



Construction Specification 203 Geosynthetic Clay Liner

SCOPE

The work shall consist of furnishing and installing a geosynthetic clay liner (GCL) with the necessary appurtenances as shown on the drawings.

MATERIALS

The GCL shall consist of a layer of high shrink-swell sodium bentonite clay encapsulated between two geosynthetics and shall comply with the criteria in Table 1.

For purposes of strength, performance, and integrity, the GCL shall be manufactured by mechanically bonding the geotextile using a needle-punching process without the use of any chemical binders as adhesives. Needle-punched GCLs are those which, by the use of a needling board, have fibers of the non-woven geotextile pushed through the bentonite clay layer and integrated into a woven or non-woven geotextile.

The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and shall be as recommended by the GCL Manufacturer.

All GCL shall be free of damage or defect. Each package delivered to the job site shall bear the name of the material, the Manufacturer's name or symbol, lot number and roll number, roll length and width, and the total roll weight of the material.

SHIPPING AND STORAGE

The GCL shall be transported to the job site in a manner not to damage the rolls. The liner rolls shall be stored so they are protected from puncture, dirt, grease, water, moisture, mechanical abrasion, excessive heat, ultraviolet light exposure, or other damage. The rolls shall be stored on a smooth surface (not wooden pallets). Rolls shall be stacked to a height no higher than the height which the lifting apparatus can be safely handled (typically no higher than four).

SUBGRADE PREPARATION

The area to be lined shall be drained and allowed to dry until the surface is firm. The subgrade surface must be firm, unyielding, and able to support people and equipment that must travel over it during installation of the GCL. All cut and fill slopes shall be constructed in accordance with the drawings. Required subgrade fill shall be placed in layers with a maximum thickness of 6 inches prior to compaction. The fill soils shall be disked or worked in such a manner as to obtain a maximum clod size of 4 inches prior to compaction. Each layer shall be compacted by a minimum of one pass over the entire surface of the fill by a fully-loaded rubber-tired scraper or a tamping roller. Operation of the compaction equipment will be continuous over the entire area during fill operations. Fill materials shall have a moisture content sufficient to insure the required compaction is achieved. The adequacy of fill moisture content and compaction will be approved by the Technician.

Irregularities and any abrupt grade changes shall be eliminated from the surface prior to placing the GCL. When the GCL is placed, the subgrade shall be dry, smooth, and free of debris, roots, ruts, and stones or any projection of more than 0.5 inch. All projections of more than 0.5 inches shall be removed, crushed, or pushed into the surface with a smooth-drum roller. No equipment tracks or footprint indentations shall be present in the subgrade.

An anchor trench for the liner shall be excavated and backfilled in accordance with the drawings. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist in the trench. Minimum trench dimensions shall be 18 inches deep and 12 inches wide.

PLACEMENT

The contractor shall confine the work to an area that can be completely installed and covered by the end of the normal working day in a manner that will prevent the occurrence of hydration prior to being covered

with the specified cover soils. Daily completion shall be defined as the full installation of the liner, covering around appurtenances, and placement of the specified cover soils.

The GCL rolls shall be deployed using a spreader bar assembly attached to a loader bucket or by other methods approved by the liner Manufacturer. The method chosen to unroll the panels shall not cause wrinkles, folds, or crimps in the GCL and shall not damage the supporting soil. The rolls shall be carefully rolled down the slope and not allowed to unroll freely and out of control. When it is necessary to drag liner panels, a geosynthetic subgrade covering known as a rub sheet shall be used to reduce friction and protect the GCL during placement.

The GCL shall not be deployed during periods of heavy precipitation, in the presence of excessive winds, or in areas of ponded water.

GCL panels shall be placed with the non-woven geotextile side against the subgrade. On slope areas exceeding a steepness of 4H:1V, the long dimension of all panels shall go up and down the slope.

This panel orientation shall apply to all covered slopes including corner slopes. Panels on flat areas require no particular orientation. Panels should be placed from the highest elevation to the lowest in the area to be lined to facilitate drainage in the event of precipitation. Panels shall be placed free of tension or stress yet without wrinkles or folds. It is not permissible to stretch the GCL in order to fit a designated area. Panels shall not be dragged across the subgrade into position except where necessary to obtain the correct overlap for adjacent panels.

The top edge of the liner shall be placed in the anchor trench and anchored with compacted backfill. Compact the backfill by wheel rolling with light rubber-tired equipment or a manually directed power tamper.

SEAMING

All GCL seams shall be formed by executing a bentonite enhanced overlap to ensure a continuous seal is achieved between panels. A 6-inch to 9-inch side overlap shall exist at seam locations. The lap line and match lines printed on the liner panels shall be used to assist in obtaining this overlap. The edges of the GCL panels should be adjusted to smooth out any wrinkles, creases, or "fishmouths" in order to maximize contact with the underlying panel.

Seams at the ends of panels should be constructed such that they are shingled in the direction of the grade to prevent flow from entering the overlap zone. The end of roll overlap shall be a minimum of 24 inches. End-of-roll seams shall be located at least 3 feet from the toe or crest of the slope. Panel overlap seams at the base of the slope shall be a minimum of 6 feet from the toe. All seam areas or runs shall be augmented with granular bentonite. Granular bentonite shall be dispersed evenly to cover the entire lapped area from the panel edge to the lap line at a minimum rate of 1 pound per 2 square feet of area covered. Seams shall remain closed during the backfill operation in order to prevent contamination of the bond surface and to ensure the panels remain in intimate contact, where jointed, at all times.

After the overlying panel is in place, its edge shall be pulled back to expose the overlap zone. Any soil or debris present in the overlap zone or entrapped in the geotextiles shall be removed. A fillet of granular bentonite shall then be poured in a continuous manner along the overlap zone (between the edge of the panel and the overlap line), at a rate of at least one-quarter pound per linear foot. The use of a watering can or line chalker is recommended to improve the uniformity and consistency of the bentonite fillet. This process shall be conducted in accordance with the Manufacturer's instructions.

For penetrations or structures the liner will contact, a 3-inch by 3-inch notch shall be cut or dug in the subgrade around the penetration or structure.

For penetrations, the liner shall be brought up to the penetration and trimmed to fit into the notch. Granular bentonite or a compact mixture of 1 part bentonite to 4 parts soil (by volume), blended dry, shall be placed into the bottom half of the notch. The liner shall then be inserted into the notch, with the remaining area in the notch filled with the granular bentonite or the 1 to 4 mixture, and compacted. A

secondary GCL collar shall be placed around horizontal penetrations. The collar shall overlap the GCL a minimum of 12 inches in each direction.

For liner terminated at a structure, granular bentonite or a compact mixture of one part bentonite to four parts soil (by volume), blended dry, shall be placed in the notch and against the structure. The liner shall extend over the notch and a minimum of 3 inches vertically adjacent to the structure.

REPAIRS

GCL that has begun to hydrate before being covered with soil shall be removed and replaced with dry GCL.

All damaged or flawed material shall be repaired as follows:

- Completely expose the affected area.
- Remove all soil or other foreign objects.
- Place a GCL patch over the exposed area with a minimum overlap of 12 inches on all edges.
- Place granulated bentonite between overlap at the rate of 1 pound per 2 square feet of area covered, and spread to a minimum width of 6 inches.
- On a sloping surface, fasten augment the bentonite-enhanced seam with construction adhesive.

PLACEMENT OF OVERLYING MATERIALS

Cover soils shall be mineral soil, free of angular stones or other foreign matter which could damage the GCL. Cover soils with high concentrations of calcium (e.g. limestone, dolomite) are not acceptable.

Soil cover shall be placed with low ground pressure equipment. The final thickness of soil cover shall be at least 1 foot over the GCL or as shown on the drawings. For high-traffic areas or roadways, a minimum of 2 feet is required. To prevent damage to the GCL, the initial lift(s) of soil cover shall not be compacted in excess of 85 percent of Modified Proctor density.

No vehicles should be driven directly on the GCL until the proper thickness of cover has been placed. Care should be taken to avoid damaging the GCL by making sharp turns or pivots with equipment.

When covering GCL installed on sloped areas steeper than 4H:1V, the soil cover shall be pushed upslope to minimize tension on the GCL.

If the cover material is a geomembrane or other geosynthetic, precautions shall be taken to prevent damage to the GCL by restricting heavy equipment traffic. Unrolling the geomembrane can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

The leading edge of GCL panels left uncovered at the end of the working day shall be protected with a waterproof sheet which is adequately secured with sandbags or other ballast.

LINER HYDRATION FOR MANURE CONTAINMENT FACILITIES

In installations where containment of manure, barnyard runoff, milking center wastes containing manure, etc., is required, the GCL must be hydrated with water prior to introducing the liquids containing manure.

The GCL on the bottom of the containment facility shall be hydrated by flooding or the use of a sprinkler system. Hydration of the side slopes shall be accomplished by the use of a sprinkler system if adequate rainfall is not anticipated prior to contact with the liquids containing manure.

FINAL TESTS AND INSPECTION

Upon completion of the work, the installation shall be subjected to a final inspection. All work in the system therein being tested shall be complete, cleaned and ready for use. The work shall meet the requirements as to the lines, grades, cleanliness and workmanship. Any discrepancies shall be repaired.

BASIS OF ACCEPTANCE

The acceptability of the geomembrane shall be determined by inspections to check compliance with all the provisions of this specification, with respect to the drawings, markings, the appurtenances, and the minimum installation requirements.

The installing Contractor shall certify that the materials and installation complies with the requirements of this specification.

TABLE 1 Requirements for Geosynthetic Clay Liner (GCL)

Material	Property	Test Method	Value ¹
Bentonite ²			
	Swell Index	ASTM D 5890	24 ml/2g min.
	Moisture Content (dry weight)	ASTM D 2216	40% max.
	Fluid Loss	ASTM D 5891	18 ml max.
Finished GCL			
	Bentonite Content ³ Mass/Area	ASTM D 5993	0.75 lb/sq ft
	Grab Strength	ASTM D 6768	45 lbs./in.
	Peel Strength	ASTM D 6496	3.5 lbs./in.
	Hydraulic Conductivity ⁴	ASTM D 5887	5 X 10 ⁻⁹ cm/sec max.
	Hydrated Internal Shear Strength ⁵	ASTM D 5321 or D 6243	500 psf
	Index Flux	ASTM D 5887	1 X 10 ⁻⁸ m ² /m ² /sec

¹ All values, unless specified otherwise, are minimum average roll values (MARVs) as reported by the specified test methods.

² These parameters are for the bentonite as delivered to the GCL manufacturer, not for the bentonite in the finished product.

³ Bentonite mass per unit area at 0% moisture content.

⁴ At 5 psi confining pressure.

⁵ Specimen hydrated for 24 hours and sheared at a 200 psf normal stress.

Specific Site Requirements