

TECHNICAL SPECIFICATIONS

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SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under this project consists of providing the labor, equipment, materials, and ancillary construction to access and construct Cell 5 at the Montezuma County Landfill, as shown on the Construction Drawings, CQA Plan, and these Technical Specifications.

1.2 DEFINITIONS

OWNER – Montezuma County

CONTRACTOR – Any and all parties performing the work as described in these Technical Specifications, excluding work to be performed by the INSTALLER.

INSTALLER – Any and all parties performing geosynthetics installation.

ENGINEER – Weaver Consultants Group

CQAE – Construction Quality Assurance Engineer, and/or construction quality assurance/quality control consultant, and/or Weaver Consultants Group

1.3 LOCATIONS

The following locations will be utilized in the submittal of bids:

Facility:

26100 Road F
Cortez, CO 81321

Submission of Bids:

Mr. Mel Jarmon
26100 Road F
Cortez, CO 81321
MJarmon@co.montezuma.co.us

1.4 INTENT OF THE CONTRACT

The intent of the Contract is to provide for construction and completion of the work in accordance with the Contract drawings and specifications, using a standard of care consistent in the solid waste construction management industry, consistent with the General and Special Conditions, and other requirements contained herein. Unless otherwise specified, the CONTRACTOR will furnish all labor, materials, tools, equipment, and incidentals that are

necessary to complete the work in a proper, complete, and acceptable manner, in accordance with the drawings and specifications.

Given the nature of this project, some field revisions to the Technical Specifications and Drawings are possible. The OWNER or its Representative(s) and the CONTRACTOR will work together to resolve field issues in a timely and cost-effective manner. The Technical Specifications, Drawings, Description of Work, and field coordination will ensure all work is completed, at minimum, in accordance with the manufacturer's specifications, good practice, and local, state, and federal regulations. Each section of the Technical Specifications provides detailed guidance to the materials and methods to be used in the construction work, and the testing and approval of the work.

1.5 SUMMARY OF WORK TO BE DONE BY CONTRACTOR

- A. Management of surface waters into and from the construction area during construction.
- B. Stripping and stockpiling of topsoil and other soils from the surface of areas to be excavated and filled.
- C. Removal and stockpiling of soils from the excavated areas to achieve design grade elevations.
- D. Construction of berms to form the perimeter of disposal Cell 5
- E. Construction of floor and sideslopes of disposal Cell 5
- F. Preparation and maintenance of the subgrade soils for construction of the liner system (by others) over the floor and sideslopes of the cells. The disposal cell base liner system, from bottom to top, includes 1-foot structural fill, geosynthetic clay liner, high density polyethylene (HDPE) textured geomembrane, 6-ounce geotextile, leachate collection layer (floor only), 8-ounce geotextile, and protective soil cover (sideslope only)
- G. Preparation and backfilling of geosynthetics anchor trenches, in coordination with the INSTALLER.
- H. Construction and placement of the leachate collection layer.

1.6 CONTRACTOR RESPONSIBILITIES

- A. Requirements of the Work. The CONTRACTOR will be responsible for knowing and understanding the requirements of the work, including these Technical Specifications and the Drawings. The OWNER or its Representative(s) will assist the CONTRACTOR with following and meeting the requirements of these documents, but the OWNER or

its Representative(s) will not be responsible for informing the CONTRACTOR of the requirements.

- B. Health and Safety. The CONTRACTOR will have sole responsibility for the health and safety of its employees and completing the work in accordance with all local, state, and federal requirements.
- C. The CONTRACTOR will provide all equipment, personnel, and materials to complete the work to the line, grade, and requirements included in this description, the Technical Specifications, and the Drawings.
- D. The CONTRACTOR will provide all temporary facilities (office, phone, power, sanitary, eyewash stations, etc.) required for its work. If the CONTRACTOR provides an office facility, space for a desk and table, with electrical power suitable for light and computer, CONTRACTOR will make it available to the OWNER or its Representative(s).
- E. Protection of Existing Facilities. The CONTRACTOR will protect existing vegetation, structures, equipment, utilities, pavement, and improvements. Any damage caused by the CONTRACTOR or its subcontractors will be repaired or replaced equal to existing work, at the expense of the CONTRACTOR.
- F. No work will be done by the CONTRACTOR without personnel from the OWNER or its Representative(s) at the site, unless previously approved by the OWNER or its Representative(s).
- G. Surveying. Except as noted below, the OWNER or their Representative(s) will provide surveying for as-built construction and for determining construction quantities. The CONTRACTOR, at their own expense, will be responsible for any additional construction or check surveying.
 - 1. The CONTRACTOR will be responsible for maintaining staking and control points provided by the OWNER or their Representative(s). Replacing these, except where removal is necessary to completing the Work, will be at the expense of the CONTRACTOR.
- H. Permits and Permissions. The CONTRACTOR will be responsible for obtaining all permits and permissions necessary to begin and complete the Work. The contractor may operate under the Montezuma County Landfill's Stormwater Permit.
- I. Environmental Controls. The CONTRACTOR will be responsible for temporary environmental controls associated with the construction work, including, but not limited to, dust suppression, drainage control, stormwater control, storage and control of petroleum products, and hazardous materials and wastes.
- J. All work must be carried out and maintained per the drawings and specifications subject to the approval of the Design Engineer and Construction Quality Assurance

Engineer (CQAE). Any materials found to be outside of the tolerances identified in the drawings and specifications must be reworked, or removed and replaced, to meet the approval of the CQAE and at no additional cost to the OWNER.

- K. CONTRACTOR will be responsible for any damage their operations cause to any portion of the Work, regardless of the circumstances, and will repair this damage to the approval of the CQAE and at no additional cost to the OWNER.
- L. CONTRACTOR will be responsible for all dewatering and repairs required due to rain or freezing; associated costs are to be included in unit prices. The CONTRACTOR will also be responsible for dust control and maintaining all required haul roads during construction.

1.7 SUMMARY OF WORK TO BE DONE BY GEOSYNTHETICS CONTRACTOR

The INSTALLER's services will be retained under The CONTRACTOR. CONTRACTOR should allow for the following activities when scheduling his work:

- A. Inspection of materials placed by the CONTRACTOR prior to geosynthetics placement.
- B. Preparation of reports and other documents describing acceptability of subgrade work completed by the CONTRACTOR.
- C. Installation of the disposal cell base liner system.
- D. Preparation of as-built panel layout drawing for each geomembrane layer.

1.8 OWNER RESPONSIBILITIES

1.8.1 OWNER-Supplied Material

For the purpose of this Contract, the OWNER will provide the following:

- Drainage stone for leachate collection system
- All soil material, including topsoil, structural fill, and general fill material. However, CONTRACTOR will be responsible for excavating and transporting the soil material from the soil borrow and/or stockpile area.

The CONTRACTOR will supply all other construction materials required for this project. However, OWNER may request the CONTRACTOR to supply other material at the unit cost listed on the Bid Worksheet.

1.8.2 OWNER-Supplied Services

Services to be provided by the OWNER for this project include:

- OWNER will provide an adequate storage area and equipment parking area in the vicinity of the actual construction area.
- OWNER will provide a Site Manager to interface with CONTRACTORS working at the site.
- OWNER (through the CQAE) will provide as-built drawings as applicable.
- The OWNER will also provide any required Contract quantity verification surveys.
- OWNER will provide a disposal area for any existing non-hazardous waste or deleterious materials that are excavated and removed by the CONTRACTOR during the project.
- OWNER will provide a source of water for soil moisturizing.
- OWNER will provide approval of work.

The CONTRACTOR will provide equipment and services necessary for on-site disposal of waste generated by the CONTRACTOR and GEOSYNTHETICS CONTRACTOR during construction.

1.9 CQAE RESPONSIBILITIES

The CQAE will be retained under a separate contract to the OWNER.

- A. The OWNER or its Representative will provide construction quality assurance/quality control (CQA/QC). This will include testing equipment, supplies, and personnel for testing earth construction (moisture/density testing), observing and documenting synthetic liner construction, and observing and documenting all other construction.
- B. The CQAE will be a Representative of the OWNER.
- C. The CQAE must have experience in constructing prepared subgrades, synthetic liners, and earthwork.
- D. The CQAE will appoint an Inspector who will be responsible for documenting field construction and the compliance of the finished product with the requirements of the Technical Specifications and Drawings, good practice, and the local, state, and federal laws and regulations governing their construction.
- E. The CQAE will have a Professional Engineer, licensed in Colorado, on their staff with suitable experience for certifying that the facility has been constructed in compliance with the requirements of these Technical Specifications and Drawings, good practice, and the local, state, and federal laws and regulations governing their construction.

1.10 COORDINATION BETWEEN CONTRACTORS

Before any work begins, each CONTRACTOR will carefully check all plans and specifications for each trade and job condition. Any lack of coordination between CONTRACTOR'S work, other Contractors, plans, specifications, or job conditions will be immediately reported to OWNER, in writing. If CONTRACTOR fails to call such conflict or lack of coordination between other

Contractors, plans, specifications, or job conditions to the OWNER's attention before any work is done, it will be assumed that no conflict or lack of coordination exists, and that all specified milestones contained in the approved baseline schedule will be met.

CONTRACTOR will coordinate all geosynthetic and certification survey scheduling through the CQAE to ensure well-coordinated operations and construction activities during the project.

END OF SECTION

SECTION 01310
SUBMITTALS, INSPECTIONS, TESTS AND REPORTS

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under this project consists of providing the labor, equipment, and materials as required by these Technical Specifications. A summary of the submittals, inspections, tests, and reports required for each section of these Technical Specifications is provided below. The CONTRACTOR will confirm that the summary matches the requirements of each section and the individual section summaries include all of the required items. The CONTRACTOR will promptly notify the Construction Quality Assurance Engineer (CQAE) of any differences. In the case of a conflict, the more stringent requirement will apply.

1.2 PROCEDURES FOR SUBMITTALS

A. Reviewing, Certifying, Approving Authority

1. The CQAE will be responsible for reviewing and certifying that submittals are in compliance with Contract requirements.
2. Approving authority on submittals is the CQAE Professional Engineer, unless otherwise specified for a specific submittal.

B. Constraints

1. Complete submittals for each definable feature of work. Components of definable features interrelated as a system will be submitted at the same time.
2. When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, submittal will be returned without review.
3. Approval of a separate material, product, or component does not imply approval of assembly in which item functions.

C. Scheduling

1. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential requirements to resubmit.
2. Except as specified otherwise, allow a review period, beginning with receipt by approving authority, which includes at least five working days for submittals for CQAE approval, unless otherwise noted or agreed in writing.
4. Period of review for each resubmittal is the same as for initial submittal.

- D. Variations. Variations from contract requirements require approval prior to their construction.
1. Considering Variations. Discussion with CQAE before submission will help ensure functional and quality requirements are met and will minimize rejections and resubmittals.
 2. Proposing Variations.
 - a. When proposing a variation, deliver a written request to the CQAE with documentation of the nature and features of the variation and why the variation is desirable and beneficial.
 - b. If lower cost is a benefit, also include an estimate of the cost savings.
 - c. In addition to documentation required for a variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.
 3. Warranting that Variations are Compatible.
 - a. When delivering a variation for approval, CONTRACTOR warrants this contract has been reviewed to establish that the variation, if incorporated, is equal to or better than the specified item.
 - b. When delivering a variation for approval, CONTRACTOR warrants this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.
 4. Review Schedule is Modified. In addition to the normal submittal review period, a period of 10 working days will be allowed for consideration of submittals with variations (a total review period of 15 working days).

1.3 CONTRACTOR RESPONSIBILITIES

- A. Determine and verify field measurements, materials, field construction criteria. Review each submittal and check and coordinate each submittal with requirements of the work and Contract Documents.
- B. Transmit submittals to CQAE to prevent delays in the work, delays to the OWNER, or delays to separate contractors.
- C. Advise OWNER and its Representative(s) of variations, as required by paragraph entitled "Variations".
- D. Correct and resubmit submittal as directed by approving authority.
 1. When resubmitting disapproved transmittals or transmittals noted for resubmittal, the CONTRACTOR will provide a copy of that previously submitted transmittal, including all reviewer comments for use by approving authority.

2. Direct specific attention, in writing or on resubmitted submittal, to revisions not requested by approving authority on previous submissions.
- E. Furnish additional copies of submittal when requested by CQAE, up to five copies per submittal.
- F. Complete work on schedule to allow timely completion of a submittal that describes the work.
- G. Ensure no work has begun until submittals for that work have been returned as “approved” or “approved as noted”, except to the extent that a portion of work must be accomplished as basis of submittal.

1.4 CQAE RESPONSIBILITIES

- A. Note date on which submittal was received from CONTRACTOR on each submittal.
- B. Review each submittal and check and coordinate each submittal with requirements of work and Contract Documents.
- C. Review submittals for conformance with project design concepts and compliance with Contract Documents.
- D. Act on submittals, determining appropriate action based on CQAE’s review of submittal.
- E. Ensure that material is clearly legible.
- F. Stamp each sheet of each submittal with CQAE certifying statement or approving statement, except that data submitted in bound volume or one sheet printed on two sides may be stamped on the front of the first sheet only.
- G. Sign certifying statement or approval statement. The person signing certifying statements will be the CQAE Professional Engineer. The signatures will be in original ink; stamped signatures are not acceptable.
- H. Establish and update a submittal register as submittal actions occur, and maintain the submittal register at project site until final acceptance of all work.
- I. Retain a copy of approved submittals at project site, including CONTRACTOR'S copy of approved samples.

1.5 SUMMARY BY SECTION

- A. Section 02300 – Earthwork
 1. Submittals

a. Qualifications

(1) CONTRACTOR

- (a) Documentation of the CONTRACTOR'S experience with projects of similar scope and size (**Section 02300, Part 1.7.A** of these Technical Specifications).
- (b) Documentation of the CONTRACTOR'S ability to provide equipment appropriate to the work in order to complete the work in a timely manner.
- (c) Documentation of the experience of the CONTRACTOR'S Superintendent on projects of similar scope and size.

(2) CQAE

- (a) Documentation of the CQAE'S experience with projects of similar size and scope.
- (b) Documentation of the CQAE'S ability to provide testing services required by this project. These services may be provided by a subcontractor to the CQAE or the CONTRACTOR, provided the CQAE'S onsite person has at least two years of experience with projects of similar size and scope.

- b. Alternate Materials and Methods proposed by the CONTRACTOR for earthwork must be submitted and approved before their use.

2. Inspections, Tests, and Reports

- a. Documentation of the weather conditions by the CQAE (**Section 02300, Part 1.9.C** of these Technical Specifications).
- b. Foundation inspections, surface inspections, panel deployment drawings, etc., as required by these Technical Specifications for liner systems.
- c. Density testing results, as required by **Section 02300, Part 3.5** of these Technical Specifications.
- d. As-built drawings (**Section 02300, Part 3.6** of these Technical Specifications).

B. Section 02513 – HDPE Liners

1. Submittals

- a. Before delivery of any geomembrane rolls 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 geomembrane and/or resin manufacturer to document the quality of the resin used in the membrane fabrication.
 - (3) Information showing the liner materials and manufacturing meet the requirements of **Section 02513, Part 2.1** of these Technical Specifications.

- b. Before delivery of any geomembrane rolls to the site and beginning liner installation, the CONTRACTOR will provide information showing the Manufacturer, Fabricator (if different than the Manufacturer), and INSTALLER meet the requirements of **Section 02513, Part 1.6** of these Technical Specifications, including qualifications of the INSTALLER's seamer.
 - c. At least three days before beginning liner installation, the INSTALLER will provide the CQAE with seam layout drawings for each panel, showing each expected seam. The CQAE will review the seam layout drawing and document that it is consistent with accepted practice and the design plans and drawings. No seaming will be performed without the CQAE'S written approval.
 - (1) In general, seams should be oriented parallel to the line of maximum slope, so they are oriented along, not across, the slope.
 - (2) In corners and at other odd geometric intersections, the number of seams should be minimized.
 - (3) All horizontal seams across the slope must be approved by the CQAE. Only end-of-panel seams are eligible for approval.
 - (4) A seam numbering system that is compatible with the geomembrane roll numbering system will be agreed upon by the INSTALLER and the CQAE.
 - d. Information regarding the quality of extrudate used in the welding apparatus (see **Section 02513, Part 1.9.E** of the Technical Specifications).
 - e. Proposed alternate seaming processes (see **Section 02513, Part 1.9.B.4** of these Technical Specifications).
2. Inspections, Tests, and Reports
- a. Materials inspections upon delivery of materials (see **Section 02513, Part 1.7** of these Technical Specifications).
 - b. Seaming quality control records (see **Section 02513, Part 1.9.C.2** of these Technical Specifications).
 - c. Documentation of weather conditions (see **Section 02513, Part 1.8.D** of these Technical Specifications).
 - d. Inspections and approval of the surface upon which liner will be placed (see **Section 02513, Part 3.1.A.4** of these Technical Specifications).
 - e. Inspections of the liner deployment (see **Section 02513, Part 3.2.H** of these Technical Specifications).
 - f. Information regarding trial seams (see **Section 02513, Part 3.3.A** of these Technical Specifications).
 - g. Collection and testing of materials samples from each roll (see **Section 02513, Parts 3.4 and 3.5** of these Technical Specifications).

- h. Documentation of capping (see **Section 02513, Part 3.3.B.6** of these Technical Specifications).
- i. Non-destructive and destructive testing of field seams (see **Section 02513, Parts 3.5.B and C** of these Technical Specifications).
- j. Visual inspection of the liner prior to covering (see **Section 02513, Part 3.7** of these Technical Specifications).

C. Section 02515 – GCL Liner

1. Submittals

- a. Before delivery of any GCL rolls to the site, the Manufacturer will provide the CQAE with the following information:
 - (1) The supplier, supplier location, and brand name.
 - (2) Any test results conducted by the manufacturer to document the quality of the material used in fabrication.
 - (3) Information showing the GCL materials and manufacturing meet the requirements of **Section 02515, Part 2.1** of these Technical Specifications.
- b. Before delivery of any GCL rolls to the site and beginning liner installation, the CONTRACTOR will provide information showing the Manufacturer, Fabricator (if different than the Manufacturer), and INSTALLER meet the requirements of **Section 02515, Part 1.6** of these Technical Specifications, including qualifications of the INSTALLER's seamer.
- c. At least three days before beginning liner installation, the INSTALLER will provide the CQAE with seam layout drawings for each panel, showing each expected seam. The CQAE will review the seam layout drawing and document that it is consistent with accepted practice and the design plans and drawings. No seaming will be performed without the CQAE'S written approval.

2. Inspections, Tests, and Reports

- a. Materials inspections upon delivery of materials (see **Section 02515, Part 1.7** of these Technical Specifications).
- b. Documentation of weather conditions (see **Section 02515, Part 1.8** of these Technical Specifications).
- c. Inspections and approval of the surface upon which liner will be placed (see **Section 02515, Part 3.1.A.4** of these Technical Specifications).
- d. Inspections of the liner deployment (see **Section 02515, Part 3.2.I** of these Technical Specifications).
- e. Collection and testing of materials samples from each roll (see **Section 02515, Parts 3.4 and 3.5** of these Technical Specifications).

- f. Visual inspection of the liner prior to covering (see **Section 02515, Part 3.6** of these Technical Specifications).

END OF SECTION

SECTION 01560
PROTECTION OF ENVIRONMENT

PART 1 GENERAL

1.1 SUMMARY

- A. CONTRACTOR, in executing Work, will maintain Work areas on and off site free from environmental pollution that would be in violation of federal, state, or local regulations.

1.2 PROTECTION OF WATERWAYS

- A. Observe rules and regulations of the State of Colorado and agencies of the U.S. Government prohibiting pollution of lakes, streams, rivers, or wetlands by dumping of refuse, rubbish, dredge material, or debris.
- B. Provide holding ponds or other approved method which will divert flows, including storm flows and flows created by construction activity, to prevent excessive silting of waterways or flooding damage to property.
- C. Comply with procedures outlined in U.S. Environmental Protection Agency (EPA) manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning and Implementation," Manual EPA 72-015 and "Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," Manual EPA 43019-73-007.

1.3 EROSION AND SEDIMENT CONTROL

- A. CONTRACTOR will obtain all required local, state, and federal permits prior to commencement of construction.
- B. Comply with site surface water management practices and requirements for stormwater discharge.
- C. Apply appropriate soil conservation measures to protect project area and adjacent lands. These measures may include filter barriers, sediment traps, and basins.
- D. Select methods of erosion and sediment control for specific job site.
 - 1. Adjust sediment control measures in field to meet conditions encountered.
- E. Provide erosion control measures in place before commencing Work on project site.
 - 1. Maintain erosion control measures during course of construction.

2. Remove erosion control measures upon establishment of permanent, surface stabilization.

1.4 PROTECTION OF AIR QUALITY

- A. Minimize air pollution by requiring use of properly operating combustion emission control devices on construction vehicles and equipment, and encourage shutdown of motorized equipment not in use.
- B. Do not burn trash on construction site.
- C. If temporary heating devices are necessary for protection of Work, they must not cause air pollution.

1.5 USE OF CHEMICALS

- A. Chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must be approved by U.S. EPA or U.S. Department of Agriculture or any other applicable regulatory agency.
- B. Use and disposal of chemicals and residues must comply with manufacturer's instructions.
- C. OWNER will be notified in writing before chemicals are delivered to or stored at facility.

1.6 NOISE CONTROL

- A. Conduct operations to cause least annoyance to residents in vicinity of Work, and comply with applicable local ordinances.
- B. Equip compressors, hoists, and other apparatus with mechanical devices necessary to minimize noise and dust. Equip compressors with silencers on intake lines.
- C. Equip gasoline or oil-operated equipment with silencers or mufflers on intake and exhaust lines.
- D. Conduct operation of dumping rock and of carrying rock away in trucks so as to minimize noise and dust.

1.7 DUST CONTROL

- A. Provide and maintain temporary site roadways, OWNER'S existing roads, and public roads used during construction operations in clean, dust free condition.

- B. Comply with state and local environmental regulations for dust control and directions of OWNER. If CONTRACTOR'S dust control measures are considered inadequate by OWNER, OWNER will require CONTRACTOR to take additional dust control measures.
- C. CONTRACTOR will supply water truck for dust control.
- D. Conduct operation of dumping rock and of carrying rock away in trucks so as to minimize noise and dust.

1.8 FUELS AND LUBRICANTS

- A. CONTRACTOR to comply with all local, state, and federal regulations concerning transportation and storage of fuels and lubricants.
- B. Fuel storage area and equipment will be approved by OWNER before installation. Containment requirements will be submitted by CONTRACTOR for approval in writing by OWNER.
- C. All spills or leakage will be reported to OWNER, and cleanup is required.
- D. OWNER will reserve the right to order damaged or leaking equipment off-site.

END OF SECTION

SECTION 02300 **EARTHWORK**

PART 1 GENERAL

1.1 SUMMARY

- A. The work to be performed under this project consists of providing the labor, equipment, and materials and ancillary construction to access and construct structural earthwork. Structural earthwork includes the structural fill, and termination berms for the disposal cell.

1.2 DESCRIPTION OF THE WORK

- A. Construction will be done in accordance with these Technical Specifications and the Drawings. This will ensure all work is completed, at minimum, in accordance with manufacturer's specifications, good practice, and local, state, and federal regulations.
- B. Summary of the Work

The proposed project site will include disposal Cell 5

Structural earthwork for this project includes the following:

- Excavation of the disposal cell
- Structural fill for the disposal cell termination berms
- Structural fill for the disposal cell

All excavations will be sloped or shored as required by site conditions to meet Occupational Safety and Health Association (OSHA) regulations.

1. Grading for Cell 5 - Cell 5 will be graded in accordance with the specifications and drawings. Cell 5 will tie into existing Cell 4 contours.

2. Structural Fill

The cell 5 structural fill will be placed in approximately 9-inch loose lifts and compacted to greater than 95% of standard proctor ASTM D698 maximum dry density. Compacted lifts shall not exceed 6 inches. Nuclear density testing shall be done to confirm soils have been properly compacted. Structural fill shall have a maximum particle size of 2-inches and have a USCS Classification of SM, SC< ML, CL, MH, or CH.

3. Termination Berms - Berms will be constructed around the disposal cell for two reasons; first, to prevent surface runoff from flowing into the cell, and second, to provide containment above ground level.

Soils suitable for fill, as determined by onsite investigations, will be used to construct the berms (see **Part 2.1.B.** of this Section of these Technical Specifications). Material exceeding 2 inches in diameter will not be used as structural fill.

Soils containing organic or other unsuitable materials will be stripped from the surface of the existing ground within the limits of the berm fill. Soils containing organic materials will be stockpiled for reuse in revegetating fill slopes and reclamation of the site.

Soils suitable for fill will be placed in approximately 9-inch loose lifts and then compacted to a minimum of 95% of Standard Proctor (ASTM D698) maximum dry density. Compacted lifts shall not exceed 6 inches. Nuclear density testing will be done to confirm soils have been properly compacted.

1.3 SUBSURFACE CONDITIONS

A. Site Investigations

Available site investigation is provided in the permit documents for the Montezuma County Landfill

B. Soils

1. The preliminary subsurface investigation of the site indicates that all soils sampled onsite fall into the Common Fill category.

C. Utilities

1. Subsurface utilities (power, water, sewer, and gas) may exist at this site. A utility clearance must be completed for this site.
2. Before beginning work, the CONTRACTOR will confirm the clearance obtained by the CONTRACTOR. This confirmation will be provided in writing to the OWNER or its Representative before beginning work.

D. Groundwater

1. Routine groundwater monitoring is performed at the site, including groundwater level measurements. Subsurface water was not found within 20 feet below ground surface, which is well below the limits of the excavation.
2. Should subsurface waters be encountered during construction in sufficient quantity to affect construction, this will be considered a change of conditions.

1.4 SUBMITTALS

A. Qualifications

1. CONTRACTOR

- a. Documentation of the CONTRACTOR'S experience with projects of similar scope and size (see **Part 1.7.A** of this Section of these Technical Specifications).
 - b. Documentation of the CONTRACTOR'S ability to provide equipment appropriate to the work in order to complete the work in a timely manner.
 - c. Documentation of the experience of the CONTRACTOR'S Superintendent on projects of similar scope and size.
 - d. Construction Quality Assurance Engineer (CQAE).
 - a. Documentation of the CQAE's experience with projects of similar size and scope.
 - b. Documentation of the CQAE's ability to provide testing services required by this project. These services may be provided by a subcontractor to the CQAE or the CONTRACTOR, provided the CQAE's onsite person has at least two years of experience with projects of similar size and scope.
- B. Alternate Materials and Methods proposed by the CONTRACTOR for earthwork must be submitted and approved before their use.

1.5 INSPECTIONS, TESTS, AND REPORTS

- A. Documentation of the weather conditions by the CQAE (see **Part 1.9.C** of this Section of these Technical Specifications).
- B. Foundation inspections, surface inspections, panel deployment drawings, etc., as required by these Technical Specifications for liner systems used in constructing the pond/cell.
- C. Density testing results, as required by **Part 3.5** of this Section of these Technical Specifications.
- D. As-built drawings, as required by **Part 3.6** of this Section of these Technical Specifications.

1.6 REFERENCES

The publications listed below form a part of this Technical Specification to the extent referenced. The publications are referred to within the text by the basic designation only. Consult only the most up to date versions of each publication referenced.

ASTM INTERNATIONAL (ASTM)

ASTM D6913	Sieve analysis of fine grained soils
ASTM D698	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D5084	Hydraulic conductivity of Soils (Constant Head)
ASTM D2487	Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2922	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.7 QUALIFICATIONS

A. CONTRACTOR

1. The CONTRACTOR is responsible for removing, processing, and replacing soils as required by these Technical Specifications and the drawings.
2. The CONTRACTOR and its Superintendent must have experience in excavating and replacing soils on projects of similar requirements and size.
3. The CONTRACTOR will have, or be able to provide, equipment appropriate to the work, and in capacity and number to complete the work in a timely fashion.

B. CQAE

1. The CQAE will be a representative of the OWNER.
2. The CQAE will have experience in constructing structural fill, synthetic liners, compacted clay liners, geosyntheticss, and earthwork.
3. The CQAE will appoint an Inspector who will be responsible for documenting that field construction and the finished product complies with the requirements of these Technical Specifications and Drawings, good practice, and the local, state, and federal laws and regulations governing their construction.
4. The CQAE will have a Professional Engineer(s) registered in Colorado and with suitable experience that will be responsible for certifying that the facility has been constructed in compliance with the requirements of these Technical Specifications and Drawings, good practice, and the local, state, and federal laws and regulations governing their construction.

1.8 DELIVERY, STORAGE, AND HANDLING

Materials and supplies for the work described in this Section will be delivered, stored, and handled as required by this or other Sections of the Technical Specifications. Sections related to this Section include **02513 – HDPE Liners**

1.9 WEATHER LIMITATION

- A. Moisture and Wind. Backfilling and compaction will not be done in the presence of excess moisture (i.e., rain or snow) or in areas of ponded water, unless approved in writing by the OWNER or its Representative.
- B. Temperature. Backfilling, moisture conditioning, and compaction will not be done when the temperature is below freezing, or when the material contains frozen soils.
- C. The CQAE will document that these requirements are met by the CONTRACTOR and will document the actual weather conditions during construction.

1.10 EQUIPMENT

The equipment to be used by the CONTRACTOR will be appropriate to the work and of number and capacity to complete the work in a timely manner.

PART 2 PRODUCTS

2.1 SOILS

A. Structural fill

1. Structural fill will be placed for the termination berms and embankments and will be free of frozen lumps, wood, or other organic material, and will be acceptable to the Soils Engineer.

Structural fill will consist of approved, unclassified soil material with the characteristics required to compact to the soil density specified for the intended location. The soils at the site fall into this category and are acceptable for the intended purpose of liner subgrade. The structural fill shall have a maximum particle size of 2-inches and a USCS Classification of SM, SC, ML, CL, MH, or CH.

- #### **B. Topsoil**. Natural soil representative of productive soils in the area, free of stumps, toxic substances, and other material detrimental to plant growth.

PART 3 EXECUTION

3.1 PREPARATION

- #### **A. Slope staking** will be the responsibility of the CONTRACTOR.

B. Clearing, Grubbing, and Topsoil Removal

1. Before beginning any excavation or fill, remove topsoil within the limits of the work.
2. Topsoil will be removed to a minimum depth of 6 inches.
3. Spread topsoil on areas already graded and prepared for topsoil or transport and deposit topsoil to areas that are to receive application of the topsoil (berm surfaces, etc.).
4. Keep topsoil separate from other excavated materials, brush, litter, and other materials that would interfere with planting and maintenance operations.
5. Stockpile, in locations indicated by the OWNER or its Representative(s), any surplus of topsoil from excavations and grading.

C. Drainage

1. Provide for the collection and disposal of surface and subsurface water encountered during construction.
2. Completely drain construction site during periods of construction to keep soil materials sufficiently dry.

3. Construct storm drainage features (ponds/basins) at the earliest stages of site development and throughout construction, grade the construction area to provide positive surface water runoff away from the construction activity, and provide temporary ditches, swales, and other drainage features and equipment, as required, to maintain dry soils.
4. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein.
5. It is the responsibility of the CONTRACTOR to assess the soil conditions presented by the plans and Technical Specifications, and to employ necessary measures to permit construction to proceed.

3.2 GENERAL EXCAVATION

- A. Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified.
- B. Perform the grading in accordance with the typical sections shown and the tolerances specified.
- C. The CONTRACTOR will plan his work to use direct transport of satisfactory excavated materials to fills or embankments within the limits of the work, as much as possible.
- D. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation.
- E. Dispose surplus satisfactory excavated material not required for immediate fill or embankment in areas approved for surplus material storage or designated waste areas.
- F. Dispose unsatisfactory excavated material in designated waste or spoil areas.
- G. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times.
- H. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas.

3.3 FILLING AND COMPACTION FOR STRUCTURES

- A. Subgrade Preparation
 1. Construction

- a. Shape subgrade to line, grade, and cross sections, and compact as specified. Include plowing, discing, and any moistening or aerating required to obtain specified compaction for this operation.
- b. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed.

2. Proof Rolling

- a. Proof-roll the subgrade of the access road, truck off-loading area, and berms after the subgrade has been prepared, as required by these Technical Specifications.
- b. Finish proof rolling on an exposed subgrade, free of surface water (wet conditions resulting from rainfall), which would promote degradation of an otherwise acceptable subgrade.
- c. Proof-roll the subgrade of the access road and truck off-loading area and berms with at least one pass of a 10-CY loaded dump truck, a Caterpillar 950 front-end loader with a loaded bucket, or equivalent.
- d. Operate the equipment in a systematic manner to ensure the number of passes and full coverage over all areas and at speeds between 2-1/2 to 3-1/2 mph.
- e. Notify the CQAE a minimum of one day before proof rolling. Proof rolling not done in the presence of the CQAE is not acceptable.
- f. If deflection during proof rolling is observed to be more than 2 inches, remove rutting or pumping material to a depth of at least 12 inches and replace with properly moisture conditioned and compacted acceptable fill material.

B. Embankments

1. Construct earth embankments from satisfactory materials free of organic, frozen, or other deleterious material.
2. Place the material in successive horizontal layers of loose material as follows:
 - a. Berms
 - (1) Soils suitable for berm construction shall meet the structural fill specifications in Section 2.1. If structural fill soils are not available in sufficient quantity, other soils may be used, as long as compaction is closely monitored, soils are acceptable to the CQAE, and compaction requirements are met.
 - (2) Loose lifts should be approximately 8 inches thick.
 - (3) Compacted lifts will be a maximum of 6 inches thick.
 - (4) Compact the lifts to a minimum of 95% of Standard Proctor (ASTM D698) maximum dry density at $\pm 2\%$ of optimum moisture content.

3. Spread each layer uniformly on a soil surface that has been moistened or aerated, as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed.
4. After spreading, plow, disc or otherwise break up each layer, moisten or aerate as necessary, thoroughly mix, and compact.
5. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

C. Frozen Material

1. Do not place material that is frozen or contains frozen chunks.
2. Do not place material on surfaces that are muddy, frozen, or contain frost.
3. Cover all uncompleted fill or fill to receive liner components, etc., that will be exposed to freezing temperatures for more than three hours with at least 1 foot of loose material. Remove all loose material and the exposed surface of the compacted fill inspected before placing additional fill, liner components, etc. The inspection will include the CQAE and work will not proceed until surface has been approved in writing the CQAE. Remove Unsuitable areas (frozen, excess loose fill, etc.) and replace with suitable properly compacted materials.

3.4 CONSTRUCTION TOLERANCES

The top surface of the subgrade within the limits of a cell will be no greater than -0.2 to 0.0 feet above the lines and grades shown on the drawings. No plus tolerance will be permitted within the cell. For fill areas outside the limits of the pond or cell and fill placed for the construction of roads, the tolerance will be ± 0.2 feet of the lines and grades shown on the drawings.

3.5 TESTING

A. Field Testing Requirements

1. The nuclear moisture/density field testing methods and minimum frequencies to be used are presented in **Table 02300-3**.
2. Field in-place moisture density tests will be verified by laboratory testing and/or alternate field methods on a periodic basis.
 - a. In addition, nuclear moisture/density devices will be standardized daily and the results of the standardization will be included in the daily field report.

**Table 02300-3
Compaction/Moisture Specifications and Minimum Field Test Frequencies**

Fill Type	Parameter/ Method	Specification	Minimum Frequency
Excavation Base (over-excavation backfill), and Embankments/berms	Soil Density ASTM D6938	≥ 95% of Standard Proctor maximum dry density	1 per 750 cy
	Moisture Content ASTM D2216	± 2% of optimum moisture content	
Anchor Trench Backfill	N/A	N/A	N/A
Structural Fill	Soil Density ASTM D6938	Min of 95% of max dry density of Standard Proctor and +/- 2% of optimum moisture content.	1 per 500 cy
	Moisture Content ASTM D2216	± 2% of optimum moisture content	1 per 2,000 cy

Note: cy = cubic yards

B. Laboratory Testing Requirements During Construction

The qualified soils testing laboratory will conduct periodic laboratory testing on samples from the soil borrow area and from the fill areas during construction. **Table 02300-4** on the following page presents the minimum laboratory test types, methods, and frequencies for all non-granular soils used as structural fill at the site.

**Table 02300-4
Laboratory Testing**

	Test	Method	Minimum Frequency
Structural Fill	Unified Soil Classification	ASTM D2487	One per 5,000 cy or change in material type
	Grain Size Analysis	ASTM D7928 with hydrometer	
	Atterberg Limits	ASTM D4318	
	Standard Proctor	ASTM D698	
Clay Liner	Grain Size Analysis	ASTM D7928 with hydrometer	1 per 1,000 cy
	Standard Proctor	ASTM D698	1 per 5,000 cy or change in material type
	Modified Proctor	ASTM D1557	
	Atterberg Limits	ASTM D4318	
	Hydraulic Conductivity	ASTM D5084	1 per 5000 cy or 1 per lift (whichever yields a larger number)
	Specific Gravity	ASTM D854	1 per material type

Note: cy = cubic yards

3.6 AS-BUILT DRAWINGS

- A. Final as-built drawings of the locations and elevations of all structures shall be prepared by the QAE to the same level of detail as the construction drawings and include necessary additional details if variations were used. The as-built drawings shall be submitted to the OWNER.

END OF SECTION

SECTION 02513
HIGH-DENSITY POLYETHYLENE (HDPE) LINER

PART 1 GENERAL

1.1 SUMMARY

- A. The work to be performed under this section consists of providing the labor, equipment and materials, and ancillary construction to access and construct the geomembrane liner in Cell 5as shown on the construction documents prepared by Weaver Consultants Group for Montezuma County.

1.2 DESCRIPTION OF THE WORK

- A. All construction will be done in accordance with these Technical Specifications and the Drawings. This will ensure all work is completed, at minimum, in accordance with manufacturer's specifications, good practice, and local, state, and federal regulations.
- B. Summary of the Work

Synthetic, high-density polyethylene (HDPE) liners will be placed over the sides and bases of Cell 5.

The HDPE liner will be constructed using the materials and methods in these Technical Specifications and the drawings for disposal cell 5:

- 60-mil double sided textured

Alternate materials and methods may be proposed by the CONTRACTOR. Alternate materials and methods must not be used without written permission of the OWNER or its Representative(s).

The HDPE liner will be placed directly over the prepared subgrade. Before installing the HDPE liner, the prepared subgrade will be inspected by the OWNER or its Representative and the geosynthetics INSTALLER. Construction of the HDPE liner must not begin until the prepared subgrade is approved in writing.

The HDPE will be anchored in trenches at the top of the slopes, placed with the long dimension parallel to the slope, placed to minimize seams on slopes and near grade breaks, placed according to an approved panel placement and seaming plan, and with double fusion welds. Extrusion welding may be used only where fusion welding is impractical and must be approved prior to use. All double-weld fusion and extrusion seams will be pressure-tested and mechanically tested, as required by these Technical Specifications and the drawings. Testing will be done by the INSTALLER under the observation of the OWNER or its Representative(s).

1.3 SUBMITTALS

- A. Before delivery of any geomembrane (HDPE) rolls to the site, the Manufacturer will provide the Construction Quality Assurance Engineer (CQAE) with the following information:
 - 1. The resin supplier, supplier location, and brand name.
 - 2. Any test results conducted by the geomembrane and/or resin manufacturer to document the quality of the resin used in the membrane fabrication.
 - 3. The Manufacturing Quality Control Plan the membrane manufacturer will be using for the membrane being supplied.
 - 4. Information showing the liner materials and manufacturing meeting the requirements of **Part 2.1** (including **Table 02513-1**) of this Section of the Technical Specifications.

- B. At least 15 days before delivery of any geomembrane rolls to the site and beginning liner installation, the CONTRACTOR will provide information showing that the Manufacturer, Fabricator (if different than the Manufacturer), and INSTALLER meet the requirements of **Part 1.6.C** of this Section of the Technical Specifications, including qualifications of the INSTALLER's seamers.

- C. At least three days before beginning liner installation, the INSTALLER will provide the CQAE with seam layout drawings for each layer and each panel showing each expected seam. The CQAE will review the seam layout drawing and document that it is consistent with accepted practice and the design plans and drawings. No seaming will be performed without the CQAE's written approval.
 - 1. In general, seams should be oriented parallel to the line of maximum slope so they are oriented along, not across, the slope.
 - 2. In corners and at other odd geometric intersections, the number of seams should be minimized.
 - 3. All horizontal seams across the slope must be approved by the CQAE. Only end-of-panel seams may be approved.
 - 4. A seam numbering system that is compatible with the geomembrane roll numbering system will be agreed upon by the INSTALLER and the CQAE.

- D. Information regarding the quality of extrudate used in the welding apparatus (see **Part 1.9.E** of this Section of the Technical Specifications).

- E. Proposed alternate seaming processes (see **Part 1.9.B.4** of this Section of these Technical Specifications).

1.4 INSPECTIONS, TESTS, AND REPORTS

- A. Materials inspections upon delivery of materials (see **Part 1.7** of this Section of these Technical Specifications).
- B. Seaming quality control (QC) records (see **Part 1.9.C.2** of this Section of these Technical Specifications).
- C. Documentation of weather conditions (see **Part 1.8.D** of this Section of these Technical Specifications).
- D. Inspections and approval of the surface upon which liner will be placed (see **Part 3.1.A.4** of this Section of these Technical Specifications).
- E. Inspections of the liner deployment (see **Part 3.2.H** of this Section of these Technical Specifications).
- F. Information regarding trial seams (see **Part 3.3.A** of this Section of these Technical Specifications).
- G. Collection and testing of materials samples from each roll (see **Parts 3.4 and 3.5** of this Section of these Technical Specifications).
- H. Documentation of capping (see **Part 3.3.B.6** of this Section of these Technical Specifications).
- I. Non-destructive and destructive testing of field seams (see **Part 3.5.B and C** of this Section of these Technical Specifications).
- J. Visual inspection of the liner prior to covering (see **Part 3.7** of this Section of these Technical Specifications).

1.5 REFERENCES

The publications listed below form a part of this Technical Specification to the extent referenced. The publications are referred to within the text by the basic designation only. Consult only the most up to date versions of each publication referenced.

ASTM INTERNATIONAL (ASTM)

ASTM D792 - Method B	Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1004	Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Density of Plastics by the Density-Gradient Technique
ASTM D1603	Carbon Black Content in Olefin Plastics
ASTM D3895	Oxidative Induction Time of Polyolefins by Thermal Analysis
ASTM D4218	Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4437	Standard Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D4833	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5199	Measuring Nominal Thickness of Geosynthetics
ASTM D5397	Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	Microscopic Evaluation of the dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D5721	Air-Oven aging of Polyolefin Geomembranes
ASTM D5820	Standard Practice for Pressurized Air Channel Evaluation of Dual-Seamed Geomembranes
ASTM D5885	Oxidative Induction time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D5994	Measuring Core Thickness of Textured Geomembrane
ASTM D6370	Rubber-Compositional Analysis by Thermogravimetry
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D6497	Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures
ASTM D6693	Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced flexible Polypropylene Geomembranes
ASTM D7466	Test Method for Measuring Asperity Height of Textured Geomembranes

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM9	Cold Weather Seaming of Geomembranes
GSI GRI GM10	The Stress Crack Resistance of HDPE Geomembrane Sheet
GSI GRI GM19a	Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barrier
GSI GRI GN4	Test Methods, Required Properties and Testing Frequency for Biplanar Geonets and Biplanar Geonet Composites

1.6 QUALIFICATIONS

- A. Manufacturer. The Manufacturer will have produced the proposed geomembrane sheets for at least five completed projects, having a total minimum area of 10,000,000 square feet.
- B. Fabricator. The Fabricator is responsible for seaming geomembrane sheets into panels. The Fabricator will have fabricated the proposed geomembrane panels for at least five completed projects, having a total minimum area of 2,000,000 square feet. CONTRACTOR will submit qualifications for the Fabricator at least 15 days prior to receiving materials.
- C. INSTALLER
1. The INSTALLER is responsible for field handling, deploying, seaming, anchoring, and field QC testing of the geomembrane.
 2. The INSTALLER will have installed the proposed geomembrane material for at least five completed projects, having a total minimum area of 2,000,000 square feet.
 3. All seamers must have seaming experience of a minimum of 500,000 square feet of polyethylene (PE) geomembrane, using the same type of equipment to be used on this project.
 4. The most experienced onsite seamer, the "master seamer" (a seamer that has successfully seamed a minimum of 2,000,000 square feet of PE geomembrane, using the same type of equipment to be used on this project), will have direct supervisory responsibility at the site over less experienced seamers.
 5. The INSTALLER will provide documentation of the qualifications of the seaming crew to the CQAE at least 15 days prior to beginning installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery
1. The CQAE and the INSTALLER will be present during delivery and unloading of the geomembrane.

2. Upon arrival, the INSTALLER and CQAE will inspect all materials for defects in the manufacturing process and for damage during transportation. Materials judged by the CQAE to be severely damaged will be rejected and removed from the site. Minor damage and defects may be repaired by the INSTALLER.
 3. Each geomembrane roll/panel will be labeled with the manufacturer's name, product identification number, roll/panel number, and roll dimensions.
 4. The INSTALLER will be responsible for making certain that the manufacturer, type, and thickness of each roll in a shipment are correct.
 5. The CQAE will also maintain a log of geomembrane roll deliveries throughout the construction process. This log must include, at a minimum, the following:
 - a. Manufacture date.
 - b. Date of receipt at the site.
 - c. Roll and lot batch numbers.
- B. Storage. Temporary storage at the project site will be on a level surface, where water cannot accumulate, and free of sharp objects.
1. The geomembrane will be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances.
 2. Storage will not result in crushing the core of roll goods or flattening of the rolls.
 3. Rolls will not be stored more than two high.
 4. Palleted materials will be stored on level surfaces and must not be stacked on top of one another.
 5. Ultraviolet sensitive materials (i.e., polyvinyl chloride (PVC)) will be covered with a sacrificial opaque and waterproof covering or placed in a temporary shelter.
 6. Damaged geomembrane will be removed from the site and replaced with geomembrane that meets the specified requirements.
- C. Handling. Rolls/panels will not be dragged, lifted by one end, or dropped.
1. A pipe of solid bar, of sufficient strength to support the full weight of a roll without significant bending, will be used for all handling activities. The diameter of the pipe of solid bar will be small enough to be easily inserted through the core of the roll.
 2. Chains will be used to link the ends of the pipe of bar to the ends of a spreader bar.
 3. The spreader bar will be wide enough to prevent the chains from rubbing against the ends of the roll.
 4. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar will be at least three-fourths the length

of the core and must be capable of supporting the full weight of the roll without significant bending.

5. If recommended by the manufacturer, a sling handling method using appropriate loading straps may be used.

1.8 WEATHER LIMITATION

- A. Moisture and Wind. Geomembrane will not be deployed or field-seamed in the presence of excess moisture (i.e., rain, snow, fog, dew), in areas of ponded water, or in the presence of excess wind.
- B. Temperature. Unless authorized by the CQAE, no placement or seaming will be attempted at ambient temperatures below 32 °F (degrees Fahrenheit) or above 104 °F.
 1. Ambient temperature will be measured at a height 12 inches above the ground or geomembrane surface.
 2. If seaming is allowed below 32 °F, follow the procedures outlined in GSI GRI GM9.
- C. In marginal conditions, cease seaming unless destructive field seam tests conducted by the QC laboratory confirm that seam properties meet the requirements listed in **Table 02513-2**. Tests will be done in accordance with paragraph "Destructive Field Seam Testing".
- D. The CQAE will document that these requirements are met by the INSTALLER and will document the actual weather conditions during the installation.

1.9 EQUIPMENT

- A. Equipment used in performance of the work will be in accordance with the following and will be maintained in a satisfactory working condition.
- B. Approved processes for field seaming are double fusion welding and extrusion welding.
 1. Double fusion welding will be used for all seams except where space and access constraints prohibit its use.
 2. Fusion welding application may be impractical where space is limited in some parts of the site.
 3. Only apparatus which have been specifically approved by the CQAE will be used.
 4. Proposed alternate processes will be documented and submitted for approval to the CQAE.
- C. Double fusion welding using a dual hot wedge-seaming device is the preferred method of seaming HDPE geomembrane.

1. The fusion welding apparatus will be equipped with gauges giving the applicable temperatures and pressures.
 2. Before installation of any geomembrane material, the INSTALLER will submit seaming QC records, including ambient temperatures, applicable apparatus temperatures and pressures, and trial seam results to the CQAE.
- D. The INSTALLER must meet the following requirements regarding use, availability, and cleaning of extrusion welding equipment to be used at the site:
1. The welding apparatus will be equipped with a continuous temperature monitoring the barrel and the nozzle.
 2. At least one spare operable double fusion and extrusion seaming device will be maintained onsite at all times.
 3. Equipment used for seaming must not damage the geomembrane.
 4. The extruder will be cleaned and purged before beginning seaming and at any time that seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.
 5. The electric generator for the equipment will be placed on an HDPE rub sheet in such a way that no damage occurs to the geomembrane.
 6. A smooth insulating plate or fabric will be placed beneath hot equipment to protect the geomembrane.
- E. The INSTALLER and, if applicable, the Manufacturer, will provide documentation to the CQAE regarding the quality of extrudate used in the welding apparatus. At a minimum, the extrudate should be compatible with the base liner material and contain the same grade and quality of PE resin as used in the base material.

PART 2 PRODUCTS

2.1 MATERIALS

A. Raw Materials

1. The PE resin will contain no more than 2% recycled polymer by weight. Recycled polymer will be limited to material generated within the geomembrane manufacturer's plant and from the same grade and type defined in this plan.
2. No more than 10% regrind, reworked, or trim material in the form of chips or edge strips will be used to manufacture the geomembrane sheets. All regrind, reworked, or trim material will be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced.
3. The PE resin from which the geomembrane is made will have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4. The geomembrane must contain no more than 1% by weight additives, filler, or extenders, excluding carbon black.
5. The geomembrane must have no striations or roughness (inconsistent with the texture), pinholes, or bubbles on the surface.
6. The geomembrane must be free of undispersed raw materials or any other sign of contamination by foreign matter.
7. No post-consumer materials or water-soluble ingredients will be used to produce the geomembrane.
8. For geomembrane with plasticizers, only primary plasticizers that are resistant to migration will be used. The CONTRACTOR will submit a copy of the test reports and QC certificates for materials used in the manufacturing of the geomembrane shipped to the site.
9. Geomembrane materials will conform to the requirements listed in **Table 02513-1** for MQC.

B. Sheet Materials

1. Geomembrane sheets will be unreinforced and manufactured as wide as possible to minimize factory and field seams.
2. Geomembrane sheets will be uniform in color, thickness, and surface texture.
3. Sheets will be textured on both faces. The textured surface features will consist of raw materials identical to that of the parent sheet material and will be uniform over the entire face of the geomembrane.
4. The sheets will be free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants, and other imperfections.
5. Geomembrane sheets and raw materials will conform to the requirements listed in **Table 02513-1** for MQC.

**Table 02513-1
60-mil Textured HDPE Geomembrane Specifications**

Test	Method	Frequency	Requirements
Sheet Thickness (min)	ASTM D5994	One per roll	54 mil (lowest individual for 8 of 10) 51 mil (lowest of any 10)
Asperity Height (min. avg.)	ASTM D7466	1 per 2 rolls	20 mil
Sheet Density	ASTM D792 Method B or ASTM D1505	One per 200,000 lb	Min. avg. of 0.940 g/cm ³
Tensile Strength Yield	ASTM D6693	One per 20,000 lb	Min. avg. 126 lb. per in. width
Break Strength	ASTM D6693	One per 20,000 lb	90 lb/in.
Elongation at Yield	ASTM D6693	One per 20,000 lb	Min. avg. 12%
Elongation at Break	ASTM D6693	One per 20,000 lb	Min. avg. 100%
Tear Resistance	ASTM D1004	One per 45,000 lb	Min. avg. 42 lbs.
Puncture Resistance	ASTM D4833	One per 45,000 lb	Min. avg. 90 lbs.
Stress Crack Resistance ¹	ASTM D5397	One per 400,000 lb	500 hr
Standard Oxidative Induction Time (OIT) ²	ASTM D3895	One per 200,000 lb	Min. avg. 100 min.
High Pressure Oxidative Induction Time (OIT) ²	ASTM D5885	One per 200,000 lb	Min. avg. 400 min.
Oven Aging @ 85 °C Standard OIT ^{2,3}	ASTM D5721 ASTM D3895	Per each formulation	Min. avg. 55% retained after 90 days
Oven Aging @ 85 °C High Pressure OIT ^{2,3}	ASTM D5721 ASTM D5885	Per each formulation	Min. avg. 80% retained after 90 days
UV Resistance High Pressure OIT ^{4,5}	GRI GM11 ASTM D5885	Per each formulation	Min. avg. 50% retained after 1600 hrs
Carbon Black Content (range) ⁶	ASTM D4218	1 per 20,000 lbs	2-3%
Carbon Black Dispersion	ASTM D5596	1 per 45,000 lbs	9 of 10 in categories 1 or 2

Notes: ¹ P-NCTL test is not appropriate for testing geomembranes with textured surfaces. Test should be conducted on smooth edges of textured rolls.

² The manufacturer has the option to select either the standard or high-pressure Oxidative Induction Time (OIT) methods to evaluate antioxidant content in the geomembrane.

³ It is recommended to evaluate the sample at 30 and 60 days to compare to the 90-day response.

⁴ The condition of the test should be 20 hr. UV cycle at 75 °C followed by 4 hr. condensation at 60 °C.

⁵ UV resistance is based on percent retained value, regardless of the original HP-OIT value.

⁶ Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

- mils = one thousandth of an inch min.avg = minimum average g/cm³ = grams per cubic centimeter lb = pound lb. per in. = pounds per inch hr = hours min. = minimum

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation

1. Surface preparation will be performed in accordance with **Section 02300** of these Technical Specifications.
2. Rocks larger than 2 inches in diameter and any other material which could damage the geomembrane will be removed from the surface to be covered with the geomembrane. No material exceeding 6 inches in diameter will be placed within 5 feet of the surface of the embankment.
3. Construction equipment tire or track deformations beneath the geomembrane will not be greater than 1.0 inch in depth.
4. Each day during placement of geomembrane, the CQAE and INSTALLER will inspect the surface on which geomembrane is to be placed and certify in writing that the surface is acceptable.
5. Repairs to the surface of the subgrade will be performed at no additional cost to the OWNER or its Representatives.

B. Anchor Trenches

1. If the anchor trench is excavated in cohesive soil susceptible to desiccation, only the amount of anchor trench required for placement of geomembrane in a single day will be excavated.
2. Ponded water will be removed from the anchor trench while the trench is open.
3. Trench corners will be slightly rounded to avoid sharp bends in the geomembrane.
4. Loose soil, rocks larger than 1/2 inch in diameter and any other material which could damage the geomembrane will be removed from the surfaces of the trench. No material exceeding 6 inches in diameter will be placed within 5 feet of the surface of the embankment.
5. The geomembrane will extend down the front wall and across the bottom of the anchor trench.
6. Backfilling and compaction of the anchor trench will be in accordance with **Section 02300** of these Technical Specifications.

3.2 GEOMEMBRANE DEPLOYMENT

- A. The procedures and equipment used will not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade.
- B. Geomembrane damaged during installation will be replaced or repaired at the CQAE's discretion.
- C. Only geomembrane panels that can be anchored and seamed together the same day will be deployed.

- D. Adequate ballast (i.e., sand bags) will be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind.
- E. No equipment will be operated on the top surface of the geomembrane without permission from the CQAE and INSTALLER.
- F. Seams will be oriented parallel to the line of maximum slope.
- G. The methods used to deploy and backfill over the geomembrane will minimize wrinkles and tensile stresses in the geomembrane.
 - 1. The geomembrane will have adequate slack to prevent the creation of tensile stress.
 - 2. Geomembrane wrinkles will not exceed 6 inches (150 mm) in height. All other wrinkles will be replaced or repaired at the CQAE's discretion
 - 3. Wrinkles that do not meet the above criteria will be cut out and repaired in accordance with the INSTALLER's approved QC manual.
- H. The CQAE will document the following:
 - 1. The length of the geomembrane overlap.
 - 2. The geomembrane overlap is adequate for the seaming process that is used.
 - 3. Procedures used to temporarily bond adjacent geomembrane rolls will not damage the geomembrane.

3.3 SUMMARY

A. Trial Seams

- 1. Trial seams will be made under field conditions on strips of excess geomembrane.
- 2. Trial seams will be performed at a minimum frequency of once per machine per 4 hours, before production seaming and whenever there is a change in seaming personnel, seaming equipment, or seaming equipment settings.
- 3. The trial seams will first be examined for squeeze out, footprint, pressure, and general appearance by the INSTALLER. If a seam fails any of these examinations, a new trial seam will be performed until satisfactory seams are obtained.
- 4. Trial seam samples will be collected and tested in accordance with ASTM D6392.
 - a. One sample will be obtained from each trial seam. This sample will be at least 34 inches long by 12 inches wide with the seam centered lengthwise.
 - b. Six random specimens 1 inch wide will be cut from the sample.
 - (1) Three seam specimens will be field tested for shear strength and three seam specimens will be field tested for peel adhesion using an approved quantitative tensiometer.

- (2) To be acceptable, all test specimens will meet seam strength requirements specified in **Table 02513-2** (see **Part 3.5** of this Section of these Technical Specifications).
5. If the field tests fail to meet these requirements, repeat the entire operation. If the additional trial seam fails, the seaming apparatus or seamer will not be used until the deficiencies are corrected by the INSTALLER and two consecutive successful trial seams are achieved.

B. Field Seams

1. Panels will be seamed in accordance with the geomembrane manufacturer's recommendations and the approved layout plan.
2. In sumps, corners and odd-shaped geometric locations, minimize the number of field seams.
3. Seaming will extend to the outside edge of panels.
4. Geomembrane panels will be overlapped a minimum of 3 inches for seaming.
5. The seam area will be free of moisture, dust, dirt, and foreign material at the time of seaming. For double fusion welding, each overlap and the sheet below the overlap will be hand-wiped clean immediately before welding.
6. Fish mouths in seams will be repaired. Large "fish mouths" or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fish mouths" or wrinkles will be seamed and any portion where the overlap is inadequate will then be patched with an oval patch of the same membrane, extending a minimum of 6 inches beyond the cut in all directions.
7. At locations where the initial seam cannot be nondestructively tested, the seam will be cap stripped with the same geomembrane material. The CQAE will observe the cap stripping to document the uniformity and completeness of the work.
8. On the side slopes, seaming will extend into the anchor trenches.

C. Polyethylene Seams

1. PE geomembranes will be seamed by thermal fusion methods.
2. Extrusion welding will only be used for patching and seaming in locations where thermal fusion methods are not feasible.
 - a. Seam overlaps that are to be attached using extrusion welds will be ground prior to welding.
 - b. Grinding marks will be oriented perpendicular to the seam direction and no marks will extend beyond the extrudate after placement.
 - c. Where extrusion welds are temporarily terminated, long enough to cool, they will be ground before applying new extrudate over the existing seam.

- d. The total depth of the grinding marks will be no greater than 10% of the sheet thickness.

D. Non-Polyethylene Seams

1. Non-PE geomembranes will be seamed by methods as recommended by the geomembrane manufacturer.
2. Seaming adhesives, solvents, or chemical cleaning agents will be stored away from the geomembrane and only spill-resistant containers will be used while working on the geomembrane.

3.4 SAMPLES

- A. The samples will be identified by manufacturer's name, product identification, lot, and roll/panel number. Also note the date, a unique sample number, and the machine direction.
- B. A 12-inch-by-12-inch quality assurance (QA) sample will be collected, labeled, and submitted to the OWNER or its Representative each time QC samples are collected.

3.5 TESTS

- A. The CONTRACTOR will provide all QC samples to the QC laboratory to determine density, thickness, tensile strength at break, and elongation at break in accordance with the methods specified in **Table 02513-1**.
 1. Samples not meeting the specified requirements result in the rejection of applicable rolls/panels.
 2. As a minimum, rolls/panels produced immediately before and immediately after the failed roll/panel will be tested for the same failed parameter. Testing will continue until a minimum of three successive rolls/panels on both sides of the original failing roll/panel pass the failed parameter.
- B. Non-Destructive Field Seam Continuity Testing
 1. Field seams will be non-destructively tested for continuity over their full length.
 - a. For double fusion welds, testing will be in accordance with ASTM D5280 (pressure testing the channel between the double fusion welds).
 - b. For extrusion welds, the vacuum box or the ultrasonic shadow method may be used in accordance ASTM D5641.
 2. Seam testing will be performed as the seaming work progresses, not at the completion of field seaming.
 3. Any seams which fail will be documented and repaired in accordance with the INSTALLER's approved QC manual.

C. Destructive Field Seam Testing

1. A minimum of one destructive test sample per 750 feet of field seam will be obtained at locations specified by the CQAE.
 - a. Sample locations will not be identified prior to seaming.
 - b. Destructive samples will be collected and tested in accordance with ASTM D6392. Samples will be at least 45 inches long by 12 inches wide with the seam centered lengthwise.
 - (1) This sample will be cut into three equal sections, with one piece retained by the INSTALLER, one piece given to the QC laboratory, and the remaining piece given to the CQAE for QA testing and/or permanent record.
 - (2) Each sample will be numbered and cross referenced to a field log which identifies:
 - (a) panel number,
 - (b) seam number,
 - (c) date and time cut,
 - (d) ambient temperature within 6 inches (150 mm) above the geomembrane,
 - (e) seaming unit designation,
 - (f) name of seamer, and
 - (g) seaming apparatus temperature, speed, and pressures (where applicable).
2. Ten 1-inch wide replicate specimens will be cut from the INSTALLER's portion of the sample.
 - a. Five specimens will be tested for shear strength and five for peel adhesion using an approved field quantitative tensiometer.
 - b. Jaw separation speed will be in accordance with the approved QC manual.
 - c. To be acceptable, four out of five replicate test specimens will meet the seam strength requirements specified in **Table 02513-2**.
3. If the field tests pass, five specimens will be tested at the QC laboratory for shear strength and five for peel adhesion in accordance with the QC laboratory's approved procedures. To be acceptable, four out of five replicate test specimens will meet the seam strength requirements specified in **Table 02513-2**.
4. If the field or laboratory tests fail, the seam will be repaired in accordance with paragraph Destructive Seam Test Repairs. Holes for destructive seam samples will be repaired the same day they are cut.

Table 02513-2
GRI GM19a Seam Strength Specifications (pounds/inch of width) for 60-mil HDPE

Test	Number of Specimens	Method	Fusion Weld Strength	Extrusion Weld Strength
60-mil Peel	1 per 750 lineal feet per welder	ASTM D6392	91	78
60-mil Shear	1 per 750 lineal feet per welder	ASTM D6392	120	120

3.6 DEFECTS AND REPAIRS

A. Destructive Seam Test Repairs

1. Seams that fail destructive seam testing may be overlaid with a strip of new material and seamed (cap stripped).
2. Alternatively, the seaming path will be retraced to an intermediate location a minimum of 10 feet on each side of the failed seam location.
 - a. At each location, a small coupon sample will be taken for two additional shear strength and two additional peel adhesion tests using an approved quantitative field tensiometer.
 - b. If these tests pass, then full samples will be taken and tested (see **Part 3.5.C** of this Section of these Technical Specifications).
 - c. If the laboratory tests pass, then the seam will be cap stripped or repaired using other approved methods between that location and the original failed location.
3. If field or laboratory tests fail, the process will be repeated.
4. After repairs are completed, the repaired seam will be non-destructively tested in accordance with paragraph Non-Destructive Field Seam Continuity Testing.

B. Patches

1. Tears, holes, blisters, and other defects will be repaired with patches.
2. Patches will have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects.
3. The geomembrane below large caps will be appropriately cut to avoid water or gas collection between the two sheets.

C. Minor localized flaws may be repaired by spot welding or seaming as determined by the CQAE.

D. Repairs will be non-destructively tested. The CQAE may also elect to perform destructive seam tests on suspect areas.

3.7 VISUAL INSPECTION AND EVALUATION

- A. Immediately before covering, the geomembrane seams and non-seam areas will be visually inspected by the INSTALLER and CQAE for defects, holes, or damage due to weather conditions or construction activities.
- B. At the CQAE'S discretion, the surface of the geomembrane will be brushed, blown, or washed by the INSTALLER if the amount of dust, mud, or foreign material inhibits inspection or functioning of the overlying material.
- C. Each suspect location will be non-destructively tested in accordance with paragraph Non-Destructive Field Seam Continuity Testing. Each location that fails non-destructive testing will be repaired in accordance with paragraph Patches and non-destructively retested.

3.8 PENETRATIONS

- A. Geomembrane penetration details will be in accordance with ASTM D6497 or as recommended by the geomembrane manufacturer.
- B. Factory fabricated boots will be used wherever possible.
- C. Field Seams for Penetrations
 - 1. Will be non-destructively tested in accordance with the INSTALLER'S approved QC manual.
 - 2. Seams that fail non-destructive testing will be repaired in accordance with the INSTALLER'S approved QC manual and non-destructively tested before acceptance.

END OF SECTION

SECTION 02515
GEOSYNTHETIC CLAY LINER (GCL)

PART 1 **GENERAL**

1.1 **SUMMARY**

- A. The work to be performed under this project consists of providing the labor, equipment, and materials and ancillary construction to access and construct the Geosynthetic Clay Liner (GCL) in Cell 5 as shown on the Construction Documents prepared by Weaver Consultants Group for the Montezuma County Landfill

- B. A GCL shall be used to construct the low-permeability layer.

1.2 **DESCRIPTION OF THE WORK**

- A. All construction will be done in accordance with these Specifications and the Drawings. This will ensure all work is completed, at minimum, in accordance with manufacturer's specifications, good practice, and local, state and federal regulations.

- B. Summary of the Work

A GCL shall be placed on top of the 1-foot structural fill within the Cell 5 boundaries throughout the bottom, on the sideslopes, and anchored in the anchor trench below the termination berms as shown on the Drawings.

The GCL shall be constructed using the materials and methods specified in these Specifications and the Drawings. The GCL recommended for this project is Bentomat®ST. 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 Installer must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this Specification. The Installer also must obtain prior approval of the alternative GCL by the OWNER or its Representatives.

The GCL will be placed directly over the 1' structural fill. (see **Part 3.3.A** of Section 02300 of these Specifications). Prior to installing the GCL, the structural fill shall be inspected by the installer and the OWNER or its Representative; construction of the GCL shall not begin until the foundation layer is approved in writing.

The GCL shall be placed with the long dimension parallel to the slope, placed to minimize seams on slopes and near grade breaks, placed according to an approved panel placement and seaming plan, and with overlap widths and sealing required by these Specifications as a minimum.

1.3 SUBMITTALS

A. Qualifications

1. Manufacturer. Documentation of the Manufacturer's experience in producing GCL (see **Part 1.6.A.** of this Section of these Specifications).
2. Installer. Documentation of the Installer's experience in constructing GCL's (see **Part 1.6.B.** of this Section of these Specifications).

B. Alternate Materials and Methods proposed by the CONTRACTOR for GCL construction must be submitted and approved prior to their use.

C. A Panel Placement Plan shall be submitted by the CONTRACTOR to the OWNER or its Representative at least seven days prior to deployment. Deployment shall not begin until the plan is approved.

D. The GCL Manufacturer's Quality Control Plan for documenting compliance with this document shall be provided to the OWNER or its Representative prior to shipping GCL to the site.

E. The Manufacturer's Quality Assurance/Quality Control (QA/QC) Certifications to verify that the materials supplied are in accordance with the Design Plans and Drawings, these Specifications and the Manufacturer's QC Plan shall be provided for each shipment. The certifications shall be signed by a responsible party employed by the GCL Manufacturer and shall include:

1. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the swell index and fluid loss specifications in **Table 02515-1.**
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 02515-1.**
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 02515-1.**

B. Warranties shall be provided by the Manufacturer and Installer prior to deployment of GCL.

1. The Manufacturer's Warranty shall state that the GCL materials meet all requirements of the contract documents and that for the intended use the GCL is warranted for ten years against deterioration.

2. The Installer's Warranty shall state that the GCL shall not fail due to improper installation within ten years.
- C. Samples of the GCL shall be submitted for every 100,000 square feet of GCL (see **Part 3.4** of this Section of these Specifications).

1.4 INSPECTIONS, TESTS and REPORTS

- A. Inspection of materials for defects, including Construction Quality Assurance Engineer (CQAE) documentation (see **Parts 1.7.A.3.** and **1.7.A.5.** of this Section of these Specifications).
- B. Documentation of the weather conditions by the CQAE (see **Part 1.8.C.** of this Section of these Specifications).
- C. Certification the surface of the underlying layer is suitable for placing GCL (see **Part 3.1.A.** of this Section of these Specifications).
- D. Documentation by the CQAE the GCL has been properly deployed (see **Part 3.2.** of this Section of these Specifications).
- E. Documentation the GCL was inspected and approved prior to covering (see **Part 3.6** of this Section of these Specifications).
- F. As-built drawings (see **Part 3.8** of this Section of these Specifications).

1.5 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Consult only the most up to date versions of each publication referenced.

ASTM INTERNATIONAL (ASTM)

ASTM D4354	Sampling of Geosynthetics for Testing
ASTM D4439	Terminology for Geosynthetics
ASTM D4759	Determining the Specification Conformance of Geosynthetics
ASTM D5261	Measuring Mass Per Unit Area of Geotextiles
ASTM D5887	Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5888	Storage and Handling of Geosynthetic Clay Liners
ASTM D5889	Quality Control of Geosynthetic Clay Liners
ASTM D5890	Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D5891	Fluid Loss of Clay Component of Geosynthetic Clay Liners

ASTM D5993	Measuring Mass Per Unit of Geosynthetic Clay Liners
ASTM D6102	Guide for Installation of Geosynthetic Clay Liners
ASTM D6495	Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
ASTM D6496	Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D6766	Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids
ASTM D6768	Tensile Strength of Geosynthetic Clay Liners

1.6 QUALIFICATIONS

- A. Manufacturer. GCL shall be the product of a GCL Manufacturer who has produced the proposed GCL using the same bentonite, polyethylene geomembrane, geotextiles, sewing thread, and adhesive for at least five completed projects and shall have produced a minimum of 2,000,000 square feet of the proposed GCL. CONTRACTOR shall submit manufacturer's qualification to the CQAE for approval a minimum of 15 days before scheduled delivery of the material to the project site.
- B. Installer
1. The Installer is responsible for field handling, deploying, seaming, anchoring, and field QC testing of the GCL.
 2. The Installer shall have installed the proposed GCL material for at least five completed projects having a total minimum area of 500,000 square feet.
- C. CQAE
1. The CQAE shall be a Representative of the OWNER.
 2. The CQAE shall have experience in constructing geosynthetic clay liners, synthetic liners, and earthwork.
 3. The CQAE shall appoint an Inspector who will be responsible for documenting field construction and that the finished product complies with the requirements of these Specifications and Drawings, good practice and the local, state and federal laws and regulations governing their construction.

The CQAE shall have a Professional Engineer with suitable experience who will be responsible for certifying that the facility has been constructed in compliance with the requirements of these Specifications and Drawings, good practice and the local, state and federal laws and regulations governing their construction.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery

1. The Manufacturer assumes responsibility for initial loading of the GCL. Shipping will be the responsibility of the party arranging for the freight transportation. Unloading, onsite handling and storage of the GCL are the responsibility of the Installer or the Installer's designated representative.
2. The CQAE and the Installer shall be present during delivery and unloading of the GCL.
3. Upon arrival, the Installer and CQAE 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 may be repaired by the Installer.
4. 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.
5. The CQAE will also maintain a log of GCL roll deliveries throughout the construction process. This log shall include, at a minimum, the following:
 - a. Manufacture date.
 - b. Date of receipt at the site.
 - c. Roll and lot batch numbers.

B. Storage. Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate.

1. The GCL shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances.
2. Rolls shall be stored in a manner that prevents sliding or rolling from the stacks.
3. Stacks shall be no higher than four rolls.
4. Palleted materials shall be stored on level surfaces and shall not be stacked on top of one another.
5. All stored GCL and accessory bentonite shall be covered with plastic sheeting or tarpaulins until their installation.
6. The integrity and legibility of the roll labels shall be preserved during storage.
7. Damaged GCL shall be removed from the site and replaced with GCL meeting the specified requirements.

C. Handling. Rolls/panels shall not be dragged, lifted by one end, or dropped.

1. A pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll.
2. Chains shall be used to link the ends of the pipe or bar to the ends of a spreader bar.
3. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll.
4. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and must be capable of supporting the full weight of the roll without significant bending.
5. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.8 WEATHER LIMITATIONS

- A. Moisture and Wind. GCL shall not be deployed or field-seamed in the presence of excess moisture (i.e., rain, snow, fog, dew), in areas of ponded water, or in the presence of excess wind.
- B. In marginal conditions, deployment or seaming shall cease unless approved by the CQAE.
- C. The CQAE will document that these requirements are met by the Installer and will document the actual weather conditions during the installation.

1.9 EQUIPMENT

The equipment to be used by the CONTRACTOR shall be appropriate to the work.

PART 2 PRODUCTS

2.1 GCL

- A. The GCL recommended for this project is Bentomat® ST or equal. Prior to using an alternate GCL, the Installer must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Installer also must obtain prior approval of the alternative GCL by the CQAE. The GCL shall substantially comply with the properties shown in **Table 02515-1**.
- B. The GCL shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles.

1. Encapsulating geotextiles shall be mechanically bonded together using a needle punch or stitch bonding process.

ENCAPSULATING GCLs

- A. Encapsulating geotextiles shall be mechanically bonded together using a needle punch or stitch bonding process.
 1. GCL shall conform to the property requirements listed in **Table 02515-1** and shall be free of tears, holes, or other defects that may affect its serviceability.
 2. Needle punched and stitch bonded GCLs shall be continuously inspected for broken needles using an in-line metal detector and broken needles shall be removed.

- B. The minimum acceptable dimensions of full-size GCL panels shall be 98 feet long by 13½ feet wide. Short rolls (less than 98 feet but greater than 70 feet) may be supplied at a rate no greater than three rolls per truckload or three rolls per 36,000 ft² of GCL, whichever is less. The length of all short rolls shall be clearly marked on the outer packaging.

- C. A 6-inch overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means of facilitating QA during seaming. Lines shall be printed in easily visible, non-toxic ink that does not negatively impact the performance of the GCL.

Table 02515-1 GCL Properties

Material Property	Test Method	Test Frequency	Required Values
Bentonite Mass per unit Area	ASTM D5261	1 per 250,000 sf	0.90 lbs/sf MARV
Grab Strength	ASTM D4362	1 per 250,000 sf	95 lbs MARV
Grab Elongation	ASTM D4632	1 per 250,000 sf	75% typical
Peel Strength	ASTM D4632	1 per 250,000 sf	15 lbs. min.
Permeability*	ASTM D5084	1 per 250,000 sf	5x10 ⁻⁹ cm.sec max

* Required values can change if published by the Geosynthetic Research Institute via the test method GM 13, with the exception of asperity height.

QC = quality control lbs = pounds ml/2g = milliliters per 2 grams min = minimum max = maximum

sf = square feet lb/sf = pounds per square feet

MARV = minimum average roll value cm/sec = centimeters per second

psf = pounds per square feet

D. Accessory Bentonite

The granular bentonite used for seaming and penetration sealing shall be made from the same natural sodium bentonite material as used in the manufacture of the GCL.

E. Manufacturing, Sampling and Testing

1. GCL and its components shall be sampled and tested in accordance with the manufacturer's approved QC manual. Sampling shall be in accordance with the specific test methods listed in **Table 02515-1**. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width according to ASTM D4354.
 - a. The manufacturer's QC procedures shall be in accordance with ASTM D5888 and D5889.
 - b. The manufacturer's QC manual shall describe procedures used to determine rejection of applicable rolls.
2. Test results not meeting the requirements specified in **Table 02515-1** shall result in the rejection of applicable rolls.
 - a. As a minimum, rolls produced immediately prior to and immediately after the failed roll shall be tested for the same failed parameter.
 - b. Testing shall continue until a minimum of three successive rolls on both sides of the original failing roll pass the failed parameter.
 - c. Conformance of the manufactured GCL to this specification shall be performed by the manufacturer or designated by the purchaser/owner. ASTM D4759 can be used as a general guide, but individual test methods must be clearly stipulated and communicated to the parties involved.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation

1. Surface preparation shall be performed in accordance with **Part 3.3.A. of Section 02300** of these Specifications.
2. Rocks larger than 1/2-inch in diameter and any other material which could damage the GCL shall be removed from or rolled into the surface to be covered with the GCL.
3. Construction equipment tire or track deformations beneath the GCL shall not be greater than 1.0 inch in depth.
4. Each day during placement of GCL, the CQAE and Installer shall inspect the surface on which GCL is to be placed, and certify in writing that the surface is acceptable.
5. Repairs to the surface of the low-permeability support layer shall be performed at no additional cost to the OWNER or its Representatives.

B. Anchor Trenches

1. Where an anchor trench is required, it shall be placed 18 inches back from the edge of the slope to be covered.
2. The anchor trench shall be 24 inches deep and 24 inches wide.
3. If the anchor trench is excavated in cohesive soil susceptible to desiccation, only the amount of anchor trench required for placement of GCL in a single day shall be excavated.
4. Ponded water shall be removed from the anchor trench while the trench is open.
5. Trench corners shall be slightly rounded to avoid sharp bends in the GCL.
6. Loose soil, rocks larger than 1/2-inch in diameter, and any other material which could damage the GCL shall be removed from the surfaces of the trench.
7. The GCL shall extend down the front wall and across the bottom of the anchor trench.
8. Backfilling and compaction of the anchor trench shall be in accordance with **Section 02300** of these Specifications.

3.2 ENCAPSULATING GCL DEPLOYMENT

- A. GCL shall be installed as soon as practical after completion and approval of the clay liner.
 1. The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the GCL, other geosynthetic layers, or the underlying clay liner.
 2. Construction equipment may be used to deploy GCL.
- B. Rolls shall be delivered to the work area in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL.
- C. GCL damaged during installation shall be replaced or repaired, at the CQAE's discretion.
- D. 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. Hydrated GCL is defined as having become soft as determined by squeezing the material with foot pressure, which leaves a footprint made after stepping on the suspect area, or material which has exhibited swelling, as determined by the CQAE.
- E. On side slopes, GCL shall be anchored at the top and deployed down the slope to minimize wrinkles.
- F. Dragging of GCL panels over the ground surface shall be minimized. The CQAE has the option of requiring the use of a slip sheet.

- G. For encapsulating GCLs with differing sides, the non-woven side of the GCL shall be placed up.
- H. Only as much GCL shall be deployed as can be covered with geomembrane at the end of the working day, unless otherwise approved by the CQAE.
- I. No equipment shall be operated on the top surface of the GCL without permission from the Installer and the CQAE. Equipment that could potentially damage the GCL or subgrade shall not be allowed to travel directly on it.
- J. The GCL shall be placed so that longitudinal panel seams are parallel to the direction of the slope. Seams shall be located at least 3 feet from the toe and crest of slopes.
- K. All GCL panels shall lie flat on the underlying surface with no wrinkles or folds.
- L. The CQAE will document the following:
 - 1. Proper deployment of the GCL.
 - 2. The length of the GCL overlap, and that the GCL overlap is adequate for the seaming process that is used.
- M. The GCL shall be cut with a sharp utility knife. Cuts shall be smooth and clean.

3.3 FIELD SEAMING OF ENCAPSULATING GCLs

- A. Field Seams are constructed by overlapping their adjacent edges.
 - 1. Panels shall be seamed in accordance with the GCL manufacturer's recommendations and the approved layout plan.
 - 2. In sumps, corners and odd-shaped geometric locations, the number of field seams shall be minimized.
 - 3. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.
 - 4. The minimum dimension of the longitudinal panel overlap shall be 6 inches for the finished (i.e., bentonite enhanced) seam.
 - 5. The minimum overlap at the end of roll seams shall be 24 inches.
 - 6. The panel seams shall be shingled in the direction of the grade.
- B. Granular Bentonite shall be used to enhance the seams.
 - 1. 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.

2. The bentonite shall be applied at a minimum rate of 0.25 pound per linear foot of seam.

3.4 SAMPLES

- A. One QC sample, 18 inches in length, for the entire width of a roll, shall be obtained for every 100,000 square feet of material delivered to the site. Samples shall not be obtained from the first 3 feet of the roll.
- B. The samples shall be identified by manufacturer's name, product identification, lot and roll/panel number. The date, a unique sample number, and the machine direction shall also be noted.

3.5 DEFECTS AND REPAIRS

- A. If a GCL panel is torn, punctured, perforated, etc. during installation, it shall be replaced or repaired per the direction of the CQAE.
- B. Patches
 1. Patches shall be sized so that a minimum 12-inch overlap is achieved around the damaged area.
 2. Prior to placement of the patch, dry bentonite shall be placed around the damaged area.
 3. 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.

3.6 VISUAL INSPECTION AND EVALUATION

- A. Immediately prior to covering, the GCL, seams, and non-seam areas shall be visually inspected by the Installer and CQAE for defects, holes, or damage due to weather conditions or construction activities.
- B. Defects and repairs shall be managed as described in **Part 3.5** of this Section of these Specifications.

3.7 PENETRATIONS

GCL penetration details shall be as shown on the drawings or as recommended by the GCL manufacturer.

3.8 AS-BUILT DRAWINGS

- A. Final as-built drawings of the GCL installation shall be prepared by the Installer and submitted to the OWNER or its Representative.
- B. These drawings shall include panel numbers, seam numbers, location of the anchor trench(es), and location of repairs and penetrations.

END OF SECTION

SECTION 02666
LEACHATE COLLECTION LAYER

PART 1 GENERAL

1.1 SUMMARY

- A. The work to be performed under this project consists of providing the labor, equipment, and materials and ancillary construction to access and construct the leachate lateral.

1.2 DESCRIPTION OF THE WORK

- A. All construction will be done in accordance with these Technical Specifications and the drawings. This will ensure all work is completed, at minimum, in accordance with manufacturer's specifications, good practice, and local, state, and federal regulations.
- B. Summary of the Work
The work will include the construction of the leachate collection layer for Cell 5 at the Montezuma County Landfill.

1.3 HANDLING AND STORAGE OF GEOTEXTILE

- A. Handling
 - 1. General
 - a. Before unloading the shipment, there must be adequate level space to unload the shipment.
 - b. The truck should be on level ground with the parking brake set and the wheels chocked.
 - c. Keep unnecessary persons away from the area during unloading.
 - 2. Unloading Site Requirements
 - a. The unloading site should be relatively flat and level and large enough for the carrier's truck, the load handling equipment and its movement, and for temporary load storage.
 - b. Palletized packages should be unloaded from the site with a forklift.
 - c. Fabrications, tanks, or other components should be unloaded from above with lifting equipment and wide web slings or from the side with a forklift.
 - 3. Handling Equipment

- a. Appropriate unloading and handling equipment of adequate capacity must be used to unload the truck. Safe handling and operating procedures must be observed.
- b. Items must not be rolled or pushed off the truck.
- c. When using a forklift or forklift attachments on equipment such as articulated loaders or bucket loaders, lifting capacity must be adequate and the load centered on the forks.
 - (1) Forklift equipment is rated for a maximum lifting capacity at a distance from the back of the forks. If the weight center of the load is farther out on the forks, lifting capacity is reduced.
 - (2) Before lifting or transporting the load, forks should be spread as wide apart as practical, forks should extend completely under the load, and the load should be as far back on the forks as possible.
- d. Lifting equipment such as cranes, extension boom cranes, and side-boom tractors should be hooked to wide-web choker slings that are secured around the load or to lifting lugs on the component.
 - (1) Only wide-web slings should be used.
 - (2) Wire rope slings and chains can damage components, and should not be used.
 - (3) Spreader bars should be used when lifting pipe or components longer than 20 feet.

B. Storage

1. Pre-Installation Storage

- a. The site and its layout should provide protection against physical damage to components.
- b. General requirements include sufficient area to accommodate items, to allow room for handling equipment to maneuver, and to have a relatively smooth, level surface free of stones, debris, or other material that could damage items or components or interfere with handling.

1.4 SUBMITTALS

A. Qualifications

1. CONTRACTOR

- a. Documentation of the CONTRACTOR's experience with projects of similar scope and size.
- b. Documentation of the CONTRACTOR's ability to provide appropriate equipment in order to complete the work in a timely manner.

- c. Documentation of the experience of the CONTRACTOR's Superintendent on projects of similar scope and size.
2. Quality Assurance Engineer
- a. Documentation of the Quality Assurance Engineer's (QAE) experience with projects of similar size and scope.
 - b. Documentation of the QAE's ability to provide testing services required by this project. These services may be provided by a subcontractor to the QAE or the CONTRACTOR, provided the QAE's onsite person is experienced with projects of similar size and scope.
- B. Alternate Materials and Method proposed by the CONTRACTOR for this project must be submitted and approved prior to their use.
- C. Results of the testing on the leachate gravel, showing compliance with **Part 2.1** of this Section of these Technical Specifications.
- D. Manufacturer's Quality Assurance/Quality Control (QA/QC) Certifications to verify that the materials supplied are in accordance with the design plans and drawings, these Technical Specifications, and the Manufacturer's Quality Control Plan shall be provided for each shipment. The certification shall be signed by a responsible party employed by the material manufacturer.

1.5 INSPECTIONS, TESTS, AND REPORTS

- A. Inspection of materials for defects, including QAE documentation.
- B. As-built drawings (see **Part 3.6** of **Section 02300** of these Technical Specifications).

1.6 REFERENCES

The publications listed below form a part of this Technical Specification to the extent referenced. The publications are referred to within the test by the basic designation only. Consult only the most up to date versions of each publication referenced.

ASTM INTERNATIONAL (ASTM)

ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM D2434	Permeability of Granular Soils (Constant Head)
ASTM 4373	Determination of Carbonate Content of Soils

1.7 QUALIFICATIONS

A. CONTRACTOR

1. The CONTRACTOR is responsible for removing, processing, and replacing soils, as required by these Technical Specifications and the drawings.
2. The CONTRACTOR and its Superintendent shall have experience in excavating and replacing soils on projects of similar requirements and size.
3. The CONTRACTOR shall have, or be able to provide, equipment appropriate to the work and in capacity and number to complete the work in a timely fashion.

B. QAE

1. The QAE shall be a Representative of the OWNER.
2. The QAE shall have experience in constructing clay liners, synthetic liners, Geosynthetics, and earthwork.
3. The QAE shall appoint an Inspector who will be responsible for documenting field construction that the finished product complies with the requirements of these Technical Specifications and Drawings, good practice, and the local, state, and federal laws and regulations governing their construction.
4. The QAE shall have a Professional Engineer, licensed in the State of Colorado, and with suitable experience that will be responsible for certifying that the facility has been constructed in compliance with the requirements of these Technical Specifications and drawings, good practice, and the local, state, and federal laws and regulations governing their construction.

1.8 EQUIPMENT

The equipment to be used by the CONTRACTOR shall be appropriate to the work and of number and capacity to complete the work in a timely manner.

PART 2 PRODUCTS

2.1 LEACHATE COLLECTION LAYER GRAVEL

- a. Provide gravel materials that will be clean (less than 5% fines) and durable with a minimum particle size of 3/4 inches and a maximum particle size of 3 inches.
- b. A grain size test (ASTM C136) will be conducted per 500 cubic yards of gravel placed.
- c. Material will be approved once bid sheets for various materials have been reviewed. The chosen material will have a permeability of $K > 5 \times 10^{-2}$ cm/sec. The options for drainage media include sand or gravel (with 5% passing No. 200 sieve)

2.2 GEOTEXTILE

- a. The gravel for the leachate drains will be underlain by a 6-ounce filter.
- b. Leachate drains will be overlain by an 8 oz non-woven geotextile. See drawings for detail.

PART 3 EXECUTION

3.1 LEACHATE COLLECTION LAYER GRAVEL

The minimum 1-foot-thick drainage media will be placed on a 6-ounce non-woven geotextile and capped by an 8-ounce non-woven geotextile. The drainage media will have a permeability of $K \geq 1 \times 10^{-2}$ cm/sec and will consist of gravel with a maximum particle size of 3 inches. Pre-construction testing on the gravel material will be conducted as shown in **Table 02666-1**.

Table 02666-1
Gravel Drainage Properties

Phase	Material	Test and ASTM Number	Frequency	Required Value
Pre-Construction	Borrow Source	Grain Size Distribution (C136)	1 per 2,500 cubic yards (cy)	<10% passing no. 200 sieve
		Permeability (D2434)	1 per 2,500 cy	$\geq 1 \times 10^{-2}$ cm/sec
		Carbonate Content (D4373)	1 per 2,500 cy	less than 15%

3.2 GEOTEXTILE

The 6-ounce filter geotextile (needle-punched non-woven) will be placed below the drainage media and above the geomembrane to protect the liner. The 8-ounce geotextile will also be used to encapsulate the gravel in the leachate collection lateral. Prior to deployment, manufacturer's certifications stating minimum compliance with mass per unit area at a frequency of 1 test per 100,000 sf and 1 test per lot.

END OF SECTION