

**EAGLE COUNTY LANDFILL**

**LEACHATE HOLDING POND CONSTRUCTION**

**TECHNICAL SPECIFICATIONS**

PREPARED FOR:

EAGLE COUNTY SOLID WASTE & RECYCLING  
815 UTE CREEK RD.  
WOLCOTT, CO 81655




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Date: January 2020  
Project No.: 4D25803



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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 4:30 PM and 8:00 AM to 3:00 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 deliver, 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.
  - 9. Maintenance of quality standards.
  - 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 by 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**

## SECTION 31 05 16 – GRANULAR MATERIALS

### 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. Culvert pipe bedding
  - 2. Road Base

#### 1.2 UNIT PRICES – MEASUREMENT AND PAYMENT

- A. Culvert Pipe Bedding
  - 1. Basis of Measurement: Included with Culvert Pipe installation.
  - 2. Basis of Payment: Included with Culvert Pipe installation.
- B. Road Base
  - 1. Basis of Measurement: Cubic Yards.
  - 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 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 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 CULVERT PIPE BEDDING

- A. The culvert bedding shall consist of granular material conforming to the specifications in Table 31 05 16 - 1.

**Table 31 05 16 - 1 Pipe Bedding Specifications**

<i>Sieve Size</i>	<i>Mass Percent Passing Square Mesh Sieves</i>
¾-inch	100
3/8-inch	> 90
No. 4	> 45
No. 100	< 10
No. 200	< 5

### 2.2 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 road base shall consist of granular material conforming to the specifications in Table 31 05 16 - 2.

**Table 31 05 16 - 2 CDOT Class 6 Road Base Specifications**

<i>Sieve Size</i>	<i>Mass Percent Passing Square Mesh Sieves</i>
1-inch	100
¾-inch	95-100
No. 4	30-65
No. 8	25-55
No. 200	3-12

### 2.3 RIPRAP

- A. Riprap shall comply with the specifications detailed in Table 31 05 16 - 3 . No specific testing of this material is required. However, the CQAE shall require testing of the material as appropriate in the event that there is any indication that the material does not meet the specifications. The performance of these materials is assured by post-closure financial assurance and their performance is readily judged by surface inspection. The stone shall have a minimum specific gravity of 2.5. Material used for riprap may be approved by the Design Engineer, if, by visual inspection, it is determined to be sound and durable. The Design Engineer may require the Contractor to furnish laboratory results, if, in the Design Engineer’s opinion, the material is marginal or unacceptable. At the request of the Design Engineer, the Contractor shall furnish laboratory test results indicating that the material meets the requirements of this specification.



Riprap and bedding materials used shall be the type designated on the Plans and Design Drawings and shall conform to the following:

**Table 31 05 16 – 3 Riprap Requirements**

<i>Rip Rap Designation</i>	<i>% Smaller by Weight</i>	<i>Intermediate Rock Dimension (in)</i>	<i>D<sub>50</sub> (in)*</i>
Type VL	70-100	12	6
	50-70	9	
	35-50	6	
	2-10	2	

\*D<sub>50</sub> = Mean equivalent spherical diameter

The riprap designation and total thickness of riprap shall be as shown on the Plans and Design Drawings. The maximum stone size shall not be larger than the thickness of the riprap. Neither width nor thickness of a single stone of riprap shall be less than 1/2 of its length. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified. Stones smaller than the 2 to 10 percent size will not be permitted in an amount exceeding 10 percent by weight of each load. Control of gradation will be by visual inspection by the CQAE.

Broken concrete pavement shall be acceptable for use in the work, with approval by the Engineer. Rounded river rock may be used if sized up at the Design Engineer's direction.

## 2.4 TYPE II BEDDING

- A. A thickness of 12-inches of Type II granular bedding shall be installed for all riprap. Granular bedding for riprap shall conform to the specification detailed in Table 31 05 16 - 4. These specifications shall be verified by conducting a minimum of one test per source of granular bedding used in this construction.

**Table 31 05 16 – 4 Type II Riprap Bedding**

<i>Sieve Size</i>	<i>Mass Percent Passing Square Mesh Sieves</i>
3-inch	90-100
¾-inch	20-90
No. 4	0-20
No. 200	0-3

Granular bedding designation and total thickness of bedding shall be as shown on the Plans and Design Drawings.

## **PART 3 EXECUTION**

### **3.1 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.

### **3.2 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  $\pm 4\%$  of optimum moisture content (ASTM D1557).

### **3.3 RIPRAP**

#### **3.3.1 INSTALLATION PREPARATION**

- A. Channel slopes or channel bottoms that are to be protected with riprap shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface and proof-rolled to the CQAE's satisfaction. The Contractor shall excavate areas to receive riprap to the subgrade for granular bedding. After an acceptable subgrade for granular bedding material is established, the bedding shall be immediately placed, compacted to the CQAE's satisfaction with vibratory compaction equipment, and leveled to the subgrade elevation. Immediately following compaction, the riprap shall be placed. In place bedding materials shall not be contaminated with soils, debris, or vegetation before the riprap is placed. If contaminated, the bedding material shall be removed and replaced at the Contractor's expense.

#### **3.3.2 PLACEMENT**

Following acceptable placement of granular bedding, riprap placement shall commence as follows:

- A. Machine Placed Riprap: Riprap shall be placed on the prepared slope or channel bottom areas in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. Riprap shall be machine placed unless otherwise stipulated in the Plans and Design Drawings or Specifications.
- B. When riprap is placed on slopes, placement shall commence at the bottom of the slopes working up the slope. Place the riprap in a stepped fashion with the bottom of the uphill riprap below the top of the downhill riprap by half of the height of the riprap minimum.
- C. The entire mass of riprap shall be placed on either channel slopes or bottoms so as to be in conformance with the required gradation mixtures and to lines, grades, and thickness shown on the Plans and Design Drawings. Riprap shall be placed to its full course thickness at one operation

and in such a manner as to avoid displacing the underlying filter material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.

- D. All material going into riprap protection for channel slopes or bottoms shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.
- E. It is the intent of these Specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by the County or CQAE, the riprap protection shall be placed in conjunction with the construction of the embankment or channel bottoms with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected. The Contractor shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the Plans and Design Drawings at no additional cost to the County. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.
- F. Hand Placed Riprap: Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements of the letter and intent of this Specification. Hand placed riprap may also be required when the depth of riprap is less than 2 times the nominal stone size, or when required by the Plans and Design Drawings or Specifications.
- G. After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown on the Drawings.

### 3.4 FIELD QUALITY CONTROL

- A. Samples shall be taken and measured for grain size analysis every 2,620 cubic yards of in-place granular material used for pipe bedding.
- B. 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.
- C. 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

## SECTION 31 05 19.13 - GEOTEXTILE

### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

1. This specification covers the technical requirements for the furnishing and installation of the geotextile described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the Design Plans and Drawings. The geotextile to be used for this project is a 12 oz/yd<sup>2</sup> nonwoven geotextile surrounding the leak detection sump gravel.

#### 1.2 REFERENCES AND DEFINITIONS

- A. "Construction Quality Assurance/Quality Control Plan for Eagle County Landfill," KRW Consulting, May 1996 (CQAQC Plan).

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

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

Overlap: Where two adjacent geotextile panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

CQAE: Construction Quality Assurance Engineer.

#### 1.3 SUBMITTALS

- A. Quality control testing will be performed by the Manufacturer to demonstrate compliance with the stated test methods. Prior to delivery of any geotextile rolls to the site, the Manufacturer will provide the CQAE with the following information:
  1. The resin supplier, supplier location, and brand name.
  2. Test results conducted by the geotextile and/or resin manufacturer to document the quality of the resin used in geotextile fabrication.
  3. The quality control plan that the Manufacturer will be using for the geotextile being supplied.

The Manufacturer will provide certification, based on test performed by the Manufacturer's laboratory or other outside laboratory contracted by the Manufacturer, that the geotextile supplied under the CQAQC Plan meets the stated specifications.

### PART 2 – MATERIALS

#### 2.1 GEOTEXTILES

- A. The geotextiles shall be manufactured from polypropylene resin. The geotextile will be supplied to the site in factory rolls. The minimum requirements for the geotextile are presented in Table 31 05 19.13 -1.

**Table 31 05 19.13 -1 Geotextile Material Properties**

<i>Property</i>	<i>Test Method</i>	<i>12 oz/yd<sup>2</sup> Geotextile</i>	<i>Minimum Test Frequency</i>
Mass/Unit Area (nominal)	ASTM D5261	12 oz/yd <sup>2</sup>	1/100,000 ft <sup>2</sup> min. 1 per lot
Grab Strength (min.)	ASTM D4632	320 lbs	
UV Resistance	ASTM D4355	≥70% strength	

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

1. First quality resins must be used and contain no more than two percent recycled material by weight as determined by thermos-gravimetric analysis
2. Recycled polymer will be limited to material generated within the Geotextile Manufacturer's plant and from the same grade and type of resin defined herein
3. The geotextile must contain no needles used in punching
4. The geotextile must be free of holes and any other signs of contamination by foreign matter.

## 2.2 PRODUCT LABELING

Each roll delivered to the site shall be labeled with the following information:

1. Manufacture date.
2. Date of receipt at the site.
3. Roll and lot batch numbers.

## PART 3 – EXECUTION

### 3.1 SHIPPING AND HANDLING

Transportation of the geotextile rolls to the job site is the responsibility of the Manufacturer. All onsite 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 to prevent excessive ultraviolet exposure prior to installation.

### 3.2 PLACEMENT

The Installer will handle all geotextiles in such a manner to ensure that they are not damaged in any way.

Placement criteria include:

- On side slopes, the geotextile shall be rolled down the slope in such a manner as two continually keep the geotextile in tension.

- In the presence of wind, all geotextiles will be secured by suitable methods, which are protective of the geotextile and the underlying components.
- Geotextiles will be cut using only approved geotextile cutters. If the geotextile is already in place at the time of cutting, special care shall be taken to prevent damage to the underlying components.
- The Installer will take necessary precautions to prevent damage to any underlying components during placement of the geotextile.
- During placement of the geotextile over a geomembrane, care will be taken not to entrap foreign matter or excessive moisture between the geotextile and geomembrane.
- A visual inspection of the geotextile will be carried out over the entire surface after installation to ensure that no potentially harmful foreign objects such as needles are present. In addition, the CQAE may undertake a sweep of the entire surface after installation using a metal detector. All such foreign objects or material shall be removed.

### 3.3 SEAMING

The following requirements will be used with regard to seaming and overlapping of geotextile rolls:

- Geotextile seams will be continuously welded or sewn and will be overlapped a minimum of three 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 will pay particular attention to seams to ensure that no earthen materials are inadvertently trapped beneath any overlying geotextile.
- Any sewing will be performed using polypropylene thread manufactured of the same base material as the geotextile. The thread shall be resistant to degradation by ultraviolet 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 observation 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.

### 3.4 DAMAGE REPAIR

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 seams using in joining rolls in the field.

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 will be examined 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 examination.

Each location, which fails 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 examined, numbered, and logged by the CQAE.

Any holes or tears in the geotextile will 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 will be taken to remove any soil or other material, which may have penetrated a torn geotextile.

### **3.5 COVER PLACEMENT**

Placement of overlying materials on the geotextile will be performed by the Contractor to prevent the following:

- Damage of the underlying components
- Slipping of the geotextile
- Imposition of excessive tensile stresses on the geotextile or other underlying material.

If there will be an extended time delay between placement of the geotextile and the start of the installation of the overlying components, the Contractor shall make provisions, approved in advance, to protect the geotextile against excessive exposure to ultraviolet radiation.

**END OF SECTION**

## SECTION 31 05 19.15 - GEOSYNTHETIC CLAY LINER

### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

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

#### 1.2 REFERENCES AND DEFINITIONS

- A. "Construction Quality Assurance/Quality Control Plan for Eagle County Landfill," KRW Consulting, May 1996 (CQAQC Plan).

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

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

Overlap: Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

#### 1.3 SUBMITTALS

- A. 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 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 31 05 19.15-1.
  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 31 05 19.15-1.
  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 31 05 19.15-1.

At the CQAE's or MCSWM's request the Contractor shall furnish:

1. A representative sample of the GCL.
2. A project reference list for the GCL consisting of the principal details of projects totaling of at least 500,000 ft<sup>2</sup> in size.

Upon shipment, the Contractor shall furnish the Manufacturer's QAQC certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.

As installation proceeds, the Contractor shall submit certificates of subgrade acceptance, signed by the Contractor and CQAE for each area that is covered by the GCL.

The 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. Manufacturer's quality control plan for documenting compliance with this specification.
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, this specification, and the CQAQC Plan (upon shipment).

## 1.4 QUALIFICATIONS

- A. The Manufacturer must have produced at least 10 million ft<sup>2</sup> of GCL, with at least 8 million ft<sup>2</sup> installed.

The Installer must have installed at least 500,000 ft<sup>2</sup> of GCL, or must provide the CQAE with satisfactory evidence that the GCL installed will be installed in a competent and professional manner.

## 1.5 CONSTRUCTION QUALITY ASSURANCE (CQA)

- A. The CQAE shall provide an inspector for CQA of the GCL installation. The inspector shall be an individual or company who is independent from the Manufacturer and Installer, who shall be responsible for monitoring and documenting activities related to the CQA of the GCL, throughout manufacturing and installation. The inspector shall have provided CQA services for the installation of not less than 500,000 ft<sup>2</sup>.

CQA shall be provided in accordance with the CQAQC Plan provided by the Design Engineer.

## PART 2 – MATERIALS

### 2.1 MATERIALS

- A. 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. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Design Engineer.
- B. All GCL used on the project shall be Reinforced GCL. Acceptable GCL products are Bentomat® ST, or an engineer-approved equal. The GCL and its components shall have the properties shown in Table 31 05 19.15 -1.

**Table 31 05 19.15 -1 GCL Properties**

<b>Material Property</b>	<b>Test Method</b>	<b>Test Frequency</b>	<b>Required Values</b>
Bentonite Swell Index	ASTM D5890	1 per 50 tons	24 mL/2g min.
Bentonite Fluid Loss	ASTM D5891	1 per 50 tons	18 mL max.
Bentonite Mass/Area	ASTM D5993	40,000 ft <sup>2</sup>	0.75 lb/ft <sup>2</sup>
GCL Grab Strength	ASTM D4632	200,000 ft <sup>2</sup>	90 lbs
GCL Peel Strength	ASTM D4632	40,000 ft <sup>2</sup>	15 lbs
GCL Index Flux	ASTM D5887	Weekly	1 x 10 <sup>-8</sup> m <sup>3</sup> /m <sup>2</sup> /sec
GCL Permeability	ASTM D5084	Weekly	5 x 10 <sup>-9</sup> cm/sec
GCL Hydrated Internal Shear Strength	ASTM D5321	Periodic	500 lb/ft <sup>2</sup>

- C. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet in length and 15 feet (4.6m) in width. Short rolls (those manufactured to a length greater than 70 feet but less than a full-length roll) may be supplied at a rate no greater than three (3) per truckload or three (3) rolls every 36,000 square feet of GCL, whichever is less.
- D. A 6-inch overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink that does not negatively impact the performance of the GCL.

## 2.2 PRODUCT LABELING

- A. Prior to shipment, the Manufacturer shall label each roll, identifying:
  1. Product identification information (Manufacturer's name and address, brand product code).
  2. Lot number and roll number.
  3. Roll length, width, and weight.

## 2.3 PACKAGING

- A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.
- B. All rolls shall be labeled and bagged in packaging that is resistant to photo-degradation by ultraviolet light.

## 2.4 ACCESSORY BENTONITE

- A. 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.

## PART 3 – EXECUTION

### 3.1 DELIVERY, HANDLING AND STORAGE

- A. 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.

- B. 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.
- C. The party responsible for unloading the GCL shall contact the Manufacturer prior to shipment to ascertain the appropriateness of proposed unloading methods and equipment.
- D. 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 4 rolls. All stored GCL and accessory bentonite shall be covered with plastic sheeting or tarpaulins until their installation. The integrity and legibility of the roll labels shall be preserved during storage.

### 3.2 EARTHWORK

- A. The Contractor will be responsible for preparing the liner foundation, according to the Design Plans and Drawings and the CQAQC Plan. Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications, Design Plans and Drawings. The surface shall be smooth, firm, and unyielding, and free of:
  - 1. Vegetation.
  - 2. Construction debris.
  - 3. Sticks.
  - 4. Sharp rocks.
  - 5. Void spaces.
  - 6. Ice.
  - 7. Abrupt elevation changes.
  - 8. Standing water.
- B. Immediately prior to GCL deployment, the subgrade shall be final graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At the completion of this activity, no wheel ruts, footprints, or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed, or pushed into the surface with a smooth-drum compactor.
- C. On a continuing basis, the CQAE shall certify acceptance of the subgrade before GCL placement.
- D. It shall be the Installer's responsibility thereafter to indicate to the CQAE any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this section.

### 3.3 PLACEMENT

- A. 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.
- B. 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.

- C. The GCL shall be placed so that longitudinal panel seams are parallel to the direction of the slope. Seams shall be located at least five feet from the toe and crest of slopes steeper than 4:1. All GCL panels shall lie flat on the underlying surface with no wrinkles or folds.
- D. Only as much GCL shall be deployed as can be covered by 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. Replacement shall be at the sole cost of the Contractor and Installer.

### 3.4 ANCHORAGE

- A. As directed by the Design Plans, Drawings, and these specifications, the end of the GCL shall be placed in an anchor trench at the top of the slope or an equivalent runout design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but not the rear trench wall.

### 3.5 SEAMING

- B. The GCL seams are constructed by overlapping their adjacent edges. The overlap shall be free of loose soil or other debris. The minimum dimension of the longitudinal panel overlap shall be six (6) inches for the finished (i.e. bentonite enhanced) seam. The minimum overlap at the end of the roll seams shall be 24 inches. The panel seams shall be shingled in the direction of the grade.
- C. 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 at a minimum rate of 0.25 pound per linear foot of seam.
- D. The GCL shall be cut with a sharp utility knife. Cuts shall be smooth and clean.

### 3.6 DETAIL WORK

- A. The GCL shall be sealed around penetrations and embedded structures in accordance with the Design Plans and Drawings and the recommendations of the Manufacturer.
- B. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

### 3.7 DEFECTS AND REPAIRS

- A. If a GCL panel is torn, punctured, perforated, etc. during installation, it shall be replaced or repair 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 potential for dislodging the patch during covering operations, the patch shall be secured to the damaged area using appropriate adhesive per CQAE approval.

### 3.8 COVER PLACEMENT

- A. If there will be an extended time delay between placement of the GCL and the start of the installation of the overlying material, the Contractor shall make provisions, approved in advance by the CQAE, to protect the GCL against exposure to the elements of nature.
- B. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of geosynthetic material placed over the GCL. The CQAE should be contacted with specific recommendations on the appropriate procedures in this situation.

**END OF SECTION**

## **SECTION 31 05 19.16 - REINFORCED POLYETHYLENE (RPE) LINER CONSTRUCTION**

### **PART 1 – GENERAL**

#### **1.1 SCOPE OF WORK**

- A. The section deals with the manufacture and installation of the 45-mil thick RPE geomembrane to be used in the leachate holding pond liner system. The RPE will be installed over the prepared foundation layer and again over the geocomposite drainage layer.

#### **1.2 REFERENCES AND DEFINITONS**

- A. "Construction Quality Assurance/Quality Control Plan for Eagle County Landfill," KRW Consulting, May 1996 (CQAQC Plan).
- B. "Reinforced Polyethylene Geomembrane Specification," Raven Engineered Films.
- C. "Reinforced Polyethylene Product Data Sheet," Colorado Lining.

#### **1.3 SUBMITTALS**

- A. Prior to the delivery of any RPE geomembrane panels to the site, the Manufacturer will provide the CQAE with the following information:
  - 1. The resin supplier, supplier location, and brand name.
  - 2. Any test results conducted by the Manufacturer to document the quality of the resin used in the RPE geomembrane fabrication.
  - 3. The quality control plan that the Manufacturer will be using for the RPE geomembrane being supplied.
  - 4. 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.

#### **1.4 QUALIFICATIONS**

- A. The Manufacturer must have produced at least 10 million ft<sup>2</sup> of RPE, with at least 8 million ft<sup>2</sup> installed.
- B. The Installer must have installed at least 500,000 ft<sup>2</sup> of RPE or must provide the CQAE with satisfactory evidence that the RPE installed will be installed in a competent and professional manner.

### **PART 2 – MATERIALS**

#### **2.1 MATERIALS**

- A. Every panel of RPE geomembrane delivered to the site must be manufactured and inspected by the Manufacturer according to the following requirements:
  - 1. The materials used for the RPE 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.
  - 2. The RPE geomembrane must be free from holes, pin holes, bubbles, blisters, excessive gels, undispersed resins, and/or carbon black, or contamination by foreign matter.

3. The RPE geomembrane must be composed of a heavy encapsulated 1,300 denier polyester bi-directional reinforcement.
  4. All factory seams must have a minimum seam width of 1.5 inch scrim to scrim.
- B. The Manufacturer will perform the tests listed in Table 31 05 19.16 -1 at the frequency of one test per every 100,000 ft<sup>2</sup> of material and will report the results to the CQAE. The 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 will comply with the specifications listed in Table 31 05 19.16-1.

**Table 31 05 19.16 – 1 45 mil RPE Geomembrane Material Properties**

<i>Property</i>	<i>Test Method</i>	<i>Minimum Roll Averages</i>	<i>Typical Roll Averages</i>
Thickness	ASTM D5199	40 mil	45 mil
Weight	ASTM D751	190 lbf/msf 27.4 oz/yd <sup>2</sup>	202 lbf/msf 29.1 oz/yd <sup>2</sup>
<b>Construction</b>			
Ply Adhesion	ASTM D6636	24 lbf/in or FTB	43 lbf/in Or FTB
Tensile Strength – lbf/in	ASTM D7003	182 MD 180 TD	202 MD 200 TD
Tensile Elongation at Break % (Film Break)	ASTM D7003	312 MD 278 TD	347 MD 309 TD
Tensile Elongation at Break % (Scrim Break)	ASTM D7003	30 MD 30 TD	32 MD 35 TD
Tongue Tear Strength – lbf	ASTM D5884	104 MD 99 TD	116 MD 110 TD
Grab Tensile – lbf (Scrim Break)	ASTM D7004	307 MD 296 TD	341 MD 329 TD
Grab Tensile Elongation at Break % (Scrim Break)	ASTM D7004	25 MD 25TD	27 MD 28 TD
High Pressure OIT (HPOIT)	ASTM D5885	1000 min	> 2200 min
Puncture Resistance	ASTM D4833	130 lbf	145 lbf
Maximum Static Use Temperature		180 °F	
Minimum Static Use Temperature		-70 °F	

## **PART 3 – EXECUTION**

### **3.1 SHIPPING AND HANDLING**

- A. Transportation of the RPE geomembrane panels to the job site is the responsibility of the 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 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.

- B. 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 RPE geomembrane deliveries throughout the construction process. This log shall include, at a minimum, the following:
  - 1. Manufacture date
  - 2. Date of receipt at the site
  - 3. Panel and lot batch numbers

### 3.2 PLACEMENT

- A. The Contractor will be responsible for preparing the subgrade (clay liner) according to the Design Plans and Drawings and the CQAQC Plan.
- B. 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 geomembrane to be installed. All observations by the CQAE and Geomembrane Installer shall be documented. It is the Contractor's responsibility to maintain the clay liner surface in a condition acceptable to the CQAE and Installer for geomembrane installation.
- C. 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. Geomembrane placement will not be conducted at ambient temperatures below 40°F (unless approved by the Manufacturer and the CQAE), during precipitation or fog, or during excessive winds.
- D. 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.
- E. The CQAE will perform/document the following:
  - 1. Evaluate and document the weather conditions for RPE geomembrane placement and inform MCSWM and the Installer when weather conditions do not meet specifications, so a determination of installation can be made.
  - 2. Monitor and document geomembrane placement as well as conditions of panels as placed:
    - a. Noting panel defects, tears, or other deformities
    - b. Measuring in-place panel dimensions
    - c. Recording panel numbers
  - 3. Document that the equipment used does not damage the geomembrane by handling, heat, leakage of hydrocarbons, or by any other means.
  - 4. Document that the prepared soil surface has not deteriorated since previous acceptance.
  - 5. Document that personnel working on geomembranes do not smoke, wear damaging clothing, or engage in activities that would damage the geomembrane.
  - 6. Document that adequate means are used to prevent uplift by wind while preventing damage to the geomembrane or supporting earthen foundation.



7. 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.
8. 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.
9. Document that the construction machinery must not perform sudden starts, stops, or sharp turns over the geomembrane.
10. Document that the cover material, if applicable, must be placed from the bottom of the slopes to the top.
11. Document that the cover material must be placed in such a manner as to not induce wrinkles in the underlying geomembrane.
12. Document all equipment that the contractor proposes to use within the geomembrane footprint is approved by the CQAE.

### 3.3 SEAMING

- A. All welding shall be completed by the Manufacturer prior to delivery of the geomembrane on site.
- B. 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.
- C. The Manufacturer is responsible to complete their own fabrication seam QA/QC during manufacturing. The contractor shall submit the Manufacturer's QA/QC procedures to the CQAE. The contractor must submit the Manufacturers QA/QC seam test results, certifications, and test reports for all welds completed by the Manufacturers to the CQAE.

### 3.4 DAMAGE REPAIR

- A. 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.
- B. All areas of the RPE 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.
- C. 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:
  1. 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.

2. 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.
  3. 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.
- D. 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.
- E. Each repair will be examined, numbered, and logged by the CQAE following these procedures:
1. 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
  2. Monitoring and recording the repair of defects and the non-destructive testing of all repairs
  3. Recording the location and the nature of all defect repairs.

### 3.5 ANCHOR TRENCH CONSTRUCTION AND BACKFILLING

- A. A trench will be used for anchoring the geosynthetics at the top of excavation slopes. The anchor trench will be excavated to the specifications shown on the Design Plans and Drawings unless otherwise specified by the CQAE.
- B. The length of the open trench shall not exceed the amount of liner to be placed in one day. The depth of a typical anchor trench shall be documented to conform to approved project drawings.
- C. The anchor trench shall be backfilled with non-granular soil (SC or CL) as approved by the CQAE. The soil shall be placed in maximum 8-inch lifts, moisture conditioned, and wheel rolled with a rubber tire machine or other method approved by the CQAE.

**END OF SECTION**

## SECTION 31 05 19.18 - GEONET

### 1.0 GENERAL

#### 1.1 SUMMARY

- A. This specification covers the requirements for the manufacture, fabrication, supply, and installation of the geonet for the leak detection layer. The geonet 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. Related Sections:
  - 1. Section 31 05 19.16 - Polyethylene Geomembrane Liner.

#### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM D 1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
  - 2. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.
  - 3. ASTM D 4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique
  - 4. ASTM D 4716 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
  - 5. ASTM D 7179 Standard Test Method for Determining Geonet Breaking Force
  - 6. ASTM D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- B. Relevant publications from the Environmental Protection Agency (EPA):
  - 1. Daniel, D.E. and R.M. Koerner, (1993), *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93/182.

#### 1.3 DEFINITIONS

- A. Construction Quality Assurance Consultant (Consultant) - Party, independent from Manufacturer and Installer that is responsible for observing and documenting activities related to quality assurance during the lining system construction.
- B. Engineer- The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.
- C. Geonet Manufacturer (Manufacturer) - The party responsible for manufacturing the geonet rolls.
- D. Geosynthetic Quality Assurance Laboratory (Testing Laboratory)- Party, independent from the 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 and deploying the geonet.
- F. Lot- A quantity of resin (usually the capacity of one rail car) used to manufacture polyethylene geonet rolls. The finished rolls will be identified by a roll number traceable to the resin lot.

## 1.4 QUALIFICATIONS

- A. Manufacturer:
  - 1. Geonet shall be manufactured by the following:
    - a. GSE Lining Technology, Inc.
    - b. Engineer Approved Equal
  - 2. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of polyethylene geonet material during the last year.
- B. Installer:
  - 1. Installer shall have installed a minimum of 500,000 square feet of geonet
  - 2. 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.
  - 3. 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.

## 1.5 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

- A. Labeling - Each roll of geonet 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. Delivery - Rolls of geonet will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.
- C. Storage - The on-site storage location for the geonet, provided by the Contractor to protect the geonet from abrasions, excessive dirt and moisture shall have the following characteristics:
  - 1. Level (no wooden pallets)
  - 2. Smooth
  - 3. Protected from theft and vandalism
  - 4. Adjacent to the area being lined.
- D. Handling:
  - 1. The Contractor and Installer shall handle all geonet in such a manner as to ensure it is not damaged in any way.

2. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geonet.

## 1.6 WARRANTY

- A. Material shall be warranted, on a pro-rata basis against defects for a period of 1-year from the date of the geonet installation.
- B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geonet completion.

## 2.0 PRODUCTS

### 2.1 GEONET PROPERTIES

- A. A geonet shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure
- B. The geonet specified shall have properties that meet or exceed the values listed in Table 31 05 19.18 - 1 below.

**Table 31 05 19.18- 1 Geonet Properties**

<i>Property</i>	<i>Test Method</i>	<i>Test Frequency</i>	<i>Value</i>
Geonet Thickness, mil <sup>(1)</sup>	ASTM D 5199	1/50,000 ft <sup>2</sup>	200
Transmissivity <sup>(2)</sup> , gal/min/ft (m <sup>2</sup> /sec)	ASTM D 4716	1/540,000 ft <sup>2</sup>	9.6 (2 x 10 <sup>-3</sup> )
Density, g/cm <sup>(3)</sup>	ASTM D 1505	1/50,000 ft <sup>2</sup>	0.94
Tensile Strength (MD), lb/in	ASTM D 7179	1/50,000 ft <sup>2</sup>	45
Carbon Black Content, %	ASTM D 4218	1/50,000 ft <sup>2</sup>	2.0
<b><i>Nominal Roll Dimensions<sup>(3)</sup></i></b>			
Roll Width, ft			15
Roll Length, ft			330
Roll Area, ft <sup>2</sup>			4,950

<sup>(1)</sup> Geonet thickness is nominal value

<sup>(2)</sup> Gradient of 0.3 normal load of 10,000 psf, water at 70°F, between steel plates for 15 minutes. Contact manufacturer for performance transmissivity value for use in design.

<sup>(3)</sup> Roll widths and lengths have a tolerance of ±1%

**Table 31 05 19.18 - 2 Raw Material Properties**

<i>Property</i>	<i>Test Method<sup>(1)</sup></i>	<i>Testing Frequencies</i>	<i>Value</i>
Density (g/cm <sup>3</sup> )	ASTM D 1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	Once Per Resin Lot	≤1.0

<sup>(1)</sup> GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

## 2.2 MANUFACTURING QUALITY ASSURANCE/CONTROL

- A. The geonet shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the Engineer.
- B. The geonet shall be tested according to the test methods and frequencies listed in Table 31 05 19.18-1.
- C. A representative of the Engineer shall observe and document the unloading, storage, deployment, and installation of the geonet.

## 3.0 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 Project Engineer.

### 3.2 MATERIAL PLACEMENT

- A. The geonet is placed between the primary liner and the secondary liner and is used as the leak detection layer allowing any fluids to flow to the fluid removal pit.
- B. The geonet roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer.
- C. 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.
- D. In the presence of wind, all geonets shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.
- E. If the project includes an anchor trench at the top of the slopes, the geonet shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geonet.
- F. In applying fill material, no equipment can drive directly across the geonet. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

- G. The overlying material shall be placed in the geonet in a manner that prevents damage to the geonet. Placement of the overlying material shall proceed immediately following the placement and inspection of the geonet.

### 3.3 SEAMS AND OVERLAPS

- A. Each component of the geonet will be secured to the like component at overlaps.
- B. Geonet Components
  1. Adjacent edges along the length of the geonet roll shall be overlapped a minimum of six (6) inches or as recommended by the Engineer.
  2. The overlapped edges shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every five (5) feet along the roll length.
  3. Adjoining rolls across the roll width should be shingled down in the direction of the slope and joined together with cable ties spaced every foot along the roll width.

### 3.4 REPAIR

- A. Prior to covering the deployed geonet, each roll shall be inspected for damage resulting from construction.
- B. Any rips, tears or damaged areas on the deployed geonet shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with Article 3.3.

**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
  - 1. Basis of Measurement: Acres.
  - 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):
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  2. ASTM D422 - Particle -Size Analysis of Soils.
  3. ASTM D653 - Terminology Relating to Soil, Rock, and Contained Fluids.
  4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft<sup>3</sup>.
  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/ft<sup>3</sup>.
  7. ASTM D1633 - Test Method for Compressive Strength of Molded Soil - Cement Cylinders.
  8. ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
  9. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
  10. ASTM D2434 - Standard Test Method for Permeability of Granular Soils Constant Head.
  11. ASTM D2487 - Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
  12. ASTM D2488 - Description and Identification of Soils (Visual-Manual Procedure).
  13. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
  14. ASTM D2901 - Test Method for Cement Content of Freshly Mixed Soil Cement.
  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 Sols and Calculation of Relative Density.

17. ASTM D4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
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%.
    - c. Maximum slope: 4:1.

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:
  1. Density Tests: ASTM D6938.
  2. Moisture Tests: ASTM D6938.
- 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:
  - 1. Basis of Measurement: Liner Feet.
  - 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):
  - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ASTM D422 - Particle -Size Analysis of Soils.
  - 3. ASTM D653 - Terminology Relating to Soil, Rock, and Contained Fluids.
  - 4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>).
  - 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 (6,000 ft-lbf/ft<sup>3</sup>).
  - 7. ASTM D1633 - Test Method for Compressive Strength of Molded Soil - Cement Cylinders.
  - 8. ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
  - 9. ASTM D2487 - Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
  - 10. ASTM D2488 - Description and Identification of Soils (Visual-Manual Procedure).
  - 11. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
  - 12. ASTM D2901 - Test Method for Cement Content of Freshly Mixed Soil Cement.
  - 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 Sols and Calculation of Relative Density.
  - 15. ASTM D4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - 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 SUBMITTAL

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

#### 1.5 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.

#### 1.6 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, 2.1 Culvert 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 deviation therefrom is approved by the Engineer.
    - a. Blend with natural terrain.
    - b. Minimum slope: 2%.
    - c. Maximum slope: 4:1.
  - 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 23 – BACKFILL

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Filling and compacting site for liners, access roads, and site drainage.
  2. Backfilling for culvert trenches.

#### 1.2 UNIT PRICES – MEASUREMENT AND PAYMENT

- A. Culvert Pipe Bedding
1. Basis of Measurement: Included with Culvert Pipe installation.
  2. Basis of Payment: Included with Culvert Pipe installation.
- B. Road Base
1. Basis of Measurement: Cubic Yards.
  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):
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  2. ASTM D422 - Particle -Size Analysis of Soils.
  3. ASTM D653 - Terminology Relating to Soil, Rock, and Contained Fluids.
  4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
  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/ft<sup>3</sup>, 2,700 kN-m/m<sup>3</sup>).
  7. ASTM D1633 - Test Method for Compressive Strength of Molded Soil - Cement Cylinders.
  8. ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
  9. ASTM D2487 - Classifications of Soils for Engineering Purposes (Unified Soil Classification System).
  10. ASTM D2488 - Description and Identification of Soils (Visual-Manual Procedure).
  11. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
  12. ASTM D2901 - Test Method for Cement Content of Freshly Mixed Soil Cement.
  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 Sols and Calculation of Relative Density.
  15. ASTM D4564 - Density of Soil in Place by the Sleeve Method.
  16. ASTM D4643 - Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.

17. ASTM D4718 - Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
18. ASTM D4832 - Compressive Strength of Controlled Low Strength Material.
19. ASTM D4914 - Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.
20. ASTM D4959 - Determination of Water (Moisture) Content of Soil by Direct Heating.
21. ASTM D5030 - Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.
22. ASTM D5080 - Rapid Determination of Percent Compaction.
23. 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. Grain Size Analysis: Based on ASTM D422/1140.
- D. Unified Soil Classification: Based on ASTM D2487.

## 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 31 23 23 – 1 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 other structural fill, including site drainage and access roads
  3. Backfill for culvert trenches

**Table 31 23 23 - 1 Non-Granular Soil Minimum Laboratory Test Frequencies**

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

### **PART 3 EXECUTION**

#### **3.1 BACKFILLING FOR STRUCTURES, SITE WORK AND APPURTENANCES**

- 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 from 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  $\pm 4\%$  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, pre-conditioning 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  $\geq 90\%$ , as directed by the Engineer.
  2. Access Roads, Culvert Backfill, and Site Drainage: Compact to  $\geq 92\%$ , as directed by the Engineer.
  3. 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. Percent Compaction: Shall meet minimum required compaction as set forth in these specifications.

- C. 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 32 11 23 - AGGREGATE

### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

- A. Furnish and install leak detection sump gravel material.

#### 1.2 REFERENCES

- A. "Construction Quality Assurance/Quality Control Plan for Eagle County Landfill," KRW Consulting, May 1996 (CQAQC Plan).
- B. ASTM C136: "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates"

#### 1.3 SUBMITTALS

- A. Contractor shall submit 5-gallon samples to the CQAE of each material to be used. Samples shall be submitted 15 days before aggregates are to be installed.

### PART 2- MATERIALS

#### 2.1 LEAK DETECTION SUMP GRAVEL

- A. The granular material placed in the leak detection sump shall be 1.5-inch washed stone conforming to the ASTM C33 size #4 specification (refer to Table 32 11 23-1). These specifications shall be verified by testing of at least one sample per source per construction phase in which the material is used. This material shall be made up of inert and stable materials such as silica and quartz.

**Table 32 11 23 - 1 Sump Gravel Specifications (ASTM C33, Size #4)**

<i>Sieve Size</i>	<i>Mass Percent Passing Square Mesh Sieves</i>
2-inch	100
1 1/2-inch	90-100
1-inch	20-55
3/4-inch	0-15
3/8-inch	0-5

### PART 3 – EXECUTION

#### 3.1 LEAK DETECTION SUMP GRAVEL

- A. The Contractor must protect the underlying liner components from damage during placement of the leak detection sump gravel.
- B. The Contractor shall propose to the CQAE a means of placing and spreading gravel in the leak detection sump. The CQAE shall approve a method of placing and spreading the materials prior to their placement. The methods used shall be protective of the underlying components.

**END OF SECTION**

## SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

### PART 1 – GENERAL

#### 1.1 SCOPE OF WORK

Work under this section includes the technical requirements for furnishing and installing the required fencing and gate in connection with the construction of the leachate holding pond. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the Design Plans and Drawings.

Fencing to be used for this project shall include the following:

- Fence framework, fabric, and accessories
- Excavation for post bases
- Concrete foundation for posts
- Manual gate and related hardware

#### 1.2 REFERENCES

ASTM A121: Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.

ASTM A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A153/A153M: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A392: Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

ASTM A491: Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.

ASTM A585: Standard Specification for Aluminum-Coated Steel Barbed Wire.

ASTM A792/A792M: Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

ASTM A1011/A1011M: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B429: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

ASTM C94: Standard Specification for Ready-Mixed Concrete.

ASTM F567: Standard Practice for Installation of Chain-Link Fence.

ASTM F668: Standard Specification for Poly (Vinyl Chloride) (PVC)-Coated Steel Chain Link Fence Fabric.

ASTM F900: Standard Specification for Industrial and Commercial Swing Gates.

ASTM F934: Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.



ASTM F1043: Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

ASTM F1083: Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

ASTM F1184: Standard Specification for Industrial and Commercial Horizontal Slide Gates.

Chain Link Fence Manufacturers Institute (CLFMI) - Product Manual.

### 1.3 SUBMITTALS

- Shop drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- Product data: Submit data on fabric, posts, accessories, fittings, and hardware.
- Operation and maintenance data.

### 1.4 QUALITY ASSURANCE

- Supply material in accordance with the Chain Link Manufacturer's Institute (CLFMI) Product Manual
- Perform installation in accordance with ASTM F567.

### 1.5 QUALIFICATIONS

The Manufacturer shall be a company specializing in manufacturing products specified in this section with a minimum of three years documented experience. The Installer shall specialize in performing the work in this section with a minimum of three years documented experience.

### 1.6 DELIVERY, STORAGE AND HANDLING

Fence fabric and accessories shall be delivered in packed cartons or firmly tied rolls. The Manufacturer's name must be clearly identified on each package. The fence fabric and accessories will be stored on site in secure and dry place.

## **PART 2 – MATERIALS**

### 2.1 MATERIALS AND DESCRIPTION

The nominal fence height shall be six (6) feet and the spacing between line posts will not exceed ten (10) feet. Framing steel will be welded ASTM F1083 Schedule 40 galvanized steel pipe with coating conforming to ASTM F1043 Type A on the pipe exterior and interior. Fabric wire sheet will be ASTM A392 zinc-coated wire fabric and the foundation will be 3,000 psi concrete.

### 2.2 COMPONENTS

The following components will make up the chain link fences and gates:

- 2.38-inch diameter line posts
- 2.88-inch corner and terminal posts
- 3.5-inch diameter gate posts

- 1.66-inch diameter plain end, sleeve couple top and brace rails
- Gate frame with 1.66-inch diameter for fittings and truss rod fabrication.
- 2-inch diamond-mesh interwoven wire, 9-gauge thick, top selvage twisted tight, bottom selvage knuckle end closed
- 7-gauge thick steel, single strand, galvanized tension wire
- Aluminum alloy steel tie wire

## 2.3 ACCESSORIES

Caps shall be galvanized cast steel, pressed steel, or malleable iron. They will be sized to post diameter and set screw retainer. Fittings will be sleeves, bands, clips, rail ends, tension bars, fasteners, and fittings made of galvanized steel. Hardware for the gate will be a center gate stop and drop rod with two 180-degree gate hinges for each leaf.

## 2.4 GATES

The gate type, opening width, and direction of operation will be as indicated in the Design Plans and Drawings or by the CQAE in the field. The gate will be factory-assembled, designed for operation by one person, and fabricated to permit 180-degree swing. The gate will be constructed in accordance with ASTM F900 with welded corners. The use of corner fittings is not permitted. The components, fabric, and hardware will be galvanized in accordance with ASTM A123/A123M. Components and hardware will be constructed in accordance with ASTM A153/A153M and fabric will be constructed in accordance with ASTM A392. A 2.0 oz/ft<sup>2</sup> coating will be utilized for components, fabric, and hardware. All accessories will have the same finish as the framing.

# PART 3 – EXECUTION

## 3.1 INSTALLATION

The following requirements will be met during installation of the fence and gate:

- Install framework, fabric, accessories, and gates in accordance with ASTM F567.
- Install posts with six (6) inches maximum clear opening from end posts to buildings, fences, and other structures.
- Excavate holes for posts to diameter and spacing indicated on Design Plans and Drawings without disturbing underlying materials.
- Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.
- Set intermediate, terminal, and gateposts plumb, in concrete footings with top of footing two (2) inches above finished grade. Slope top of concrete for water runoff.
- Line post footing depth below finished grade: ASTM F567.
- Corner, gate, and terminal post footing depth below finished grade: ASTM F567.
- Allow footings to cure minimum seven (7) days before installing fabric and other materials attached to posts.
- Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gateposts.
- Install top rail through line post tops and splice with 6-inch long rail sleeves.
- Install center and bottom brace rail on corner gate leaves.

- Place fabric on outside of posts and rails.
- Stretch fabric on outside of posts and rails.
- Stretch fabric between terminal posts or at intervals of 1200 feet maximum, whichever is less.
- Position the bottom of fabric two (2) inches above finished grade.
- Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- Attach fabric to end, corner, and gateposts with tension bars and tension bar clips.
- Install bottom tension wire stretched taut between terminal posts.
- Install support arms sloped outward and attach barbed wire; tension and secure, with barbed wire installed with lowest strand not less than eight (8) feet from ground level.
- Support gates from gateposts. Do not attach hinged side of gate from building wall.
- Install gate with fabric and barbed wire overhang to match fence. Install three (3) hinges on each gate leaf.
- Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings, if double gates are called for on the Design Plans and Drawings.

### 3.2 ERECTION TOLERANCES

- Maximum variation from plumb: 1/4 inch
- Maximum offset from indicated position: 1 inch

**END OF SECTION**

## SECTION 32 92 19 – SEEDING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Preparation of subsoil.
  - 2. Placing topsoil.
  - 3. Seeding, Hydroseeding, Seed Drilling.
  - 4. Mulching.
  - 5. Maintenance.
- B. Related Sections:
  - 1. Section 31 22 13 – Rough Grading

#### 1.2 UNIT PRICE – MEASUREMENT AND PAYMENT

- A. Grassed Areas:
  - 1. Basis of Measurement: By acre.
  - 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. ASTM C602 – Standard Specification for Agricultural Liming Materials.

#### 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 15<sup>th</sup> through April 15<sup>th</sup>, or July 1<sup>st</sup> through August 15<sup>th</sup> 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 32 92 19 - 1:

**Table 32 92 19 - 1 Seeding Mixture for Native Seeding**

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

\*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  $(0.9 \times 0.93) = 0.837$ ,  $(5.2 \text{ pounds PLS required} / 0.837) = 6.2$  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**



## 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.
  - 3. Bedding.
  - 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; backfill; pipe, fittings and accessories assembled; repair of damaged coating.

#### 1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO M252 – Standard Specification for Corrugated Polyethylene Drainage Pipe.
  - 2. AASHTO M294 – Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.
- B. ASTM International:
  - 1. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
  - 2. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

#### 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 33 42 13 - 1.

**Table 33 42 13 - 1 Minimum HDPE Culvert Pipe Stiffness**

<i>Pipe Diameter (inches)</i>	<i>Pipe Stiffness (psi)</i>
18	56
24	50
30	46
36	40
42	35
48	35
60	30

## 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.

**END OF SECTION**

## SECTION 33 47 30 - HDPE PIPE AND FITTINGS

### PART 1 GENERAL

#### 1.1 SCOPE OF WORK

- A. Specifications (i.e., material size, etc.) for pipe used at the site are noted on the Design Plans and Drawings.

#### 1.2 REFERENCES

- A. ASTM D1248: "Specification for Polyethylene Plastics Molding and Extrusion Materials".
- B. ASTM D3261: "Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing"
- C. ASTM D3350: "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials"
- D. "Construction Quality Assurance/Quality Control Plan for Eagle County Landfill," KRW Consulting, May 1996 (CQAQC Plan).

#### 1.3 MANUFACTURER'S QUALITY ASSURANCE

- A. The Manufacturer shall have an established quality assurance program responsible for inspecting incoming and outgoing materials. At a minimum, incoming PE materials shall be inspected for density per ASTM D1505, melt flow rate per ASTM D1238, and contamination. All incoming PE materials shall be certified by the PE Supplier. Certification shall be verified by Quality Assurance. Incoming materials shall be approved by quality assurance before processing into finished goods.
- B. The Manufacturer shall have an established quality assurance program responsible for assuring the long-term performance of materials and products. Representative samples of PE materials shall be tested against the physical property requirements of this specification. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D1598.
- C. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. PE Manufacturer's quality control shall perform tests of density, melt flow rate, carbon content, and carbon dispersion. In addition, samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst testing per ASTM D1599 or ring tensile strength per ASTM D2290. Molded fittings shall be subject to x-ray for voids, and tests for knit line strength. All fabricated fittings shall be inspected for fusion quality alignment.
- D. The Manufacturer shall maintain permanent QAQC records.

#### 1.4 MATERIAL PACKAGING DELIVERY AND HANDLING

- A. The Manufacturer shall package products for shipment in a manner suitable for safe transport by commercial carrier. When delivered, a receiving inspection shall be performed by the Contractor and CQAE, and the Contractor shall report any shipping damage to the Manufacturer. Pipe and fittings shall be handled, installed, and tested in accordance with the Manufacturer's recommendations, and the requirements of this specification.

## **PART 2 – MATERIALS**

### **2.1 HDPE PIPE PHYSICAL PROPERTIES**

- A. The pipe and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties. Clean rework or recycled material generated by the PE Manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this section of the specification.

### **2.2 PIPE AND FITTINGS**

- A. HDPE pipe manufacture and workmanship shall comply with ASTM D3035 for 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 nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with ASTM D2513. Standard installation and/or laying lengths shall be 40 feet  $\pm$ 2 inches. Fittings such as coupling, wyes, tees, adaptors, etc. for use in pipe connections shall have standard dimensions that conform to ASTM D3261.
- B. Where possible, pipe and fittings should be produced by the same PE Manufacturer and from identical materials meeting the requirements of this specification. Special or custom fittings may be exempted from this requirement.
- C. Pipe and fittings shall be pressure-rated to meet the service pressure requirements specified by the Design Engineer. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.
- D. Molded fittings shall meet the requirements of ASTM D3261 and this specification. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. Upon request, the Manufacturer shall provide an explanation of the production code.
- E. Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information:
  - 1. ASTM standard designation
  - 2. Pipe size
  - 3. Class and profile number
  - 4. Production code
  - 5. Standard dimension ratio

## **PART 3 – EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. The pipe and fittings shall be free of foreign inclusions and visible defects. Unintended holes in 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 pipe.

## 3.2 INSTALLATION

- A. All HDPE pipe placement areas shall be prepared and constructed in accordance with applicable sections of these specifications. The following construction and installation specifications are applicable to this project:
  - 1. Fusion welding of pipe
  - 2. Butt fusion weld in accordance with the PE Manufacturer's recommendation for butt fusion methods.
- B. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by the Manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with the PE Manufacturer's recommendations.
- C. Pipe shall not be bent to a greater degree than the minimum radius recommended by the Manufacturer for type and grade.
- D. Pipe shall not be subject to strains that will overstress or buckle piping or impose excessive stress on joints.
- E. Branch saddle fusions shall be joined in accordance with the PE Manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within the trench. Before butt fusing the pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe and cover open ends of fused pipe at the end of each working day with a cap to prevent entry by animals or debris. Use compatible fusion techniques when polyethylenes of different melt indexes are fused together. Refer to the PE Manufacturer's specifications for compatible fusion.
- F. The following steps shall be observed during flange jointing:
  - 1. Use only on flanged pipe connection sections.
  - 2. Connect slip-on carbon steel backup flanges with galvanized, stainless steel nuts and bolts.
  - 3. Butt fuse or fusion weld fabricated flange adapters to pipe.
  - 4. Align flanges or flange/valve connections to provide a tight seal. Use nitrile-butadiene gaskets if needed to achieve seal. Gaskets are required for flange/valve connections.
  - 5. Place U.S. Standard round washers as may be required on some flanges in accordance with the Manufacturer's recommendations. Bolts shall be lubricated in accordance with the Manufacturer's recommendations.
  - 6. Tighten flange bolts in sequence and accordance with the Manufacturer's recommendations. Do not over-torque bolts.
  - 7. Pull bolt down by degrees to uniform torque in accordance with the Manufacturer's recommendation.
  - 8. Protect below-grade bolts and flanges by covering with a 5-mil polyethylene wrap. Duct tape the wrap to the HDPE pipe. Electrofusion couplers, where used, shall be installed per the Manufacturer's specifications.

## 3.3 PIPE PLACEMENT

- A. Grade control equipment shall be of type to accurately maintain design grades, elevations, and slopes during installation of pipe.
- B. Remove any standing water in trench before pipe installation. Unless otherwise specifically stated, install pipe in accordance with the Manufacturer's recommendations. Maximum lengths

of fused pipe to be handled as one section shall be placed according to the Manufacturer's recommendations as to pipe size, pipe SDR, and topography so as to not cause excessive gouging or surface abrasion; but not to exceed 400 feet in length. Cap pipe sections longer than single joining (usually 40 feet) on both ends during placement except during fusing operations.

- C. Notify the CQAE prior to installing pipe and allow time for the CQAE's observation. The Contractor will correct irregularities found during inspection in a timely manner as to not slow down field operations or pipe installation. Corrections shall be completed prior to the installation of additional pipe. Complete tie-ins within the trench whenever possible to prevent overstressed connections. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins, or backfilling activity.
- D. Where relevant, pipe shall be installed in trenches and backfilled with granular placed to the spring line of the pipe in accordance with these specifications and section 3.3.3 of the CQAQC Plan. Initial bedding installation and backfill shall be accomplished prior to leak testing. Utility burial tape shall be placed at the top of the bedding layer. Compactable soil, free of rocks (over 4-inches in their longest dimension) and organic material, shall be installed in the trench to within two (2) feet of the ground surface and mechanically compacted using a method or methods proposed by the Contractor and approved by the CQAE. Note that the density of this material shall be adequate to prevent slumping in the trench and to allow attainment of the density specification for the top two (2) feet of backfill in the trench. The top two feet of the trench shall be backfilled with non-granular soil (SC to CL). The general compaction specification for the top two feet of backfill is 92% of maximum modified Proctor dry density (ASTM D1557) at  $\pm 4\%$  of optimum moisture content.

### 3.4 PIPE BEDDING

- A. Pipe bedding material shall be placed in all pipe trenches in a manner proposed by the Contractor and approved by the CQAE. Initial pipe bedding shall be placed prior to pipe leak testing. Trench backfilling shall be completed following satisfactory pipe testing.

### 3.5 BACKFILL

- A. Backfill shall be placed in loose 8-inch maximum lifts and compacted to a minimum of 92% of maximum modified Proctor dry density at  $\pm 4\%$  of optimum moisture content. Field moisture density tests shall be conducted at a rate no less than one test per compacted soil lift per 100 feet of trench.

**END OF SECTION**