $________________________

Net Changes: $________________________

Contract Sum to Date: $________________________

Total Completed & Stored to Date: $________________________

Less 5% Retainage of Contract Value: $________________________

Total Earned Less Retainage: $________________________

Less Previous Payments: $________________________

Amount Due this Application: $________________________

CONTRACTOR’S Certification:

The undersigned CONTRACTOR certifies that (1) all previous progress payments received from County on account of Work done under the Contract referred to above have applied to discharge in full all obligations of CONTRACTOR incurred in connection with Work covered by prior Applications for Payment numbered 1 through _______ inclusive; and (2) title to all materials and equipment incorporated in said Work or otherwise listed in or covered by this application for Payment will pass to County at time of payment free and clear of all liens, claims, security interests and encumbrances (except such as covered by Bond acceptable to County).

Dated: ______________, 20 __

By: __________________________

County REPRESENTATIVE Recommendation:

This Application (with accompanying documentation) meets the requirements of the Contract Documents and payment of the above AMOUNT DUE THIS APPLICATION is recommended.

Dated: ______________, 20 ___

Mesa County Engineering Division

By: __________________________
CERTIFICATE OF SUBSTANTIAL COMPLETION

County’s Project No.:

Project:

Contractor: ________________________________________________________________

Contract for: ______________________________________________________________

Contract Date: _____________________________________________________________

This Certificate of Substantial Completion applies to Work under the Contract Documents:

To:  MESA COUNTY
     County

And To:
     Contractor

The Work to which the Certificate applies has been inspected by authorized representatives of County, CONTRACTOR and ENGINEER, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on:

_______________________________
Date of Substantial Completion

A tentative list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of CONTRACTOR to complete all the Work in accordance with the Contract Documents. When this Certificate applies to a specified part of the Work the items in the tentative list shall be completed or corrected by CONTRACTOR within 30 days of the above date of Substantial Completion.
The Date of Substantial Completion is the date upon which all guarantees and warranties begin, except as follows:

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

The responsibilities between County and CONTRACTOR for security, operation, safety, maintenance, and insurance shall be as follows:

Responsibilities:

County: Shall be in accordance with Contract Documents

CONTRACTOR: Shall be in accordance with Contract Documents

The following documents are attached to and made a part of this Certificate:

______________________________________________________________________________

______________________________________________________________________________

Executed by County’s REPRESENTATIVE on ________________

By: __________________________________________________________

The CONTRACTOR accepts this Certificate of Substantial Completion on ________________

By: __________________________________________________________
LIEN WAIVER

$______________  ___________________________, Colo., Date: ________________

Received of _______________________________________________________________
being the sum of _____________________________________________________ Dollars,
being (check one) ☐ partial payment ☐ full payment of all demands for labor, services,
machinery, tools, equipment, laborers or materials heretofore furnished to ________________
______________________________________________ in connection with Mesa County
Project ______________________ located in the County of Mesa, State of Colorado, and in
consideration of the aforesaid payment the undersigned hereby waive, relinquish and absolutely
release forever, all right to claim a mechanic’s lien against the above described property which
might accrue under the laws of the State of Colorado by virtue of the aforesaid work done,
laborers or material furnished prior to _______________________ (date).

The undersigned hereby swears and affirms that this instrument is signed under no
constraint as a free and voluntary act, and that the undersigned is authorized to release the above-
reference claim on behalf of sub-contractor __________________________________________.

____________________________________
Sub-Contractor

State of ________________________)  ss.
County of ______________________)

Being duly sworn states that he/she is __________________________ of
(Sub-Contractor) __________________________ and that the all statements herein contained are
true and correct.

Subscribed and sworn to before me this ________ day of ________________, 20______.

______________________________
Notary Public

(seal)

My Commission Expires __________________________
Contractor

State of ______________________) ss.
County of ______________________)

Being duly sworn states that he/she is __________________________ of (Contractor)________________________ and that all statements herein contained are true and correct.

Subscribed and sworn to before me this __________ day of _________________, 20______.

_________________________
Notary Public

(seal)

My Commission Expires __________________________
1.0 SCOPE OF WORK

Mesa County Solid Waste Management (hereafter referred to as “MCSWM”) is soliciting bids for construction of a landfill cell, hereafter designated as Phase 7B & 7C, at the MCSWM Campus in Grand Junction, Colorado. The work for this project includes:

- Excavation to achieve design subgrade grades
- Construction of a 12-inch thick compacted clay liner, including tie-in to existing clay/composite liner
- Placement of geosynthetics, including:
  - 60-mil HDPE textured geomembrane
  - Geocomposite leachate drainage layer
- Placement of a 12-inch thick operations layer over the geosynthetics
- Construction of an access road and culvert
- Installation of stormwater controls

2.0 SITE DESCRIPTION

The proposed work site is located in Sections 4 and 9 of Township 2 South, Range 1 East, Ute Principal Meridian.

The present site includes the existing landfill area, surface water control features and structures, an active gas collection and control system (GCCS), a maintenance building, an administration building, and a scale house. In addition, the Campus operates an Organic Materials Composting (OMC) Facility and a Household Hazardous Waste Collection (HHWC) Facility.

Please refer to Sheet 2 of the Construction Drawings for existing conditions at the Campus. Water for construction (dust suppression, moisture conditioning soil, etc.) is available at the on-site OMC Facility, approximately 0.75 miles north of the construction area.

3.0 SCHEDULE

MCSWM intends to begin the project on March 15, 2020. The Contractor must complete this scope of work by September 15, 2020. Weather delays will be approved by the MCSWM Representative based on suitable justification provided by the Contractor.

4.0 PAYMENT

All quantities on the Bill of Quantities are estimates prepared from the Construction Drawings. Except for items designated as Lump Sum in the Bill of Quantities, actual payment will be based on in-place quantities
surveyed by MCSWM or its Representative. The Contractor may have their own surveys done, at their
own cost, to confirm in-place quantities.

Payment for geomembrane and geocomposite is based on area covered and does not include allowance
or payment for waste, overlap, material in the anchor trench, or materials used for the convenience of
the Contractor. Measurement for the geomembrane and geocomposite will be to the edge of liner at
the interim liner termination berm and liner tie-ins to existing liner as shown on Sheet 7 of the
Construction Drawings. The cost for material not included in the measured pay quantity (overlap,
waste, etc.) must be included in the unit price.

Pay estimates will be prepared by the MCSWM Representative based on quantities measured while
construction is in progress.

5.0 SALIENT FEATURES

The project’s salient features are as follows:

1. Mobilization
2. Contractor Survey
3. Earthwork (Excavation)
4. Construction of Access Road and Culvert
5. Existing Clay Liner/New Composite Liner Tie-In
6. Existing Composite Liner/New Composite Liner Tie-in
7. Clay Liner Construction
8. Supply and Installation of HDPE Geomembrane
9. Supply and Installation of Geocomposite
10. Placement of Operations Layer
11. Installation of Stormwater Controls
12. Installation of Seed, Fertilizer and Mulch
13. Acceptance Survey
14. Final Acceptance

The Bidder shall include a proposed construction schedule showing the salient features listed above. A
bar chart is acceptable.

Alternative materials may be proposed by the Contractor, but the bid shall be prepared using the provided
Bill of Quantities only. Alternative materials may not be used without prior written approval of MCSWM
or its Representative.

6.0 CRITICAL WORK METHODS STATEMENTS

The Bidder shall provide statements describing how they will accomplish certain critical work:

1. Describe placement of operations layer over geosynthetics:
   a. Describe equipment to be used to place the operations layer.
   b. Describe how operations layer will be installed without damage to the underlying
      geosynthetics.
2. Provide prior experience of Geosynthetics Installer.
7.0 DOCUMENT ORDER OF PRECEDENCE

The above description of the site and the work are for the convenience of the Contractor. All work will be governed by the Contract Documents, CQAQC Plan, the Specifications, and the Construction Drawings. Where there are differences between these documents, the order of precedence shall be as follows:

1. Contract Documents
2. CQAQC Plan
3. Construction Drawings
4. Specifications
5. Description of Work

8.0 MCSWM RESPONSIBILITIES

MCSWM or its Representative will provide the CQAQC Plan, Specifications, and field CQAQC documentation. The CQAQC documentation will include testing equipment, supplies, and personnel for testing earthwork construction (moisture/density testing) and observing and documenting installation of geosynthetics. The Contractor shall assist MCSWM’s Representative with testing, as necessary, to properly complete all testing to the satisfaction of the requirements stated in the CQAQC Plan. The Contractor may be asked to stop work in areas to be tested, and to prepare areas for testing (e.g., cutting or scraping flat areas for nuclear density testing).

MCSWM’s Representative, Souder, Miller & Associates (SMA), will perform all pre-construction, post-construction, and as-built surveys to determine billable quantities.

Each component of the Phase 7B & 7C liner system must be certified by SMA before work on the next component may commence. If the Contractor requests a certification survey and the subsequent survey indicates that the area does not meet final grade and is therefore not certified, the Contractor shall be invoiced for the post-construction survey.

9.0 CONTRACTOR RESPONSIBILITIES

The Contractor shall be fully responsible for knowing and understanding the requirements of the work, including the CQAQC Plan. SMA will assist the Contractor with following and meeting the requirements of the CQAQC Plan, but SMA shall not be responsible for informing the Contractor of the requirements.

The Contractor shall provide all equipment, personnel, materials, and construction staking to complete the work to the line, grade, and requirements included in the Description of Work, CQAQC Plan, Specifications, and the Construction Drawings. If the Contractor provides onsite fuel tanks, the tanks shall be double-walled or provided with acceptable secondary containment. The Contractor shall also provide portable toilets as necessary. No potable water will be available at the site.

The Contractor shall protect existing vegetation, structures, equipment, utilities, pavement, monitoring wells, and improvements that are not scheduled to be demolished during the project. Any damage caused by the Contractor or its subcontractors shall be repaired or replaced equal to existing work, at the expense of the Contractor.
The Campus will remain open during the construction period. The Contractor shall complete the work so as to cause the least possible interference with normal operations at the Campus. This shall include, but not be limited to, the following:

- Maintaining all roads, fencing, utilities, water control piping, etc., in working condition.
- Campus hours of operation are Monday through Friday from 7:00 AM to 4:45 PM and Saturday from 8:00 AM to 4:15 PM. If the Contractor needs to work outside of these hours, arrangements shall be made with MCSWM at least three (3) days in advance. During such work, the Contractor shall be responsible for all site security.
- **No work shall be done by the Contractor without personnel from MCSWM or SMA on site.**
- If any disruptions to Campus facilities or operations will be necessary for the Contractor to complete the work, the Contractor shall make arrangements with MCSWM at least one week in advance.
- The Contractor shall be responsible for scheduling all certification as-built documentation survey work. Requests for certification as-built documentation surveying shall be made at least **72 hours in advance** of when the surveying will be required, and the Contractor shall have the areas ready for certification, as necessary.
- The Contractor shall be responsible for maintaining staking and control points provided by SMA. Replacing these will be at the expense of the Contractor.
- The Contractor shall be responsible for slope staking.
- Prior to beginning any excavation, the Contractor shall remove all topsoil and soils containing organic materials. These soils shall be stockpiled on the site in an area approved by MCSWM.

The Contractor shall be responsible for obtaining all permits and permissions necessary to begin and complete work.

The Contractor shall be responsible for temporary environmental controls associated with the construction work including, but not limited to, dust suppression, drainage control, storm water control, and storage and control of petroleum and hazardous materials and wastes.

The Contractor or subcontractor responsible for geosynthetics installation must demonstrate experience installing high-density polyethylene (HDPE) and geocomposite in accordance with the CQAQC Plan.

The Contractor shall have on the project, at all times that work is being performed, a competent superintendent capable of reading and understanding the contract documents and with experience in the type of work being performed. The superintendent will receive instructions from MCSWM and SMA and shall be authorized to act for the Contractor on the project and to execute orders or directions of MCSWM or SMA without delay. The superintendent shall promptly supply materials, equipment, tools, labor, and incidentals to complete the Contract, regardless of the amount of work sublet.

### 10.0 PHASE 7A ACCESS ROAD

An access road will be constructed to connect the existing haul road east of Phase 7B & 7C to Phase 7A (the cell located south of Phase 7B & 7C), as presented on Sheets 3 and 5 of the Construction Drawings. Construction of the access road includes:
- Excavate and fill to the line and grade shown on Sheets 3 and 5 of the Drawings. MCSWM has performed partial excavation for the access road subgrade. However, the Contractor shall finish subgrade construction. Assumed remaining cut and fill quantities are included in the Bill of Quantities.
- The surface presented on Sheet 3 of the Drawings is the final surface of the access road (top of road base). Excavate 6 inches from the final surface grades shown on Sheet 3 (to accommodate the road base), scarify at least 6 inches of this excavated subgrade surface and compact the exposed subgrade in accordance with the CQAQC Plan.
- Install a culvert as shown on Sheet 3 of the Drawings.
- Place six inches of Class 6 road base above the compacted subgrade and compact in accordance with the CQAQC Plan.
- Fertilize, seed and mulch the excavation area highlighted on Sheet 3 of the Drawings.

Fill for the access road subgrade shall be placed in loose 8-inch maximum lifts and compacted to a minimum of 92% of maximum modified Proctor dry density at ±4% of optimum moisture content.

10.1 STORMWATER CONTROLS

The following stormwater controls will be installed with the construction of the Phase 7A access road:
- Wattles are to be installed every 30 feet along the 3:1 cut slopes of the access road (see Sheets 3 and 8).
- Rock check dams will be installed at the intervals indicated on Detail 5 of Sheet 8 in the drainage channels that are to be constructed along the perimeter of the access road.
- A riprap-lined run down channel will be installed in the location presented on Sheet 3 of the Drawings. As displayed on Detail 3 of Sheet 8:
  - 12-inches of the subgrade will be excavated, re-conditioned, and re-compacted to 90% of maximum modified Proctor dry density at ±4% of optimum moisture content
  - A non-woven geotextile fabric will be installed over the subgrade
  - 12-inches of D50 riprap will be placed over the geotextile fabric.

11.0 PHASE 7B & 7C CONSTRUCTION

MCSWM has been approved to utilize the Base Liner System Alternate 2 discussed in Section 4.0 of the CQAQC Plan for the Phase 7B & 7C liner. Construction of Phase 7B & 7C includes:
- Excavation and fill of Phase 7B & 7C to subgrade (one foot below the grade shown on Sheet 3 of the Construction Drawings)
- Construction of 12-inch thick clay liner (material for this liner is to be obtained from the excavation required for construction of the access road and a stockpile adjacent to the proposed construction area):
  - Excavate, load, haul, and place clay soils
  - Moisture condition and compact the clay soils to form a minimum 12-inches thick low hydraulic conductivity layer for the base of Phase 7B & 7C in accordance with the CQAQC Plan and Sheet 3 of the Construction Drawings.
  - Tie liner into existing liner west of Phase 7B & 7C and south of Phase 7B & 7C in Phase 7A
• Installation of textured 60-mil HDPE geomembrane (Agru Microspike® or equivalent) in Phase 7B & 7C
• Installation of 250-mil geocomposite with 6 oz/yd² non-woven geotextile on top and bottom (leachate drainage layer). Alternately, DrainTube 606 ST Series geocomposite can be proposed.
• Placement of 12-inch thick operations layer
• Construction of interim liner termination berm

Clay liner shall be constructed using non-granular soils placed in loose 8-inch thick maximum lifts and compacted to a minimum of 92% maximum modified Proctor dry density at 0 to 4% of optimum moisture content to reach a nominal hydraulic conductivity of at least $1 \times 10^{-7}$ cm/sec.

Phase 7B & 7C must be properly tied into the existing liner system as detailed on Sheet 7 of the Construction Drawings. Previous as-built liner at the Campus is either a clay liner system with a 12-inch thick clay liner and a 12-inch thick operations layer or a composite liner system with a 12-inch thick clay liner and HDPE geomembrane with a 12-inch thick operations layer. Sheet 7 of the Construction Drawings details the different tie in techniques for each liner system. See Sheet 3 of the Construction Drawings for the locations of each tie in.

After the clay liner has been tested, inspected, surveyed, and certified as meeting the requirements of the CQAQC Plan, the geosynthetics Installer shall place the 60-mil HDPE geomembrane in Phase 7B & 7C, followed by the geocomposite drainage layer and the 12-inch thick operations layer.

Installation/construction of the subgrade, geomembrane, drainage layer, and operations layer are described in greater detail below.

HDPE geomembrane and the leachate drainage layer shall be constructed in Phase 7B & 7C using materials specified in the CQAQC Plan. Alternate materials may be proposed by the Contractor; however, alternate materials shall not be used without permission by SMA.

11.1 SUBGRADE EXCAVATION

Excavation shall be observed by SMA and excavation conditions documented prior to clay liner construction. The subgrade shall be free of loose, saturated, or frozen soils, pooled water, and unstable materials prior to installation of clay liner. Proof-rolling with heavy equipment will be performed to identify any areas of undesirable material or soft soils and will be observed by SMA.

Where unacceptable subgrade conditions exist, the surface will be re-rolled or over-excavated to reduce the impact of such conditions. When over-excavated, the resulting depression will be backfilled with structural fill. Backfilling will be accomplished in accordance with the CQAQC Plan. The completed subgrade will be surveyed to determine that the subgrade is in accordance with the Drawings.

Portions of excavation may be extremely difficult due to the dense shale material found on-site. Excavation of this dense shale material may require additional equipment or personnel. Please provide a separate price for excavation of this dense shale material. The price will be utilized only when both MCSWM and the Contractor come to an agreement that field conditions necessitate additional equipment or personnel. Although boulders are not expected, please provide a separate excavation price in the event that boulders greater than 4-feet in diameter are discovered.
11.2 HDPE GEOMEMBRANE (AGRU MICROSPIKE® OR EQUIVALENT)

One layer of 60-mil HDPE (AGRU Microspike® or equivalent) shall be installed on the base of Phase 7B & 7C. The HDPE shall be placed directly over the clay liner.

The HDPE geomembrane shall be placed according to an approved panel placement and seaming plan, and with double fusion welds. Extrusion welding may be used only where fusion welding is impractical and must be approved prior to use. All fusion seams shall be pressure-tested and mechanically tested, as required by the CQAQC Plan. Testing shall be done by the Installer, under the observation of SMA.

11.3 LEACHATE DRAINAGE LAYER

The leachate drainage layer consists of a double-sided 250-mil geocomposite or DrainTube 606 ST Series geocomposite. The geocomposite shall have a 6 oz/yd² non-woven geotextile bonded on both sides. The geocomposite shall be installed over the HDPE geomembrane in Phase 7B & 7C. It shall be overlapped a minimum of four inches, and with adjacent geogrid materials joined by contrasting colored plastic fasteners placed at 5-foot intervals in accordance with the CQAQC Plan and Construction Specifications. If DrainTube 606 ST Series geocomposite is used, the adjacent piping shall be joined per Manufacturer’s specifications. The top layers of geotextiles are to be sewn together or heat bonded, at the direction of SMA. Geotextiles shall be overlapped a minimum of 4-inches.

11.4 OPERATIONS LAYER

The one-foot operations layer shall be constructed using materials specified in the CQAQC Plan. The operations layer shall be placed over the leachate drainage layer in Phase 7B & 7C.

The placement of the operations layer should be accomplished using a lightweight, low ground pressure bulldozer as approved by SMA. It is the Contractor’s responsibility to place the operations layer in a manner that minimizes the potential for damage to the underlying liner materials. Any damage to any of the underlying liners or layers shall be repaired by the Contractor at no expense to MCSWM. The soil to be used for the operations layer may need to be screened to meet the maximum 2-inch particle size.

12.0 STORMWATER CONTROLS

One stormwater berm will be installed north and west of Phase 7B & 7C. The purpose of the stormwater control berm is to limit the amount of stormwater that enters Phase 7B & 7C. The tack-on berm should be a minimum of 15-inches tall and should be constructed with a slope of 3:1. The stormwater control berm should be placed approximately in the location shown on Sheet 3 of the Drawings. However, the placement of the berm may have to be field located so that stormwater is directed away from the landfill phase.

An existing stormwater control berm is located at the southwest corner of Phase 7B & 7C (see Sheet 3 for the approximate location of the berm). The new stormwater control berm should be placed so that it ties in properly to the existing berm.
13.0 MEASUREMENT AND PAYMENT

As indicated on the Bill of Quantities, all payments shall be based on in-place surveyed quantities or lump sum. No payment will be made for pipe wastage, soil consolidation, or geosynthetics overlap, waste, or geosynthetics placed in an anchor trench. The bid price should include installed quantities for all items unless identified differently in the Bill of Quantities.

Survey will be provided by SMA. The Contractor may verify quantities with an independent survey, if desired, at the Contractor’s expense.

Unit Prices include:

1. Defined work for each until price item which will provide a functionally complete project when combined with all unit price items. If there are specific work items which the Contractor believes are not identified in any unit price item, but are required to provide a functionally complete project, the identified specific work items shall be included in the appropriate unit price item.
2. The method of measurement for payment.
3. The price per unit for payment.

Lump Sum Prices include:

1. All work items which will result in a functionally complete project in accordance with the specifications and drawings. If there are specific work items which the Contractor believes are not identified in any lump sum item, but are required to provide a functionally complete project, then the identified specific work items shall be included in the appropriate lump sum item.

13.1 GENERAL WORK ITEMS

Include, when appropriate, costs for the following work items which are common to all items on the Bill of Quantities:

1. Maintenance, protection, replacement, and/or repair of damaged facilities outside the area identified for payment in a separate item
2. Site access requirements, including temporary soil material as required for the Contractor to access the work and equipment
3. Dust control, including, but not limited to, watering of grades and construction access/haul roads
4. Traffic control
5. Erosion control construction
6. Right-of-way requirements
7. Regulatory requirements
8. Construction staking and other survey work not provided by SMA
9. Location of existing utilities and piping
10. Protection of existing underground piping, utilities, and site groundwater monitoring wells (that are not already scheduled to be abandoned)
11. Quality assurance and quality control testing and inspections not provided by SMA
12. All safety-related costs
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SECTION 01 00 00 – BASIC REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 CONTRACT DESCRIPTION

A. Work of the Project includes the construction of solid waste disposal Phase 7B & 7C including excavation, grading, installation of a clay liner, HDPE geomembrane liner, geocomposite drainage layer, and operations layer and construction of perimeter earthwork. An access road and site drainage will also be constructed.

B. Perform Work of Contract under a stipulated price basis with the Owner in accordance with the Contract.

1.1.2 SPECIAL CONSIDERATION

A. Earthwork will be completed by the Contractor, including finishing cells, roads, and drainage to grade and fine grading.

B. Contractor is responsible for the excavation and backfilling of anchor trenches, if required.

C. Contractor is required to place the operations layer over liner materials.

D. Contractor, or Contractor’s subconsultant, is required to provide and place all geosynthetic materials.

E. Contractor is responsible for cell dewatering and cleanup if rainfall occurs during the construction period.

F. The geosynthetics pay quantities will not include liner material in an anchor trench, overlap, or waste. Measurement will be from the inside edge of the anchor trench, edge of liner at interim termination berm, and/or edge of liner at tie-in to existing clay liner and existing geosynthetic liner tie-in. The cost for material not included in the measured pay quantity (overlap, waste, material in anchor trench, etc.) must be included in the unit price.

G. Water for construction is available for use on site, as presented on Sheet 2 of the Construction Drawings.

H. Contractor shall prepare record drawing information under the direction of a Licensed Professional Surveyor. Refer to Article 1.8.7 Project Record Documents below for specific requirements related to As-Built Drawings.

I. Contractor must maintain a full set of Construction Drawings, Technical Specifications, and the Construction Quality Assurance/Quality Control (CQAQC) Plan at the construction site at all times throughout the construction process. All subcontractors must possess at least all Construction Drawings and Technical Specifications pertaining to their portion of the work while on the construction site at all times.

1.1.3 WORK BY OWNER

A. Not applicable.
1.1.4 CONTRACTOR’S USE OF PREMISES

A. Campus hours of operation are Monday through Friday from 7:00 AM to 4:45 PM and 8:00 AM to 4:15 PM on Saturday. If the Contractor needs to work outside of these hours, arrangements shall be made with the Owner at least three (3) days in advance. During such work, the Contractor shall be responsible for all site security.

B. The Contractor shall resist operations as nearly as possible to the immediate site. Unnecessary cutting of vegetation adjacent to the site is prohibited. Every effort shall be made to minimize erosion during and after construction and the site shall be returned to its original condition, except where improvements are indicated or required.

C. The Contractor shall take affirmative action to prevent the misuse of the natural environment, wasting of natural resources, or destruction of natural values.

1.2 PRICE AND PAYMENT PROCEDURES

1.2.1 UNIT PRICES

A. Engineer or Engineer’s representative will take measurements and compute quantities accordingly; all quantities will be in-place. The Contractor will assist in taking of measurements and determination of work prior to preparation of corresponding Application for Payment.

B. As indicated on the Bill of Quantities, all payments shall be based on in-place surveyed quantities or lump sum. No payment will be made for pipe wastage or soil consolidation. The bid price should include installed quantities for all items unless identified differently in the Bill of Quantities.

C. The geosynthetics pay quantities will not include liner material in an anchor trench, overlap, or waste. Measurement will be from the inside edge of the anchor trench, edge of liner at interim termination berm, and/or edge of liner at tie-in to existing clay liner and existing geosynthetic liner tie-in. The cost for material not included in the measured pay quantity (overlap, waste, material in anchor trench, etc.) must be included in the unit price.

1.2.2 GENERAL WORK ITEMS

A. Include, when appropriate, costs for the following work items which are common to all items on the Bill of Quantities:
   1. Maintenance, protection, replacement, and/or repair of damaged facilities outside the area identified for payment in a separate item
   2. Site access requirements including temporary soil material as required for the Contractor to access the work and equipment
   3. Dust control, including watering of grades and construction access/haul roads
   4. Traffic control
   5. Erosion control construction
   6. Right-of-way requirements
   7. Construction staking and other survey work not provided by the Owner
   8. Location of existing utilities and piping
   9. Protection of existing underground piping, utilities, and site groundwater monitoring wells (that are not already scheduled to be abandoned)
   10. Quality assurance and quality control testing and inspections not provided by the Owner
   11. All safety-related costs
12. Attendance at construction meetings
13. Shop drawings and other submittals

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 COORDINATION

A. Coordinate scheduling, submittals, and Work of various sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.
B. The Contractor is responsible for obtaining all necessary permits from regulatory agencies having jurisdiction.
C. The Contractor is responsible for timely scheduling of any pertinent inspections with local, county and state agencies with jurisdiction, and as required by the permits.
D. All notices, demands, requests, instructions, approvals, proposals and claims must be in writing.
E. Any notice or demand upon the Contractor shall be sufficiently given if delivered at the office of the Contractor stated on the signature page of the Contract Documents.
F. All papers required to be delivered to the Owner shall, unless otherwise specified in writing to the Contractor, be delivered to the Owner at the address stated in the Contract Documents.
G. Any such notice shall be deemed to have been given as of the time of actual delivery, in the case of mailing, when the same should have been received in due course of post, or in the case of certified mail, or telephone facsimiles, at the time of actual receipt as the case may be.

1.3.2 SUSPENSION OF WORK

A. The Owner may order suspension of work due to seasonal or other conditions unsuitable for construction work.
B. Maintenance during suspension: Prior to suspension for any cause, the Contractor shall take necessary precautions to protect the work during the period of suspension from any factors which would contribute to its deterioration.
C. Time elapsed during suspension of the work shall not count as contract time. The contractor shall make no claim for damages due to delay, additional mobilization charges, nor any additional costs that may be incurred solely due to suspension of work.
D. Requests for additional time to be added after the “contract completion date” due to delays or extra work shall be made to the Owner in writing by the Contractor within ten (10) days after the time of the occurrence of the delay or receipt of a Change Order for extra work. Such requests shall set forth the justification for the additional time.
E. Upon approval, the additional contract time shall then be in full force and effect, the same as though it were the original date for completion and will be shown as the completion date plus an amount of additional working days. Any time required to complete the work beyond the contract time or additional contract time will result in the assessment of liquidated damages, as specified in the Contract Documents. Failure to make such requests within the above limits will be considered as a waiver on the part of the Contractor as to the need for additional contract time.

1.3.3 FIELD ENGINEERING

A. Establish elevations, lines, and levels and certify and confirm elevations and locations of the Work, conforming with the Contract Documents, with the Engineer prior to performing any excavation.
B. Verify field measurements are as indicated on shop drawings or as instructed by manufacturer.
C. From the information provided by the Owner, the Contractor shall develop and make all detail surveys needed for construction such as slope stakes, batter boards, easement alignments, stakes for pipe locations and other working points, lines, elevations and cut sheets.

1.3.4 PRE-CONSTRUCTION MEETING

A. The Engineer will schedule a Pre-Construction meeting after the Notice of Award for affected parties.
B. The Contractor, or his duly authorized representative, and subcontractor representatives will attend the meeting.

1.3.5 PROGRESS MEETINGS

A. Schedule in coordination with the Engineer as necessary and attend all Progress Meetings throughout progress of the Work.
B. The purpose of the meetings will be to review the following:
   1. Work progress since previous meetings.
   2. Field observations, problems, conflicts.
   3. Problems which impede construction schedule.
   4. Corrective measures and procedures to regain projected schedule.
   5. Revisions to construction schedule.
   6. Plan progress and schedule during succeeding work period.
   7. Coordination of schedules.
   8. Off-site fabrication and delivery schedules.
  10. Proposed changes, construction schedule and completion date.
  11. Coordination of separate contracts.
  12. Record or “as-built” drawings of completed work.
  13. Other business as required.
  14. Regulatory requirements.
  15. Funding requirements.
C. During each meeting, the Contractor is required to present any issues which may impact the Work, with a plan to resolve these issues expeditiously.
D. Together with each payment application, the Contractor must present the current as-built drawings reflecting all work performed to date.

1.4 SUBMITTALS

1.4.1 SUBMITTAL PROCEDURES

A. Identify Project, Contractor, subcontractors and suppliers; pertinent drawing and detail number, and specification section number, appropriate to submittal.
B. Apply Contractor’s stamp as applicable, signed or initialed, certifying that review, verification of Products required, field dimensions and elevations, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
C. Identify variations from the Contract Documents or system limitations which may be detrimental to successful performance of completed Work.

D. Revise and resubmit submittals as required by the Engineer; identify changes made since previous submittal.

E. Prior to commencing construction activities, the Contractor must submit a safety plan for approval by the Engineer.

1.4.2 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule after Owner-Contractor Agreement for Engineer review.

B. Submit revised schedules with each Application for Payment, identifying changes since previous version. Indicate estimated percentage of completion for each item of Work at each submission.

C. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties.

D. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.

E. Indicate delivery dates for Owner furnished products and products identified in the Bill of Quantities.

1.4.3 PROPOSED PRODUCTS LIST

A. Unless required as an attachment to Bid, after date of Owner-Contractor Agreement, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product per the CQAQC Plan.

B. For products specified only be reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.4.4 PRODUCT DATA

A. Product Data: Submit to Engineer for review, per CQAQC Plan, for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Submit copies and distribute in accordance with Submittal Procedures article.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers’ standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.4.5 SHOP DRAWINGS

A. Shop Drawings:

   1. Submitted to Engineer, per CQAQC Plan, for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

   2. Include detail design calculations, shop drawings, fabrication, installation drawings, erection drawings, list, graphs, catalog sheets, data sheets, and similar items.
3. Design calculations shall bear the signature and seal of an engineer registered in the appropriate branch and in the state wherein the project is to be built, unless otherwise directed.
4. After review, provide copies and distribute in accordance with Submittal Procedures article and for record documents purposes as specified.
5. Except as may otherwise be indicated herein, the Engineer will return copies of each submittal to the Contractor with comments noted thereon, within 30 calendar days following their receipt by the Engineer.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
C. Submit number of opaque reproductions Contractor requires, plus two copies Engineer will retain.

1.4.6 TEST REPORTS
A. Submit for Engineer’s knowledge as contract administrator or for Owner.
B. Submit test reports, per CQAQC Plan, for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.4.7 MANUFACTURER’S INSTRUCTIONS AND CERTIFICATES
A. When specified in individual specification sections, submit manufacturer printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
C. When specified in individual specifications sections, submit certifications by manufacturer to Engineer, in quantities specified for Product Data.
D. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
E. Certificates may be recent or previous test results on material or Product but must be acceptable to Engineer.

1.5 QUALITY REQUIREMENTS

1.5.1 QUALITY CONTROL
A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality, per CQAQC Plan.
B. Comply with manufacturer’s instructions.
C. Comply with specified standards as minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

1.5.2 TOLERANCES
A. Monitor fabrication and installation tolerance control of installed products over suppliers, manufacturers, products, site conditions, and workmanship, to produce acceptable Work, per CQAQC Plan. Do not permit tolerances to accumulate.
B. Comply fully with manufacturer’s tolerances.

1.5.3 REFERENCES
A. Conform to reference standards by date of issue current as of date of Contract Documents.
B. When specified reference standard conflict with Contract Documents, request clarification from Engineer before proceeding.

1.5.4 MANUFACTURER’S FIELD SERVICES AND REPORTS
A. Per CQAQC Plan, when specified in individual specification sections, require material or product suppliers or manufacturers to furnish qualified staff personnel to observe site conditions and to initiate instructions when necessary.
B. Report observations and site decisions or instructions that are supplemental or contrary to manufacturer’s written instructions.

1.5.5 EXAMINATION
A. Per CQAQC Plan, verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
B. Verify utility services are available, of correct characteristics, and in correct location.
C. Contractor is solely responsible for utility location, protection and verification.
D. It shall be the responsibility of the Contractor to become acquainted with the location of all underground structures which may be encountered, or which may affect the Work hereunder.

1.6 TEMPORARY FACILITIES AND CONTROLS

1.6.1 TEMPORARY SERVICES
A. Maintain uninterrupted water and electric service to all properties adjoining the Work, except where specifically approved by the authority having jurisdiction. Services damaged by the Contractor shall be immediately and permanently repaired or replaced at the expense of the Contractor. Give a minimum of 48-hour advance notice to occupants of adjacent properties before interrupting any service. Any interruption of service shall be kept to the minimum length of time possible.
B. Until final inspection and approval of the Work and issuance of the Certificate of Substantial Completion, the Contractor is responsible for all Work directly or indirectly affected by the Contractor’s activities. Such responsibility continues for all Work detailed on the punch list that may accompany the Certificate of Substantial Completion, until satisfactorily completed by the Contractor and approved by the Owner and Engineer.
C. Furnish, install and maintain any temporary water storage structures, electrical connections, meters, wiring, outlets, switches, lamps, etc., as necessary for the work. The Contractor shall provide such temporary heat as may be necessary for the prevention of injury to the work or material through dampness or cold. All temporary connections, installations, facilities and supplies furnished or installed as specified in this paragraph, shall be removed prior to the completion of the Contract, and the premises left perfectly clean and satisfactory to the Owner.
D. Maintain ambient temperature above freezing in enclosed/occupied areas where construction is in progress, unless indicated otherwise in specifications.
E. Provide temporary electricity and power outlets for construction operations, connections, branch wiring, distribution boxes, and flexible power cords as required. Do not disrupt Owner's need for continuous service.
F. Provide and maintain required sanitary facilities and enclosures in clean and sanitary condition.

1.6.2 ACCESS ROADS

A. Construct and maintain temporary roads accessing public thoroughfares to serve construction area.
B. Existing on-site roads, designated by the Owner, may be used for construction traffic.

1.6.3 PROGRESS CLEANING AND WASTE REMOVAL

A. Collect and maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.
B. Remove waste and surplus materials, rubbish, and construction facilities from site. Restore all job sites and adjoining areas, including roads and driveways, to a condition equal to or better than the original status. Special attention will be made to not disturb unimproved roads by placing any excavated material to the sides of these roads when water lines are located along the right-of-way.
C. Brush and trees shall be felled parallel to the right-of-way to minimize damage to trees and structures on adjacent property. All brush, tree tops, stumps and other debris shall be removed from the right-of-way and disposed of by the Contractor, subject to and in conformity with the special provisions applying to the tract of land involved (if any). The Contractor shall not destroy nor remove any trees, shrubbery, nor any other improvements, without permission of the Owner.
D. The Contractor shall not dispose of debris, refuse or sanitary wastes in an open dump or in a natural watercourse, whether on public or private property, or in such places that undesirable wastes can eventually be exposed or carried to a natural watercourse.

1.6.4 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification sections.

1.6.5 SECURITY

A. Provide security and facilities to protect Work and existing facilities, and Owner’s operations from unauthorized entry, vandalism, or theft.

1.6.6 WATER CONTROL

A. Provide erosion control.
B. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
C. The Contractor shall submit to the Owner’s Representative a Storm Water Pollution Prevention Plan (SWPPP) that will address all construction phases and the proposed pollution prevention and sediment control measures. This shall be done in accordance with the National Pollution Discharge Elimination System (NPDES) general permit requirements for all construction activities and shall include all required reporting.
D. The Contractor shall conduct his operations to minimize damage to natural watercourses, and shall not permit petroleum products, volatile fluid wastes, or any other wastes which are prohibited by local ordinances, or excessive amounts of silt, clay, or mud to enter any drainage system. The bed of natural watercourses or man-made irrigation ditches shall be restored to normal gradient and cross-section after being disturbed.

1.6.7 POLLUTION AND ENVIRONMENTAL CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

B. Provide dust control, erosion and sediment control, noise control, pest control and rodent control to allow for proper execution of the Work. Short term effects of dust produced by equipment will be mitigated by sprinkling traffic areas with water. Motor equipment shall be kept in repair and equipped with anti-pollution devices, if possible, to cut down on exhaust emissions. Burning as a method of cleaning or disposal will not be permitted without approval of the proper authorities.

C. Comply with all applicable standards, orders, or regulations issued pursuant to the applicable regulatory agencies. Violations will be reported as necessary.

D. The Contractor shall be responsible for the reporting and the cleanup of spills associated with project construction and shall report and respond to spills of hazardous materials such as gasoline, diesel, motor oil, solvents, chemicals, toxic and corrosive substances, and other materials which may be a threat to the public health or the environment. The Contractor shall be responsible for reporting past spills encountered during construction and of current spills not associated with construction. The Contractor shall clean up any unreported spills associated with project construction identified after construction.

1.6.8 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, and materials, prior to Substantial Completion review.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.7 PRODUCT REQUIREMENTS

1.7.1 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components specifically identified for reuse.

B. Do not use materials and equipment removed from existing premises, except as specifically identified or allowed by the Contract Documents.

C. Provide interchangeable components of same manufacturer for components being replaced.
1.7.2 DELIVERY, HANDLING, STORAGE, AND PREPARATION

A. Per CQAQC Plan, deliver, handle, store, and protect Products in accordance with manufacturer's instructions.

1.7.3 SUBSTITUTIONS

A. Substitutions will only be considered when Product becomes unavailable through no fault of Contractor, or where an “approved equal” is specifically allowed elsewhere in the Technical Specifications or noted on the Construction Drawings.
B. Specific manufacturers may be required for certain items in order to maintain consistency with the Owner’s existing inventory. In such cases, substitutions will not be allowed as indicated in each specification section where applicable.
C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

1.8 EXECUTION REQUIREMENTS

1.8.1 CLOSEOUT PROCEDURES

A. Submit written certification Contract Documents have been reviewed, Work has been inspected, and Work is complete in accordance with Contract Documents and ready for Engineer’s inspection.
B. Submit final Application for Payment identifying total adjusted Contract Price, previous payments, and amount remaining due.

1.8.2 FINAL CLEANING

A. Execute final cleaning prior to final inspection.
B. Upon completion of the work under this contract, thoroughly clean and make any needed repairs caused by damage during construction to any existing utilities or other structures on the site.
C. Notify the Engineer in writing once final cleaning is complete. The final estimate will not be prepared until the Contractor has complied with all requirements set forth and the Engineer has made a final inspection of the entire work and is satisfied that it is properly constructed and the site properly cleaned.

1.8.3 STARTING OF SYSTEMS

A. Provide seven [7] days notification prior to start-up of each item.
B. Ensure each piece of equipment or system is ready for operation.
C. Execute start-up under supervision of responsible persons in accordance with manufacturer’s instructions.
D. Submit written report stating equipment or system has been properly installed and is functioning correctly.

1.8.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner’s personnel prior to the date of Substantial Completion.
B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at designated location.

1.8.5 TESTING, ADJUSTING, AND BALANCING
A. Adjust operating products and equipment to ensure smooth and unhindered operation.
B. Owner retains the right to appoint, employ, and pay for services of independent firm to perform testing, adjusting, and balancing. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with requirements of Contract Documents.
C. Contractor will cooperate with independent firm; furnish assistance as requested.
D. Re-testing required because of non-conformance to specified requirements will be charged to Contractor.

1.8.6 PROTECTING INSTALLED CONSTRUCTION
A. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
B. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
C. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
D. Prohibit traffic from landscaped areas.

1.8.7 PROJECT RECORD DOCUMENTS
A. Maintain on site one set of Contract Documents to be utilized for record documents.
B. Record actual revisions to the Work. Record information concurrent with construction progress.
C. Specifications: Legibly mark and record at each Product section description of actual Products installed.
D. Record Documents and Shop Drawings (As-Built Drawings): Legibly mark each item to record actual construction. Deliver As-Built Drawings with redlines to the Owner upon completion of the Project. The As-Built Drawings will be submitted to the Engineer prior to processing of final payment to the Contractor.
E. Contractor shall prepare record drawing information under the direction of a Licensed Professional Surveyor. As-Built Record Drawings shall include elevation at top of pipe, northing and easting of top of waterline or new utility at intervals not to exceed 100 feet and at all fittings, valves and transitions and other appurtenances as well as finished grade elevations at same and at the top of flange or top of nut (specify on drawing point description) of all hydrants. Ties to surface features for triangulation purposes in the field shall also be included. Final As-Built Record Drawings shall be stamped by a Licensed Professional Surveyor, tied to established control monuments and other reference points, stating combined ground-to-grid scale factor used, equipment used and date of completion of survey.
F. Submit documents to Engineer together with claim for final Application for Payment.
1.8.8 WARRANTIES

A. Execute and assemble transferable warranty documents from subcontractors, suppliers, and manufacturers for all products with extended warranties beyond one (1) year.

B. Submit prior to final Application for Payment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install granular fill materials as shown on the Construction Drawings and as specified herein. Associated work includes screening and washing, excavation, loading, shipping, delivering, stockpiling, placement and installation of granular fill materials.

B. The granular soils will be used for the following:
   1. Operations layer material
   2. Culvert pipe bedding
   3. Road Base

1.2 UNIT PRICES – MEASUREMENT AND PAYMENT

A. Operations Layer
   2. Basis of Payment: Payment will be based on volume as measured in-place.

B. Culvert Pipe Bedding
   2. Basis of Payment: Measurement for payment will be based on linear feet of culvert placed.

C. Road Base
   2. Basis of Payment: Payment will be based on volume as measured in-place.

1.3 SUBMITTALS

A. Contractor shall submit information on material to be utilized for operations layer, culvert pipe bedding, and road base, including grain size analysis (ASTM D422) results.

B. If Contractor elects to utilize on-site granular material, Contractor must submit information on how material will be processed and layout of processing area.

1.4 QUALIFICATIONS

A. The work shall be performed by a firm that has experience in processing and installation of operations layers on top of synthetic liners.

1.5 EXCAVATION AND STORAGE

A. If the Contractor elects to utilize on-site materials during excavation activities, Contractor will identify those materials that will be utilized for the granular material. The Contractor shall remove this material and store properly until the granular material is installed. Screening and washing of the material may be required and will be accomplished by the Contractor at no additional cost to the project. Provision shall be implemented to minimize surface water impact on the stockpile.
Removal and placement of granular material shall be done in a manner to minimize intrusion of soils adjacent to and beneath the stockpile.

B. If the Contractor elects to import the granular material, the Contractor shall designate a location to stockpile material and provide information on how materials will be protected and kept free of contamination.

PART 2 PRODUCTS

2.1 OPERATIONS LAYER GRANULAR MATERIAL

A. Operations layer material, whether from an on-site source or an imported material, must meet the following specification:
   1. Soils must be reasonably free of roots, sticks, or any other foreign materials to the extent practical and will consist of material that will not damage the underlying geosynthetics.
   2. Maximum particle size is 2-inches.

2.2 CULVERT PIPE BEDDING

A. The culvert bedding shall consist of granular material conforming to the specifications in Table 1.

   Table 1 PIPE BEDDING SPECIFICATIONS

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Percent Passing Square Mesh Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>No. 4</td>
<td>&gt; 45</td>
</tr>
<tr>
<td>No. 100</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>No. 200</td>
<td>&lt; 5</td>
</tr>
</tbody>
</table>

2.3 CLASS 6 ROAD BASE

A. Road base, whether from an on-site source or an imported material, must meet the following specification:
   1. Material must be 6-inch minimum thickness CDOT Class 6 road base.
   2. Material must be reasonably free of roots, sticks, or any other foreign materials to the extent practical.
   3. The culvert bedding shall consist of granular material conforming to the specifications in Table 2.

   Table 2 CDOT CLASS 6 ROAD BASE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Percent Passing Square Mesh Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-65</td>
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<td>No. 8</td>
<td>25-55</td>
</tr>
<tr>
<td>No. 200</td>
<td>3-12</td>
</tr>
</tbody>
</table>
PART 3  EXECUTION

3.1  OPERATIONS LAYER PLACEMENT
A. After installation completion and acceptance of the geocomposite drainage material and related work activities, place the operations layer material to thickness and area extent as shown on the Construction Drawings in a single lift.
B. During the placement of the operations layer, no construction equipment shall be allowed directly on the liner system and any damage shall be repaired immediately in accordance with these Specifications and the CQAQC Plan.
C. Care shall be taken to protect the liner. Ramps shall be provided at down slopes and in other heavily traveled areas. All heavily traveled areas shall have a minimum of 3 feet of material above the liner system. Only large radius turns by any equipment shall be permitted as sharp turns may damage the liner.
D. Granular materials shall not be placed over a fold in the liner. Placement of liner protection materials shall be such that material will “walk out” wrinkles, not fold them over.
E. Granular material shall be placed on the side slopes steeper than 10% starting at the toe of the slope and working toward the top of the cell.
F. Operations layer material can only be spread when the liner is taut or stretched evenly over the base of the landfill. The operations layer material shall not be spread when the liner is elongated due to higher daytime temperatures and exposure to the sun. The Contractor must make provisions to cover the liner under non-elongated conditions.
G. The placement of the operations layer should be accomplished using a lightweight, low ground pressure bulldozer.

3.2  CULVERT PIPE BEDDING MATERIAL PLACEMENT
A. The Engineer will observe the spreading and grading of the pipe bedding and document that it meets the specifications.
B. A 6-inch minimum layer of pipe bedding shall be placed in the culvert trench prior to placing the culvert. After placement of the culvert, the trench shall be filled with pipe bedding to the spring line of the pipe.
C. Care should be taken to prevent damage to the culvert during placement of pipe bedding. Actual damage, as well as corrective action taken, will be fully documented.

3.3  ROAD BASE MATERIAL PLACEMENT
A. The Engineer will observe the spreading and grading of the road base and document that it meets the specification.
B. A 6-inch minimum layer of road base shall be placed over the road subgrade.
C. The material shall be compacted to 92% of maximum modified Proctor dry density at ±4% of optimum moisture content (ASTM D1557).

3.4  FIELD QUALITY CONTROL
A. Samples shall be taken and measured for grain size every 6,540 cubic yards of in-place granular fill material for the operations layer.
B. Samples shall be taken and measured for grain size analysis every 2,620 cubic yards of in-place granular material used for pipe bedding.

C. The operations layer thickness shall be measured at the certification points presented on the Construction Drawings to confirm that the thickness of the installed material is in accordance with the Construction Drawings.

D. The samples shall be taken by the qualified inspector or his/her designated representative and the material will be tested to determine if the material meets specifications as outlined in Part 2 of this section.

E. Any sample or area tested shall be rejected, removed, and replaced if it does not meet the requirements of the Specifications. Reconstructed areas shall have feathered, overlapping edges that tie into adjacent fill material.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Specifications and guidelines for manufacturing and installing geomembrane liners.
B. The geomembrane liner shall be 60-mil thick HDPE geomembrane (AGRU Microspike® or equivalent) to be used in the geocomposite liner system. The HDPE will be installed over the prepared clay liner.

1.2 UNIT PRICE – MEASUREMENT AND PAYMENT
A. Basis of Measurement: Square Feet.
B. Basis of Payment: Measurement for payment will be based on the actual plan view area of HDPE geomembrane installed as measured by survey. Measurement will be from the inside edge of the anchor trench, edge of liner at interim termination berm, and/or edge of liner at tie-in to existing clay liner and existing geosynthetic liner tie-in. The cost for material not included in the measured pay quantity (overlap, waste, material in anchor trench, etc.) must be included in the unit price.

1.3 REFERENCE
A. American Society for Testing and Materials (ASTM)
   1. ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
B. Geosynthetic Research Institute (GRI)
   2. GRI GM 17 Test Properties - Testing Frequency and Recommended Warranty for Linear Low-Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

1.4 DEFINITIONS

A. Lot - A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.

B. Engineer - The individual or firm responsible for the design and preparation of the project’s Contract Drawings and Specifications. The Engineer will also serve as the Construction Quality Assurance Consultant (Consultant).

C. Geomembrane Manufacturer (Manufacturer) - The party responsible for manufacturing the geomembrane rolls.

D. Geosynthetic Quality Assurance Laboratory (Testing Laboratory) - Party, independent from the Owner, Manufacturer and Installer, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the Owner.

E. Installer - Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams. For the sake of the present Contract Documents, reference to Installer throughout this specification shall be understood to be one and the same as Contractor, whether the Contractor subcontracts the installation or not.

F. Panel - Unit area of a geomembrane that will be seamed in the field that is larger than 100 ft².

G. Patch - Unit area of a geomembrane that will be seamed in the field that is less than 100 ft².

H. Clay Liner – Soil layer surface that immediately underlies the geosynthetic material(s).

1.5 SUBMITTALS POST-AWARD

A. Furnish the following product data, in writing, to Engineer prior to shipment of the geomembrane material:
   1. Information required for Manufacturer prequalification including, but not limited to:
      a. Manufacturer’s capabilities
      b. Manufacturer’s quality control manual
      c. Manufacturer’s field installation Quality Control Manual
   2. Resin Data shall include the following:
      a. Certification stating that the resin meets the Specification requirements.
      b. A copy of the quality control certificates issued by the resin supplier noting results of density and melt index.
   3. Geomembrane Roll:
      a. Statement certifying no more than two (2) percent recycled polymer by weight. Recycled polymer shall be limited to material generated within the geomembrane manufacturer’s plant and from the same grade and type defined in this Specification and the CQAQPC Plan.
      b. Statement certifying the geomembrane must contain no more than one (1) percent by weight additives, fillers, or extenders, excluding carbon black.
c. Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to this facility.
d. Reports on the tests conducted by the Manufacturer to certify the quality of the liner sheets.

**B.** The Contractor shall furnish the following information to the Engineer prior to delivery and installation:

1. One quality control certificate for every roll
2. Installation layout drawings:
   a. Must show proposed panel layout including field seams and details.
   b. Must be approved prior to installing the geomembrane.
   i. Approved drawings will be for concept only and actual panel placement will be determined by site conditions.

**C.** Prior to Installation, geomembrane conformance sampling will be performed at the stated frequencies as presented in the CQAQC Plan. If possible, the conformance sampling shall be performed by the Geosynthetic Manufacturer at the plant prior to shipping to the site. Samples may be selected from geomembrane rolls delivered to the site for offsite conformance testing by a geosynthetics testing laboratory other than the Geosynthetic Manufacturer.

**D.** During installation, documentation files for field quality control shall be maintained by the Contractor and daily logs shall be submitted at the end of each week to the Engineer or Engineer’s representative after being updated and checked.

**E.** The Contractor will submit the following to the Engineer upon completion of installation:

1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents.
2. Material and installation warranties.
3. As-built drawings showing actual geomembrane placement and seams, including typical anchor trench detail.

### 1.6 QUALITY ASSURANCE

**A.** The Owner may engage and pay for the services of a Geosynthetic Quality Assurance Consultant and Laboratory to monitor geomembrane installation.

**B.** Manufacturing Quality Control Sampling:

1. Sampling shall be in accordance with the specific test methods listed in this Specification. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.
2. The number of tests shall be in accordance with the appropriate test methods listed in this Specification.
3. The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in this specification, hence the values listed are the minimum average values.

**C.** Manufacturing Quality Control Retest and Rejection:

1. If the results of any test do not conform to the requirements of this Specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer’s quality manual.
1.7 QUALIFICATIONS

A. Manufacturer:
   1. Manufacturer shall have manufactured a minimum of 10 million ft$^2$ of HDPE, with at least 8 million ft$^2$ installed.

B. Installer:
   1. The Installer must have installed at least 500,000 ft$^2$ of HDPE or must provide satisfactory evidence that the HDPE will be installed in a competent and professional manner.

1.8 MATERIAL LABELING, DELIVER, STORAGE AND HANDLING

A. Labeling – Each roll of geomembrane delivered to the site shall be labeled by the Manufacturer. The label will identify:
   1. Manufacturer’s name.
   2. Product identification.
   3. Thickness.
   4. Length.
   5. Width.
   6. Roll number.

B. Packaging – The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means.

C. Delivery – Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

D. Storage – The on-site storage location for geomembrane material, provided by the Contractor to protect the geomembrane from punctures, abrasions and excessive dirt and moisture for should have the following characteristics:
   1. Level (no wooden pallets).
   2. Smooth and dry.
   3. Protected from theft and vandalism.
   4. Adjacent to the area being lined.

E. HDPE rolls are to be unloaded under the supervision of the liner installer using straps or other devices that will prevent damage to the liner material.

F. Rolls should be stored on subgrade that is clean, dry, and well compacted. HDPE materials shall be stacked not more than two rolls high.

G. If any material damage is noted during unloading, the damaged areas are to be marked with a permanent marker, and a notation made as to the roll number, location of damage, and type of damage. Recording of minor damage to the outer wraps of liner material is not required.

H. Handling – Materials are to be handled so as to prevent damage.

1.9 WARRANTY

A. Material shall be warranted for a period of one (1) year from the date of geomembrane installation.

B. Installation shall be warranted against defects in workmanship for a period of one (1) year from the date of geomembrane completion.
PART 2  PRODUCTS

2.1 GEOMEMBRANE

A. Manufacturer:
   1. Geomembrane shall be manufactured by the following:
      a. Raven Engineered Films; or
      b. Approved equal.

B. Material shall be textured HDPE as shown on the Construction Drawings.

C. Resin:
   1. Do not exceed a combined maximum total of one (1) percent by weight additives other than carbon black.
   2. Geomembrane shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.
   3. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating roll number, thickness, length, width and manufacturer.
   4. All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in this Specification and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

D. Extrudate Rod or Bead:
   1. Extrudate material shall be made from same type resin as the geomembrane.
   2. Additives shall be thoroughly dispersed.
   3. Materials shall be free of contamination by moisture or foreign matter.

2.2 EQUIPMENT

A. Welding equipment and accessories shall meet the following requirements:
   1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.
   2. An adequate number of welding apparatuses shall be available to avoid delaying work.
   3. Power source must be capable of providing constant voltage under combined line load.

PART 3  EXECUTION

3.1 GENERAL

A. Installer:
   1. Installation shall be performed by one of the following installation companies:
      a. Raven Engineered Films
      b. Approved equal.

3.2 DEPLOYMENT

A. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.
B. If a Liner Installation Plan has been submitted, the geomembrane shall be installed in accordance with said Plan. The panel layout may be adjusted in the field if required by site conditions. Panels are to be identified with a Panel Number that allows ready identification of the location of the panel. The Panel Number is to be written on the liner material with a permanent marker.

C. Prior to placement of any liner materials, the clay liner is to be inspected and approved by the Engineer. Any areas found to be unacceptable are to be corrected prior to placement of liner material. Documentation of this inspection is to be provided if required by the Specifications.

D. Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

E. Materials will not be deployed when moisture, high winds, or other adverse weather conditions are expected.

F. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:
   1. HDPE materials are to be deployed using methods that will not crimp, bend, or otherwise damage the material, nor damage the underlying surface. Unless otherwise approved, HDPE materials are to be deployed using a “spreader bar” manufactured especially for this purpose.
   2. Place ballast (commonly sandbags) on geomembrane which will not damage geomembrane to prevent wind uplift.
   3. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.
   4. No motorized equipment will be allowed to operate directly over the geomembrane material. Portable equipment (portable generators, compressors, etc.) will be mounted on rubber tires (less than 6 psi) or placed on a sacrificial sheet of material.
   5. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.

G. The liner panels shall be oriented at right angles to the toe of the berm (downslope) where possible. Except for roll end (butt) seams, horizontal seams are not allowed on slopes steeper than 8:1. Transition seams between vertical slope panels and horizontal panels will be located at least 5 feet from the toe of the slope. Liner panels are to be deployed in a manner that minimizes field seams.

H. HDPE liner materials are to be deployed in a manner that minimizes wrinkling but allows for sufficient material slack to properly conform to the subgrade and allow for thermal expansion and contraction of the material. Ambient weather conditions and liner temperature are to be taken into account when making this determination.

I. The range of weather conditions under which geomembrane seaming can be performed follows:
   1. Unless otherwise authorized by the Engineer, no seaming will be attempted at an air temperature colder than 40°F or warmer than 104°F as measured 6 inches above the sheet.
   2. Between ambient temperatures of 40°F and 50°F, as measured 6 inches above the sheet, seaming will be performed only if the geomembrane is pre-heated by either the sun or hot air device, provided there is no excessive ambient cooling resulting from wind conditions.
   3. The geomembrane will be dry and protected from the wind.
4. Seaming will not be performed during any precipitation.
5. Seaming will not be performed in areas where ponded water has collected beneath the surface of the geomembrane.
6. When HDPE materials are deployed at temperatures greater than 80° F and in direct sunlight, the material will be allowed to stabilize overnight before the anchor trenches are backfilled. Stabilizing is accomplished using the following techniques:
   a. Leave sufficient excess liner material on the outboard side of the anchor trench to allow for anticipated liner shrinkage.
   b. Temporarily weight the liner in the anchor trench using sandbags.
   c. Place sufficient sandbags at the toe of the slope to allow the liner to pull the excess material from the anchor trench as it shrinks. The number and placement of sandbags will vary according to the design and expected weather conditions.
   d. Inspect the liner material while the material is still cool the following morning. If sufficient liner shrinkage has occurred, the anchor trench is to be backfilled.

3.3 FIELD SEAMING

A. Seams shall meet the following requirements:
   1. To the maximum extent possible, orient seams parallel to the line of slope, i.e., down and not across slope.
   2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.
   3. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.
   4. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the Engineer and the Installer.
   5. Align seam overlaps consistent with the requirements of the welding equipment being used. Unless otherwise specified below, a minimum 4-inch overlap is required.

B. During Welding Operations:
   1. Provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

C. Extrusion Welding:
   1. Extrusion welding is to be used for detail work, repairs, and in other areas where wedge welding cannot be used.
   2. The extrusion welder shall be purged prior to beginning a seam until all potentially heat-degraded extrudate has been removed from the barrel.
   3. Areas to be extrusion welded are to be clean and dry. Surface oxidation is to be removed by grinding. Grinding is to be done not more than one hour prior to the time the extrusion weld is made, using the procedures listed below:
      a. The grinding shall not extend more than ¼ inch beyond the limit of the extrudate after seam completion.
      b. Grinding shall be performed preferentially in a perpendicular path across the seam.
      c. The depth of grinding shall be less than 10 percent of the sheet thickness.
d. All shavings produced from grinding shall be removed from the seaming area prior to welding.

4. Where patches are required, the patches are to be round or oval in shape and are to overlap the damaged area by a minimum of 4-inches on all sides. Patches are to be heat sealed to the main liner prior to extrusion welding to prevent the edge of the patch from lifting when the extrudate is applied.

5. Extrusion welds are to be tested by use of a vacuum box or the ultrasonic shadow method.

D. Hot Wedge Welding:

1. After allowing the liner temperature to stabilize, overlap adjacent panels a minimum of 4-inches. Remove any excessive wrinkles prior to seaming.

2. Field seams are to be made using the dual-hot-wedge welding method whenever possible.

3. The area to be seamed is to be clean and dry. If required, a protective layer is to be placed under the seam to prevent dust or moisture from entering the seam area, and/or the liner material in the seam area is to be wiped with a clean rag.

4. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.

5. At the start of each seam, the machine operator is to mark the date, time, machine number, machine temperature, machine speed, and operator initials on the lining material with a permanent marker. This information is to be recorded in the project log.

6. The machine operator is responsible for ensuring that the area to be seamed is clean and dry. If any questionable seam areas are noted, the operator is to mark these areas for later inspection and testing.

7. The machine operator is to read the machine temperature at intervals of approximately 100-feet. This procedure will ensure that seams are made at the proper temperature. If an excessively high or low temperature reading is noted, the operator is to stop seaming and mark the affected area for testing. The cause of the problem is to be located and corrected, and a new trial seam made and tested before seaming resumes.

8. Each overlap and the sheet below the overlap shall be hand-wiped clean immediately prior to welding.

9. Large “fish mouths” or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle to achieve a flat overlap. The cut “fish mouths” or wrinkles shall be seamed, and any portion of inadequate overlap will then be patched with an oval patch of the same geomembrane, extending a minimum of 6-inches beyond the cut in all directions.

10. On side slopes, seaming will extend into the anchor trenches.

11. At locations where the initial seam cannot be non-destructively tested, the seam will be cap-stripped with the same geomembrane material. The Engineer will observe the cap-stripping to document the uniformity and completeness of the work.

E. Trial Welds:

1. Prior to seaming any materials, perform trial welds on geomembrane samples to verify welding equipment is operating properly.

2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.
3. Trial seams are to be conducted immediately prior to the start of any welding period, and at least once every five hours thereafter, for each seaming apparatus used that day. Additionally, trial seams shall be done when ambient temperatures are ≥ 104°F (if seaming is allowed) measured 6 inches above the geomembrane surface per machine, per operator, and with each change in temperature of > 20°F. Each seamer will make at least one trial seam each day. All trial seams will be made under the same conditions as actual seaming work.

4. Upon completion of a successful test, the date, time, seamer name, wedge welding machine number, machine temperature setting, machine speed setting, and test results are to be recorded in a trial seam log. No seaming is to be done until a successful test seam has been completed and recorded.

5. If a trial seam fails the test, the entire process will be repeated. If the same welding machine and seamer fail the testing a second time, the welding machine and the seamer will not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are complete.

6. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully complete and recorded trial weld.

F. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. The Installer shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

G. Defects and Repairs
   1. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
   2. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

3.4 FIELD QUALITY ASSURANCE

A. The Manufacturer and Installer shall participate in and conform to all terms and requirements of the Owner’s quality assurance program. The Contractor shall be responsible for assuring this participation.

B. Quality assurance requirements are as specified in this Section and in the Field Installation Quality Assurance Manual if it is included in the contract.

C. Field Testing:
   1. Non-destructive testing may be carried out as the seaming progresses or at completion of all field seaming.
      a. Vacuum Testing, Pressure Testing or Ultrasonic Shadow Testing shall be performed in accordance with GRI Specifications.
      b. For Pressure Testing, a pressurization of the open channel at 27 to 30 psi is required with a maximum pressure drop of 3 psi over five minutes.
   2. Destructive Testing (performed by Installer):
      a. Location and Frequency of Testing:
         i. Collect destructive test samples at a frequency of one every 750 lineal feet of seam length.
ii. Test locations will be determined after seaming.

b. Sampling procedures are performed as follows:
   i. Installer shall cut samples at locations designated by the Engineer as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.
   ii. Installer will number each sample, and the location will be noted on the installation as-built.
   iii. Samples shall be twelve (12) inches wide by minimal length with the seam centered lengthwise.
   iv. Cut a 2-inch wide strip from each end of the sample for field-testing.
   v. Cut the remaining sample into two parts for distribution as follows:
      a) One portion for the Installer, 12-inches by 12-inches.
      b) One portion for the third-party laboratory, 12-inches by 12-inches.
      c) One portion to the Engineer for archive storage, 12-inches by 12-inches.
      d) Additional samples may be archived if required.
   vi. Destructive testing shall be conducted for shear and peel in accordance with ASTM D 6392.
   vii. The Installer shall repair all holes in the geomembrane resulting from destructive sampling.
   viii. Repair and test the continuity of the repair in accordance with these Specifications.

3. Failed Seam Procedures
   a. If the seam fails, the Installer shall follow one of two options:
      i. Reconstruct the seam between any two passed test locations.
      ii. Trace the weld to intermediate location at least 10 feet minimum or where the seam ends in both directions from the location of the failed test.
   b. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10 feet long.
   c. If the sample passes, then the seam shall be reconstructed or capped between the test sample locations.
   d. If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

3.5 REPAIR PROCEDURES

A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.
B. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.
C. The Installer shall be responsible for repair of defective areas.
D. Agreement upon the appropriate repair method shall be decided between the Engineer and Installer by using one of the following repair methods:
1. Patching – Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.
2. Spot Seaming – Used to repair small tears, pinholes, or other minor localized flaws.
4. Removing the bad seam and replacing with a strip of new material seamed in place – used for repairing large lengths of fusion seams.
5. Other – as agreed upon by the Installer and the Engineer

E. The following procedures shall be observed when a repair method is used:
   1. All geomembrane surfaces shall be clean and dry at the time of repair.
   2. Surfaces of the polyethylene which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.
   3. Extend patches or caps at least 6-inches beyond the edge of the defect, and around all corners of patch material.

F. Repair Verification:
   1. Number and log each patch repair (performed by the Installer).
### Table 3 Material Properties – Textured 60-mil HDPE Geomembrane

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Value - Textured</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geomembrane Manufacturer Quality Assurance Testing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt Flow Index (g/10 min)</td>
<td>ASTM D 1238</td>
<td>≤ 1.0</td>
<td>1/100,000 ft² min. 1 per resin batch</td>
</tr>
<tr>
<td>Resin Density (gm/cm³)</td>
<td>ASTM D 1505</td>
<td>≥ 0.93</td>
<td>1/100,000 ft² min. 1 per resin batch</td>
</tr>
<tr>
<td>Thickness (mil)</td>
<td>ASTM D 5199</td>
<td>60</td>
<td>Per roll</td>
</tr>
<tr>
<td>Lowest individual of 10 readings (mil)</td>
<td>(as modified in Annex A)</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Asperity Height (mil)</td>
<td>ASTM D 7466</td>
<td>16</td>
<td>2nd roll</td>
</tr>
<tr>
<td>Sheet Density (gm/cm³)</td>
<td>ASTM D 1505/D792</td>
<td>≥ 0.940</td>
<td>200,000 lb</td>
</tr>
<tr>
<td>Tensile Properties (each direction)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Strength at Break (lb/in-width)</td>
<td>ASTMD 6693, Type IV</td>
<td>90</td>
<td>20,000 lb</td>
</tr>
<tr>
<td>• Strength at Yield (lb/in-width)</td>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>• Elongation at Break (%)</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>• Elongation at Yield (%)</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D 1004</td>
<td>min. 42 lbs</td>
<td>45,000 lb</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D 4833</td>
<td>min. 90 lbs</td>
<td>45,000 lb</td>
</tr>
<tr>
<td>Stress Crack Resistance</td>
<td>ASTM D 5397</td>
<td>500 hr</td>
<td>Per GRI-GM10</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D 1603</td>
<td>2.0-3.0%</td>
<td>20,000 lb</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>ASTM D 5596</td>
<td>Only near spherical agglomerates, 10 views in cat. 1 or 2</td>
<td>45,000 lb</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT)</td>
<td>ASTM D 3895 or D 5885</td>
<td>≥ 100 mins (D 3895)</td>
<td>200,000 lb</td>
</tr>
<tr>
<td>Oven Aging at 85°C</td>
<td>ASTM D 5885</td>
<td>80%</td>
<td>Per formulation</td>
</tr>
<tr>
<td>UV Resistance percent retained after 1,600 hours</td>
<td>ASTM D 5885</td>
<td>50%</td>
<td>Per formulation</td>
</tr>
<tr>
<td><strong>Geomembrane Manufacturer Conformance Testing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Properties (each direction)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Strength at Break (lb/in-width)</td>
<td>ASTMD 6693, Type IV</td>
<td>90</td>
<td>1/100,000 ft²</td>
</tr>
<tr>
<td>• Strength at Yield (lb/in-width)</td>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>• Elongation at Break (%)</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>• Elongation at Yield (%)</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Construction Quality Assurance Testing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDPE Peel Strength (ppi)</td>
<td>ASTM D 6392</td>
<td>90 (fusion)</td>
<td>1 per 500 lineal feet of welded seam</td>
</tr>
<tr>
<td>HDPE Shear Strength (ppi)</td>
<td>ASTM D 6392</td>
<td>78 (extrusion)</td>
<td></td>
</tr>
<tr>
<td>Peel Separation (%)</td>
<td>ASTM D 6392</td>
<td>126</td>
<td>&lt; 10%</td>
</tr>
</tbody>
</table>

1. Maximum of one (1) non-FTB (Film Tear Bond) per five (5) specimens tested is acceptable provided that strength requirements are met on that sample. Film Tear Bond (FTB) definition: A failure to the ductile mode of one of the
bonded sheets by tearing prior to complete separation to the bonded area. Examples of FTB and the associated locus of break codes are provided in ASTM D 6392.

2. For dual-track seams, both tracks will be tested for compliance with the minimum property values listed above.

3. Destructive seams will be evaluated for strength parameters according to ASTM D 6392, excluding Section 6.3 “Conditioning.” Destructive seams will be evaluated for elongation during cold weather seaming. The Geosynthetics Installer is required to submit a cold weather seaming plan for approval along with recommendations in GRI publication GRI GM 9 or superseding GRI guidance document.

4. As modified by NSF 54.

5. Manufacturer Quality Assurance specifications provided by Agru America® If revised or alternate industry standard test methods or procedures become industry standard, the industry standard test method may be substituted with approval by the CQAE.

END OF SECTION
SECTION 31 05 19.19 – DRAINAGE GEOCOMPOSITE

PART 1  GENERAL

1.1  SUMMARY

A. This specification covers the requirements for the manufacture, fabrication, supply and installation of the drainage geocomposite. The geocomposite and its individual components shall meet or exceed the requirements of this specification. The manufacture, handling, storage and installation shall be performed in accordance with the procedures provided in this Specification.

B. The Contractor shall provide all labor, materials, tools, and equipment and perform all operations necessary to furnish, deploy, and install geocomposite in the areas indicated on the Construction Drawings or as required by the Engineer.

1.2  UNIT PRICE – MEASUREMENT AND PAYMENT

A. Basis of Measurement: Square Feet.

B. Basis of Payment: Measurement for payment will be based on the actual plan view area of geocomposite installed as measured by survey. Measurement will be from the inside edge of the anchor trench, edge of liner at interim termination berm, and/or edge of liner at tie-in to existing clay liner and existing geosynthetic liner tie-in. The cost for material not included in the measured pay quantity (overlap, waste, material in anchor trench, etc.) must be included in the unit price.

1.3  REFERENCES

A. American Society for Testing and Materials (ASTM):

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1.4 QUALIFICATIONS

A. Manufacturer:
   1. Raven Engineered Films; or
   2. Engineer Approved Equal

B. Installer:
   1. The Installer shall have worked in a similar capacity on at least three (3) projects similar in complexity to the project described in the Contract Documents.
   2. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents within the past three (3) years.
   3. The Contractor shall demonstrate at least four (4) years of experience in sewing geotextiles and shall have completed at least four (4) projects that required geotextile sewing. Alternatively, the Contractor shall engage an experience Subcontractor or manufacturer’s agent who shall meet the experience requirements.

1.5 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling – Each roll of geocomposite delivered to the site shall be labeled by the Manufacturer. The label will identify:
   1. Manufacturer’s name
   2. Product identification
   3. Length
   4. Width
   5. Roll number

B. Rolls of geocomposite shall be shipped to the site in a manner that will not cause damage to the rolls.

C. The Contractor shall be responsible for the handling, storage, and care of the geocomposite from the time of delivery to the site until final acceptance of the completed work by the Engineer. The Contractor shall be liable for all damages to the materials during such time.

D. The Contractor shall comply with ASTM D4873 with respect to storing and handling the geocomposite.

E. The rolls shall be stored on flat on a smooth surface protected against dirt, mud, and excessive heat.

F. Geocomposite shall not be stockpiled or stored within the work area limits.
1.6 WARRANTY

A. The installation shall be warranted against defects in workmanship for a period of one (1) year from the date that the installation is deemed complete.

PART 2 PRODUCTS

2.1 MATERIAL DESCRIPTION

A. The geocomposite shall consist of two 6 oz/yd² nonwoven geotextile layers comprised of short synthetic fibers of 100% polypropylene or polyester which are needle-punched together with a structural 250-mil conductive geonet. Alternatively, a geocomposite consisting of the aforementioned geotextiles and drainage tubing instead of the 250-mil geonet may be used, as long as it meets the specifications in Table 4. The Engineer shall review any alternatives; the alternatives shall not be used unless approved, in writing, by the Engineer.

2.2 GEOCOMPOSITE PROPERTIES

Table 4 Geocomposite Material Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Value</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geonet/Geotextile Resin Component:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resin Density</td>
<td>ASTM D1505</td>
<td>0.94 g/cm³ min.</td>
<td>1 per resin batch</td>
</tr>
<tr>
<td>Resin Melt Flow Index</td>
<td>ASTM D1238</td>
<td>1.0 g/10 min. max.</td>
<td></td>
</tr>
<tr>
<td>Geonet Component</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D1505</td>
<td>0.94 g/cm³ min.</td>
<td>1 per resin batch</td>
</tr>
<tr>
<td>Thickness</td>
<td>ASTM D5199</td>
<td>250 mil</td>
<td>1/50,000 ft², min. 1 per resin batch</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D4218</td>
<td>2-3%</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D5035/7179</td>
<td>55 lbs/in²</td>
<td></td>
</tr>
<tr>
<td>Geotextile Component</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass per Unit Area</td>
<td>ASTM D5261</td>
<td>6 oz/yd²</td>
<td>1/100,000 ft², min. 1 per resin batch</td>
</tr>
<tr>
<td>Grab Strength</td>
<td>ASTM D4632</td>
<td>170 lb</td>
<td></td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D4833</td>
<td>435 lb</td>
<td></td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D4491</td>
<td>1.5 sec⁻¹</td>
<td>1/500,000 ft², min. 1 per resin batch</td>
</tr>
<tr>
<td>Apparent Opening Size</td>
<td>ASTM D4751</td>
<td>No. 70 sieve</td>
<td></td>
</tr>
<tr>
<td>UV Resistance</td>
<td>ASTM D4355</td>
<td>70% retained after 500 hrs.</td>
<td>1 per resin batch</td>
</tr>
<tr>
<td>Geocomposite:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmissivity</td>
<td>ASTM D4716</td>
<td>2.4 gal/min/ft</td>
<td>1/500,000 ft², min. 1 per resin batch</td>
</tr>
<tr>
<td>Ply Adhesion</td>
<td>ASTM D7005</td>
<td>1.0 lbs/in</td>
<td>1/50,000 ft², min. 1 per resin batch</td>
</tr>
</tbody>
</table>
PART 3 EXECUTION

3.1 FAMILIARIZATION

A. Inspection:
   1. Prior to implementing any of the work in the section to be lined, the Installer 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 section may properly commence without adverse impact.
   2. If the Installer has any concerns regarding the installed work of other sections, he shall notify the Engineer.
   3. Prior to deploying the geocomposite, the Installer shall carefully inspect the surface upon which the material will be placed and verify that the material may be placed without adverse impact.
   4. The Installer shall certify in writing that the surface on which the geocomposite will be installed is acceptable. The certificate of acceptance shall be given to the Engineer prior to commencement of installation in the area under consideration.

3.2 MATERIAL PROTECTION

A. Geocomposite shall not be exposed to ultraviolet rays for more than 14 days before being covered by Operations Layer material.
B. No construction equipment shall drive directly across the geocomposite without permission from the Engineer.
C. The upper layer shall be placed on the geocomposite in a manner that prevents damage to the geocomposite. Placement of the Operations Layer shall proceed immediately following the placement and inspection of the geocomposite.

3.3 MATERIAL PLACEMENT

A. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer.
B. If the project contains long, steep slopes, special care should be taken so that only full-length rolls are used at the top of the slope. If the roll length cannot cover the entire slope, then the next roll should be situated towards the toe of the slope. The locations of connections of adjacent panels should be staggered at least 10 feet apart.
C. In the presence of wind, all geocomposite shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.
D. The geocomposite shall not be placed, seamed/joined, or repaired during periods of precipitation, excessively high winds, or in areas of ponded water or excessive moisture.
E. The geocomposite shall be installed in accordance with the manufacturer’s recommendations, and as shown on the Construction Drawings and specified herein.
F. The geocomposite shall be kept clean prior to and during installation.
G. Folds or excessive wrinkling of deployed geocomposite shall be removed to the extent practicable.
H. The Installer/Contractor shall exercise care not to entrap stones, excessive dust, or foreign objects in the material.
3.4 SEAMS AND OVERLAPS

A. Adjacent sheets of geocomposite shall be overlapped as described below:
   1. Connections along the side of the geocomposite shall be overlapped a minimum of four (4) inches and the geonet shall be secured with contrasting color plastic fasteners, placed at 5-foot intervals.
   2. Adjoining geocomposite rolls (end to end) along the roll width shall be shingled down in the direction of the slope, with the up-gradient roll overlapping the down gradient roll a minimum of 12-inches across the roll width. The geonet shall be secured as described above every 12-inches across the roll width and every 6-inches in the anchor trench as specified by the Engineer.
   3. The top layers of geotextiles shall be sewn together, or at the discretion of the Engineer, may be heat bonded together. Geotextiles shall be overlapped a minimum of 4-inches prior to seaming or heat bonding, geotextile sewn seams to be used are Prayer, “J” or Butterfly. The seam shall be a two thread, double lock stitch or a double row of single thread, chain stitch. If heat bonding is to be used, care must be taken to avoid burn-through of the geotextile. It is important that the geotextiles be joined continuously along to the roll as to prevent any soil particle migration into the geonet core flow channels. Spot seaming shall not be allowed.
   4. Geotextile cap strips shall be a minimum of 2-feet in width, thermally bonded to the geotextile component of the geocomposite.
   5. Cap strips shall be placed over any exposed edges of geocomposite.

B. If DrainTube 606 ST Series geocomposite is used, the adjacent piping shall be joined per Manufacturer’s specifications. The top layers of geotextiles are to be sewn together or heat bonded, as described above for the geocomposite and at the direction of SMA. Geotextiles shall be overlapped a minimum of 4-inches.

3.5 REPAIR

A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage.
B. Any rips, tears or damaged areas on the geocomposite shall be removed and patched.
   1. If the geotextile is ripped or torn, install an undamaged piece of the same material. Overlap shall be made as described in section 3.4 above.
   2. If the area to be repaired is more than 50 percent of the width of the panel, then the damaged area shall be cut out and replaced with undamaged material.

END OF SECTION
SECTION 31 10 00 – SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. This Section Includes:
   1. Removing surface debris.
   2. Removing designated paving, curbs, and other obstructions.
   3. Removing designated trees, shrubs, and other plant life.
   4. Removing abandoned utilities.
   5. Excavating topsoil.

1.2 UNIT PRICES – MEASUREMENT AND PAYMENT

A. Site Clearing
   2. Basis of Payment: Payment is based on area in Plans that requires clearing.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify waste area and/or salvage area for placing removed materials.

3.2 PREPARATION

A. Call Colorado “One Call” at 811 and local utility companies at least three (3) days before performing Work.
   1. Request that underground utilities be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.
B. Protect trees, plant growth, and features designated to remain, as final landscaping.
C. Protect benchmarks, survey control points, and existing structures from damage or displacement.

3.4 REMOVAL

A. Remove debris, rock, and extracted plant life from the site.
B. Continuously clean up and remove waste materials from the site. Do not allow materials to accumulate on site.
C. The Engineer will indicate to the Contractor which obstructions are to be removed, disposed of, or salvaged, and will required special documentation.
D. Do not burn or bury materials on site. Leave site in clean condition.

3.5 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or regraded, without mixing with foreign materials for use in finish grading.
B. Do not excavate wet topsoil.
C. Stockpile in an area designated on site to depth no exceeding 8 feet and protect from erosion. Stockpile material on impervious material and cover over with same material, until disposal.
D. Remove excess topsoil not intended for reuse, from the site.
E. All equipment shall be properly maintained and with proper safety devices.
F. The Contractor must maintain control of dust and minimize blowing debris.
G. All equipment shall be operated as to not interfere with the operation of the landfill or patrons.

END OF SECTION
SECTION 31 22 13 – ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating subsoil.
   2. Cutting, grading, filling, rough contouring, and compacting site for liners, access roads, and site drainage.

1.2 UNIT PRICE – MEASUREMENT AND PAYMENT

A. Rough Grading
   1. Basis of Measurement: Cubic Yards
   2. Basis of Payment: Payment will be based on topographic surveys to be completed before and after grading to verify quantity of material cut. No allowances will be made for shrinking or swelling.

1.3 REFERENCES

A. American Society for Testing and Materials International (ASTM):
   2. ASTM D422 - Particle -Size Analysis of Soils.
   5. ASTM D1140 - Amount of Material in Soils Finer than the No. 200 Sieve.
  11. ASTM D2487 - Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
  15. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  16. ASTM D4254 - Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
18. ASTM D4564 - Density of Soil in Place by the Sleeve Method.
19. ASTM D4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.
20. ASTM D4718 - Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
21. ASTM D4832 - Compressive Strength of Controlled Low Strength Material.
22. ASTM D4914 - Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.
23. ASTM D4959 - Determination of Water (Moisture) Content of Soil by Direct Heating.
24. ASTM D5030 - Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.
25. ASTM D5080 - Rapid Determination of Percent Compaction.
26. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS
A. Density testing as required for compaction of liner or access road subgrade.
B. Materials Source: Submit name of imported materials suppliers.
C. Materials testing as required for gradation and uniformity of subgrade.
D. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS
A. Project Record Documents:
   1. Density test results and locations.
   2. Final grade topographic survey prior to placement of liner.

PART 2 PRODUCTS

2.1 MATERIALS
Not Used.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify survey benchmark and intended elevations for the Work are as indicated on the Construction Drawings.

3.2 PREPARATION
A. Call Colorado “One Call” at 811 and local utility companies at least three (3) days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.
B. Identify required lines, levels, contours, and datum.
C. Notify utility company to remove and relocate utilities.
D. Protect remaining utilities from damage.
E. Protect plant life, lawns, and other features remaining as portion of final landscaping.
F. Protect benchmarks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 SUBSOIL EXCAVATION
A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded.
B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.
C. Remove excess subsoil not intended for reuse, and store at location specified by Owner.
D. Stability: Replace damaged or displaced subsoil as specified for fill.
E. Notify Owner of any utility damage at once to emergency measures can be taken. The Contractor will be financially responsible for any required repairs.
F. Intercept and divert surface drainage and precipitation away from excavation through use of dikes, curb walls, ditches, pipes, or other means.
G. Remove and exclude water, including storm water, groundwater, irrigation water, and/or other waters, from all excavations. Dewatering wells, well-points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level below the bottom of excavations. Water shall be removed and excluded until backfilling is complete and all field soils testing have been completed.
H. Comply with Colorado state standards and requirements for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.
I. Excavation below Fills and Embankments: The subgrade areas beneath embankments shall be excavated to remove not less than the top one-foot of native material and, where such subgrade is sloped, the native material shall be benched. After the required excavation or over-excavation has been completed, the top 12-inches of material shall be scarified and moisture added or material dried to optimum moisture and the exposed surface shall be proof rolled.
J. Material beyond prescribed lines which is loosened by the Contractor’s operations shall be removed, replaced and/or compacted, as directed by the Engineer, at no additional cost to the Owner.

3.4 FILLING
A. See Section 31 23 23 – Backfill.

3.5 DISPOSAL OF EXCAVATED MATERIALS
A. Excess excavated material or excavated material not suitable for backfill may be disposed of on-site, provided that:
   1. The finished grade substantially conforms with the Construction Drawings, or any deviation therefrom is approved by the Engineer.
      a. Blend with natural terrain.
      b. Minimum slope: 2%.
2. All excess excavated material spread on the right-of-way is compacted to the same specifications as final backfill, as set for in Section 31 23 23 – Backfill and the Construction Drawings, and
3. All on-site disposal of material is approved by the Engineer.

B. Do not dispose of waste material by dumping from tops of slopes.
C. Do not dispose of excess material within 15 feet of any wash, drainage or waterway.

3.6 TOLERANCES

A. Top Surface of Subgrade: Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot. Horizontal measurements shall be read to the nearest 0.1 foot to establish locations at a minimum precision of 0.5 foot.

3.7 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D1557, ASTM D4318, ASTM D422/1140, ASTM D2487
B. Perform in-place compaction tests in accordance with the following:
C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
D. Compaction testing shall be done to the extent such that the Owner and Engineer can be reasonably assured that the backfill has been placed in accordance with the requirements of the Contract Documents. When a testing allowance is established on the Bill of Quantities, the Owner and Engineer will determine the testing frequency to be used throughout the project.

END OF SECTION
SECTION 31 23 17 – TRENCHING

PART 1    GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating trenches for culverts.
   2. Compacted fill from top of culvert bedding to finished grade.
   3. Backfilling and compaction.

1.2 UNIT PRICES – MEASUREMENT AND PAYMENT

A. Trenching and Backfill:
   2. Basis of Payment: Measurement for payment will be based on linear feet of culvert placed.

1.3 REFERENCES

A. American Society for Testing and Materials International (ASTM):
   2. ASTM D422 - Particle-Size Analysis of Soils.
   5. ASTM D1140 - Amount of Material in Soils Finer than the No. 200 Sieve.
   9. ASTM D2487 - Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
  13. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  14. ASTM D4254 - Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
  16. ASTM D4564 - Density of Soil in Place by the Sleeve Method.
  17. ASTM D4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.
18. ASTM D4718 - Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
19. ASTM D4832 - Compressive Strength of Controlled Low Strength Material.
20. ASTM D4914 - Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.
21. ASTM D4959 - Determination of Water (Moisture) Content of Soil by Direct Heating.
22. ASTM D5030 - Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.
23. ASTM D5080 - Rapid Determination of Percent Compaction.
24. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTAL
A. Materials Source: Submit name of imported fill materials suppliers.
B. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE
A. Perform Work in accordance with applicable state standards.
B. Perform Work in accordance with applicable Occupational Safety and Health Administration (OSHA) trench safety standards.

1.5 FIELD MEASUREMENTS
A. Verify field trench locations.

PART 2 PRODUCTS

2.1 FILL MATERIALS
A. Suitable materials for culvert bedding are described in Section 31 05 16, Granular Materials, Part 2 Products, 2.2 Pipe Bedding.
B. Backfill: Same Material as Liner Subgrade.

PART 3 EXECUTION

3.1 LINES AND GRADES
A. Excavate culvert trench to lines and grades indicated on Construction Drawings.
   1. The Engineer reserves the right to make changes in lines, grades, and depths of culverts when changes are required for Project conditions.

3.2 PREPARATION
A. Call Colorado “One Call” at 811 and local utilities not less than three (3) working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.
B. Identify required lines, levels, contours, and datum locations.
C. Protect benchmarks and existing structures from excavating equipment and vehicular traffic.
D. Maintain and protect above and below grade utilities indicated to remain.
E. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 LINES, GRADES, AND DIMENSIONS
A. Excavate trench to lines and grades indicated on Construction Drawings.
   1. The Engineer reserves the right to make changes in lines, grades, and depths of culverts when changes are required based on field conditions.
   2. When the bottom of the trench is rocky, over-excavate and fill as specified in Section 31 23 23.
B. Excavate trench to minimum width as indicated on Construction Drawings.
   1. Cut trenches to width indicated on Construction Drawings. Permission in writing to use a greater width shall be obtained from the Engineer.
   2. Increase the trench width as required to meet embedment compaction requirements. Increased trench width, if needed to meet these requirements, shall be provided at no additional cost to the Owner.

3.4 TRENCHING
A. Excavate subsoil required for culverts.
B. Remove lumped subsoil, boulders, and rock up to the size that would require special equipment beyond conventional machinery used for trenching, in which case the Engineer should be notified immediately.
C. The Contractor is solely responsible for safety of all open trenches and bears sole liability for any incidents or accidents arising from open trenches.
D. The Owner may restrict the amount of open trench as needed due to safety, land use or environmental considerations.
E. Intercept and divert surface drainage and precipitation away from excavation through use of dikes, curb walls, ditches, pipes, or other means.
F. Dewater and maintain substantially dry subgrade during culvert installation.
   1. Remove groundwater by pumping to keep excavations dry.
   2. Comply with state standards and requirements for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.
   3. If a separate bid item is not included on the Bill of Quantities for dewatering, the cost thereof will be considered incidental to the cost of trenching and culvert installation.
G. When subsurface materials at the bottom of the trench are loose or soft, excavate to a greater depth as directed by the Engineer until suitable material is encountered. Backfill and compact to reach specified or directed line and grade. Refer to the specifications for backfill, as set forth in Section 31 23 23.
H. Cut out soft areas of subgrade not capable of compaction in place. Backfill and compact to specified or directed line and grade. Refer to specifications for backfill, as set forth in Section 31 23 23.
I. Correct over excavated areas with compacted backfill as specified for authorized excavation as directed by the Engineer.
J. Store excess subsoil not intended for reuse as directed by Owner.
K. Protect open trench at all times to prevent danger to the public and to wildlife. Any safety
requirements imposed by agencies or entities with jurisdiction must be met.

3.5 BACKFILLING OF TRENCHES
A. See Section 31 23 23 – Backfill for general backfill requirements, as well as trench backfill and
bedding requirements around pipelines.
B. Compact to 92% of the maximum dry density as determined by the modified Proctor procedure
(ASTM D1557) for culverts.
C. Compact trench backfill in 8-inch lifts.

3.6 DISPOSAL OF EXCAVATED MATERIALS
A. Excess excavated material or excavated material not suitable for backfill may be disposed of on-
site, provided that:
   1. The finished grade substantially conforms with the Construction Drawings, or any
development therefrom is approved by the Engineer.
      a. Blend with natural terrain.
      b. Minimum slope: 2%.
   2. All excess excavated material spread on the right-of-way is compacted to the same
   specifications as final backfill, as set forth in Section 31 23 23 – Backfill and the
   Construction Drawings, and
   3. All on-site disposal of material is approved by the Engineer.

3.7 TOLERANCES
A. Survey of the inlet and outlet inverts of culverts shall be conducted to the nearest 0.1 foot vertical
and 0.5 foot horizontal. Survey of the cover thickness (as specified on the Construction Drawings)
shall verify conformance to the same tolerance as the inlet and outlet survey.

3.8 FIELD QUALITY CONTROL
A. Refer to compaction and laboratory testing requirements in Section 31 23 23 – Backfill, as
applicable.

3.9 PROTECTION OF FINISHED WORK
A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION
SECTION 31 23 18 – ROCK REMOVAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing identified and discovered rock during excavation.
   2. Expansive tools and/or Explosives to assist rock removal.

B. Related Sections:
   2. Section 31 23 17 - Trenching: Trenching and backfilling for utilities.

1.2 UNIT PRICE – MEASUREMENT AND PAYMENT

A. Site Rock Removal:
   1. Basis of Measurement: By cubic yard measured after disintegration.
   2. Basis of Payment: Includes preparation of rock for removal, mechanical disintegration of rock, removal from position, loading and removing from site. For over excavation, payment will not be made for over excavated work nor for replacement materials.
   3. Contractor shall notify Engineer prior to commencement of rock removal work when rock is encountered and specialized equipment will be required and await approval from Engineer before proceeding.
   4. Contractor and Engineer must agree on rock quantity at the end of each day that such work was completed, and both parties must sign off on the quantity on the corresponding daily field report.

B. Trench Rock Removal:
   1. Basis of Measurement: By vertical linear foot (VLF) of trench excavation. Each VLF is measured as horizontal linear foot of trench multiplied by the depth of excavated rock. The depth of the excavated rock may be less than the total trench depth. The width of trench is not a factor in the VLF calculation.
   2. Basis of Payment: Includes preparation of rock for removal, mechanical disintegration of rock, removal from position, loading and removing from trench.
      a. If native trench rock is processed and used as backfill material, the cost of such processing will be considered incidental to the cost of trench rock removal.
      b. If trench rock is hauled away from site and replaced with imported material, the costs of rock hauling and disposal, as well as the costs of obtaining and hauling imported fill material will be considered incidental to the cost of trench rock removal.
   3. Contractor shall notify Engineer prior to commencement of rock removal work when rock is encountered and specialized equipment will be required, and shall await approval from Engineer before proceeding.
4. Contractor and Engineer must agree on rock quantity at the end of each day that such work was completed, and both parties must sign off on the quantity on the corresponding daily field report.

1.3 REFERENCES

A. National Fire Protection Association (NFPA):

1.4 SUBMITTALS

A. Section 01 00 00 - Submittals: Submittal procedures.
B. Submit type of equipment to be used for rock removal and/or processing.
C. If processed native rock is to be used for embedment and backfill, submit sieve analyses and other geotechnical data on the processed material, as required in field by Engineer.
   1. Laboratory costs associated with such testing shall be reimbursable under project testing allowance. Other costs, such as sample collection and transport, are not covered under the allowance.
D. Shop Drawings: Indicate proposed method of blasting, delay pattern, explosive types, type of blasting mat or cover, and intended rock removal method.

1.5 QUALITY ASSURANCE

A. Seismic Survey Firm: Licensed company specializing in seismic surveys with a minimum five years of experience.
B. Explosives Firm: Company specializing in explosives for disintegration of rock, with five years’ experience.

1.6 PROJECT CONDITIONS

A. Conduct survey and document conditions of buildings near locations of rock removal, prior to blasting, if blasting is required, and photograph existing conditions identifying existing irregularities.
B. Advise owners of adjacent buildings or structures in writing, prior to executing seismographic survey. Explain planned blasting and seismic operations.
C. Obtain seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

1.7 SCHEDULING

A. Schedule Work to avoid disruption to occupied buildings nearby.
B. Conduct blasting operations between hours of 8:00 a.m. and 4:30 p.m. only.
C. Section 01 00 00 - Administrative Requirements: Coordination.
PART 2   PRODUCTS

2.1 MATERIALS

A. Explosives: Type recommended by explosive firm following seismic survey and required by authorities having jurisdiction.
B. Delay Device: Type recommended by explosives firm.
C. Blast Mat Materials: Type recommended by explosives firm.

PART 3   EXECUTIONS

3.1 EXAMINATION

A. Section 01 00 00 - Administrative Requirements: Coordination.
B. Verify site conditions and note subsurface irregularities affecting Work of this section.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.3 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method.
B. Cut away rock at bottom of excavation to form level bearing.
C. Remove shale layers to provide sound and unshattered base for footings.
D. Remove excavated materials from site.

3.4 ROCK REMOVAL BY EXPLOSIVE METHODS

A. When rock is uncovered requiring explosives method for rock disintegration, notify Engineer. Rock removal by explosive methods will require Engineer’s approval prior to any blasting.
B. Provide seismographic monitoring during progress of blasting operations.
C. Drill blasting holes within 12 feet of finished slope.
D. Disintegrate rock and remove from excavation.
E. Remove rock at excavation bottom to form level bearing.
F. Remove shale layers to provide sound and unshattered base for footings.
G. Remove excavated material from site.

3.5 FIELD QUALITY CONTROL

A. Section 01 00 00 - Execution Requirements: Testing, adjusting, and balancing.
B. Request visual inspection of foundation bearing surfaces by Engineer before installing subsequent work.

END OF SECTION
SECTION 31 23 23 – BACKFILL

PART 1  GENERAL

1.1  SUMMARY

   A. Section Includes:
      1. Placement of Clay Liner.
      3. Filling and compacting site for liners, access roads, and site drainage.
      4. Backfilling for culvert trenches.

1.2  UNIT PRICES – MEASUREMENT AND PAYMENT

   A. Clay Liner
      2. Basis of Payment: Payment will be based on volume as measured in-place.

   B. Operations Layer
      2. Basis of Payment: Payment will be based on volume as measured in-place.

   C. Culvert Pipe Bedding
      2. Basis of Payment: Measurement for payment will be based on linear feet of culvert placed.

   D. Road Base
      2. Basis of Payment: Payment will be based on volume as measured in-place.

1.3  REFERENCES

   A. American Society for Testing and Materials International (ASTM):
      2. ASTM D422 - Particle -Size Analysis of Soils.
      4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
      5. ASTM D1140 - Amount of Material in Soils Finer than the No. 200 Sieve.
      6. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³, 2,700 kN-m/m³).  
      9. ASTM D2487 - Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
13. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
14. ASTM D4254 - Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
16. ASTM D4564 - Density of Soil in Place by the Sleeve Method.
17. ASTM D4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.
18. ASTM D4718 - Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
19. ASTM D4832 - Compressive Strength of Controlled Low Strength Material.
20. ASTM D4914 - Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.
21. ASTM D4959 - Determination of Water (Moisture) Content of Soil by Direct Heating.
22. ASTM D5030 - Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.
23. ASTM D5080 - Rapid Determination of Percent Compaction.
24. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Percentage Compaction: Ratio, expressed as percentage, of actual density of material compared with maximum dry density based on modified Proctor (ASTM D1557).
B. Optimum Moisture Content: Based on modified Proctor (ASTM D1557).
C. Atterberg Limits: Based on ASTM D4318.
D. Grain Size Analysis: Based on ASTM D422/1140.
E. Unified Soil Classification: Based on ASTM D2487.
F. Hydraulic Conductivity: Based on ASTM D5084.

1.5 SUBMITTALS

A. Submit samples and certified test documentation of all materials to be used.
B. Materials Source: Submit name of imported fill materials suppliers.
C. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.
D. Submit field soil test on material in place as backfill.

PART 2 PRODUCTS

2.1 NON-GRANULAR FILL MATERIALS

A. Suitable materials may be processed on-site or may be imported. Regardless if materials are imported or processed on site, they are required to meet the quantity requirements of the project and will be provided at no additional expense to the Owner. Table 5 presents the minimum
laboratory test types, methods, and frequencies for all non-granular soils used at the site. Non-granular fill materials include the following:

1. Fill soil for subgrade construction
2. Construction of the compacted clay liner
3. Construction of other structural fill, including site drainage and access roads
4. Backfill for culvert trenches

Table 5 Non-Granular Soil Minimum Laboratory Test Frequencies

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Minimum Frequency</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Proctor</td>
<td>ASTM D1557</td>
<td>1 test/6,540 cy or change in material type</td>
<td>N/A</td>
</tr>
<tr>
<td>Atterberg Limits</td>
<td>ASTM D4318</td>
<td>1/Proctor or change in material type</td>
<td>LL ≥ 30, PI ≥ 15</td>
</tr>
<tr>
<td>Grain Size Analysis</td>
<td>ASTM D422/1140</td>
<td>1/Proctor or change in material type</td>
<td>≥ 50% P200, 2-in max size</td>
</tr>
<tr>
<td>Unified Soil Classification</td>
<td>ASTM D2487</td>
<td>1/Proctor or change in material type</td>
<td>SC or CL</td>
</tr>
<tr>
<td>Hydraulic Conductivity</td>
<td>ASTM D5084</td>
<td>1 test/13,000 cy or change in material type</td>
<td>≤ 1x10^-7 cm/sec</td>
</tr>
</tbody>
</table>

2.2 OPERATIONS LAYER MATERIALS

Suitable materials for the operations layer are described in Section 310516, Granular Materials, Part 2 Products, 2.1 Operations Layer Material.

PART 3 EXECUTION

3.1 BACKFILLING FOR STRUCTURES, SITE WORK AND APPURTEANCES

A. Backfill areas to contours and elevations with unfrozen materials as indicated on the Construction Drawings or as directed by the Engineer.
B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
C. Each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer.
D. Employ placement method that does not disturb or damage other work.
E. Maintain optimum moisture content of backfill materials to attain required compaction density.
F. Shape and drain embankments and excavations, maintain ditches and drains to provide drainage at all times. Protect graded areas against action of elements prior to acceptance of work and reestablish grade where settlement or erosion occurs.
G. Place surplus backfill materials at the location indicated by the Owner.
H. Leave fill material stockpile areas free of excess fill materials.

3.2 COMPACTION OF NON-GRANULAR SOILS

A. Do not place and compact soil under the following conditions:
   1. Ambient air temperature below freezing.
   2. Rain that creates puddles in clayey or silty materials.
3. Ice or snow pockets visible in material being placed.

B. Surface Preparation:
   1. Prepare surface so that first compacted lift will be placed on firm, stable base. Compact surface to specified percent compaction, if necessary.
   2. For water-retaining compacted fill, scarify and moisten surface to provide satisfactory bonding surface before placing first layer of material to be compacted.
   3. Do not place material to be compacted on frozen surface.

C. Placement:
   1. Place soil to be compacted in horizontal layers.
   2. Blend materials as needed to ensure compacted fill is homogenous and free form lenses, pockets, streaks, voids, laminations and other imperfections.

D. Compaction Procedures:
   1. Cohesionless Free-Draining Material: Compact in horizontal layers to maximum compacted thickness of:
      a. Tampers and rollers: 6 inches
      b. Crawler-type tractors, vibrating drum rollers, surface vibrators or similar equipment: 12 inches
      c. Saturation and internal vibration: Penetrating depth of vibrator.
   2. Demonstration: Lift thicknesses may vary depending on equipment and methods. Field adjustments to the specified lift thicknesses may be allowed or required. The Contractor shall demonstrate that proposed equipment and methods will meet required compaction for the proposed lift thicknesses. Typically, lifts should be no greater than 8-inches.
   3. Flooding and jetting are not allowed unless specifically approved by the Engineer.

E. Moisture Content:
   1. Optimum moisture content for each soil type, whether native soil or imported material, shall be determined by the modified Proctor method, ASTM D1557.
   2. Moisture content during compaction shall be within 0 to +4 percentage points of optimum moisture content for clay liner; and ±4% percentage points of optimum moisture content for structural fill and culvert trench backfill.
   3. Moisten or aerate material, as necessary, to provide specified moisture content. Add water to soil in increments that will permit moisture content to be uniform and homogenous through each layer after mixing.
   4. Add no more than two (2) percent water to fill by sprinkling just prior to compaction when fill is clayey and contains dry clods of clay.
      a. If clayey soil is more than four (4) percent below optimum moisture, preconditioning and curing may be required to obtain uniform and homogenous distribution of moisture in clods.
      b. Use of disks, harrows, or rakes may be required to blend moisture prior to placement and compaction.
   5. For cohesionless soils, add water as necessary during compaction, as these soils are free-draining.

F. Minimum Percent Compaction:
   1. Structural Fill: Compact to ≥ 90%, as directed by the Engineer.
   2. Compacted Clay Liner: Compact to ≥ 92%, as directed by the Engineer.
3. Access Roads, Culvert Backfill, and Site Drainage: Compact to ≥ 92%, as directed by the Engineer.
4. Note that all percent compaction values in these Specifications and Construction Drawings are based on modified Proctor, ASTM D1557, unless otherwise noted.

3.3 TOLERANCES

A. Top Surface of Subgrade and Structural Fill: Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot. Horizontal measurements shall be read to the nearest 0.1 foot to establish locations at a minimum precision of 0.5 foot.

B. Compacted Clay Liner: Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot and to verify that the clay liner is a minimum of 1.0 foot thick. Horizontal measurements shall be read to the nearest 0.1 foot to establish locations at a minimum precision of 0.5 foot.

C. Percent Compaction: Shall meet minimum required compaction as set forth in these specifications.

D. Moisture Content: As set forth in these specifications.

3.4 FIELD QUALITY CONTROL

A. When tests indicate Work does not meet specified requirements, remove material, replace, recompact, and retest.

B. Compaction testing shall be done to the extent such that the Owner and Engineer can be reasonably assured that the backfill has been placed in accordance with the requirements of the Contract Documents, or as required by the utility for which the trenching is being provided, whichever is more stringent.

C. Correction of Substandard Work: All fill and backfill represented by tests that fail to meet compaction, moisture content, soil classification or other specifications shall be uncovered as needed, replaced as needed, re-compacted and re-tested until all specifications are met, at no additional expense to the Owner.

1. Elevations, lines and grades of replaced material, as well as of pipe and other structures resting against such material, shall be re-surveyed at the direction of the Engineer. The Contractor shall correct elevations, lines and grades as needed, at no additional expense to the Owner.

3.5 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subject to vehicular traffic.

END OF SECTION
SECTION 33 42 13 – PIPE CULVERT

PART 1  GENERAL

1.1  SUMMARY
A. Section Includes:
   1. Smooth interior corrugated polyethylene culvert.
   2. Joints and accessories.
   4. Slope protection at pipe end.

1.2  UNIT PRICE – MEASUREMENT AND PAYMENT
A. Pipe Culvert:
   1. Basis of Measurement: By linear foot invert length of pipe, including tapered ends.
   2. Basis of Payment: Includes hand trimming, excavating; removing soft subsoil, bedding fill, compacting; pipe, fittings and accessories assembled; repair of damaged coating.

1.3  REFERENCES
A. American Association of State Highway and Transportation Officials:
   2. AASHTO M294 – Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.
B. ASTM International:

1.4  SUBMITTALS
A. A manufacturer’s certification that the product was manufactured, tested, and supplied in accordance with this specification shall be furnished to the Engineer.
B. Project Record Documents:
   1. Accurately record actual locations of pipe runs, connections, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2  PRODUCTS

2.1  SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE
A. Culvert pipe used on the project shall be high-density polyethylene (HDPE) corrugated pipe with an internally formed smooth interior and hydraulic characteristics as specified in the Construction Drawings.
B. Requirements for test methods, dimensions, and markings are those found in AASHTO Designations M252 and M294.

C. Pipe and fittings shall be made of polyethylene compounds, which meet or exceed the requirements of Type 111, Category 4 or 5, Grade P33 or P34, Class C per ASTM D3350 with the applicable requirements defined in ASTM D3350. Clean, reworked material may be used.

D. Minimum parallel plate pipe stiffness values, per ASTM test Method D2412, shall be as indicated in Table 6.

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Pipe Stiffness (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>56</td>
</tr>
<tr>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>60</td>
<td>30</td>
</tr>
</tbody>
</table>

2.2 BEDDING AND COVER MATERIALS

A. Bedding: As defined in Section 31 05 16.
B. Backfill: As defined in Section 31 23 23.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on the Construction Drawings.

3.2 PREPARATION

A. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 EXCAVATION AND BEDDING

A. Excavate culvert trench to at least 6-inches below pipe invert, in accordance with Section 31 23 17 of this Specification. Hand trim excavation for accurate placement of pipe to elevations indicated.
B. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6-inches compacted depth.

3.4 INSTALLATION – PIPE

A. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.
B. Shore pipe to required position; retain in place until after compaction of adjacent fills. Ensure pipe remains in correct position and to required slope.
C. Repair surface damage to pipe protective coating with two (2) coats of compatible bituminous paint coating.
D. Install pipe bedding to spring line of pipe.
E. Install culvert end gratings as necessary.
F. Refer to Section 31 23 17 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

3.5 PIPE ENDS
A. Place fill at pipe ends, embankment slopes, concrete aprons, adjacent construction, as indicated on Construction Drawings.

3.6 ERECTION TOLERANCES
A. Lay pipe to alignment and slope gradients noted on Construction Drawings; with maximum variation from indicated slope of 1/8-inch in 10 feet.
B. Maximum variation from intended elevation of culvert invert: ½-inch.
C. Maximum offset of pipe from indicated alignment: 1-inch.
D. Maximum variation in profile of structure from intended position: 1 percent.

3.7 FIELD QUALITY CONTROL
A. Request inspection prior to and immediately after placing pipe bedding.
B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.8 PROTECTION OF INSTALLED CONSTRUCTION
A. Protect pipe and bedding from damage or displacement until backfilling operation is in progress.
SECTION 32 92 19 – SEEDING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Preparation of subsoil.
   2. Placing topsoil.
   4. Mulching.
   5. Maintenance.
B. Related Sections:
   1. Section 31 22 13 – Rough Grading

1.2 UNIT PRICE – MEASUREMENT AND PAYMENT
A. Grassed Areas:
   2. Basis of Payment: Includes preparation of subsoil, topsoil, placing topsoil, seeding, watering and maintenance to specified time limit.

1.3 REFERENCES
A. Federal Specifications:
   1. OF-241 – Fertilizers, Mixed, Commercial.
B. ASTM International:

1.4 DEFINITIONS
A. Weeds: Vegetative species other than specified species to be established in given area.

1.5 SUBMITTALS
A. Section 01 00 00 – Submittal Procedures: Requirements for submittals.
B. Product Data: Submit data for seed mix, fertilizer, mulch, and other accessories.

1.6 QUALITY ASSURANCE
A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.
B. Perform Work in accordance with NRCS standards.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Product storage and handling requirements shall be as specified in applicable sections of these Specifications and in accordance with recommendations of the supplier.
B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.8 COORDINATION

A. Section 01 00 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate seeding dates to October 15th through April 15th, or July 1st through August 15th to take advantage of the time of best moisture availability. Other dates to be approved by Owner and Engineer. Final seeding shall occur 4-6 weeks after the last killing frost.
C. Dates of seeding will correspond to the high probability (60 percent or more) of receiving effective precipitation (0.6 to 1.0 inch during any three-week period) for seeding establishment.

1.9 MAINTENANCE SERVICE

A. Section 01 00 00 - Execution Requirements: Requirements for maintenance service.
B. The cover will be maintained by occasional mowing, spot spraying, reseeding weak areas, or by controlled burns. Maintain seeded areas for three months from Date of Substantial Completion. Maintenance shall include weekly watering.
C. If after the first full season of growth (not the first year) the cover should be mowed or grazed to control annual weeds to encourage good growth. Timing of mowing should avoid nesting times of birds (March - June).

PART 2 PRODUCTS

2.1 FERTILIZER

A. Fertilizer shall conform to applicable Colorado fertilizer laws. It shall be uniform in composition, dry, and free flowing, and shall be delivered to the site in the original, unopened containers, each bearing the Fertilizer Manufacturer’s guaranteed analysis. Fertilizer which becomes caked or damaged will not be accepted.

2.2 SEED MIXTURE

A. All seed shall be furnished in bags or containers clearly labeled to show the following:
   1. Name and address of supplier
   2. Seed mixture name
   3. Lot number
   4. Net weight
   5. Origin
   6. Percent of weed seed content
   7. Guaranteed percentage of purity and germination
   8. Pounds of pure live seed (PLS) of each seed species
   9. Total pounds of PLS in container
B. All seeds shall be free from noxious weed seeds in accordance with current state and local lists. The Contractor shall furnish to the Engineer a signed statement certifying that the seed is from a lot that has been tested by a recognized laboratory for seed testing within thirteen months prior to the date of seeding. The Engineer may obtain seed samples from the seed equipment, furnished bags, or containers to test seed for species identification, purity, and germination. Seed
tested and found to be less than 10% of the labeled certified PLS and different than the specified species will not be accepted. Seed which has become wet, moldy, or damaged in transit or storage will not be accepted.

C. Seed types and amount of PLS required per acre shall be as presented in Table 7:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Percent of Mixture</th>
<th>Drilled Rate Pounds PLS/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada Wildrye</td>
<td>Elymus canadensis</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Forage Kochia</td>
<td>Kochia prostrata</td>
<td>10</td>
<td>0.75</td>
</tr>
<tr>
<td>Indian Ricegrass</td>
<td>Achnatherum hymenoides</td>
<td>20</td>
<td>1.6</td>
</tr>
<tr>
<td>Sand Dropseed</td>
<td>Sporobolus cryptandrus</td>
<td>10</td>
<td>0.1</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>Panicum virgatum</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Thickspike Wheatgrass</td>
<td>Elymus lanceololatus</td>
<td>20</td>
<td>1.2</td>
</tr>
<tr>
<td>Western Wheatgrass</td>
<td>Pascopyrum smithii</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Western Yarrow</td>
<td>Achillea millefolium</td>
<td>5</td>
<td>0.025</td>
</tr>
</tbody>
</table>

*PLS = Pure Live Seed, calculated by multiplying the % germination x% purity for given lot of seed. Example: a bag of smooth brome grass with 90% purity and 93% germination (shown on seed tag) would require (0.9 X 0.93) = 0.837, (5.2 pounds PLS required/0.837) = 6.2 pounds, 6.2 pounds per acre of smooth brome seed would need to be purchased.

2.3 MULCH

A. Mulch shall be applied by hydraulic mulching (wood cellulose fiber mulch with mulch tackifier added to water to form a homogenous slurry).

B. Wood cellulose fiber mulch shall consist of virgin wood fibers manufactured expressly from clean whole wood chips. The chips shall be processed in such a manner as to contain no growth or germination inhibiting factors. Fiber shall not be produced from recycled materials such as sawdust, paper, cardboard, or residue from pulp and paper plants. The wood cellulose fiber mulch shall be packaged in units containing current labels, with the Mulch Manufacturer’s name, the net weight, and certification that the material meets all requirements.

C. Material for mulch tackifier shall consist of a free-flowing, noncorrosive powder produced from pre-gelatinized 100 percent natural corn starch polymer. All fibers shall be colored green or yellow with a biodegradable dye. The material used for mulch tackifier shall not contain any mineral filler, recycled cellulose fiber, clays, or other substances which may inhibit germination or growth of plants.

2.4 SOIL MATERIALS

A. Topsoil: Excavated from site and free of weeds.

2.5 ACCESSORIES

A. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.

B. Erosion Fabric: Jute matting, open weave.
C. Herbicide: If required, Owner and Engineer’s approval must be obtained prior to use.
D. Stakes: Softwood lumber, chisel pointed.
E. String: Inorganic fiber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify prepared soil base is ready to receive the Work of this section.

3.2 PREPARATION OF SUBSOIL

A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas. The heel of a boot should not sink in more than ½ to 1 inch.
B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.
C. Topsoil removed from the right-of-way must not be mixed with sagebrush debris which may impede seed germination during the revegetation process.
D. Areas needing reseeding need the top layer of soil softened by ripping and disking prior to seeding to create the soil structure necessary to allow for seed germination.
E. Scarify subsoil to depth of 6 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

3.3 PLACING TOPSOIL

A. Spread topsoil to minimum depth of 6 inches over area to be seeded. Rake until smooth.
B. Place topsoil during dry weather and on dry unfrozen subgrade.
C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

3.4 SEEDING

A. Apply seed at rates specified in 2.2.C of this Section. Rake in lightly and use a light harrow or log chain to drag over area to incorporate seed approximately ½ inch to ¾ inch deep.
B. Do not seed areas in excess of that which can be mulched on same day.
C. Planting Season: See 1.8.B of this Section.
D. Do not sow immediately following rain, when ground is too dry, or when winds are over 15 mph.
E. Immediately following seeding and dragging, apply mulch to thickness of 1/8 inch. Maintain clear of shrubs and trees.
F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.5 HYDROSEEDING

A. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at an approved rate evenly in one pass.
B. After application, apply water with fine spray immediately after each area has been hydroseeded. Saturate to 4 inches of soil and maintain moisture levels two to four inches.
3.6 SEED DRILLING
   A. If a seed drill (planter) is used; the specified rates of application should be reduced by one-half of those listed in 2.2.C of this Section.

3.7 SEED PROTECTION
   A. The mulch will be anchored to the soil immediately following application by mechanically crimping it to the soil using a heavy disk implement with dull blades or other suitable equipment traversing the side slope. Crimping will be conducted so that it generally does not sever the mulch and mulching shall not be conducted when wind velocities at the site exceed 15 miles per hour. Where crimping is not practical or possible, the mulch shall be anchored with commercial netting.

3.8 MAINTENANCE
   A. Immediately reseed areas showing bare spots.
   B. Repair washouts or gullies.
   C. Protect seeded areas with warning signs during maintenance period.

3.9 SCHEDULE
   A. All utility routes, disturbed areas, vault areas, and non-traveled areas in road rights-of-way to be reseeded when Work is completed in affected areas.

END OF SECTION
MESA COUNTY LANDFILL

CONSTRUCTION QUALITY ASSURANCE / QUALITY CONTROL PLAN

PREPARED FOR
MESA COUNTY SOLID WASTE MANAGEMENT

PREPARED BY
SOUDER, MILLER & ASSOCIATES

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SMA Project Number
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1.0 INTRODUCTION

This Construction Quality Assurance/Quality Control Plan (CQAQCP) has been prepared as part of the Design and Operations Plan for the Mesa County Landfill (Landfill), Mesa County, Colorado. This CQAQCP addresses the quality assurance (QA) of the construction, inspection, and maintenance of environmental control systems at the Landfill, including earthen materials (low hydraulic conductivity soils and drainage materials) and man-made materials (geomembranes and geotextiles). This CQAQCP is intended to be a "working" document that is updated to reflect changes in specific materials used in construction practices, or in tests and test methods.

In accordance with Section 3.3.3 of the Regulations Pertaining to Solid Waste Sites and Facilities, 6 CCR 1007-2, Part 1 (Regulations), CQAQCP implementation and reporting are required for all engineered components of the landfill, generally including the base and final cover liner systems, as well as leachate collection components.

The CQAQCP includes the construction information and procedures for the following systems at the Landfill:

- Compacted clay liner
- Geomembrane and geotextile installation
- Leachate collection and removal system
- Final cover
- Surface water drainage.

The scope of this CQAQCP includes the QA applicable to these landfill systems for the following:

- Soil excavation and placement
- Manufacturing, fabricating, shipping, handling, and installation of the geosynthetic components
- Surface water control features

Construction quality assurance (CQA) and construction quality control (CQC) are defined as follows:

Construction Quality Assurance is a planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes inspections, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. CQA refers to measures taken by the CQA organization to assess if the installer or contractor is in compliance with the plans and specifications for the project.

Construction Quality Control is a planned system of inspections that is used to directly monitor and control the quality of a construction project. CQC is normally performed by the geosynthetics installer, or for natural soil materials, by the earthwork contractor, and is necessary to achieve quality in the constructed or installed system. CQC refers to measures taken by the installer or contractor to determine compliance with the
requirements for materials and workmanship as stated in the plans and specifications for
the project.

1.1 GENERAL TESTING REQUIREMENTS

This CQAQCP includes references to test procedures of the American Society for

Unless indicated otherwise, tests will be performed in strict accordance with the
referenced test procedure and the description included in this plan. Any deviations to
test procedures specified in this plan must be approved by the CQA Engineer (CQAE)
and the Colorado Department of Public Health and Environment (CDPHE).

1.2 ORGANIZATION AND USE OF THE CQAQCP

The CQAQCP is divided into eight main sections as follows:

Section 1.0 – Introduction
Section 2.0 – Surveying Requirements
Section 3.0 – Prequalification Testing
Section 4.0 – Earthen Materials
Section 5.0 – Geosynthetics
Section 6.0 – HDPE Pipe
Section 7.0 – Well and Exploratory Boring Decommissioning Procedures
Section 8.0 – Construction Documentation Report
Section 9.0 – Unexpected Waste

This organization is based on general construction procedures and materials and does
not necessarily follow the actual sequence of systems as they are constructed within the
Landfill.

1.3 DEFINITIONS

1.3.1 Definition and Responsibility of Parties

The successful completion of Landfill construction is dependent on the interaction of
several qualified parties. These parties include those associated with the ownership;
design and specification preparation; manufacture, fabrication, transportation,
installation, and quality assurance of any geosynthetics; and the placement, testing, and
quality assurance of construction of earthen materials.

CDPHE, Hazardous Materials and Waste Management Division, is involved in the
review and approval of this CQAQCP, but it is not a party to the actual implementation
and day-to-day activities of the plan except that final documentation reports and major
design changes will be submitted to the CDPHE for review and approval, prior to
implementation.
Within each of the following party descriptions, reference is made to title and, where applicable, to the individuals within that party responsible for carrying out the provisions of this CQAQC Plan.

1.3.2 Construction Quality Assurance Engineer

The Owner/Operator will retain an independent consulting firm to fulfill the role of CQAE. The CQAE consulting firm shall provide a Colorado registered professional engineer for oversight and supervision of CQAE activities. The CQAE will observe and document activities related to construction of environmental containment systems at the site and will provide overall coordination of documentation submitted in support of this plan. The CQAE will also be responsible for surveying (horizontal and vertical control). A professional engineer registered in Colorado employed by the CQAE will prepare and certify the Construction Documentation Report, which will be submitted to CDPHE upon approval by the Owner. The term “CQAE” is used throughout this document to indicate the official representative of the CQAE.

1.3.3 Construction Quality Assurance Monitor(s)

The CQA Monitor(s), under direct supervision of the CQAE, shall be present on site to perform observations and testing during construction activities, including:

- Testing of construction materials
- Collection of soil samples, as necessary
- Preparation of field reports.

1.3.4 Design Engineer

The Design Engineer is the company hired by the Owner to prepare the Landfill Design and Operations Plan. This Plan is prepared under the supervision of, and is sealed by, a Colorado registered professional engineer. The term “Design Engineer” is used throughout this document to indicate the official representative of the Design Engineer, whether on site or not.

1.3.5 Facility Owner

Mesa County is the Owner of the Landfill. The term “Owner” is used throughout this document to indicate the Owner or the official representative of the Owner.

1.3.6 Facility Operator

Mesa County is the Operator of the Landfill. The term “Operator” is used throughout this document to indicate the Operator or official representative of the Operator.

1.3.7 General Contractor

The General Contractor will have overall responsibility for the completion of closure construction tasks at the landfill facility. The General Contractor will also be responsible
for hiring all subcontractors. The term “Contractor” is used throughout this document to indicate the official representative of the Contractor.

1.3.8 Geosynthetic Installer

The Geosynthetic Installer is the General Contractor or a subcontractor hired to install the geosynthetic components referenced in this plan. The term “Installer” is used throughout this document to indicate the official representative of the Geosynthetic Installer.

1.3.9 Geosynthetic Manufacturers

The Geosynthetic Manufacturers are those hired by the General Contractor to furnish the geosynthetic components referenced in this manual. The terms “Geomembrane Manufacturer” and “Geotextile Manufacturer”, are used throughout this document to indicate the specific company supplying these materials to the job site. This plan includes specific quality assurance and quality control (QC) requirements for the geosynthetic manufacturers in their role of providing the QC during geosynthetic manufacturing.

1.3.10 Resin Supplier

The Resin Supplier is the company or companies selected by the Geomembrane Manufacturer and Geotextile Manufacturer to furnish the resins used in fabricating the geosynthetic components. The term “Resin Supplier” is used in this manual to denote, individually, each respective supplier. Designations of the specific resin suppliers are not necessary since all communication and responsibilities within this plan are between the respective manufacturers and suppliers.

1.3.11 Soils Laboratory

The Soils Laboratory is an independent qualified laboratory hired by the Owner or CQAE to perform laboratory QA/QC soils tests as indicated in the CQAQCP. The term “Soils Laboratory” is used throughout this manual to denote the official representative of the company providing these services. The Soils Laboratory will supply technicians, as necessary, for collection and laboratory analyses of samples. The QA/QC testing performed by the Soils Laboratory shall be performed under the supervision of a Colorado registered professional engineer.

1.4 ORGANIZATION OF THE CQAQCP PARTIES

Overall responsibility for carrying out the provisions of this CQAQCP is with the CQAE, who will consult the Design Engineer regarding design specifications and/or recommended changes in the Design Plans and Drawings.

The Contractor (including any subcontractors that might be brought to the site) will report to the Owner and the CQAE for matters relating to the CQAQCP. The Owner and CQAE shall consult the Design Engineer with questions about, or possible modifications to, the Design Plans and Drawings.
1.5 MEETINGS

There are two types of meetings required for implementation of this CQAQCP: pre-construction meetings and problem/deficiency meetings.

A pre-construction meeting will be conducted immediately prior to the commencement of each phase of landfill construction and will be attended by the Owner, Operator, and the Contractor, along with other appropriate parties such as the Soils Laboratory, and CQAE. The purposes of this meeting are to:

- Review the project and the CQAQCP as it applies to environmental control system construction and familiarize all parties with their respective responsibilities and interactions
- Provide each party with all relevant QA/QC documents and supporting information
- Determine any changes to the CQAQCP and its role relative to the design criteria, plans, and specifications
- Review the responsibilities of each party and review lines of authority and communication for each party
- Discuss the established procedures or protocol for observations and tests including sampling strategies
- Discuss the established procedures/protocol for addressing construction non-conformance, repairs, and re-tests
- Review methods for documenting and reporting test data.

Problem/deficiency meetings will be conducted, as requested by the Owner, Operator, or CQAE, to work out problems, which may arise with the construction or QA/QC testing. The meetings will be attended by appropriate parties.

1.6 DEFICIENCIES AND RESOLUTION

If a deficiency is discovered in the construction work, the CQAE will determine the extent and nature of the defect by additional testing, observation, review of data, or other appropriate means, and will then inform the Owner, who, with the CQAE, will direct the Contractor to perform the necessary corrective tasks. The previously defective area will be re-tested as appropriate to document the success of corrective action.

1.7 DOCUMENTATION

This section describes the types of documentation reports that must be completed by each party which have direct QA/QC responsibility for the landfill construction. The parties with these responsibilities are the CQAE, CQA Monitor(s), and the Soils Laboratory.

The documentation of CQA activities is the most effective method to make certain that the QA requirements have been addressed and satisfied. The documentation process includes:

- Recognition of construction tasks that should be documented
• Assignment of responsibilities for the observation, testing, and documentation of these tasks
• Completion of the required forms, data sheets, and reports to provide an accurate record of the work performed during construction.

1.7.1 Daily Construction Report

A construction report will be completed by the CQAE/CQA Monitor(s) or the Soils Laboratory each day that they perform work on the site. This report will provide a chronological record for identifying and recording other reports, data sheets, forms, and checklists. This report will contain, at a minimum, the following information to be filled out in pen and preferably pre-printed so that the required information is organized in an easily accessible manner:

• Date/Project Name/Location
• Report preparer’s name
• The number and name of people on site under the direction of the preparer related to QAQC tasks
• Summary of weather conditions including temperature, humidity, wind direction/speed, cloud cover, and precipitation
• Equipment and personnel on the project, including contractors
• Calibration and recalibration of test equipment
• Summary of any meetings held and attendees
• An accurate record of communications with other CQAQC parties, or any other outside companies, regulators, etc.
• Failing field tests, corrective action(s) taken, and retesting confirmation if a problem/deficiency identification and correction action report is not completed
• Test locations, procedures, results, and test data sheets
• Summary of construction activities and locations
• Documentation and chain of custody for samples collected and shipped to laboratory
• Detailed description of any problems or non-conforming construction
• Description of delays in construction activities
• Progress of work in terms of approximate quantities
• Description of off-site materials received
• Chronological description of work in progress including any notices to, or requests from, the Contractor
• A description of non-conforming work and corresponding problem/deficiency identification

1.7.2 Problem/Deficiency Identification and Corrective Action Reports

Problem and/or deficiency and corrective action reports will be completed by the CQAE and/or Soils Laboratory when any construction material or activity observed or tested does not meet the requirements set forth in this CQAQCP. These reports are not necessary for a failing field test if corrective action is taken and re-testing confirms acceptable properties. These reports shall be cross-referenced to the forms, data sheets, checklists, and other reports that contain data or observations leading to the determination of a problem or deficiency. At a minimum, the Problem/Deficiency Identification and Corrective Action Reports will include the following information:
• A detailed description of the problem or deficiency, including reference to any supplemental data or observations responsible for determining the problem or deficiency.

• Location of the problem or deficiency, including how and when the problem or deficiency was discovered. In addition, an estimate of how long the problem or deficiency has existed should be included, as well as an opinion as to the probable cause of the problem or deficiency.

• A recommended corrective action for resolving the problem or deficiency should also be included in the report. If the corrective action has already been implemented, then the observations and documentation to show that the problem or deficiency has been resolved should be included. If the problem or deficiency has not been resolved by the end of the day upon which it was discovered, then the report will clearly state that it is an unresolved problem or deficiency.

A problem/deficiency report will be submitted to the CQAE by the end of the working day during which the problem or deficiency occurred. If a solution to the problem or deficiency has not been agreed to by the end of the day, then the CQAE will discuss the issue with the Owner, and the Owner will take the necessary corrective actions to resolve the problem or deficiency as soon as practical. The CQAE is responsible to make certain that all Problem/Deficiency Identification Reports have been adequately resolved.

The CQAE will carefully review all problem/deficiency reports to determine whether or not similar reports on the same problem or deficiency are an indication of a need to make changes to the Design Plans and Drawings and/or the CQAQCP. If this situation should develop, a meeting will be held to determine whether or not revisions to the plans, Design Plans and Drawings, or this CQAQCP should be made. Any revisions to the Design Plans and Drawings, the CQAQCP, or major design changes must be approved by the Owner, Operator, the CQAE, and CDPHE. Note that a section on “problem/deficiencies” completed on the CQAE/CQA Monitor(s) daily report may suffice as a Problem/Deficiency Report.

1.7.3 Photographs

Photographs shall be obtained for all items of construction. A sufficient number of photographs shall be obtained to provide adequate documentation of construction of each construction item. Panoramic views of completed construction work will be taken as necessary. A photo log containing the following information will be maintained:

• Date, time, location, and orientation of photograph

• Location and description of the work.

Construction problems and non-conforming work shall be documented with photographs taken before and after the problem or when the non-conforming work has been corrected. When possible, photographs should also be taken during corrective actions to document those activities.
1.7.4 Test Data Sheets

The CQAE/CQA Monitor(s) will record all test data results on the test data sheets. Independent consultants engaged by the CQAE shall submit their test results or data on forms acceptable to and approved by the CQAE.

1.7.5 Storage of Records

All daily records will be stored in 3-ring binders, or similar, at the construction site or landfill office. Copies of all documents will be on file at the CQAE’s office.

1.7.6 Final Construction Documentation Reports

A Final Construction Documentation Report will be prepared by the CQAE for each phase of landfill construction. Please see Section 6.0 of this CQAQCP for a description of the Final Construction Documentation Report.
2.0 SURVEYING REQUIREMENTS

2.1 SURVEY CONTROL

A Professional Land Surveyor (Surveyor) registered in the State of Colorado will establish field control reference points and benchmarks. Horizontal control lines will be developed in advance of construction operations, and in coordination with the Operations Contractor.

The CQAE shall independently verify the accuracy of previously used control for each construction phase.

2.2 REQUIRED AS-BUILT SURVEYS

Surveys performed for inclusion in the construction documentation report shall include, but not necessarily be limited to:

- As-built landfill subgrade contours and grades.
- As-built top of compacted clay liner contours and grades.
- As-built leachate collection system.
- As-built pipe.
- As-built final cover elevations including:
  - As-built top of barrier layer contours and grades, if applicable.
  - As-built top of topsoil layer contours and grades.
  - As-built top of water balance cover, if applicable.
- As-built locations, contours, and grades of all engineered surface water diversion structures.

2.3 LANDFILL SUBGRADE SURVEYING

Upon completion of excavation or backfill to establish subgrade, a verification survey will be performed to document clay liner subgrade elevation. The elevations will be verified by surveyors under the direction of the CQAE. This survey will serve as the base elevations for the clay liner thickness determination. Vertical elevations will be documented based on a grid spacing of 50 feet or less, and the axes of the tops and toes of slopes will be surveyed on a spacing of 50 feet or less. Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot and to verify that the foundation layer is a minimum of 1.0 foot thick ±0.1 foot. Horizontal measurements shall be read to the nearest 0.1 foot to establish locations at a minimum precision of 0.5 foot.

2.4 COMPACTED CLAY LINER SURVEYING

Subsequent to completed placement of the compacted clay liner, a verification survey will be performed to document the surface of the clay liner and the thickness of the layer. Thickness measurements on slopes must take into account the slope angle and must provide for the required component thickness as measured perpendicular to the slope. Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot and to verify that the clay liner is a minimum of 1.0 foot
thick. Horizontal measurements shall be read to the nearest 0.1 foot to establish locations at a minimum precision of 0.5 foot. The CQAE may grant variances from the survey tolerances provided that:

- The minimum required clay liner thickness is achieved, and
- The minimum required slope in the direction of leachate collection is maintained.

2.5 LEACHATE COLLECTION SYSTEM

The leachate collection sump, leachate holding pond, and grade breaks should be surveyed at intervals sufficient to give a clear three-dimensional presentation of the configuration of the sump and leachate holding pond and their component layer thicknesses. All sump edges, leachate holding pond edges, and base break lines will be surveyed. Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot and to verify that the clay liner in the sump is a minimum of 1.0 foot thick. Acceptable horizontal tolerances will be 0.1 foot in any direction. The CQAE may grant variances from the survey tolerances provided that the minimum thickness of the drainage layer is achieved.

2.6 FINAL COVER SURVEYING

The CQAE will document final landfill cover elevations. Under the supervision of the CQAE, the surveyor will establish vertical elevations of the final cover (top of barrier layer and top of topsoil layer, or top of water balance cover) to a tolerance of ±0.1-foot as measured by appropriate surveying methods. Vertical elevations of each layer will be documented based on a grid spacing of 50 feet or less, and the axes of the tops and toes of slopes will be surveyed on a spacing of 50 feet or less. It should be noted that the finish grades shown on the final grading plan represent the target for final construction; settlement of the landfill mass, however, might occur before, during, and after placement of final cover. Therefore, the final contours of the landfill may be lower or higher than the design contours as long as the minimum and maximum design slopes are met and the thickness of each layer of the final cover configuration is no less than specified. However, at no point will final refuse grade exceed an elevation that would prevent the final cap from being constructed within the approved final elevation for the landfill. These areas will be identified in the construction certification report and drawings. CDPHE will be notified of any changes.

At the discretion of the CQAE, the barrier layer may be bored to determine thickness, prior to installation of the topsoil layer. If boring techniques are used, a minimum of one hole shall be bored every 50 feet on a grid to establish minimum layer thickness. All borings shall be backfilled throughout the entire depth with bentonite and hydrated. However, boring will not be a substitute for appropriate surveys of the top of the foundation layer or the top of the low hydraulic conductivity barrier layer. If the barrier layer thickness is verified by surveying, the survey shall be completed on a grid spacing of 50 feet or less. The top of the closure landfill cover (top of the topsoil layer) shall be verified by surveying on a grid spacing of 50 feet or less. Survey points will be located such that the same point will be surveyed for the foundation layer, barrier layer, and topsoil layer, so thickness verification can be accurately performed.
At the discretion of the Owner, Contractor, or both, and to minimize overfilling as a result of landfill settlement concurrent with cover construction, settlement plates may be used to assist in documentation of the thickness of the cover layers. The frequency of installation of these plates is discretionary with the Contractor or Owner. Thickness of the landfill cover components shall be measured normal to the final slope configuration.

2.7 PIPING SURVEYING

The horizontal and vertical locations of all pertinent piping for leachate collection and conveyance shall be established by surveyors under the direction of the CQAE. The piping shall include, but not necessarily be limited to the following:

1. Leachate force main piping between the leachate collection sump and the leachate holding pond.
2. Trench (for leachate force main piping) invert elevations.
3. Leachate collection sump risers.
4. Leachate holding pond riser and leak detection piping.
5. Culvert placement and cover

The top of the leachate force main piping shall be surveyed on a spacing of 25 feet. In addition, the beginning and ending and all turning points (vertical or horizontal) in each pipe shall be surveyed. Elevations shall be measured to the nearest 0.01 foot. Horizontal locations shall be measured to the nearest 0.1 foot.

Survey of the inlet and outlet inverts of culverts shall be conducted to the nearest 0.1 foot vertical and 0.5 foot horizontal. Survey of the cover thickness (as specified on the Construction Drawings) shall verify conformance to the same tolerance as the inlet and outlet survey.

2.8 SURFACE WATER DRAINAGE SURVEYING

The as-built configuration of all man-made permanent surface water drainage features shall be measured by surveying. These features include but are not necessarily limited to the following:

- Perimeter run on and run off channels
- Down drain channels

The flow line of each drainage channel shall be surveyed for horizontal and vertical location on a spacing of 50 feet or less. All turning points in the channels shall also be surveyed. Cross sections of the channels shall be surveyed every 200 feet or less of channel length to verify construction in accordance with the Design Plans and Drawings. Elevations shall be measured to the nearest 0.01 foot. Horizontal locations shall be measured to the nearest 0.1 foot.

2.9 ROAD SURVEYING

The as-built road construction shall be measured by surveying. For the road’s cross-sectional survey, including the center line, each road edge and associated drainage shall be surveyed 100 feet or less of road. In addition, sufficient cross sections of road curves shall be surveyed to allow preparation of accurate as-built locations and grades.
2.10 LEACHATE SUMP RISER STAGING PAD SURVEYING

The as-built configuration of the leachate sump riser staging pad shall be measured by surveying. Vertical elevations of finish grades will be documented based on a grid spacing of 25 feet or less, and the axes of the tops and toes of slopes will be surveyed on a spacing of 25 feet or less. Vertical measurements shall be read to the nearest 0.01 foot to establish elevations at a minimum precision of 0.1 foot. Horizontal measurements shall be read to the nearest 0.1 foot to establish locations at a minimum precision of 0.5 foot.

2.11 DOCUMENTATION

Surveys will be provided to the CQA, as requested, to facilitate determination of compliance with specification requirements. Survey data will be provided in a topographic survey, as well as in tabular format. The as-built survey information, certified by the Surveyor, will be submitted in or with the CQA Report.
3.0 PREQUALIFICATION TESTING

Prequalification testing will establish that the materials used for the engineered components conform to the minimum specifications for this design. Site specific interface testing of the design liner materials will be performed as a prequalification test.

Site specific interface testing of the design liner materials should be performed once prior to initial construction to verify the minimum assumed strength parameters are exceeded. Subsequent construction projects should have the CQAE verify the material characteristics are similar to those tested and verified as passing results. If different materials or a different borrow source are utilized, additional testing may be directed by the CQAE.

Samples of geosynthetics used for testing interface shear strength should be selected from the geosynthetic rolls that will be used at the facility or from rolls that represent the materials that will be used at the facility. Materials are considered representative if they are from the same manufacturer, use the same manufacturing process, and have the same manufacturing specifications. Results shall be submitted to the CQAE prior to arrival of liner materials on-site unless otherwise directed by the CQAE. The CQAE will review and verify that the reported test results meet with project specifications at least 30 days prior to use of the material on-site.

Prequalification interface shear testing is only required if 4H:1V slopes longer than 30 feet in length are utilized.

Interface testing will only be completed on the composite liner system. Interface shear strength will be tested for each pair of the selected component of the composite liner system.

As necessary, samples are to be prepared as follows:

- Clay sample(s) shall be compacted to 92% of dry density and hydrated to +4% of optimum moisture in accordance with ASTM D1557 at a minimum 1-foot thickness
- Operations layer sample(s) will require no additional preparation, but will be a minimum thickness of 1-foot
- If selected, tire shred sample(s) shall be placed in layers 20-inches thick and compressed to a 1-foot thickness (k > 1 cm/sec)
- If selected, granular drainage material shall be placed in layers 1-foot thick
- All geosynthetics interfaces shall be oriented same side to same side as placed on-site.

Three tests per interface will be performed in accordance with ASTM D5321, at a normal force of 130 pounds per square foot (psf), 4,500 psf and 9,000 psf. The chosen normal forces will simulate the liner system in the construction phase, working phase, and post-closure phase.

The results of the interface testing in accordance with ASTM D5321 should verify that each interface has friction angles and cohesion values equal to or greater than those presented in Table 1. Should any of the friction angle and cohesion parameters fail to
meet the requirements in Table 1, the results of the analysis should be submitted to the Design Engineer for further analysis prior to construction.

### Table 1  Critical Interface Shear Strength Parameters

<table>
<thead>
<tr>
<th>Liner Sequence</th>
<th>Cohesion (psf)</th>
<th>Friction Angle (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations Layer to Geocomposite Drainage Layer</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Granular Drainage Layer to 60-mil HDPE Geomembrane</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Compressed Tire Shreds to 60-mil HDPE Geomembrane</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Geocomposite Drainage Layer to 60-mil HDPE Geomembrane</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>60-mil HDPE to Compacted Clay Liner</td>
<td>0</td>
<td>22</td>
</tr>
</tbody>
</table>

Note: Cohesion and friction angles were acquired from the values provided in the Slope Stability Analysis for Mesa County Landfill, SCS Aquaterra, 2015
4.0 **EARTHEN MATERIALS**

This part of the CQAQCP describes the earthen materials used in constructing the landfill liner and final cover, leachate collection and removal system, permanent roads, and drainage structures for the landfill.

The landfill liner will consist of one of the following systems:

**Base Liner System Alternate 1**
- 12 inches of operations layer
- Drainage Layer
- 12 inches of clay liner (k < 1 x 10^{-7} cm/sec)

**Base Liner System Alternate 2**
- 12 inches of operations layer
- 16 oz/\text{yd}^2 non-woven geotextile (if required)
- Drainage Layer
- 16 oz/\text{yd}^2 non-woven geotextile (if required)
- 60-mil HDPE geomembrane
- 12 inches of clay liner (k < 1 x 10^{-7} cm/sec)

**Base Liner System Sump**
- 12 inches of operations layer
- 16 oz/\text{yd}^2 non-woven geotextile (if required)
- Drainage Layer
- 16 oz/\text{yd}^2 non-woven geotextile (if required)
- 60-mil HDPE membrane
- 2 layers of geosynthetic clay liner
- 12 inches of clay liner (k < 1 x 10^{-7} cm/sec)

**Base Liner System Leachate Holding Pond**
- 16 oz/\text{yd}^2 non-woven geotextile
- 45-mil RPE geomembrane
- 220-mil geocomposite geonet
- 45-mil RPE geomembrane
- 8 oz/\text{yd}^2 non-woven geotextile
- 12 inches of clay liner (k < 1 x 10^{-7} cm/sec)

The landfill cover will consist of one of the following:

**Final Cover System Alternate 1**
- 12 inches of cover soil (nominally compacted clay with vegetation)
- 24 inches of compacted clay barrier layer
Final Cover System Alternate 2

- 48 inches of cover soil (42-inch thick water storage layer and 6-inch thick vegetative growth layer)

4.1 NON-GRANULAR SOILS (SC TO CL)

This section includes the QA/QC requirements for placement, backfilling, and compaction of non-granular soils used for constructing the landfill liner and final cover. For purposes of this CQAQCP, non-granular soils are select clayey sands (SC) to sandy/silty clays (CL) present as colluvium at the site. These soils will be used for the following:

- Fill soil for subgrade construction (if required)
- Construction of the compacted clay liner
- Construction of the barrier layer of the landfill final cover
- Construction of the leachate holding pond and leachate sump riser staging pad

Any field tests, soil sample locations, and survey measurements will be recorded in reports by the CQAE/CQA Monitor(s) including locations (by site grid station) and elevations of all field tests and laboratory sample points.

In addition to the on-site clayey materials, bentonite will be imported to the site for repair of test probe holes installed in the clay liner and cover barrier layer during moisture-density testing. Perforations due to nuclear moisture-density testing and sampling for hydraulic conductivity testing shall be backfilled by using granular bentonite compacted by hand and hydrated to achieve continuity of the compacted layers at these locations.

4.1.1 Materials of Construction

Materials from excavation may be used for constructing the clay liner or final cover, provided that they meet the material property requirements listed in Tables 2, 3, or both, as applicable.

In excavated areas, the bearing surface for the clay liner will be proof-rolled using a vehicle of sufficient ground pressure to reveal areas requiring stabilization, such as a loaded tandem axle dump truck, loaded front end loader, or smooth drum roller. The proof-rolling vehicle and methods will be approved by the CQAE. Stabilization methods, if required, will be approved by the CQAE and MCSWM.

Areas that exhibit greater than 2 inches of deflection, or other indications of instability as determined by the CQAE or Design Engineer, will be stabilized. If undercutting is performed for stabilization, excavation will extend to a depth sufficient to produce a stable bearing surface as determined by visually evaluating the subgrade using proof-rolling equipment. Backfill materials will consist of a soil that is relatively free of organic material and does not contain particle sizes greater than 6 inches in diameter for initial lifts and 3 inches in diameter for final lifts, or as approved by the CQAE. If Portland cement or lime is used for stabilization, it will be mixed to a depth and in proportions sufficient to produce a stable bearing surface. The subgrade will be scarified prior to placement of the initial lift of compacted clay liner.
4.1.2 Field and Laboratory Testing Requirements

Non-granular soil placement will be performed in accordance with the Design Plans and Drawings. The soils will be of sufficient consistency to provide compliance with the Design Plans and Drawings. The CQAE shall document that backfilling and recompacting operations are conducted in compliance with the Design Plan and Drawings and with this CQAQCP.

The nuclear moisture-density field testing methods used during construction shall be performed in accordance with ASTM D 6938.

Test frequencies for performing field moisture/density tests on clayey soils are presented in Table 2.

**Table 2 Compaction/Moisture Specifications and Minimum Field Test Frequencies**

<table>
<thead>
<tr>
<th>Fill Type</th>
<th>Specification</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Fill</td>
<td>≥ 90% ASTM D 1557 @ ±4% of optimum moisture</td>
<td>4/acre/lift (nuclear gauge moisture and density). Minimum 1 test/day.</td>
</tr>
<tr>
<td>Compacted Clay Liner</td>
<td>≥ 92% ASTM D 1557 @ 0 to +4% of optimum moisture; Nominal hydraulic conductivity of ≤1x10^-7 cm/sec</td>
<td>4/acre/lift (nuclear gauge moisture and density); 1/hectare/lift (hydraulic conductivity). Minimum 1 test/day.</td>
</tr>
<tr>
<td>Cover Barrier Layer</td>
<td>≥ 90% ASTM D 1557 @ 0 to +4% of optimum moisture; Nominal hydraulic conductivity of ≤ 1 x 10^-5 cm/sec</td>
<td>4/acre/lift (nuclear gauge moisture and density); 1/hectare/lift (hydraulic conductivity). Minimum 1 test/day.</td>
</tr>
</tbody>
</table>

Field in-place moisture-density tests shall be verified by laboratory testing and/or alternate field methods on a periodic basis. At least one verification test shall be performed per 30 field tests. Verification tests may include testing of Shelby tube samples, sand cone tests, or separate nuclear density device tests. The verification test will be within two feet of a required test and shall be considered acceptable if the dry density values of the two tests are within 5% of each other. In addition, nuclear moisture-density devices shall be calibrated daily and the results of the calibration tests included in the daily field report.

The qualified Soils Laboratory will conduct laboratory testing on samples from the non-granular soil. Table 3 presents the minimum laboratory test types, methods, and frequencies for all non-granular soils used at the site.

**Table 3 Non-Granular Soil Minimum Laboratory Test Frequencies**

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Minimum Frequency</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Proctor</td>
<td>ASTM D 1557</td>
<td>1 test/6,540 yds³ or change in material type</td>
<td>NA</td>
</tr>
</tbody>
</table>
### Test Method Minimum Frequency Criteria

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Minimum Frequency</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atterberg Limits</td>
<td>ASTM D 4318</td>
<td>1/Proctor or change in material type</td>
<td>LL (\geq 30), PI (\geq 15)</td>
</tr>
<tr>
<td>Grain Size Analysis</td>
<td>ASTM D 422/1140</td>
<td>1/Proctor or change in material type</td>
<td>(\geq 50%) P200, 2-in. max size</td>
</tr>
<tr>
<td>Unified Soil Classification</td>
<td>ASTM D 2487</td>
<td>1/Proctor or change in material type</td>
<td>SC or CL</td>
</tr>
<tr>
<td>Hydraulic Conductivity</td>
<td>ASTM D 5084</td>
<td>1 test/13,000 yds(^3) or change in material type</td>
<td>(\leq 1\times10^{-7}) cm/sec (liner) or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(\leq 1\times10^{-6}) cm/sec (cover)</td>
</tr>
</tbody>
</table>

#### 4.1.3 Non-Granular Soils Acceptance Criteria

The following acceptance criteria will apply to clayey soil for the landfill liner and cover systems:

- The soils will be compacted to the density specified in Table 2 and on the Design and Plan and Drawings. Moisture content specifications will be met for all soils. Moisture will be maintained within 0 to +4 percentage points of optimum moisture content. When moisture content is outside of these limits, measures will be taken to bring the moisture content within the specification. Moisture content, however, will not be used as the sole criterion for failing a density test.
- Any soils that do not classify as CL or SC by the Unified Soil Classification System shall be reported immediately to the CQAE.
- A laboratory determination of hydraulic conductivity greater than \(1 \times 10^{-7}\) cm/sec for the liner or greater than \(1 \times 10^{-6}\) cm/sec for final cover barrier layer will be reported immediately to the CQAE.
- If a hydraulic conductivity test fails the specification, at least one additional sample will be collected from the general area (within 25 feet) of the failing test. Based on the initial test and the re-test results, the CQAE will determine whether additional tests should be conducted and/or repairs made to correct the deficiency.

#### 4.1.4 Placement Criteria

The non-granular structural fill soils shall be placed with emphasis on the following:

- Segregation and removal of unsuitable material.
- Removal of boulders, stumps, and roots.
- Removal of structurally weak material (i.e., refuse, organic debris, and soils that classify as silt [ML] under the Unified Soil Classification System).

Field densities, moisture contents, and hydraulic conductivities will be measured in areas where compacted clayey soil has been placed in order to document that the in-place soils are in conformance with the required specifications.

Any placement of non-granular soils will be accomplished in accordance with the following requirements:
- Observed stones greater than 2 inches in any dimension will be removed from this material during soil homogenizing and moisture-conditioning.
- No frozen soils will be used for backfilling. Any frozen soils in the compaction work area will be removed.
- The loose thickness of layers for soil compaction shall not exceed 8 inches.
- As needed, clay shall be disked or otherwise mechanically processed prior to compaction to break up clods and allow for moisture conditioning. The maximum clod size shall be 4 inches in any dimension.
- Clayey soil compaction will be performed on properly homogenized and moisture-conditioned soil so as to accomplish continuous and complete layer bonding and continuity of all soil construction joints. Footed equipment having feet at least as long as the loose lift height shall be used for compaction. Sufficient number of passes of the compaction equipment shall be made over each lift to ensure complete remolding of the clay.
- The clay surface of a completed lift shall be scarified prior to placement of additional clay.
- The clay component of a liner or cover in adjacent phases shall be keyed together to from a continuous clay seal. This shall be accomplished by excavating steps along the edge of the existing clay liner/cover and overlapping them with lifts of clay placed for the new phase.
- Clay soils will be compacted to achieve a hydraulic conductivity no greater than $1 \times 10^{-7}$ cm/sec for liner and no greater than $1 \times 10^{-6}$ cm/sec for cover.
- Unacceptable compaction density or moisture content will be reported immediately to the CQAE. Corrective action will consist of moisture-conditioning of the soil, additional compactive effort, or both, as necessary.

Upon satisfactory completion of the compacted clay liner, the surface of the soil may be prepared for deployment of the geomembrane liner, where applicable. The CQAE will observe and document this process. The surface must be prepared in such a manner as to allow the geosynthetics to lie in intimate contact with the underlying clay liner. The surface will also be deemed acceptable for geomembrane deployment and seaming by the Geomembrane Installer.

### 4.1.5 Other Structural Fill

#### 4.1.5.1 Leachate Holding Pond Embankments

The leachate holding pond embankments will be constructed using non-granular soils placed in loose 8-inch maximum lifts and compacted to a minimum of 90% of maximum modified Proctor density at ±4% of optimum moisture. Prior to constructing the embankments, the area beneath the embankments shall be scarified and proof-rolled to the satisfaction of the CQAE. Field moisture density tests shall be conducted at a rate no less than one test per compacted soil lift per embankment. The as-built construction of the embankments shall be verified by surveying as specified in Section 2.5.
4.1.5.2 Anchor Trench Backfill

The backfill in the anchor trenches is not integral to liner stability or performance. Nevertheless, non-granular soils used for backfilling of anchor trenches shall be moisture-conditioned and wheel-rolled or compacted with a hand operated compactor in the anchor trench to the satisfaction of the CQAE. Care shall be taken not to damage the liner during compaction of the soils. The CQAE shall observe all compaction operations in the anchor trench. There are no prescribed quantitative tests for this material; however, at the discretion of the CQAE, laboratory and field testing may be requested to access moisture, density, and grain size distribution.

4.1.5.3 Permanent Roads

Where non-granular soils are used as structural fill, the soil shall be placed in loose 8-inch maximum lifts and compacted to a minimum of 92% of maximum modified Proctor density at ± 4% of optimum moisture. Field moisture density tests shall be conducted at a rate no less than one test per 300 cubic yards of fill or two tests per acre per lift, whichever frequency is greater. The as-built construction of the road shall be verified by surveying as specified in Section 2.9.

4.1.5.4 Leachate Sump Riser Staging Pad

The leachate sump riser staging pad shall be constructed using non-granular soils placed in loose 8-inch maximum lifts and compacted to a minimum of 92% of maximum modified Proctor density at ± 4% of optimum moisture. Field moisture density tests shall be conducted at a rate no less than two tests per compacted soil lift. The as-built construction of the leachate sump riser staging pad shall be verified by surveying as specified in Section 2.10.

4.1.5.5 Leachate Force Main Pipe Backfill

The top two feet or less of the leachate force main pipe backfill shall be constructed using non-granular soils placed in loose 8-inch maximum lifts and compacted to a minimum of 92% of maximum modified Proctor density at ± 4% of optimum moisture. Field moisture density tests shall be conducted at a rate no less than one per compacted soil lift per 100 feet of trench. The as-built construction of the trench shall be verified by surveying as specified in Section 2.7.

Placement of non-granular materials as backfill in the trench, below the top two feet, shall be conducted in such a manner to minimize voids and to ensure that the compaction specification can be met with the overlying material. The Contractor shall propose a compaction method for these soils below the top two feet for acceptance by the CQAE; however, the Contractor shall be responsible for achieving the compaction and moisture compaction requirement for the top two feet of backfill in the trench irrespective of the method used on the lower fill.
4.1.6 Deficiencies and Resolution

If a deficiency is discovered in the construction work, the CQAE will determine the extent and nature of the defect by additional testing, observation, review of data, or other appropriate means and will then inform the Owner. The CQAE and Owner will obtain written approval from CDPHE to implement the resolution to any significant change and direct the Contractor to perform the necessary corrective tasks. The previously defective area will be re-tested as appropriate to document the success of corrective action. Any revisions to the Design Plans and Drawings or the CQAQCP, or major design changes must be approved by the Owner, the CQAE, and CDPHE.

4.2 OPERATIONS LAYER

In order to minimize drying and desiccation of the clay liner, or damage to the geosynthetics (as applicable), a minimum thickness of 12 inches of operations layer will be placed on the base liner system immediately following liner construction.

4.2.1 Material Evaluation

Material evaluation will be performed for each soil type to be used as an operations layer.

Laboratory qualification testing should be accomplished through source testing of the proposed soils at a frequency of 1 grain size analysis (ASTM D 422) per 6,540 cubic yards (cy) of soil.

Soils to be used in the operations layer will be reasonably free of roots, sticks, or any other foreign materials to the extent practical. Maximum particle size of the operations layer is 2 inches. The CQAE will notify the Contractor of observed non-conformities. In the event such non-conformities are not resolved, the placement effort should be suspended, and the CQAE will be notified.

During construction of the operations layer, visual control will be exercised to observe material consistency and appropriate construction methods. The CQAE will perform continuous visual observation of the materials being placed as the operations layer. The CQAE will visually observe the soil for deleterious matter and oversized particles. The CQAE will document the construction process.

4.2.2 Placement Techniques

The placement of the operations layer should be accomplished using a lightweight, low ground pressure bulldozer as approved by the CQAE. The layer will be placed in a single lift and nominally compacted with the placement equipment. The CQAE will maintain continuous visual observations of the placement effort, and document the placement techniques. If the operations layer is to be placed over a geosynthetic liner component, cover placement on any liner slopes steeper than 10 percent will begin at the base of the slope, and progress up the slope.

Placement in this manner will serve to maximize liner stability during cover placement activities.
4.3 GRANULAR SOILS

Granular soils will be used in construction of the leachate collection sump. Granular soils are also proposed as one alternative for the leachate drainage layer. Relatively high permeability granular soils may be placed as drainage layer material overlying the base liner. Granular soil placement will be performed in accordance with the Design Plans and Drawings.

4.3.1 Material Evaluation

The CQAE will be responsible for making sufficient observations of the granular materials during their placement to verify that they meet the materials specifications. Any field tests, laboratory test results, and survey results, including locations (by grid station) and elevations of all field tests, and laboratory sample points, will be recorded by the CQAE.

Laboratory testing of granular drainage layer material will include:

- Grain size analysis (ASTM D 422) – 1 test per 2,620 cy
- Carbonate content testing (ASTM D 3042, 1 test per 2,620 cy.
- Hydraulic conductivity (ASTM D 2434) – 1 test per 2,620 cy.

4.3.1.1 Leachate Drainage Layer

If the granular soils alternative is selected, the leachate drainage layer shall consist of a sand and/or gravel with an in-place hydraulic conductivity of 1 cm/sec or greater and a maximum particle size of 0.75 inches, and percent passing the No. 200 sieve of < 5 percent. The leachate drainage layer materials will be poorly graded, and be made up of inert stable materials such as silica and quartz. The material and its particle size distribution shall be approved by the CQAE.

Tire shreds may be substituted for the granular leachate drainage layer. Tire shreds shall have a minimum in-place hydraulic conductivity of 1 cm/sec. Before materials for this layer are procured, one sample per material source shall be tested under anticipated construction loads for hydraulic conductivity in substantial conformance to USBR Method 5605. Tire shreds must meet the hydraulic conductivity specification under the anticipated loads while maintaining a minimum in-place thickness of 1 foot under landfill loads. The tire shred drainage layer shall consist of 4 inch nominal diameter tire shred material.

4.3.1.2 Leachate Sump Aggregate Materials

The granular material placed in the leachate sump shall be 1.5-inch washed stone conforming to the ASTM C 33 size #4 specification. This material shall be made up of inert and stable materials such as silica and quartz. The material shall be rounded to sub-rounded, in accordance with ASTM D 2488.3.3.3 Testing Requirements.

For the leachate collection sump, a minimum of one sample shall be collected for grain size analysis. In addition, a minimum of one grain size analysis will be performed on each source of the sump aggregate. The CQAE might require additional testing depending on routine observations of the material being delivered to the site.
The analytical results will be sent to the CQAE, who will determine whether or not the materials meet the required specifications.

4.3.1.3 Pipe Bedding

Pipe bedding shall be constructed for the leachate force main pipe outside the lined area. Pipe bedding shall consist of granular material conforming to the specifications in Table 4. These specifications shall be verified by a minimum of one test per source of pipe bedding. Pipe bedding material shall be approved by the CQAE.

**Table 4 Pipe Bedding Specifications**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Mass Percent Passing Square Mesh Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 - inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8 – inch</td>
<td>&gt;90</td>
</tr>
<tr>
<td>No. 4</td>
<td>&gt;45</td>
</tr>
<tr>
<td>No. 100</td>
<td>&lt;10</td>
</tr>
<tr>
<td>No. 200</td>
<td>&lt;5</td>
</tr>
</tbody>
</table>

4.3.2 Granular Soils Acceptance Criteria

Generally, the acceptance criteria for the granular soils are the material specifications, based on particle size, hydraulic conductivity, and visual observation. In addition, the granular soils must consist of inert and stable materials. Material that does not meet these criteria will be rejected. Commercially available aggregate in Mesa County is typically silica and quartz-based; the CQAE, however, might require testing for carbonate content in accordance with ASTM D 4373 in the event that soluble materials are suspected to be present in the aggregate.

4.3.3 Placement Criteria

The Contractor shall propose to the CQAE a means of placing and spreading granular material over the liner and in the sump. The CQAE shall approve a method of placing and spreading the materials prior to their placement.

The following placement criteria will be used by the Contractor while installing the drainage layer or the sump gravel:

- During placement of the leachate drainage layer over the liner, at least 3 feet of granular soils shall be maintained between the earth-moving equipment and underlying liner except for during final spreading when a minimum of 1 foot separation shall be maintained. Final spreading of the leachate drainage layer shall be conducted using a low ground pressure (less than 5 psi) dozer approved.
by the CQAE, and shall be performed in a manner that protects the underlying geosynthetics, i.e., no sharp turns, quick stops, etc.

- A minimum final thickness of 1 foot of drainage material will be placed over the floor liner.
- The CQAE will observe the spreading and grading of the granular material and document that it meets the project specifications. This observation will also be conducted to detect potential and/or actual damage to the underlying geosynthetics upon which the material is being placed. Where damage is suspected, the underlying component surface will be exposed and observed to determine its condition. Actual damage, as well as corrective action taken, will be fully documented.

4.3.4 Deficiencies and Resolutions

If a deficiency in earthwork is discovered during construction, the CQAE will immediately determine the extent and nature of the defect by additional testing, observation, review of data, or other appropriate means and will then notify the Contractor of the defect. The CQAE and Owner will obtain written approval from CDPHE to implement the resolution to any significant change. The Contractor will perform the necessary corrective tasks. The area will then be re-tested or re-observed to document that the defect has been satisfactorily corrected. Additional work shall not be performed in the area of deficiency until the deficiency is corrected. Any revisions to the Design Plans and Drawings or the CQAQCP or major design changes must be approved by the Owner, the CQAE, and CDPHE.

4.4 WATER BALANCE COVER

This section includes the CQA/CQC requirements for placement, backfilling, and compaction of water balance cover soils, specifically the water storage layer and vegetative growth layer.

The water balance cover (Final Cover System Alternate 2) consists of a minimum thickness of 4.0 feet measured normal to the slope placed according to the Design Plan and Drawings. The thickness of the water storage layer and the total cover thickness shall be verified as specified in Section 2.6 of this CQAQCP.

The water storage layer consists of a 4-foot thick lift of clayey soil placed in a single “monolithic” lift to minimize over-compaction. These layers shall not be compacted and shall be placed and shaped with low ground pressure (LGP) equipment such as an LGP dozer.

The upper 6 inches will be considered vegetative growth layer. The upper 6 inches of soil are to be tested for nutrient content, and results of these tests will be provided to the CQAE. Soil amendments such as finished compost may be used as needed to support revegetation efforts. Some additional material may be imported if it is determined that on-site materials are insufficient.

Any field tests, soil sample locations, and survey measurements will be recorded in reports by the CQAE or his representative including locations (by site grid station) and elevations of all field tests and laboratory sample points.
4.4.1 Materials of Construction

The approved water balance cover is 4.0 feet. The upper six inches of the cover (vegetative growth layer) will be amended as necessary to promote vegetative growth. The soil used for the water storage layer of the water balance cover should meet the following requirements:

- Contain $\leq 15\%$ gravel (> 2.00 millimeters, retained on the No. 10 sieve)
- Limit maximum particle size to <2 inches in longest dimension

Soils used for construction of the water balance cover will be imported, taken from on-site stockpiles, or directly from excavation areas.

4.4.2 Field and Laboratory Testing Requirements

The nuclear moisture-density field testing methods and requirements during construction are:

- Moisture Content (ASTM D 6938) – less than optimum moisture content as determined by ASTM D 698
- Soil Density (ASTM D 6938) – 80 to 90 percent as determined by ASTM D 698.

Test frequencies for performing field moisture-density tests on water balance cover soils are 4 per acre per lift. During construction of the water balance cover, a minimum of 1 test per day is required. Field in-place moisture-density tests shall be verified by laboratory testing, alternate field methods, or both, on a periodic basis. At least one verification test shall be performed per 30 field tests. Verification tests may include testing with a separate nuclear moisture-density device. The verification test will be within two feet of a required test and shall be considered acceptable if the dry density values of the two tests are within 5% of each other. In addition, nuclear moisture-density devices shall be calibrated daily and the results of the calibration tests included in the daily field report.

Prior to cover soil placement, the subgrade shall be proof-rolled with a loaded water truck or equivalent bearing pressure equipment to verify a stable subgrade.

The Soils Testing Laboratory, CQAE, or both, will conduct laboratory testing on water balance cover soil samples. Table 5 presents the minimum laboratory test types, methods, and frequencies for water balance cover soils used at the site.
Table 5 Water Balance Cover Soil Laboratory Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Minimum Frequency</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Proctor</td>
<td>ASTM D 698</td>
<td>1 test/3,000 cy or change in soil type</td>
<td>NA</td>
</tr>
<tr>
<td>Grain Size Analysis</td>
<td>ASTM D 422/1140</td>
<td>1 test/3,000 cy or change in soil type</td>
<td>≥ 15% passing No. 10 sieve, 2-mm. max. size</td>
</tr>
<tr>
<td>Water Content</td>
<td>ASTM D 2216</td>
<td>As appropriate</td>
<td>NA</td>
</tr>
<tr>
<td>pH</td>
<td>EPA Method SW-846 SW 9045C</td>
<td>1 test/6,540 cy*</td>
<td>6.0 – 8.4</td>
</tr>
<tr>
<td>CaCO₃</td>
<td>USDA Handbook Number 60</td>
<td>1 test/6,540 cy*</td>
<td>&lt; 15% by weight</td>
</tr>
</tbody>
</table>

* Test frequency may be increased based on the homogeneity of the soil.

4.4.3 Placement Criteria

The water balance cover soils shall be placed with emphasis on the following:
- Removal of debris and any deleterious materials that would negatively affect the design intent of the water balance cover, as determined by the CQAE
- Removal of frozen soils
- Clod size less than 4 inches in the longest dimension, with clod defined as a soil aggregation that does not break down by hand
- Nominal compaction of the water balance cover soils.

As discussed above, the soils shall not be compacted and shall be placed and shaped with LGP equipment. The LGP equipment shall “track-walk” the soil after placement to aid in the removal of any voids created during placement. Track-walking will be performed by moving the LGP equipment back and forth one time in one direction (i.e., north-south), and then by crossing the same area one time in a perpendicular direction (i.e., east-west). Moisture content shall be less than the optimum at the time of placement.

The Soils Testing Laboratory, CQAE, or both, shall document that backfilling and re-compacting operations are conducted in accordance with the Design Plans and Drawings, and with this CQAQCP.

If over-compaction occurs, the soil may be ripped or disked and then re-compacted to attain the required 80 to 90 percent compaction specification. This procedure is intended only for alleviation of over-compaction and will not be used as the standard technique for water balance cover soils placement.
5.0 GEOSYNTHETICS

Inclusion of a textured high density polyethylene (HDPE) geomembrane liner on top of the compacted clay liner is among the permitted landfill base liner alternate configurations. Upon acceptance of the surface of the completed compacted clay liner installation, geomembrane will be placed either in direct and uniform contact with the prepared clay liner surface or over a geosynthetic clay liner (GCL). If granular material is used as the leachate conveyance layer, a geotextile cushion layer will be placed between the geomembrane and overlying granular drainage layer. If a geocomposite drainage material is used as the leachate conveyance layer, the geocomposite drainage material will be installed directly on the geomembrane. The leachate holding pond will be lined with a double reinforced polyethylene (RPE) geomembrane liner. The lower component of the double liner will be placed in direct and uniform contact with the prepared clay liner surface of the pond. The leachate holding pond liner system also includes a geocomposite drainage layer between the two RPE geomembrane layers. The following sections detail CQA requirements related to the installation of the geosynthetics.

5.1 HDPE

The HDPE used for this project shall be 60-mil HDPE geomembrane AGRU Microspike® or equivalent.

5.1.1 HDPE Manufacturing

Prior to delivery of any geomembrane rolls to the site, the Manufacturer will provide the CQAE with the following information:

- The resin supplier, supplier location, and brand name
- Any test results conducted by the geomembrane and/or resin manufacturer to document the quality of the resin used in the membrane fabrication
- The QC plan that the geomembrane manufacturer will be using for the geomembrane being supplied.

Every roll of HDPE geomembrane delivered to the site must be manufactured and inspected by the Manufacturer according to the following requirements:

- The polyethylene (PE) resin shall contain no more than 2 percent recycled polymer by weight. Recycled polymer shall be limited to material generated within the geomembrane manufacturer's plant and from the same grade and type defined in this CQAQCP.
- The geomembrane must contain no more than 1 percent by weight additives, fillers, or extenders, excluding carbon black.
- The geomembrane must have no striations or roughness (inconsistent with the texture), pinholes, or bubbles on the surface.
- The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will perform the tests listed in Table 6 at the stated frequencies, and will report the results to the CQAE. The Geomembrane Manufacturer
will provide certification based on tests performed by the Manufacturer's laboratory, or other outside laboratory contracted by the Manufacturer, that the membrane supplied under this plan will substantially comply with specifications listed in Table 6.

Conformance sampling will be performed as presented in Table 6 at the stated frequencies. If possible, the conformance sampling shall be performed by the Geomembrane Manufacturer at the plant prior to shipping to the site. Samples may also be selected from geomembrane rolls delivered to the site for offsite conformance testing by a geosynthetics testing laboratory other than the Geomembrane Manufacturer.

5.1.2 Delivery, Handling, and Storage of Geomembrane Rolls

Transportation of the geomembrane rolls to the job site is the responsibility of the Geomembrane Manufacturer. All on site handling is the responsibility of the Installer. The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. Upon arrival, the Installer shall inspect all materials for defects in the manufacturing process and for damage during transportation. Materials judged by the CQAE to be severely damaged shall be rejected and removed from the site. Minor damage and defects shall be repaired by the Installer.

The Installer will be responsible for making certain that the Manufacturer, geomembrane type, and thickness of each roll in a shipment are correct. The CQAE will also maintain a log of geomembrane roll deliveries throughout the construction process. This log shall include, at a minimum, the following:

- Manufacture date
- Date of receipt at the site
- Roll and lot batch numbers.

The CQAE will be responsible throughout the pre-construction, construction, and post construction periods for observing and documenting that the Installer provides adequate handling equipment for use in moving geomembrane rolls and that the equipment for the moving of the geomembrane rolls preserves the integrity of the geomembrane. The CQAE will perform the following:

- Observing and documenting the unloading of trucks delivering the geomembrane rolls to the site
- Observing and documenting the handling and on-site storage procedures and location of geomembrane
- Recording the manufacturing roll and batch number of geomembrane delivered to the site, date of fabrication, and physical dimensions
- Reviewing manufacturer's QA testing for conformance with specifications, including:
  - Name of the manufacturer and fabricator
  - Name and type of liner
  - Thickness of liner
  - Origin and identification of the raw materials
Copies of quality control certificates that are issued by the producer of the raw materials

Reports of tests that are conducted to verify the quality of the raw materials, such as specific gravity, melt flow index, and percent carbon black

Reports conducted at the fabrication plant documenting panel seaming tests, if appropriate

Interpreting laboratory test results in accordance with the specifications and accepting or rejecting delivered panels based on results of off-site testing

Visual reviewing and marking of the geomembrane panels as they are deployed at the job site for uniformity, damage, and imperfections, including holes, cracks, thin spots, tears, punctures, blisters, and foreign matter.

Geomembrane rolls must be stored on site in a manner that prevents excessive ultra-violet (UV) exposure prior to installation.

5.1.3 Foundation

The Earthwork Contractor will be responsible for preparing the subgrade (clay liner) according to the Design Plans and Drawings and this CQAQCP.

After the underlying surface has been accepted by the CQAE and Installer, it will be the Installer's responsibility to report to the CQAE any change in that surface that may require repair work. The supporting surface will be examined by the Installer and the CQAE to evaluate the surface conditions immediately prior to placement of the HDPE geomembrane. The CQAE and Geosynthetic Installer shall document in the daily report that the foundation layer surface condition is compatible with the geosynthetics to be installed. All observations by the CQAE and Geomembrane Installer shall be documented. It is the Earthwork Contractor's responsibility to maintain the clay liner surface in a condition acceptable to the CQAE and Geomembrane Installer for geomembrane installation.

5.1.4 Placement Criteria

A panel layout drawing will be prepared by the Geomembrane Installer, and provided to the CQAE at least ten calendar days prior to installation of the geomembrane.

Geomembrane placement must not be conducted at ambient temperatures below 40°F or above 104°F (unless approved by the manufacturer), during precipitation or fog, in ponded water, or during winds in excess of 20 miles per hour. Where adjacent or transverse panels are seamed, temperature effects on these panels should be taken into account to reduce the problem of "fish mouths" that may be encountered in the seaming process.

The CQAE will perform/document the following:

- Obtain a written acceptance of the subgrade by the Geomembrane Installer.
- Evaluate and document weather conditions (e.g., temperature, wind) for geomembrane placement and inform MCSWM and the Geomembrane Installer when weather conditions do not meet specifications, so a determination of installation can be made.
Monitor and document geomembrane placement as well as conditions of panels as placed:
   - Noting panel defects, tears, or other deformities
   - Measuring in-place panel dimensions
   - Recording panel numbers.

Record the locations of installed panels and check that the panels have been installed in accordance with the design plan:
   - Assign each panel a unique panel number and identify that panel with the Manufacturer’s roll number.

Document that the equipment used does not damage the geomembrane by handling, heat, leakage of hydrocarbons, or by any other means.

Document that the prepared soil surface for the geomembrane has not deteriorated since previous acceptance.

Document that personnel working on geomembranes do not smoke, wear damaging clothing, or engage in activities that would damage the geomembrane.

Document that the method of unrolling the geomembrane does not cause scratches or crimps in the geomembrane.

Document that the method and sequencing used to place the rolls minimizes wrinkles and seaming problems.

Document that adequate means are used to prevent uplift by wind while preventing damage to the geomembrane or supporting earthen foundation.

Document that the direct contact with the geomembrane will be minimized. The geomembrane will be protected by geotextiles or extra geomembrane materials in areas where excessive traffic is anticipated.

Document that the heavy construction equipment shall not be allowed to move directly on any deployed geomembrane. This includes rubber tired vehicles such as automobiles and pickup trucks but does not include lightweight equipment like all-terrain vehicles.

Document that the minimum initial lift height of soil placed over geosynthetics shall be no less than 12 inches. Ground contact pressure equipment of less than 5.0 psi is required unless at least 3 feet of material exists between the equipment and geomembrane surface.

Document that the construction machinery must not perform sudden starts, stops, or sharp turns over the geomembrane.

Document that the cover material must be placed from the bottom of slopes to the top.

Document that the cover material must be placed in such a manner as not to induce wrinkles in the underlying geomembrane.

Document that the all equipment that the contractor proposes to use within the geomembrane footprint must be approved by the CQAE.
5.1.5 Seaming Equipment

Approved processes for field seaming are double-fusion welding and extrusion welding. Double-fusion welding shall be used for all seams except where space and access constraints prohibit its use. Fusion welding application may be impractical where space is limited in some parts of the site. Only apparatuses that have been specifically approved by the CQAE shall be used. Proposed alternate processes shall be documented and submitted for approval to the CQAE.

Double-fusion welding using a hot wedge seaming device is the preferred method of seaming HDPE geomembrane. The fusion welding apparatus shall be equipped with gauges giving the applicable temperatures and pressures. Prior to installation of any geomembrane material, the Installer shall submit seaming quality control records, including ambient temperatures and applicable apparatus temperatures and pressures, and trial seam results to the CQAE. Trial seam results shall be logged by the Installer or the CQAE.

The Installer shall meet the following requirements regarding use, availability, and cleaning of extrusion welding equipment to be used at the site:

- The welding apparatus will be equipped with a continuous temperature monitor in the barrel and at the nozzle.
- At least one spare operable double-fusion and extrusion seaming device will be maintained on site at all times.
- Equipment used for seaming shall not damage the geomembrane. The extruder will be cleaned and purged prior to beginning seaming, and at any time that seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane.
- A smooth insulating plate or fabric will be placed beneath hot equipment to protect the geomembrane.

The Installer, and if applicable the Manufacturer, will provide documentation to the CQAE regarding the quality of extrudate used in the welding apparatus. At a minimum, the extrudate should be compatible with the base liner material and contain the same grade and quality of PE resin as used in the base material.

5.1.6 Seamer Qualifications

All personnel performing seaming operations must be qualified by experience and by successfully passing seaming tests for the type of seaming equipment to be used. All seamers must have seaming experience of a minimum of 500,000 ft² of polyethylene geomembrane using the same type of equipment to be used on this project. The most experienced on-site seamer, the “master seamer” (a seamer who has successfully seamed a minimum of 2,000,000 ft² of polyethylene geomembrane using the same type of equipment to be used on this project) will have direct supervisory responsibility at the site over less experienced seamers. The Installer shall provide documentation of the qualifications of the seaming crew to the CQAE.
5.1.7 Weather Conditions During Seaming

The range of weather conditions under which geomembrane seaming can be performed are as follows:

- Unless otherwise authorized by the CQAE, no seaming will be attempted at an air temperature colder than 40°F or warmer than 104°F as measured 6 inches above the sheet.
- Between ambient temperatures of 40°F and 50°F, as measured 6 inches above the sheet, seaming will be performed only if the geomembrane is pre-heated by either the sun or hot air device, provided there is no excessive ambient cooling resulting from wind conditions.
- The geomembrane will be dry and protected from the wind.
- Seaming will not be performed during any precipitation.
- Seaming will not be performed in areas where ponded water has collected beneath the surface of the geomembrane.

The CQAE will document that these requirements are met by the Installer and will document the actual weather conditions during the installation.

5.1.8 Overlapping and Temporary Bond

The CQAE or Installer will document the following:

- The length of the geomembrane overlap, typically 4 to 6 inches.
- The geomembrane overlap is adequate for the seaming process that is used.
- Procedures used for temporary bonding of adjacent geomembrane rolls shall not damage the geomembrane.

5.1.9 Trial Seams

Trial seams will be made on fragment pieces of membrane to document that the seaming conditions are adequate. Such trial seams will be made at the beginning of each seaming period, and at least once every five hours thereafter, for each seaming apparatus used that day. Additionally, trial seams shall be done when ambient temperatures are ≥ 104°F (if seaming is allowed) measured 6 inches above the geomembrane surface per machine, per operator, and with each change in temperature of > 20°F. Each seamer will make at least one trial seam each day. All trial seams will be made under the same conditions as actual seaming work. Trial seams will be logged and documented in the Certification Report.

The trial seams will first be examined for squeeze out, footprint, pressure, and general appearance by the CQAE and Installer. If a seam fails any of these examinations, a new trial seam will be performed until satisfactory seams are obtained.

The trial seam samples will be a minimum of 3-feet long by 1-foot wide after seaming, with the seam oriented lengthwise and with the overlap described previously.

A minimum of four, 1-inch-wide specimens will be cut from each end of each trial seam sample by the Installer. The specimens or “coupons” will be tested for “peel” and “shear”
in the field using a calibrated tensiometer (calibrated within 90 days of the start of work). Installer must provide documentation of tensiometer calibration to the CQAE prior to start of installation. A passing test is when the break is ductile and occurs at the edge or outside the seam but not in the seam. A failure is defined as the seam or weld peeling. Strength values used in the trial seams shall be the same as those used for destructive seams (Table 6). If a specimen fails, the entire trial seam shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted until corrective measures are taken and two successive trial seams are successfully completed. After completion of these tests, the remaining portion of the passing trial seam will be logged and retained for reference if any further information might be required. The results of all test seams shall be forwarded to the CQAE.

5.1.10 General Seaming Procedures

The general seaming procedures are as follows:

- For double-fusion welding, each overlap and the sheet below the overlap shall be hand-wiped clean immediately prior to welding.
- Large "fish mouths" (large fish mouths are of a size that will prevent airtight bonding between geomembrane panels) or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fish mouths" or wrinkles shall be seamed, and any portion of inadequate overlap will then be patched with an oval patch of the same geomembrane, extending a minimum of 6 inches beyond the cut in all directions.
- On the side slopes, seaming will extend into the anchor trenches.
- At locations where the initial seam cannot be non-destructively tested, the seam will be cap-stripped with the same geomembrane material. The CQAE will observe the cap-stripping to document the uniformity and completeness of the work.

5.1.11 Non-Destructive Testing

Each field seam will be non-destructively tested over the full length of the seam to the extent practical. Any seams that cannot be effectively tested will be reported to the CQAE. The purpose of the non-destructive testing is to determine the continuity of the seams.

The method for conducting non-destructive seam testing is pressure testing the open channel between the double fusion welds. Geosynthetics Research Institute (GRI) method GM 6 shall be used to test double-fusion-welded seams. This method requires the pressurization of the open channel at 27 to 30 psi with a maximum pressure drop of 3 psi over five minutes for 60-mil HDPE.

The vacuum box or the ultrasonic shadow method may be used on extrusion welds in accordance with GRI specifications. Other test methods may be used only upon approval by the CQAE.

The CQAE will perform the following tasks related to seam testing:
• Observe non-destructive seam testing and examine all seams for squeeze-out, footprint, pressure, and general appearance. Failure of these criteria will be considered as failure of the seam, and repair or reconstruction will be required.
• Document the location, date, test unit number, name of tester, and outcome of all testing.
• Inform the Installer of any required repairs.

5.1.12 Destructive Testing

Destructive seam tests shall be conducted throughout the seaming project at locations selected by the CQAE. The tests shall be conducted so that results are obtained prior to covering the geomembrane with another material. The purpose of the tests is to verify that welds are fully integrated and to evaluate seam strength.

At a minimum, the CQAE or installer shall document, in the daily report, the following information related to all destructive seam samples:
• The location by seam and sample number of the samples
• The results of all field testing of destructive samples
• Actions taken as a result of testing.
• Repairs of the sampled seams.

5.1.12.1 Test Location and Frequency

Destructive samples shall be collected at locations specified by the CQAE at a minimum rate of one sample for every 750 linear feet of seam, as recommended in the CDPHE Guidance on CQAQCPs. The seaming technician shall not be informed in advance of the time when, or locations where, seam samples will be taken.

5.1.12.2 Sampling Procedure

Samples shall be cut by Installer at locations specified by the CQAE. A number shall be assigned to each sample based on the seam number and sample sequence. The sample location and identifier shall be recorded in the daily report.

At each sampling location, two types of samples will be collected. Two sample coupons will be collected for field testing. Each of these coupons shall be 1-inch wide by 12 inches long with the seam centered parallel to the length. The minimum distance between these two coupons shall be 42 inches. If both sample coupons pass the field test described in Section 4.1.12.3 of this CQAQCP, a sample shall be cut from the seam between the locations of the two coupons. This sample shall be cut into three parts and distributed as follows:
• One portion to the Installer for testing (12 inches wide by 18 inches long)
• One portion to the Geosynthetic Quality Assurance Laboratory for testing (12 inches wide by 12 inches long)
• One portion to the CQAE for archive storage (12 inches wide by 12 inches long).

Sample size may vary slightly depending on the needs of each party in the distribution list. Final sizes shall be determined at a Pre-Construction meeting.
5.1.12.3 Testing Procedure

Testing shall be conducted for shear and peel. Shear testing applies a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing, peels the top sheet back against the overlapped edge of the bottom 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. The specifications for seam strength are presented in Table 6.

5.1.12.4 Procedures Following Destructive Test Failure

All acceptable seams must be bounded by two locations from which samples passing destructive tests have been taken. There are two options for mitigation of a failed destructive test:

1. Re-construct the seam between any two passed test locations, or
2. Trace the welding path to an intermediate location (10 feet maximum from the point of the failed test in each direction) and take a small sample coupon for an additional field test at each location. If these additional samples pass the tests, then full samples (as described in Section 4.1.12.2 of this CQAQC Plan) are taken. If these samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, the process is repeated to establish a zone in which the field seam will be reconstructed.

5.1.13 Defects and Repairs

This section applies to all defects including damage during placement and repairs from examinations, tests, or visual observations performed on the geomembrane material and on field seams.

The CQAE will examine each roll for damage after placement but prior to seaming and will determine which rolls or portions of rolls should be rejected, repaired, or accepted. Damaged rolls, or portions of rolls, that have been rejected will be marked, and their removal from the site will be recorded by the CQAE.

All seam and non-seam areas of the geomembrane will be visually observed and documented by the CQAE for identification of defects, holes, blisters, undispersed raw materials, large wrinkles, and any signs of contamination by foreign matter. The surface of the geomembrane will be clean at the time of visual observation. Each location that fails visual observation will be marked by the CQAE and repaired by the Installer. Work will not proceed in any area where defects are identified until suitable repairs are made.

Several procedures exist for the repair of flawed areas. The final decision as to the appropriate repair procedure will be agreed upon between the Installer and the CQAE prior to commencement of the repair. The following procedures are available:

- **Patching** – used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter
- **Spot Seaming** – used to repair small tears, pinholes, or other minor localized flaws
- **Capping** – used to repair large lengths of failed seams
• Removing the Bad Seam and Replacing with a Strip of New Material Seamed in Place – used for repairing large lengths of fusion seams
• Other – as agreed upon by the Installer and the CQAE.

At a minimum the following provisions will be provided for repairs:
• Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches
• The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

Each repair will be examined, numbered, and logged by the CQAE following these procedures:
• Performing systematic visual observation of the entire surface of the geomembrane to locate and document defects and indicate for each defect the type of repair that is required
• Monitoring and recording the repair of defects and the non-destructive testing of all repairs
• Recording the location and the nature of all defect repairs.

5.1.14 Geomembrane Electronic Leak Location Survey

An electronic leak location survey of the geomembrane may be performed at the option of the Owner and CQAE. QA associated with an electronic leak location survey would include the following:
• Determination of the suitability of site conditions for the survey
• Performance of the survey in accordance with ASTM D 7007 to identify potential leak locations of the installed geomembrane
• Potential leak locations would be marked with flags, paint, or other means to clearly locate the areas. Location coordinates would be recorded
• Observation and documentation of repairs in accordance with project specifications, as applicable
• Following repairs to initially identified perforations, the area at and generally around the repair will be re-surveyed to determine repair success. This process will be repeated until all identified perforations have been repaired and successfully re-tested.

5.1.15 Field Reporting and Documentation

Documenting and reporting methods will be implemented to allow the systematic recording of results of on-site monitoring and testing. Reporting forms will be used for roll and panel placement, trial seam testing, panel seaming, non-destructive seam testing, and destructive seam testing. Unique identifying numbers will be assigned to each panel and seam and used to referenced panel and seam location and test results.

A Geomembrane Installer’s certificate of subgrade acceptance will be obtained prior to panel placement. Panel location and seam location diagrams will be kept showing
locations of all panels, seams, repairs, and destructive samples. These diagrams will be updated on a daily basis.

A daily report will be prepared by the CQAE for each day of activity. At a minimum, the report will contain the following information:

- Date
- Type of inspection
- Summary of weather conditions
- Summary of any meetings held and attendees
- Equipment and personnel on the project
- Summary of construction activities and locations
- Description of off-site materials received, if applicable
- Calibration and recalibration of test equipment, if applicable
- Description of construction/installation procedures used
- Test locations, procedures, results, and test data sheets, if applicable
- Summary of samples collected, if applicable
- Personnel involved in inspection and sampling activities
- Description of delays in construction activities
- Detailed description of any problems or non-conforming construction activities
- Progress of work in terms of approximate quantities.

Photographs shall be obtained for all construction components. A sufficient number of photographs shall be obtained to document the construction of each construction item (e.g., soil placement, methods of anchoring geomembrane, geomembrane placement, etc.). A photo log containing the following information will be maintained:

- Date, time, location, and orientation of photograph
- Name of photographer
- Location and description of the work.

Construction problems and non-conforming work shall be documented with photographs taken before and after the problem or when the non-conforming work has been corrected.
### Table 6 Material Properties – Textured 60 mil HDPE Geomembrane

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Value</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geomembrane Manufacturer Quality Assurance Testing&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt Flow Index (g/10 min)</td>
<td>ASTM D 1238</td>
<td>≤ 1.0</td>
<td>1/100,000 ft&lt;sup&gt;2&lt;/sup&gt; min. 1 per resin batch</td>
</tr>
<tr>
<td>Resin Density (gm/cm&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>ASTM D 1505</td>
<td>≥ 0.93</td>
<td>1/100,000 ft&lt;sup&gt;2&lt;/sup&gt; min. 1 per resin batch</td>
</tr>
<tr>
<td>Thickness (mil)</td>
<td>As MI 5199 (as modified in Annex A)</td>
<td>60</td>
<td>per roll</td>
</tr>
<tr>
<td>Asperity Height (mil)</td>
<td>ASTM D 7466</td>
<td>20</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; roll</td>
</tr>
<tr>
<td>Sheet Density (gm/cm&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>ASTM D 1505/D 792</td>
<td>≥ 0.940</td>
<td>200,000 lb</td>
</tr>
<tr>
<td>Tensile Properties (each direction)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength at Break (lb./in-width)</td>
<td>ASTM D 6693, Type IV</td>
<td>132</td>
<td>20,000 lb</td>
</tr>
<tr>
<td>Strength at Yield (lb./in-width)</td>
<td></td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Elongation at Break (%)</td>
<td></td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Elongation at Yield (%)</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D 1004</td>
<td>min. 45 lbs.</td>
<td>45,000 lb</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D 4833</td>
<td>min. 120 lbs.</td>
<td>45,000 lb</td>
</tr>
<tr>
<td>Stress Crack Resistance</td>
<td>ASTM D 5397</td>
<td>500 hr</td>
<td>200,000 lb</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D 1603</td>
<td>2.0-3.0%</td>
<td>20,000 lb.</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>ASTM D 5596</td>
<td>Only near spherical agglomerates, 10 views in cat. 1 or 2</td>
<td>45,000 lb.</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT)</td>
<td>ASTM D 3895 or D 5885</td>
<td>≥140 minutes (D 3895)</td>
<td>200,000 lb.</td>
</tr>
<tr>
<td>Oven Aging at 85°C</td>
<td>ASTM D 5885</td>
<td>80%</td>
<td>each formulation</td>
</tr>
<tr>
<td>UV Resistance percent retained after 1600 hours</td>
<td>ASTM D 5885</td>
<td>50%</td>
<td>each formulation</td>
</tr>
<tr>
<td>Geomembrane Manufacturer Conformance Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Properties (each direction)</td>
<td>ASTM D 6693, Type IV</td>
<td>132</td>
<td>1/100,000 ft&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Strength at Break (lb./in-width)</td>
<td></td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Strength at Yield (lb./in-width)</td>
<td></td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Elongation at Break (%)</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Elongation at Yield (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Quality Assurance Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness (mil)</td>
<td>ASTM D 5199 (as modified in Annex A)</td>
<td>60</td>
<td>per roll</td>
</tr>
<tr>
<td>Lowest individual of 10 readings (mil)</td>
<td></td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Property</td>
<td>Test Method</td>
<td>Required Value</td>
<td>Minimum Test Frequency</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------</td>
<td>----------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>HDPE Peel Strength (ppi) (1,2)</td>
<td>ASTM D 6392 (3,4)</td>
<td>98 (fusion) 70 (extrusion)</td>
<td>1 per 750 linear feet of welded seam</td>
</tr>
<tr>
<td>HDPE Shear Strength (ppi) (1,2)</td>
<td>ASTM D 6392 (3,4)</td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>Peel Separation (%) (1,2)</td>
<td>ASTM D 6392 (3,4)</td>
<td>&lt;10%</td>
<td></td>
</tr>
</tbody>
</table>

1. Maximum of one (1) non-FTB (Film Tear Bond) per five (5) specimens tested is acceptable provided that strength requirements are met on that sample. Film Tear Bond (FTB) definition: A failure to the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area. Examples of FTB and the associated locus of break codes are provided in ASTM D 6392.
2. For dual-track seams, both tracks will be tested for compliance with the minimum property values listed above.
3. Destructive seams will be evaluated for strength parameters according to ASTM D 6392, excluding Section 6.3 “Conditioning.” Destructive seams will be evaluated for elongation during cold weather seaming. The Geosynthetics Installer is required to submit a cold weather seaming plan for approval along with recommendations in GRI publication GRI GM 9 or superseding GRI guidance document.
4. As modified by NSF 54.
5. Manufacturer Quality Assurance specifications provided by Agru America®

If revised or alternate industry standard test methods or procedures become industry standard, the industry standard test method may be substituted with approval by the CQAE.

5.2 GEOTEXTILE

Geotextile covered under this section will include a 8 and 16 oz/yd² nonwoven geotextile as a protective layer over the geomembrane.

5.2.1 Manufacturing

The geotextiles shall be manufactured from polypropylene resin. The geotextiles will be supplied to the site in factory rolls. The minimum requirements for the geotextiles are presented in Table 7.

Table 7 Material Properties - Geotextile Cushion Layer

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Value</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass/Unit Area (nominal)</td>
<td>ASTM D 5261</td>
<td>16 oz/yd²</td>
<td>1/100,000 ft² min. 1 per lot</td>
</tr>
<tr>
<td>Grab Strength (min.)</td>
<td>ASTM D 4632</td>
<td>390 lbs</td>
<td></td>
</tr>
<tr>
<td>UV Resistance</td>
<td>ASTM D 4355</td>
<td>≥ 70% strength</td>
<td></td>
</tr>
<tr>
<td>Mass/Unit Area (nominal)</td>
<td>ASTM D 5261</td>
<td>8 oz/yd2</td>
<td>1/100,000 ft² min. 1 per lot</td>
</tr>
<tr>
<td>Grab Strength (min.)</td>
<td>ASTM D 4632</td>
<td>220 lbs</td>
<td></td>
</tr>
<tr>
<td>UV Resistance</td>
<td>ASTM D 4355</td>
<td>≥ 70% strength</td>
<td></td>
</tr>
</tbody>
</table>
QC testing will be performed by the Geotextile Manufacturer to demonstrate compliance with the stated test methods. Prior to delivery of any geotextile rolls to the site, the Geotextile Manufacturer will provide the CQAE with the following information:

- The resin supplier, supplier location, and brand name
- Test results conducted by the geotextile and/or resin manufacturer to document the quality of the resin used in geotextile fabrication
- The quality control plan that the Geotextile Manufacturer will be using for the geotextile being supplied.

Every roll delivered to the site must be manufactured and inspected by the Geotextile Manufacturer according to the following requirements:

- First quality resins must be used containing no more than two percent recycled material by weight as determined by thermo-gravimetric analysis. Recycled polymer will be limited to material generated within the Geotextile Manufacturer's plant and from the same grade and type of resin defined in this plan.
- The geotextile must be certified needle-free.
- The geotextile must be free of holes and any other signs of contamination by foreign matter.

The Geotextile Manufacturer will provide certification, based on tests performed by the Manufacturer's laboratory or other outside laboratory contracted by the Manufacturer, that the geotextile supplied under this plan meets the stated specifications.

5.2.2 Delivery, Handling, and Storage of Geotextile Rolls

Transportation of the geotextile rolls to the job site is the responsibility of the Geotextile Manufacturer. All on site handling is the responsibility of the Installer. The geotextile will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. Upon receipt of material shipments at the site, the Installer shall inspect all materials for defects in the manufacturing process and for damage during transportation. Materials judged to be severely damaged shall be rejected and removed from the site. Minor damage and defects shall be repaired by the Installer. The geotextile rolls will be stored on site in a manner, which prevents excessive UV exposure prior to installation.

The CQAE will be responsible throughout the pre-construction and construction periods for observing and documenting that the Installer uses adequate handling equipment for moving the geotextile rolls.

The CQAE will be responsible for making certain that the manufacturer, geotextile type, and thickness of each roll in a shipment is correct. The CQAE will also maintain a log of the geotextile rolls delivered throughout the construction process. This log shall include, at a minimum the following:

- Manufacture date
- Date of receipt at the site
- Roll and lot batch numbers.
5.2.3 Placement Criteria

The Installer will handle all geotextiles in such a manner to verify that they are not damaged in any way. The CQAE will observe and document that all of the following steps are performed by the Installer:

- On side slopes, the geotextile shall be rolled down the slope in such a manner as to keep the geotextile continually in tension.
- In the presence of wind, all geotextiles will be secured by suitable methods that are protective of the geotextile and the underlying geomembrane.
- Geotextiles will be cut using only approved geotextile cutters. If the geotextile is in place at the time of cutting, special care shall be taken to prevent damage to the underlying geomembrane.
- The Installer must take necessary precautions to prevent damage to the geomembrane liner during placement of the geotextile.
- During placement of the geotextile over the geomembrane, care must be taken to prevent the entrapment of foreign matter or excessive moisture between the geotextile and geomembrane.
- A visual inspection of the geotextile must be carried out over the entire surface after installation by the Installer, to verify that no potentially harmful foreign objects or excessive moisture are present. All such foreign objects or material shall be removed.

5.2.4 Seams and Overlaps

The following requirements must be used with regard to seaming and overlapping of geotextile rolls:

- Geotextile seams must be continuously welded or sewn and will be overlapped a minimum of 3 inches prior to seaming. Spot seaming will not be allowed.
- Horizontal seams on the landfill side slopes (except as part of a patch) will be allowed only at the approval of the CQAE.
- The Installer must pay particular attention to seams to verify that no earthen materials are inadvertently trapped beneath the geotextile.
- Any sewing must be performed using polypropylene thread manufactured of the same base material as the geotextile. The thread shall be resistant to degradation by UV radiation.

The CQAE will observe and document that the Installer follows all of the seaming and overlapping protocol. The CQAE will perform a final geotextile examination after installation of the geotextile layer has been completed to detect the presence of holes or tears and to examine seams for tension due to excessive stretching of the fabric during installation. Repairs will be made for areas not conforming to acceptable practices.

5.2.5 Defects and Repairs

This section applies to all defects including damage during placement and repairs undertaken based on defects detected during examinations, tests, or visual observations performed on the geotextile material and on field seams.
The CQAE will examine each roll for damage after placement, but prior to seaming, and will determine which rolls or portions of rolls should be rejected, repaired, or accepted. Damaged rolls or portions of rolls, which have been rejected, will be marked, and their removal from the site will be recorded by the CQAE.

All seam and non-seam areas of the geotextiles must be visually observed and documented by the CQAE for identification of defects, holes, undispersed raw materials, large wrinkles, and any signs of contamination by foreign matter. The surface of the geotextiles will be clean at the time of visual observation.

Each location that fails visual observation will be marked by the CQAE and repaired by the Installer. Work will not proceed in an area where defects are identified until suitable repairs are made. Each repair will be visually observed, numbered, and logged by the CQAE.

Any holes or tears in the geotextile must be reported to the CQAE and repaired as follows:

- A patch made from the same geotextile will be sewed, welded, or heat-bonded in place, with a 3-inch minimum overlap in all directions
- Care must be taken to remove any soil, excessive moisture, or other material that might have penetrated a torn geotextile.

5.2.6 Placement of Soil Materials

Placement of soil materials on top of the geotextile must be performed by the Contractor in such a manner as to confirm the following:

- Damage of the underlying geotextile or geomembrane does not occur
- Slippage of the geotextile on the underlying geomembrane is minimal
- No excess tensile stresses are imposed on the geotextile or geomembrane.

If there will be an extended time delay between placement of the geotextiles and the start of the installation of the overlying material, the Owner shall make provisions, approved in advance by the CQAE and CDPHE, to protect the geotextile against excessive exposure to UV radiation.

5.3 GEOCOMPOSITE DRAINAGE LAYER

The geocomposite drainage net shall consist of HDPE geonet each side of which is laminated to a 6-oz/yd2 non-woven geotextile fabric. The geocomposite drainage net used for this project shall be AgruAmerica 250mil geocomposite double sided or equivalent. The following sections summarize the QA plan for testing and monitoring of the geocomposite drainage layer installation.

5.3.1 Geocomposite Rolls and Panels

CQA monitoring for the rolls and panels includes:

- Monitoring and documenting the unloading of trucks delivering geocomposite rolls to the site
- Monitoring and documenting the handling and onsite storage procedures and location of geocomposite rolls.

- Review of manufacturer's QA testing for conformance with specifications summarized in Table 8.

- Visual review and marking of the geocomposite as it is unrolled and deployed at the job site for uniformity, damage, and imperfections, including holes, tears, punctures, and foreign matter.

5.3.2 Panel Placement

Quality assurance monitoring for panel placement includes:

- Monitoring and documenting geocomposite placement as well as conditions of panels as placed, including the following:
  - Noting panel defects, tears or other deformities
  - Orientation of panels as placed
  - Anchorage procedures
  - Documentation that cover materials are placed in a manner that prevents damage to the geocomposite
  - Documentation that each component of the geocomposite is secured to like components of adjacent panels.

- Adjacent panels shall be overlapped a minimum of 4 inches and the geonet fastened together with contrasting color plastic fasteners, placed at 5-foot intervals.

- Adjoining geocomposite rolls (end to end) along the roll width shall be shingled down in the direction of the slope, with the up gradient roll overlapping the down gradient roll a minimum of 12 inches across the roll width. Geonet shall be tied every 12 inches across the roll width and every 6 inches in the anchor trench or as specified by the CQAE.

- The top layers of geotextiles shall be sewn together, or at the discretion of the CQAE, may be heat bonded together. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming or heat bonding, geotextile sewing seams to be used are Prayer, "J" or Butterfly. The seam shall be a two thread, double lock stitch or a double row of single thread, chain stitch. If heat bonding is to be used, care must be taken to avoid burn through of the geotextile. It is important that the geotextiles be joined continuously along to the roll as to prevent any soil particle migration into the geonet core flow channels. Spot seaming shall not be allowed.

- Geotextile cap strips shall be a minimum 2 feet in width, thermally bonded to the geotextile component of the geocomposite.

- Cap strips shall be placed over any exposed edges of geocomposite.
Table 8 Geocomposite Material Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Value</th>
<th>Minimum Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geocomposite Manufacturer QA Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geonet/Geotextile Resin Component:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resin Density</td>
<td>ASTM D 1505</td>
<td>0.94 g/cm³ min.</td>
<td>1 per resin batch</td>
</tr>
<tr>
<td>Resin Melt Flow Index</td>
<td>ASTM D 1238</td>
<td>1.0 g/10 min. max.</td>
<td></td>
</tr>
<tr>
<td>Geonet Component:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D 1505</td>
<td>0.94 g/cm³ min.</td>
<td>1/50,000 ft², min. 1</td>
</tr>
<tr>
<td>Thickness</td>
<td>ASTM D 5199</td>
<td>250 mil</td>
<td></td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D 4218</td>
<td>2-3%</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 5035/ D 7179</td>
<td>55 lbs/in²</td>
<td>1/500,000 ft², min. 1</td>
</tr>
<tr>
<td>Geotextile Component:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass per Unit Area</td>
<td>ASTM D 5261</td>
<td>6 oz/sy</td>
<td>1/100,000 ft², min. 1</td>
</tr>
<tr>
<td>Grab Strength</td>
<td>ASTM D 4632</td>
<td>170 lb.</td>
<td></td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D 4833</td>
<td>435 lb.</td>
<td></td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D 4491</td>
<td>1.5 sec⁻¹</td>
<td>1/500,000 ft², min. 1</td>
</tr>
<tr>
<td>Apparent Opening Size</td>
<td>ASTM D 4751</td>
<td>No. 70 sieve</td>
<td></td>
</tr>
<tr>
<td>UV Resistance</td>
<td>ASTM D 4355</td>
<td>70% retained after 500 hrs.</td>
<td>1 per resin batch</td>
</tr>
<tr>
<td>Geocomposite:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmissivity</td>
<td>ASTM D 4716</td>
<td>2.4 gal/min/ft</td>
<td>1/500,000 ft², min. 1</td>
</tr>
<tr>
<td>Ply Adhesion</td>
<td>ASTM D 7005</td>
<td>1.0 lbs/in</td>
<td>1/50,000 ft², min. 1</td>
</tr>
</tbody>
</table>

5.4 GEOSYNTHETIC CLAY LINER (GCL)

The GCL used on this project shall be Bentomat ® ST or equal. The 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. Only reinforced GCL shall be used. Prior to using an alternate GCL, the Installer must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Installer also must obtain prior approval of the alternative GCL by the CQAE.

5.4.1 GCL Properties

The GCL shall substantially comply with the properties shown in Table 9. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet long by 15 feet wide. Short rolls (less than 150 feet but greater than 70 feet) may be supplied at a rate no
greater than three rolls per truckload or three rolls per 36,000 ft² of GCL, whichever is less. The length of all short rolls shall be clearly marked on the outer packaging.

A 6-inch overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means of facilitating quality assurance during seaming. Lines shall be printed in easily visible, non-toxic ink that does not negatively impact the performance of the GCL.

### Table 9 GCL Properties

<table>
<thead>
<tr>
<th>Material Property</th>
<th>Test Method</th>
<th>Test Frequency</th>
<th>Required Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentonite Swell Index</td>
<td>ASTM D5890</td>
<td>1 per 50 tons</td>
<td>24 mL/2g min.</td>
</tr>
<tr>
<td>Bentonite Fluid Loss</td>
<td>ASTM D5891</td>
<td>1 per 50 tons</td>
<td>18 mL max.</td>
</tr>
<tr>
<td>Bentonite Mass/Area</td>
<td>ASTM D5993</td>
<td>40,000 ft²</td>
<td>0.75 lb/ft²</td>
</tr>
<tr>
<td>GCL Grab Strength</td>
<td>ASTM D4632</td>
<td>200,000 ft²</td>
<td>90 lbs</td>
</tr>
<tr>
<td>GCL Peel Strength</td>
<td>ASTM D4632</td>
<td>40,000 ft²</td>
<td>15 lbs</td>
</tr>
<tr>
<td>GCL Index Flux</td>
<td>ASTM D5887</td>
<td>Weekly</td>
<td>1 x 10⁻⁸ m³/m²/sec</td>
</tr>
<tr>
<td>GCL Permeability</td>
<td>ASTM D5084</td>
<td>Weekly</td>
<td>5 x 10⁻⁸ cm/sec</td>
</tr>
<tr>
<td>GCL Hydrated Internal Shear Strength</td>
<td>ASTM D5321</td>
<td>Periodic</td>
<td>500 lb/ft²</td>
</tr>
</tbody>
</table>

Selected samples from GCL rolls delivered to the site will be sent to a third geosynthetics testing laboratory for conformance testing. If possible, the conformance testing shall be performed by the Manufacturer at the plant prior to shipping to the site. Conformance testing will be performed as follows:

- Clay mass/unit area (ASTM D5993) at a frequency of 1/100,000 square feet of GCL installed
- Moisture content (ASTM D2216) at a frequency of 1/100,000 square feet of GCL installed
- Index flux (ASTM D5887) at a frequency of 1/100,000 square feet of GCL installed

### 5.4.2 GCL Materials, Manufacturing, and Installation

The GCL Installer shall provide the CQAE with the following:

1. A conceptual description of the proposed placement of GCL panels over the area of installation.
2. GCL Manufacturer’s quality control plan for documenting compliance with this document.
3. A representative sample of the GCL material.
4. A project reference list for GCL construction (upon request).
5. Manufacturer’s QAQC certifications to verify that the materials supplied are in accordance with the Design Plans and Drawings and this CQAQCP (upon shipment).

The GCL Manufacturer shall provide the Contractor or other designated party with manufacturing QAQC 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 swell index and fluid loss specifications in Table 9.
2. Manufacturer’s test data for the finished GCL product of bentonite mass/area, GCL tensile and peel strength demonstrating compliance with the specifications in Table 9.
3. GCL lot and roll numbers supplied for the project and corresponding shipping information.
4. Manufacturer’s test data for finished GCL product for index flux, permeability, and hydrated internal shear strength showing compliance with the specifications in Table 9.

5.4.3 GCL Product Labeling

Prior to shipment, the GCL Manufacturer shall label each roll in a manner that clearly identifies the following information:

1. Product identification including Manufacturer’s name, address, brand name, and product code.
2. Lot number and roll number.
3. Roll length, width, and height.

5.4.4 GCL Product Packaging

The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling with mechanized equipment. The core is not necessarily intended to support the roll for lifting, but shall be sufficiently strong to prevent collapse during transit.

All rolls shall be labeled and packaged in materials that are resistant to photo degradation by ultraviolet light.

5.4.5 Accessory Bentonite

The granular bentonite used for seaming and penetration sealing shall be made from the same natural sodium bentonite material as used in the manufacture of the GCL.
5.4.6 GCL Shipping and Handling

The Manufacturer assumes responsibility for initial loading of the GCL. Shipping will be the responsibility of the party arranging for the freight transportation. Unloading, on site handling, and storage of the GCL are the responsibility of the Installer or the Installer’s designated representative.

A visual inspection of each roll shall be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging shall be marked and set aside for further inspection. The packaging shall be repaired as necessary to protect the GCL from damage during storage and handling.

The party responsible for unloading the GCL shall contact the Manufacturer prior to shipment to ascertain the appropriateness of proposed unloading methods and equipment.

5.4.7 GCL Storage

Storage of the GCL rolls shall be the responsibility of the Installer. A level, dry, well-drained, and dedicated storage area shall be selected at the job site outside of high traffic areas. Rolls shall be stored in a manner that prevents sliding or rolling from the stacks. Stacks shall be no higher than four rolls. All stored GCL and accessory bentonite shall be covered with plastic sheeting or tarpaulins until their installation. The integrity and legality of the roll labels shall be preserved during storage.

5.4.8 GCL Installation

GCL rolls shall be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. The non-woven side of the GCL shall be placed up.

Equipment that could potentially damage the GCL or subgrade shall not be allowed to travel directly on it. Care shall be taken to minimize dragging GCL across the subgrade. At the direction of the CQAE, a temporary geosynthetic slip sheet shall be used when necessary to reduce friction during GCL placement.

The GCL shall be placed so that longitudinal panel seams are parallel to the direction of the slope. Seams shall be located at least three feet from the toe and crest of slopes steeper than 5:1. All GCL panels shall lie flat on the underlying surface with no wrinkles or folds.

Only as much GCL shall be deployed as can be covered with geomembrane at the end of the working day unless otherwise approved by the CQAE. If premature hydration of the GCL occurs, (i.e., prior to covering the GCL), the CQAE shall determine whether or not the GCL shall be replaced.

The GCL Installer must have installed at least 500,000 ft² of GCL, or must provide the CQAE with satisfactory evidence that the GCL will be installed in a competent and professional manner.
5.4.9 GCL 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. The minimum dimension of the longitudinal panel overlap shall be six inches for the finished (i.e. bentonite enhanced) seam. The minimum overlap at the end of roll seams shall be 24 inches. The panel seams shall be shingled in the direction of the grade.

Granular bentonite shall be used to enhance the seams. The underlying edge of the overlap panel shall be exposed, and a continuous fillet of granular sodium bentonite shall be applied along a zone defined by the edge of the underlying panel and the 6-inch line. The bentonite shall be applied by the Installer at a minimum rate of 0.25 pound per linear foot of seam.

In the leachate sump areas where two thicknesses of GCL are placed, the seams of the top layer shall be offset from underlying layer seams by at least 24 inches. The contractor shall use a smooth HDPE slip sheet as necessary to facilitate positioning the top GCL layer over the underlying later. The GCL shall be cut with a sharp utility knife. Cuts shall be smooth and clean.

5.4.10 GCL Damage Repair

If a GCL panel is torn, punctured, perforated, etc. during installation, it shall be replaced or repaired per the direction of the CQAE. Patches shall be sized so that a minimum 12-inch overlap is achieved around the damaged area. Prior to placement of the patch, dry bentonite shall be placed around the damaged area. If there is no potential for dislodging the patch during covering operations, the patch shall be secured to the damaged area using appropriate adhesive per CQAE approval.

5.4.11 Field Reporting and Documentation

Documenting and reporting methods will be implemented to systematically record results of on-site monitoring. A photo log will be created containing photos of all phases of the GCL installation.

5.5 REINFORCED POLYETHYLENE GEOMEMBRANE

The reinforced polyethylene geomembrane (RPE) used on this project shall be 45-mil or equal.

5.5.1 RPE Manufacturing

- Prior to delivery of any RPE geomembrane panels to the site, the Manufacturer will provide the CQAE with the following information: The resin supplier, supplier location, and brand name
- Any test results conducted by the geomembrane and/or resin manufacturer to document the quality of the resin used in the membrane fabrication
- The QC plan that the geomembrane manufacturer will be using for the geomembrane being supplied.
Every panel of RPE geomembrane delivered to the site must be manufactured and inspected by the Manufacturer according to the following requirements:

- The materials used for the geomembrane must consist of first-quality 100% virgin products designed and manufactured specifically for the purpose of this work, which must have been satisfactorily demonstrated to be suitable and durable for such purposes.
- The geomembrane must be free from holes, pin holes, bubbles, blisters, excessive gels, undispersed resins, and/or carbon black, or contamination by foreign matter.
- The geomembrane must be composed of a heavy encapsulated 1300 denier polyester bi-directional reinforcement.
- All factory seams must have a minimum seam width of 1.5 inch scrim to scrim.

The RPE Geomembrane Manufacturer will perform the tests listed in Table 10 at the frequency of one test per every 100,000 feet of material and will report the results to the CQAE. The RPE Geomembrane Manufacturer will provide certification based on tests performed by the Manufacturer’s laboratory, or other outside laboratory contracted by the Manufacturer, that the membrane supplied under this plan will substantially comply with specifications listed in Table 10.

5.5.2 Delivery, Handling, and Storage of RPE Geomembrane Rolls

Transportation of the RPE geomembrane panels to the job site is the responsibility of the Geomembrane Manufacturer. All on site handling is the responsibility of the Installer. The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. Upon arrival, the Installer shall inspect all materials for defects in the manufacturing process and for damage during transportation. Materials judged by the CQAE to be severely damaged shall be rejected and removed from the site. Minor damage and defects shall be repaired by the Installer.

The Installer will be responsible for making certain that the Manufacturer, geomembrane type, and thickness of each panel in a shipment are correct. The CQAE will also maintain a log of geomembrane panel deliveries throughout the construction process. This log shall include, at a minimum, the following:

- Manufacture date
- Date of receipt at the site
- Panel and lot batch numbers.

The CQAE will be responsible throughout the pre-construction, construction, and post construction periods for observing and documenting the handling and storage of the RPE geomembrane to ensure that the integrity of the material is preserved. The CQAE will ensure the following:

- Fabricated panels (accordion-folded in one direction, rolled in the other direction) will be unloaded from trucks in such a way that no damage occurs to the geomembrane.
- Fabricated panels accordion folded in both directions will not be used.
- Fabricated panels on pallets will be moved by forklifts.
- Folds of fabricated panels shall be examined for damage, particularly at kinks in the folds.
- All material will be stored on smooth clean dry level surfaces such that it will not be damaged, become dirty, or get wet internally.
- Depending on the timeline of the project, material shall be stored in a safe central location then staged at appropriate intermediate locations for deployment.
- Fabricated panels will ultimately be placed in the correct location and in the correct orientation for deployment as shown on the protective packaging or in contained deployment instructions.

5.5.3 Foundation

The Earthwork Contractor will be responsible for preparing the subgrade (clay liner) according to the Design Plans and Drawings and this CQAQCP.

After the underlying surface has been accepted by the CQAE, it will be the Installer's responsibility to report to the CQAE any change in that surface that may require repair work. The supporting surface will be examined by the Installer and the CQAE to evaluate the surface conditions immediately prior to placement of the RPE geomembrane. The CQAE and Installer shall document in the daily report that the subgrade surface condition is compatible with the geosynthetics to be installed. All observations by the CQAE and Geomembrane Installer shall be documented. It is the Earthwork Contractor's responsibility to maintain the clay liner surface in a condition acceptable to the CQAE and Geomembrane Installer for geomembrane installation.

The RPE geomembrane must not be susceptible to differential settlement and there shall be no standing water on the subgrade when the liner is placed.

5.5.4 Placement Criteria

A panel layout and deployment instructions will be prepared by the Installer, and provided to the CQAE at least ten calendar days prior to installation of the RPE geomembrane. Panels shall be unrolled and unfolded as indicated in the instructions. Unfolding shall be done with a person every 15 to 30 feet, depending on the size/weight of the panel.

RPE geomembrane placement must not be conducted during strong or gusty winds or during precipitation events and lightning storms. The CQAE will perform/document the following:

- Evaluate and document weather conditions for geomembrane placement and inform MCSWM and the Installer when weather conditions do not meet specifications, so a determination of installation can be made.
- Monitor and document geomembrane placement as well as conditions of panels as placed:
  - Noting panel defects, tears, or other deformities
  - Measuring in-place panel dimensions
  - Recording panel numbers.
Document that the equipment used does not damage the geomembrane by handling, heat, leakage of hydrocarbons, or by any other means.

Document that the prepared soil surface for the geomembrane has not deteriorated since previous acceptance.

Document that personnel working on geomembranes do not smoke, wear damaging clothing, or engage in activities that would damage the geomembrane.

Document that adequate means are used to prevent uplift by wind while preventing damage to the geomembrane or supporting earthen foundation.

Document that the direct contact with the geomembrane will be minimized. The geomembrane will be protected by geotextiles or extra geomembrane materials in areas where excessive traffic is anticipated.

Document that the heavy construction equipment shall not be allowed to move directly on any deployed geomembrane. This includes rubber tired vehicles such as automobiles and pickup trucks but does not include lightweight equipment like all-terrain vehicles.

Document that the construction machinery must not perform sudden starts, stops, or sharp turns over the geomembrane.

Document that the cover material, if applicable, must be placed from the bottom of slopes to the top.

Document that the cover material must be placed in such a manner as not to induce wrinkles in the underlying geomembrane.

Document all equipment that the contractor proposes to use within the geomembrane footprint is approved by the CQAE.

5.5.5 Geomembrane Seaming

All welding shall be completed by the Geosynthetic Manufacturer prior to delivery of the geomembrane on site.

Welding should be done as uniformly and consistently as possible. The objective is to melt the two surfaces and to allow them to cool and solidify as one integral body. When the weld is sectioned there should not be a well-defined interface, nor should there be any particulates or voids along the weld line. There should be no crimps due to overheating. The adjacent geomembrane should not be overheated and oxidized such that it becomes brittle. The cross sections of welds shall be examined for symmetry, lack of crimping (overheating), and the presence of voids and foreign particulates. If voids and particulates are present, the weld will be rejected.

The Geosynthetic Manufacturer is responsible to complete their own fabrication seam QA/QC during manufacturing. The contractor shall submit the Geosynthetic Manufacturer’s QA/QC procedures to the CQAE. The contractor must submit the Geosynthetic Manufacturers QA/QC seam test results, certifications, and test reports for all welds completed by the Geosynthetic Manufacturers to the CQAE.

If field seaming is necessary, all personnel performing seaming operations must be qualified by experience and by successfully passing seaming tests for the type of seaming equipment to be used. All seamers must have seaming experience of a minimum of 500,000 ft² of RPE geomembrane using the same type of equipment to be
used on this project. The most experienced on-site seamer, the “master seamer” (a seamer who has successfully seamed a minimum of 2,000,000 ft² of RPE geomembrane using the same type of equipment to be used on this project) will have direct supervisory responsibility at the site over less experienced seamers. The Installer shall provide documentation of the qualifications of the seaming crew to the CQAEC.

5.5.6 Defects and Repairs
This section applies to all defects including damage during placement and repairs from examinations, tests, or visual observations performed on the RPE geomembrane material and on field seams.

All areas of the RPE geomembrane will be visually observed and documented by the CQAEC for identification of defects, holes, blisters, undispersed raw materials, large wrinkles, and any signs of contamination by foreign matter. The surface of the geomembrane will be clean at the time of visual observation. Each location that fails visual observation will be marked by the CQAEC and repaired by the Installer. Work will not proceed in any area where defects are identified until suitable repairs are made.

Several procedures exist for the repair of flawed areas. The final decision as to the appropriate repair procedure will be agreed upon between the Installer and the CQAEC prior to commencement of the repair. The following procedures are available:

- All non-penetrating linear flaws less than 0.125 inches wide may be repaired with no more than one extrusion bead of the same base polymer as the geomembrane.
- Penetrating holes less than 0.125 inches in diameter that do not expose scrim yarns may also be repaired with no more than one bead application.
- Holes that expose scrim yarns and those that are more than 0.125 inches in diameter shall be patched with the same geomembrane with patch yards oriented in the same direction as in the geomembrane. The patch shall extend at least three inches from the edge of the nearest damage if the damaged area is less than one inch in diameter. When damage exceeds one inch in diameter, the patch shall extend at least six inches from the nearest damage.

Under no circumstances will parallel and overlapping beads be used to fill in a flawed area or a gap. All patch extrusion welds shall be vacuum box tested and hot air patches can be either air lanced or vacuum tested and the results recorded.

Each repair will be examined, numbered, and logged by the CQAEC following these procedures:

- Performing systematic visual observation of the entire surface of the RPE geomembrane to locate and document defects and indicate for each defect the type of repair that is required
- Monitoring and recording the repair of defects and the non-destructive testing of all repairs
- Recording the location and the nature of all defect repairs.
5.5.7 RPE Geomembrane Electronic Leak Location Survey

An electronic leak location survey of the geomembrane may be performed at the option of the Owner and CQAEC. QA associated with an electronic leak location survey would include the following:

- Determination of the suitability of site conditions for the survey
- Performance of the survey in accordance with ASTM D 7007 (water and soil-covered liners) to identify potential leak locations of the installed geomembrane
- Potential leak locations would be marked with flags, paint, or other means to clearly locate the areas. Location coordinates would be recorded
- Observation and documentation of repairs in accordance with project specifications, as applicable
- Following repairs to initially identified perforations, the area at and generally around the repair will be re-surveyed to determine repair success. This process will be repeated until all identified perforations have been repaired and successfully re-tested.

5.5.8 Field Reporting and Documentation

Documenting and reporting methods will be implemented to allow the systematic recording of results of on-site monitoring and testing. Reporting forms will be used for panel placement. Unique identifying numbers will be assigned to each panel and used to reference panel location.

An Installer’s certificate of subgrade acceptance will be obtained prior to panel placement. Panel location diagrams will be kept showing locations of all panels. These diagrams will be updated on a daily basis.

Table 10 Material Properties - 45 mil RPE Geomembrane

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Minimum Roll Averages</th>
<th>Typical Roll Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>ASTM D5199</td>
<td>40 mil</td>
<td>45 mil</td>
</tr>
<tr>
<td>Weight</td>
<td>ASTM D751</td>
<td>190 lbf/msf 27.4 oz/yd²</td>
<td>202 lbf/msf 29.1 oz/yd²</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ply Adhesion</td>
<td>ASTM D6636</td>
<td>24 lbf/in or FTB</td>
<td>43 lbf/in Or FTB</td>
</tr>
<tr>
<td>Tensile Strength – lbf/in</td>
<td>ASTM D7003</td>
<td>182 MD 180 TD</td>
<td>202 MD 200 TD</td>
</tr>
<tr>
<td>Tensile Elongation at Break % (Film Break)</td>
<td>ASTM D7003</td>
<td>312 MD 278 TD</td>
<td>347 MD 309 TD</td>
</tr>
<tr>
<td>Tensile Elongation at Break % (Scrim Break)</td>
<td>ASTM D7003</td>
<td>30 MD 30 TD</td>
<td>32 MD 35 TD</td>
</tr>
<tr>
<td>Property</td>
<td>Test Method</td>
<td>Minimum Roll Averages</td>
<td>Typical Roll Averages</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Tongue Tear Strength – lbf</td>
<td>ASTM D5884</td>
<td>104 MD 99 TD</td>
<td>116 MD 110 TD</td>
</tr>
<tr>
<td>Grab Tensile – lbf (Scrim Break)</td>
<td>ASTM D7004</td>
<td>307 MD 296 TD</td>
<td>341 MD 329 TD</td>
</tr>
<tr>
<td>Grab Tensile Elongation at Break % (Scrim Break)</td>
<td>ASTM D7004</td>
<td>25 MD 25 TD</td>
<td>27 MD 28 TD</td>
</tr>
<tr>
<td>High Pressure OIT (HPOIT)</td>
<td>ASTM D5885</td>
<td>400 min</td>
<td>&gt; 2200 min</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D4833</td>
<td>130 lbf</td>
<td>145 lbf</td>
</tr>
<tr>
<td>Oven Aging at 85°C2</td>
<td>ASTM D7238</td>
<td>35% 60%</td>
<td>each formulation</td>
</tr>
<tr>
<td>Standard OIT</td>
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<td>High Pressure OIT</td>
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<td></td>
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<tr>
<td>UV Resistance2</td>
<td>ASTM D7238</td>
<td>35% 60%</td>
<td>each formulation</td>
</tr>
<tr>
<td>Maximum Static Use Temperature</td>
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<td>180 °F</td>
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</tr>
<tr>
<td>Minimum Static Use Temperature</td>
<td></td>
<td>-70 °F</td>
<td></td>
</tr>
<tr>
<td>Manufacturer Seam Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peel Strength (ppi)1</td>
<td>ASTM D7747</td>
<td>100</td>
<td>Per 750 feet of lineal seam</td>
</tr>
<tr>
<td>Shear Strength (ppi)1</td>
<td>ASTM D7747</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Air Lance Test1</td>
<td>ASTM D4437</td>
<td>Apparent failure</td>
<td>100% of seam</td>
</tr>
</tbody>
</table>

1 No more than 2 patches per 100 feet of seam
2 Derived from Geosynthetic Research Institute Test Method GM25
6.0 HDPE PIPE

6.1 HDPE PIPE

HDPE pipe manufacture and workmanship shall comply with ASTM D3035 and F714. Pipe joining shall be by butt fusion welding or by electro-fusion coupling. The HDPE pipe coupling system shall be approved by the CQAE prior to installation of the pipe. The pipe shall be leak tested to a minimum of 45 psi for at least 10 minutes. The maximum allowable pressure drop is 3 psi over 10 minutes. The testing procedures shall be previously approved by the CQAE.

6.2 SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE

6.2.1 Culvert Manufacturing

Culvert pipe used on the project shall be HDPE corrugated pipe with an integrally formed smooth interior and hydraulic characteristics as specified in the Construction Drawings.

Requirements for test methods, dimensions, and markings are those found in AASHTO Designations M252 and M294.

Pipe and fittings shall be made of polyethylene compounds, which meet or exceed the requirements of Type 111, Category 4 or 5, Grade P33 or P34, Class C per ASTM D3350 with the applicable requirements defined in ASTM D3350. Clean reworked material may be used.

Minimum parallel plate pipe stiffness values, per ASTM test Method D2412, shall be as indicated in Table 11.

Table 11 Minimum HDPE Culvert Pipe Stiffness

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>Pipe Stiffness (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>56</td>
</tr>
<tr>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>36</td>
<td>40</td>
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<tr>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>60</td>
<td>30</td>
</tr>
</tbody>
</table>

A manufacturer’s certification that the product was manufactured, tested, and supplied in accordance with this specification shall be furnished to the CQAE.

6.2.2 Culvert Placement

Installation shall be in accordance with ASTM Recommended Practice D2321 or as specified by the CQAE.

Pipe bedding (see section 4.3.1.3 of this Plan) shall be used as the bedding and envelope material around the culvert. Testing requirements for the pipe bedding are
also provided in section 4.3.1.3 of this Plan. Soil used as the backfill material above the bedding shall be approved by the CQAE and shall be compacted to a minimum of 92 percent of maximum modified Proctor dry density at ±4 percentage points of optimum moisture content. The soil shall be compacted in lifts not greater than 8 inches thick (loose). The soil shall extend above the pipe to the recommended minimum height of cover. At least one moisture-density test shall be conducted per lift of soil per culvert installation.

Culverts shall be placed based on elevations specified on the Construction Drawings or as otherwise indicated by the CQAE based on field conditions.

6.2.3 Acceptance Criteria

The pipe and fittings shall be free of foreign inclusions and visible defects. Holes in the corrugation crests or sidewalls shall be considered unacceptable. The ends of the pipe shall be cut squarely and cleanly so as not to adversely affect joining. All joints shall be observed and accepted by the CQAE prior to backfilling around the culvert.
7.0 WELL AND EXPLORATORY BORING DECOMMISSIONING PROCEDURES

This section of the CQAQCP deals with boreholes and completed groundwater monitoring wells drilled at the landfill site, which are planned for decommissioning. The CQAE will be responsible for overseeing the boring and well decommissioning procedures.

Wells completed into unconfined aquifers and unconsolidated aquifers shall be drilled out to remove the casing and shall be plugged and sealed by filling the boring to the static water level with drill cuttings, clean sand or clean gravel, then with high-yield thick bentonite grout to within five feet of the ground surface. The top five feet of the hold shall be filled with granular bentonite and hand compacted to prevent settling. Any wells or exploratory borings discovered during the excavation of the Landfill will be staked and decommissioned in the same manner as described above.

The CQAE will observe and document all well and exploratory boring decommissioning including the dates of decommissioning, methods used, volumes and types of backfill material used, drilling conditions, and any problems encountered. Appropriate decommissioning forms will be submitted, by the CQAE, to the Colorado Division of Water Resources in accordance with Colorado Department of Natural Resources, Rules and Regulations for Waterwell Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction.
8.0 CONSTRUCTION DOCUMENTATION REPORT

A Final Construction Documentation Report must be prepared by the CQAE for construction of landfill phases and final landfill cover and associated features. At a minimum, the Final Construction Documentation Report will contain the following information from CDPHE Guidance on As-Built Reports (2008):

- Certification by a professional engineer, registered in Colorado, that, based on his/her knowledge and review of the construction records, the construction has been completed in accordance with the approved Design Plans and Drawings and specifications
- Detailed narrative describing the construction events in chronological order and results of the quality assurance testing
- Relevant correspondence with CDPHE regarding this particular project
- The entire CQAQC plan in effect at that time
- Photographs documenting all aspects of construction
- Documentation of all required surveys
- A summary of all problem/deficiency reports and resolutions
- Summaries of test results and survey data
- All daily reports, field and laboratory results for granular soils and non-granular soils
- All manufacturer and field testing results of geosynthetics
- Correspondence regarding placement and testing of fill
- Copy of the Geosynthetics Installer’s CQAQC plan
- All QA laboratory testing results for geosynthetics by Manufacturer
- All Installer's Daily Reports on panel deployment, seaming repairs and associated testing and calibration data for geomembranes and geotextiles
- HDPE and RPE Geomembrane liner and GCL as-built layout plan prepared by the Installer
- All shippers’ listing of panel or roll numbers, thickness, and dimensions for geomembranes, GCLs, and geotextiles
- Any installation acceptance forms completed by Owner/Operator and Installers
- A discussion of changes made to the approved design
- As-built construction drawings (sealed by a professional engineer registered in Colorado).

The as-built construction drawings shall include, but shall not be limited to:

- Subgrade excavation contour map illustrating constructed grades and elevations
- Top of liner contour map illustrating constructed grades and elevations
- Seam layout drawings for geomembrane liners. Additionally, as-built drawings will show locations of repairs and destructive seam tests on geomembrane components, as well as locations of field soils testing and sampling
• Top of operations layer contour map illustrating constructed grades, elevations, liner terminations, interim termination berms, and locations of interim diversion ditches, if applicable
• Top of topsoil contour map illustrating final top of cover constructed grades, elevations, and thicknesses
• Pertinent elevations and locations of leachate sump and leachate holding pond
• Maps as necessary illustrating constructed locations of permanent surface water features, access roads, site wells and gas monitoring probes, and fences
• Sedimentation basins, run-off ponds, and other surface water control features
• Final cover drainage features.

Final construction documentation reports shall be submitted to CDPHE and MCSWM.
9.0 UNEXPECTED WASTE

This section of the CQAQCP deals with waste that might be encountered during construction activities. The CQAE must be notified of any landfill materials encountered during the construction activities. Waste encountered will be removed and re-located to an active area of the Landfill or another permitted and operating landfill.

The CQAE will determine, based on specific site conditions, what measures shall be taken to protect the health and safety of the workers and the environment during the removal and re-locating activities associated with the encountered waste.

Although excavation into the existing waste is not anticipated, refuse that might be encountered during construction activities will be managed in accordance with the Construction Health and Safety Plan and a Materials Management Plan, which will be prepared by the contractor prior to initiation of construction activities. Any hazardous wastes encountered in the proposed lateral expansion construction shall be managed in accordance with applicable state and federal law.