



AGRU GEOCLAY™ GEOSYNTHETIC CLAY LINER INSTALLATION MANUAL

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This manual is provided only as a guideline and not meant as an
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PART 1 - GENERAL

1.01 Summary

This manual provides guidance and a general overview of the procedures for the installation of Agru GeoClay™ geosynthetic clay liners (GCLs). These procedures are consistent with standard industry accepted practices and are designed to ensure that the GCL is handled and installed in a manner that maximizes safety, efficiency, and the physical integrity of the GCL.

These guidelines are based upon experience at a variety of different sites and should be generally applicable to any type of lining project using Agru GeoClay™. Any variance from or additional requirements to these guidelines would be at the engineer's discretion. Therefore, it should be noted that strict adherence to the customer's project specific specification is also required.

The ultimate performance of Agru GeoClay™ or any GCL is fully dependent on the quality of its installation. Therefore, it is the installer's responsibility to adhere to these guidelines, as well as the project specifications and drawings, as closely as possible. In addition, it is the responsibility of the engineer and owner to provide construction quality assurance (CQA) for the installation in order to ensure the proper installation. This document covers only installation procedures.

For additional guidance or assistance regarding Agru GeoClay™, you may contact Agru America, Inc.'s Technical Support Staff at (843) 546-0600.

For additional guidance beyond this document, refer to the standards referenced below.

1.02 References

American Society for Testing and Materials (ASTM):

- ASTM D5888: Standard Guide For Storage and Handling of Geosynthetic Clay Liners.
- ASTM D 6102: Standard Guide For Installation of Geosynthetic Clay Liners

Geosynthetic Research Institute (GRI):

- GRI-GCL3: Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)
- GRI-GCL5: Design Considerations for Geosynthetic Clay Liners (GCLs) in Various Applications.



PART 2 – Equipment and Personnel Requirements

2.01 Installer Requirements

Agru America, Inc. (Agru) is committed to ensuring that its Agru GeoClay™ is installed properly to fully ensure the physical integrity and performance of the material. Therefore, Agru reserves the right to limit the sale of any of its materials to customers who can show that they have adequate equipment, personnel, experience and knowledge to provide the proper installation required.

2.02 Personnel Requirements

It is the sole responsibility of the Installer to ensure that an adequate number of appropriately trained personnel are provided to ensure the proper and safe installation of Agru GeoClay™.

2.03 Equipment Requirements

Agru GeoClay™ is delivered in rolls which are typically 1,600-3,500 lbs (725-1600kg). Product dimensions and weights will vary according to the specific AGRU GeoClay™ product which is ordered. Please note that it is necessary to support this weight using an appropriate core pipe or other method for lifting the GeoClay rolls. For any installation, it is important to minimize the deflection of a roll to a maximum of 3” (75mm) from midpoint to either end when a full GCL roll is lifted.

Appropriately rated lifting chains/straps may be used in combination with a steel pipe (preferably solid) and an I-beam to fabricate a “spreader bar”. The spreader bar ensures lifting chains or straps do not chafe against the ends of the roll, allowing it to rotate freely during installation. The entire assembly with the roll can then be lifted with a crane, front end loader, excavator or other suitable equipment for deployment.

Alternatively, a forklift specially fitted with a carpet pole (stinger) attachment may also be used for on-site handling. A forklift without a stinger attachment should not be used to lift or handle the rolls.

When installing over certain geosynthetic materials, a 4-wheel, all-terrain vehicle (ATV) can be used to deploy the GeoClay™. An ATV can be driven directly on the GCL provided that no sudden stops, starts, or turns are made and the ground pressure exerted ATV is kept to a minimum.

Additional equipment that may be needed for installation includes, but may not be limited to, the following:

- Utility knife and spare blades.
- Granular bentonite (available from Agru) for enhanced seams and for sealing around structures.
- Waterproof tarpaulins (for temporary cover on installed material as well as for stockpiled rolls).
- Flat-bladed vise grip pliers (for adjusting/positioning panels by hand).



PART 3 – Shipping, Unloading and Storage

3.01 Shipping

All material lot and roll numbers should be recorded and compared to the packing list. In addition, each roll of GeoClay™ should also be visually inspected to determine if any of the materials have been damaged.

Major damage suspected to have occurred during loading/unloading or transit should be reported immediately to the carrier and to Agru America, Inc. The exact nature and extent of the damage should also be indicated on the bill of lading along with the specific lot and roll numbers of the damaged materials.

Accumulation of some moisture within roll packaging is normal and does not damage the product.

3.02 Loading/Unloading

The party directly responsible for unloading the GeoClay™ should refer to this manual prior to arrival of the material in order to ascertain the appropriateness of their unloading equipment and procedures. All unloading and on-site handling efforts should be appropriately supervised.

In most cases, Agru GeoClay™ is delivered on flatbed trucks. There are three methods of unloading: core pipe and spreader bar; slings; or stinger bar. To unload the rolls from the flatbed using a core pipe and spreader bar, first insert the core pipe through the core tube. Secure the lifting chains or straps to each end of the core pipe and to the spreader bar mounted on the lifting equipment. Hoist the roll straight up and make sure its weight is evenly distributed so that it does not tilt or sway when lifted.

Agru GeoClay™ is typically delivered with two polyester endless slings on each roll. Wherever possible the core pipe should be inserted in the core tube for support even when lifting with the slings. Before lifting, it is very important to check the position of the slings. Each sling should be attached in the choke position approximately one third from the end of the roll. Always lift the roll straight up so that it does not tilt or sway when lifted.



In some cases, GeoClay™ rolls will be stacked in pyramids on flatbed trucks. If slings are not used, the rolls must be unloaded using a stinger/carpet pole on an extendible boom fork lift. The use of a spreader bars will not work in this situation due to the limited access between the pyramids of GeoClay™. To unload, guide the stinger through the core tube before lifting the GCL roll and carefully remove the roll from the truck.

An extendible boom fork lift equipped with a stinger is required for unloading enclosed containers. Rolls in the front and center of the container should first be carefully pulled toward the door using the slings provided prior to removing.

3.03 Storage

AGRU GeoClay™ rolls should be stored at the job site away from high-traffic areas which may result in damage to the material. However, they should be as close as possible to the deployment area to minimize handling. Any designated storage area should be flat, dry and stable. Regardless, the storage area SHOULD not be located in an area that is susceptible to flooding or in areas known for high storm water runoff.

All Rolls should be carefully stacked in a manner that prevents them from sliding or rolling. This typically requires chocking the bottom layer of rolls. Agru GeoClay™ rolls should be stacked only as high as can be safely handled by the Installers personnel and equipment under the site specific conditions (typically no higher than four rolls high). Agru GeoClay rolls should never be stacked on end.

While the Agru GeoClay's packaging is designed to provide some moisture protection, additional tarpaulins or plastic sheeting is/are also recommended to cover and protect the rolls of GCL material. Any rolls of material that are identified as being potentially hydrated or physically damaged should be isolated for further inspection to determine the extent of their usability.



PART 4 – Subgrade Preparation

4.01 Subgrade Inspection

When Agru GeoClay™ is deployed over a soil subgrade, the finished surface should be smooth without any abrupt elevation changes, voids, cracks, ice, or standing water. In addition it should be firm and unyielding, and compacted to a degree such that deployment or other construction equipment does not leave tracks or ruts greater than 1” (25 mm) in depth.

The prepared subgrade surface must be smooth and free of any vegetation, sharp-edged rocks, stones, sticks, construction debris, and other foreign matter that could contact and potentially damage the GCL. The subgrade should be rolled with a smooth-drum compactor to remove any wheel ruts, tracks, or other abrupt grade changes greater than 1” (25mm) in depth. Furthermore, all protrusions extending more than 0.5 inch (12 mm) from the subgrade surface shall be removed. The GCL may be installed on a frozen subgrade, however only if the subgrade soil in the unfrozen state meets the requirements listed above.

In applications where the Agru GeoClay™ is the only barrier, subgrade surfaces consisting of granular soils or gravels are not acceptable due to their large void fraction and puncture potential. In these applications subgrade soils should have a particle-size distribution at least 80% passing a #60 sieve with no particles greater than ¾” (19 mm).

4.02 Subgrade Approval

Notwithstanding the above requirements, the subgrade surface must also be prepared in strict accordance with the project drawings and specifications, and the engineer’s approval of the subgrade must be obtained prior to material deployment.



PART 5 - Installation

5.01 Material Deployment

Agru GeoClay™ rolls should be transported to the deployment area in their original packaging. The orientation of the GCL (i.e., which side faces up) may be important if the GCL has differing types of geotextiles/geosynthetics. Always check with the project engineer in order to determine if there is a preferred installation orientation for the GCL.

If no specific orientation is specified or required, allow the roll to unwind from the bottom rather than pulling the flap from the top. Take care in removing the packaging so as not to damage the rolls.

Agru GeoClay™ rolls should not be released on the slope and allowed to unroll freely by gravity.

Agru GeoClay™ should always be cut using a sharp utility knife. Frequent blade replacement is recommended to avoid irregular tearing of the geotextile components during the cutting process.

Equipment which could damage the GCL should not be allowed to travel directly on it. Allowable equipment which may be utilized on the GCL is limited to lightweight ATVs with a maximum bearing capacity of 5psi (21.5 kPa). Care should always be taken in the operation of any equipment on Agru GeoClay™ so as to avoid sudden starts and stops, abrupt turns, or other maneuvers that could damage the GCL.

To minimize traffic on the Agru GeoClay™, installation may be accomplished by unrolling the GCL in front of a vehicle moving backwards. Any rutting or other damage to the subgrade must be repaired prior to the continued placement of the GCL or other material. Alternately if sufficient access is available, Agru GeoClay™ may be deployed by suspending the roll from a spreader bar at the top of the slope and using a group of laborers and equipment to spool the material off of the roll and pull it down the slope.

Regardless of the deployment method care must be taken to minimize the extent to which the roll is dragged across the subgrade or other surface in order to prevent damage to the GCL. Care must also be taken when adjusting the GCL panels to avoid damage to the geotextile surface by the subgrade or another adjacent geosynthetic material such as a textured geomembrane. A temporary geosynthetic/geomembrane sheet, commonly known as a slip sheet or rub sheet, may be used to prevent or reduce friction damage during placement.



The GCL should always be deployed/placed so that longitudinal seams are parallel to the direction of the slope. End-of-panel or butt seams should also be located a minimum of 3' (1 m) from the toe and crest of any slopes steeper than 4H:1V. Butt seams on slopes should be used only if the liner is not expected to be in tension and interface friction testing confirms this.

All Agru GeoClay™ panels should be placed to lie flat, with no wrinkles or folds, especially at the exposed edges of the panels.

Several General rules for the deployment of Agru GeoClay™ in order to prevent premature hydration are as follow:

- Never install in standing water or during rainy weather.
- Only deploy as much Agru GeoClay™ as can be covered at the end of the working day with soil, geomembrane, or a temporary waterproof tarpaulin, and
- Agru GeoClay™ should not be left uncovered overnight.

If Agru GeoClay™ is allowed to hydrate when no confining stress is present, it may be necessary to remove and replace the hydrated material. Agru recommends that premature hydration be evaluated on a case-by-case basis. The project engineer or CQA inspector should be consulted for specific guidance if premature hydration occurs. The type of GCL, duration of exposure, degree of hydration, location in the liner system, and expected bearing loads should be considered. In many instances, a needlepunched reinforced GCL may not require removal/replacement if the following are true:

- (1) the geotextiles have not been separated, torn or otherwise damaged;
- (2) there is no evidence that the needlepunching between the two geotextiles has been compromised;
- (3) the GCL does not leave deep indentations when stepped upon; and
- (4) any overlapped seams with bentonite enhancement (see Section 7) are intact.

5.02 Anchorage

The end(s) of the roll may require placement in an anchor trench at the top of a berm or slope. The front edge of this anchor trench should be rounded to eliminate any sharp corners or protrusions which may cause excessive stress on the GCL. Loose soil should be removed or compacted into the floor of the trench prior to placement of the GCL.

The GCL should be placed in the anchor trench such that it covers the entire trench floor but does not extend up the rear trench wall.



To complete the anchor trench, soil backfill should be placed in the trench to provide resistance against pullout. The size and shape of the trench, as well as the appropriate backfill procedures, should be in accordance with the project drawings and specifications.

Sufficient anchorage may alternately be obtained by extending the end(s) of the Agru GeoClay™ rolls beyond the crest of the slope a prescribed distance and covering with soil. The length of this “run out” anchor, as well as the amount of cover soil, should be in accordance with any project drawings and specifications.

5.03 Seaming

Agru GeoClay™ seams are constructed by overlapping adjacent panel edges and ends. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. For pond applications, supplemental bentonite must be used in longitudinal seams regardless of the specific Agru GeoClay™ GCL used.

Longitudinal seams should be overlapped a minimum of 6” (150mm). For high-head applications (greater than 1’ or 30.48 cm), a minimum longitudinal seam overlap of 12” (300 mm) and supplemental bentonite is recommended. Butt seams should be overlapped 24 inches (600mm).

Butt seams are constructed such that they are shingled in the direction of the grade to prevent runoff from entering the overlap zone. Butt seams on slopes are permissible, provided adequate slope stability analysis has been conducted (i.e., the GCL is not expected to be in tension). Bentonite-enhancement is required for all butt seams.

Bentonite-enhanced butt seams are constructed first by overlapping the adjacent panels, exposing the underlying panel, and then applying a continuous bead or fillet of granular sodium bentonite 12” (300mm) from the edge of the underlying panel. The minimum application rate at which the bentonite is applied is one-quarter pound per linear foot (0.4 kg/m).

If bentonite enhancement is required for longitudinal seams are required, they are constructed by first overlapping the adjacent panels by a minimum 6” (150 mm), exposing the underlying edge, and applying a continuous bead of granular bentonite approximately 3” (75 mm) from the edge. For pond



applications, longitudinal seams are constructed by overlapping adjacent panels by 12” (300 mm), exposing the underlying edge and applying a continuous bead of bentonite approximately 6” (150 mm) from the edge. The minimum application rate for the granular bentonite is one quarter pound per linear foot (0.4 kg/m).

5.04 Sealing around Penetrations and Structures

The Installation of Agru GeoClay™ around structures or penetrations should be in accordance with the project drawings and specifications. Agru GeoClay may be secured to structures through the use of mechanical fasteners, clamps, batten bars, or other methods. The Agru GeoClay™ should be sealed around any penetrations, structures embedded in the subgrade, and/or other appurtenances by liberally using granular bentonite (approx. 2 lb/ln ft. or 3 kg/m) to seal the GCL to these structures.

When Agru GeoClay™ is placed over a penetration (pipe, piling, or other appurtenance), a “notch” should be excavated into the subgrade around the penetration to a depth of approximately 4” (100mm) and at a width of approximately 3” (75mm) around the entire structure. The notch should then be filled with granular bentonite. A secondary GCL collar fabricated from Agru GeoClay™ should then be placed around the penetration. It is usually helpful to first trace the outline of the penetration on the GCL and then cut a star-shaped pattern in the collar to enhance the collar’s fit to the penetration. The GCL collar should extend a minimum of 12” (300mm) from the structure in all directions. Granular bentonite should be placed between the primary GCL and the secondary GCL collar as well as in in minor gaps or voids that may exist around the interface with the structure.

When Agru GeoClay™ is terminated at a structure that is embedded into the subgrade on the containment area floor, the subgrade should be notched as described previously. The notch is filled with granular bentonite, and the GCL should be placed over the notch and up against the structure. Connection to the structure can be accomplished through the placement of soil or stone backfill in this area. Should the structure be located at the top of a slope, additional detailing may be required.

5.05 Damage Repair

If the Agru GeoClay™ is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch of Agru GeoClay™ to cover the damaged area. Any damaged material should be brought to the attention of the Engineer in order to determine the extent of the



damage and any repairs which may be required.

If it is determined that the damaged roll is reparable, a patch of Agru GeoClay™ can be cut to cover the damaged area. The patch should be sized such that a minimum overlap of 12 inches (300 mm) is achieved around all parts of the damaged area. Granular bentonite should be liberally applied around the damaged area prior to placement of the patch.

Depending on site conditions, it may be necessary to use an adhesive such as wood glue to affix the patch in place to prevent displacement during cover placement. Smaller patches may be tucked under the damaged area to prevent patch movement.



PART 6 – Cover Placement

6.01 General Cover Information

Only as much GCL shall be deployed as can be covered by the end of the working day with soil, geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. As previously noted, if the GCL is hydrated in the absence of confining stress, it may be necessary to remove and replace the hydrated material.

6.02 Soil Cover Requirements

The required thickness of soil cover over Agru GeoClay™ varies with the application. However, a minimum of 1' (300 mm) of cover is typically required to provide the appropriate confining stress to the GCL, thereby eliminating the potential for seam separation and preventing potential damage of exposed or inadequately covered material.

Any soils (including cover soils) used in direct contact with the GCL should be free of angular stones or other foreign matter that could damage the material. In addition, any cover soils should be approved by the Engineer with respect to particle size, uniformity, and chemical compatibility. Consult with the Engineer and Agru if cover soils containing high concentrations of calcium (e.g., limestone, dolomite, gypsum, seashell fragments) are present.

Cover soils with a particle size distribution ranging between fines and 1 inch (25 mm) are recommended for direct placement on the GCL, unless a cushioning geotextile is utilized.

6.03 Cover Placement

Soil cover shall be placed over the GCL only using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1' (300 mm) of cover material should be maintained between any equipment tires/tracks and the Agru GeoClay at all times. In areas of high-traffic or roadways, a minimum thickness of 2 feet (600 mm) is required.

Soil cover should be placed in a manner that prevents the soil from entering the GCL seams. Soil cover should always be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

When a geomembrane liner is being placed over the GCL, the leading edge of the GCL should be folded and tucked under the geomembrane so that the leading edge of the geomembrane extends a minimum of 2' (600mm) beyond the GCL. Sand bags or other suitable ballast should



be used to secure the edge of the geomembrane against wind uplift or storm water runoff.

When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering commonly referred to as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

Cyclical wetting and drying of Agru GeoClay™ covered only with geomembrane may cause overlap separation. Therefore, soil cover should be placed promptly whenever possible. Geomembranes should be covered with a white geotextile and/or operations layer without delay to minimize the intensity of wet-dry cycling. If there is the potential for unconfined cyclic wetting and drying over an extended period of time, the longitudinal seam overlaps should be increased based on the project engineer's recommendations.

To avoid potential seam separation, the GCL should not be placed in tension by the weight or movement of a textured geomembrane on steep slopes. In the event that there is the potential for expansion and contraction of an unconfined geomembrane over an extended period of time, the longitudinal seam overlaps should be increased based upon the project engineer's recommendations.



PART 7 - Hydration

7.01 Hydration Methods

Ultimately, hydration of the Agru GeoClay™ will be required in order for the material to perform properly as a barrier layer. It is very important to note that this hydration must occur in the presence of a confining stress. The confining stress is most often provided through the use of a minimum of 12” (300mm) of cover soil.

Hydration is typically accomplished naturally by rainfall and/or the absorption of moisture from soil. However, in cases where the containment of non-aqueous liquid is required, it may be necessary to manually hydrate the covered GCL prior to use. If such manual hydration is necessary, water may be introduced to the GCL by flooding the covered lined area or by using a sprinkler system, irrigation system or other method of applying the water for hydration.

7.02 Premature Hydration

In the event that the Agru GeoClay™ is hydrated in the absence of confining stress, it may be necessary to remove and replace the improperly hydrated material. However, as discussed earlier in Part 5, a reinforced GCL may not require removal/replacement if the following are true:

- The GCL’s component geotextiles have not been torn, separated, or otherwise compromised/damaged;
- There is no physical evidence that the needle punching between the two geotextiles has been compromised;
- The GCL does not exhibit deep indentations from being walked upon or from other pressures that may have been applied, and
- The overlapped seams with bentonite enhancement remain intact.