

Installation Quality Assurance Manual



GSE GundSeal

Geomembrane Supported Geosynthetic Clay Liner Products





Table of Contents

1.0	Introduction.....	1
2.0	Unloading Procedures.....	1
3.0	Storage.....	2
4.0	Subgrade Preparation.....	2
5.0	Deployment for Overlapped Seams.....	2
6.0	Deployment for Welding Geomembrane Seams.....	4
7.0	Attachment Details.....	6
8.0	Anchoring.....	7
9.0	Repairs.....	7
10.0	Inspection.....	7
11.0	Cover Material.....	7



1.0 INTRODUCTION

This manual provides an overview of the GSE Installation Quality Assurance procedures consistent with industry accepted practices to ensure that the GSE GundSeal GCL products installed will best perform for its intended purpose. In addition, all installation work will be performed in strict accordance per the customer's specifications. Please read the procedures below completely before you begin. If you need further clarification, contact the GSE Engineering Support Staff for assistance or please refer to ASTM D 6102, Standard Guide for Installation of Geosynthetic Clay Liners and ASTM D 5888, Standard Guide for Storage and Handling of Geosynthetic Clay Liners. Remember safety first and use safe practices always on every project.

2.0 UNLOADING PROCEDURES

As with all lifting or unloading operations, appropriate equipment and experienced personnel should be employed along with proper safe handling methods. The party responsible for unloading the GSE GundSeal, should contact GSE prior to shipment, to determine the correct unloading methods and equipment, if different from the pre-approved and specified methods as described below.

Lifting GCL rolls can typically be accomplished with by using a 2.5 in - 3.0 in (63 mm - 75 mm) outside diameter (O.D.) steel pipe (preferably solid), with a wall thickness capable of providing sufficient beam strength to support the weight of the roll, which average less than 3,000 lb (1,364 kg) and the length is approximately 18 ft (5.5 m). This core pipe is inserted through the hollow center of the GCL cardboard core. Heavy-duty slings or chains, which are approximately 10 ft (3.1 m) long, each are attached to each end of the pipe, which are then fastened to a I-beam spreader bar or a GSE approved alternative. Care should be taken to ensure that lifting chains or straps do not rub, chafe, or otherwise damage the GCL. A crane, backhoe, front-end loader or another suitable piece of construction equipment can then lift the entire assembly.

An all-terrain, extendable boom forklift, such as a Lull or Caterpillar Telehandler, can be fitted with a special, solid steel "carpet pole" or stinger, typically 14.0 ft (4.3 m) in length having an outside diameter of no more than 3.38 in (8.6 mm). The carpet pole can be inserted into the hollow cardboard core of the GCL roll.

The roll should not be fully suspended until the pole extends through the entire length of the core tube or you run the risk that the core may break creating additional handling and unloading difficulties.

A properly structured and supported pole can be used to unload GCL rolls onsite. As an alternative, straps that are appropriately rated can be used as a GSE approved lifting method to unload GCL rolls. Lifting straps are supplied on every roll. Each GCL roll label contains roll weight information that should be consulted in determining appropriate lifting equipment and factors of safety.

The CQA inspector or owner's representative should verify that only appropriate handling equipment is utilized, i.e. equipment that does not pose any danger to personnel or undue risk of damage or deformation to the liner material.



All roll numbers should be recorded during the unloading operations and compared to shipping papers to ensure receipt of only project compliant materials. Furthermore, rolls should be visually inspected for damage and suspect rolls marked, recorded, and set aside for further investigation by CQA personnel.

3.0 STORAGE

While stored GCL needs to be kept dry and away from potential flooding or high storm runoff. On the job site storage methods include; storing the rolls tarped on pallets; storing the rolls under roof in a clean, dry protected area; and storing the rolls on a flat, dry, stable surface suitably covered with protective waterproof tarps. Rolls can be stacked as long as it is done in a manner that prevents them from rolling, shifting, or spontaneously moving. Maximum roll height should be determined by CQA personnel, but never more than can be safely managed considering site conditions, equipment and personnel.

Stored rolls should be tarped and remain in their original, unopened plastic shipping sleeves to prevent damage and undue prehydration prior to installation. Any rolls that come in contact with water should be examined by CQA or an owner's representative prior to installation. Prehydrated or physically damaged rolls should be set aside for further examination to determine the plausibility of repair or need to replace.

4.0 SUBGRADE PREPARATION

The surface upon which the GSE GundSeal is installed should be smooth and free of wheel ruts, debris, roots, sticks, and rocks larger than 1.0 in (25 mm). Site specific compaction requirements should be followed in accordance with the project plans and specifications. At a minimum, the site should be smooth rolled the level of compaction such that installation equipment and other construction vehicles traffic does not cause rutting greater than 1.0 in (25 mm) deep. Furthermore, all protrusions extending more than 0.5 in (12 mm) from the subgrade shall be removed, crushed, or pushed into the subgrade.

In applications where the product is the sole barrier, subgrade surfaces consisting of gravel or granular soils may not be acceptable due to their large void content. For these applications, the subgrade shall be greater than 80% fines and contain no particles larger than 1 in (25 mm).

Immediately prior to deployment of the GCL, the subgrade shall be final compacted to fill in any remaining voids or desiccation cracks and to ensure that no sharp irregularities or abrupt elevation changes exist greater than 1.0 in (25 mm). The surfaces to be lined shall be maintained in this condition and free of standing water. GCL can be deployed on a frozen subgrade, if the subgrade would meet all the conditions as previously outlined if unfrozen.

The subgrade surface and preparation should be inspected and certified by the CQA inspector prior to GSE GundSeal placement. Upon approval by the CQA inspector, it is the geosynthetic installer's responsibility to communicate to the engineer of any changes in the condition of the subgrade that might render it out of compliance, with any of the requirements of the project specification or ASTM Standard D 6102.



5.0 DEPLOYMENT FOR OVERLAPPED SEAMS

As rolls are selected for deployment, the labels should be removed and recorded by the installer, along with any other pertinent information. The rolls should only be transported from the storage area using approved lifting equipment as described in section 2.0 and the rolls should be deployed properly as outlined below.

A. *Installation Options*

GSE GundSeal can either be installed with the geomembrane side down, facing the subgrade, or with the bentonite side down, facing the subgrade. The installation procedures for these two methods are different given that additional care must be taken when installing the bentonite side down to prevent the bentonite from dislodging from the geomembrane backing.

Final decision on GSE GundSeal deployment should be left to the design or CQA engineer or an owner's representative.

Care should also be taken to keep unloading and installation equipment and vehicles from making excessive contact with the bentonite portion of the product during installation operations.

1. *Deployment Geomembrane Side Down*

Methods of deployment range from manually pulling the GSE GundSeal from a suspended roll to securing the roll end and unrolling each panel as the equipment slowly moves backwards.

Laborers should manually move the panels to their final and proper position paying strict adherence to required overlaps. Cutting the panels after placement is accomplished with a sharp hook blade utility knife or equivalent.

2. *Deployment Bentonite Side Down*

The GSE GundSeal roll should be aligned next to the adjacent product sheet prior to unrolling. The installation equipment then begins unrolling the panel as the equipment moves in the direction of material deployment. For final material alignment, laborers should manually move the panels to the proper position with the required overlap distance. Care should be taken not to dislodge the sodium bentonite during installation.

B. *Seams*

Seaming between adjacent GSE GundSeal panels is accomplished by overlapping adjacent roll edges. The addition of supplemental granular bentonite into the seams is not required. When deployed geomembrane side up, longitudinal/lengthwise seams should be overlapped a minimum of 12.0 in (300 mm) unless engineering specifications indicate otherwise. Overlap of butt/widthwise seams should be a minimum of 12.0 in (300 mm), unless engineering specifications indicate otherwise. Overlap line markings can be printed on the longitudinal/lengthwise edges during the manufacturing process to facilitate added accuracy of the overlap distance.

When deployed geomembrane side down, overlapped longitudinal/lengthwise seams should be a



minimum 6.0 in (150 mm), unless engineering specifications indicate otherwise. Overlapped butt/widthwise seams should be a minimum 12.0 in (300 mm), unless engineering specifications indicate otherwise.

If the bentonite coating of the product becomes wet (> 30% moisture) allow the bentonite layer to air-dry before completing installation. [Note: GSE GundSeal bentonite coating will be dry for installation when desiccation marks show across the bentonite surface]. Alternately, the hydrated bentonite area can be patched with the same product material. For installations where shear strength is of concern, the hydrated area should be removed and patched with the equivalent material. If roll edges become hydrated, the overlap should be increased by the width of hydrated area to ensure a minimum 6.0 in (150 mm) of dry bentonite overlap.

6.0 DEPLOYMENT FOR WELDING GEOMEMBRANE SEAMS

The following procedures are guidelines for fusion welding and extrusion welding GSE GundSeal GCL geomembrane seams. These procedures are in addition to the standard GSE GundSeal installation procedures as discussed in sections 1.0 to 5.0 of this manual and in the GSE Installation Quality Assurance Manual for geomembrane products.

To facilitate welding panels together a 9.0 in (225 mm) wide protective tape is placed on both lengthwise edges during the manufacturing process. The tape is typically removed after winding rolls, thus providing bentonite free edges for welding prior to edge welding, the GSE GundSeal is installed in accordance with sections 1.0 to 5.0 of these guidelines.

A. Seam Layout

GSE GundSeal with bentonite free edges material should be deployed bentonite side down (geomembrane side up) in accordance with sections 1.0 to 5.0.

For fusion welded seams, a GSE GundSeal seam strip is deployed below the seam area with the bentonite facing up and centered under the overlap to be welded. Seam strips are typically GSE GundSeal with 15.0 mil (0.4 mm) HDPE geomembrane backing fabricated into 2.0 ft (600 mm) wide panels, effectively replaces the bentonite removed from the GSE GundSeal rolls during manufacturer to facilitate welding. The typical length of each is 200 ft (61 m).

End of roll edges (widthwise) do not have bentonite free edges. Therefore, seams are made by overlapping panels a minimum of 6.0 in (150 mm) and extrusion welding a separate overlying geomembrane cap strip over the seam area. Alternately, the widthwise seams can be extrusion welded by scraping, or removing, a bentonite strip approximately 3.0 in (75 mm) wide and directly extrusion welding the two geomembranes together.

B. Lengthwise Seaming Preparation & Fusion Welding

Standard welding and support equipment should be used as outlined in the GSE Installation Quality Assurance Manual for geomembrane products.



1. After aligning the adjacent panels lengthwise, manually fold back the edges to inspect the bentonite free edge or remaining protective edge tape. The edges of the GSE GundSeal should be folded back far enough to allow the edges to lay flat with no undue stress applied to the geomembrane backing. The taped edges, the entire length of the seam, should be exposed.
2. Unroll the seam strip, bentonite side up. The seam strip should be installed directly below the two GSE GundSeal panels, centered directly under the final seam location, with the bentonite side of the seam strip facing upward. Seam strips should be overlapped a minimum of 6.0 in (150 mm) with the overlying bentonite coating of both base panel edges.
3. Visually inspect the upper and lower exposed geomembrane surfaces. The surfaces must be clean and free of moisture, dust, dirt and any foreign materials.
4. Fold the roll edges back into the position to be welded. The overlap should lay flat and directly on top of the seam strip. Seams should be aligned with the fewest possible number of wrinkles and "fish mouths".
5. Trial seams should be made in accordance with standard GSE geomembrane seaming procedures prior to each welding period. Fusion welded and extrusion welded trial seams should be made with representative GSE GundSeal material and bentonite free geomembrane edges.
6. Fusion weld the seam using standard geomembrane seaming procedures as outlined in the GSE Installation Quality Assurance Manual for geomembrane products.
7. Non-destructive seam testing should be carried out on the complete length of the fusion weld using standard air pressure testing methods.
8. Destructive seam testing should be carried out as outlined in the GSE Installation Quality Assurance Manual for geomembrane products.

C. Widthwise Seam Preparation & Extrusion Welding

1. Widthwise seams, typically 17.5 ft (5.3 m) wide, should be overlapped a minimum of 6.0 in (150 mm).
2. Seams should be aligned with the fewest possible number of wrinkles and "fish mouths".
3. The seams should be welded by placement of a geomembrane cap strip over the seam and extrusion welding the cap strip to the geomembrane backings on both sides of the overlap. Alternately, the geomembrane backings of the GSE GundSeal panels can be extrusion welded together directly. This is accomplished by removing approximately 3.0 in (75 mm) of the bentonite coating from the outer edge of the upper geomembrane. Bentonite can be removed by



“scraping” the geomembrane with a dull putty knife or equivalent that will not damage the geomembrane. The overlap should include a minimum 6.0 in (150 mm) of bentonite overlap that does not include the edge with scraped off bentonite.

4. Non-destructive seam testing should be carried out on the complete length of weld by standard vacuum testing procedures.
5. Destructive seam testing should be carried out as outlined in the GSE Installation Quality Assurance Manual for geomembrane products.

D. Patching & Repairs For Welded GSE GundSeal

1. GSE GundSeal material should be inspected for cuts, tears or areas of bentonite loss.
2. The area to be repaired or patched must be free of contamination by foreign matter. Patches should be constructed of the same material as the damaged or affected area. Patches should have a minimum 6.0 in (150 mm) of bentonite overlap completely around the perimeter of the damaged area.
3. All patches should be secured to the underlying geomembrane backing material by extrusion welding the complete perimeter of the patch to base the GSE GundSeal liner as outlined in this section.
4. Non-destructive seam testing should be carried out on the complete length of weld by standard vacuum testing procedures.

7.0 ATTACHMENT DETAILS

GSE GundSeal attachments to structures, including concrete, steel and fiber glass, is accomplished by mechanically attaching the edge of the product liner to the structure by stainless steel batten strip. Alternately, for irregular shapes and PVC or HDPE pipe penetrations, GSE GundSeal is attached utilizing a supplemental fabricated HDPE geomembrane pipe boot.

The GSE GundSeal panel is deployed against concrete or steel structures with the bentonite side against the structure. As with geomembrane attachments, the leading edge of the GSE GundSeal liner is secured to the structure by a stainless steel batten strip around the perimeter of the structure. The liner should extend a minimum 6.0 in (150 mm) vertically upward on side walls.

Loose granular sodium bentonite or bentonite paste should be liberally applied at corners and areas where the bentonite may not be continuously in direct contact with the structure or subgrade.

GSE GundSeal should be attached to pipes and fiberglass with a separate HDPE pipe boot fabricated to fit snugly against the pipe or protrusion. The boot must lay flat against the adjacent installed GSE GundSeal panels.



GSE GundSeal should be deployed with the geomembrane side facing up adjacent to the pipe penetration. The end of the pipe boot sleeve should be attached to the pipe surface with a steel band fastened snugly around the perimeter of the pipe surface. Alternately, if the pipe is polyethylene, the end of the pipe boot sleeve can be extrusion welded to pipe surface. The pipe boot skirt should extend completely around the perimeter of the structure or penetration through the base of the liner and extend a minimum 1.0 ft (300 mm) over the adjacent geomembrane backing.

8.0 ANCHORING

GSE GundSeal is typically anchored in a trench around the perimeter of the lined area, which provides the required pullout resistance. In most cases, GCL can be anchored in the same trench as any adjacent geosynthetic liner components (if used). Dimensions and locations of the trench should be provided in the project drawings. Alternately, the material may be anchored by deploying additional run out of material, a minimum of 3.0 ft (1.0 m), past the slope crest and toe. Typically GCL should not be deployed in tension. The force holding the GCL in place should be provided by friction between the GCL and adjacent materials.

Steps should be taken to ensure that precipitation does not accumulate in the trench prior to backfilling. The GCL should only cover the front face and bottom of the anchor trench. The trench should be back filled and properly compacted prior to placing cover soil on the slopes.

9.0 REPAIRS

Repair all damaged areas by placing a patch of the same material over the damaged area. Overlap of the patch around the damaged area should be a minimum 12.0 in (300 mm) in all directions. For installations with the geomembrane side up, the patch may be secured to the installed GSE GundSeal geomembrane backing with duct tape or equivalent adhesive tape if desired.

10.0 INSPECTION

Prior to soil covering the panels, penetrations and any other details should be visually inspected to ensure full coverage and proper orientation. Once the installed GSE GundSeal material has been approved the next layer of geosynthetics or soil covering may be applied.

11.0 COVER MATERIAL

When placing cover material directly on top of the GSE GundSeal geomembrane backing, the soil should be pushed perpendicular to the product seams, where possible from the upper sheet to the lower sheet. Care should be taken to prevent soil from being lodged into and separating the product seams. A minimum of 1.0 ft (300 mm) of cover soil should be placed over the deployed liner with approximately 2.0 ft (600 mm) for high traffic areas to ensure adequate protection and prevent sodium bentonite free swell.

Cover soil should be free of all rocks greater than 0.75 in (18 mm) diameter, sharp or angular objects, sticks, roots or debris.

When the product is deployed with the bentonite side up (geomembrane against the subgrade), it is recommended to cover all exposed bentonite within the same day. This is typically accomplished by installing a geomembrane directly over the bentonite layer.



HOUSTON • HAMBURG • BANGKOK • SANTIAGO • CAIRO