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GRI-GN2* and GRI-GC13*

Standard Guide for

"Joining and Attaching Geonets and Drainage Composites"

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1. Scope

1.1 Geocomposite drainage materials consist of at least one geotextile attached to a geonet or other type of drainage core. The geotextile serves as both a filter and separator to the adjacent soil so that it allows for liquid flow yet prevents soil intrusion. Oftentimes, geotextiles are on both sides of the drainage core. The geonet or drainage core is the "drain" component which allows for liquid transmission within its plane to a downgradient exit area; be it a outlet pipe, sump, or swale.

Since manufactured rolls of geocomposite drainage materials must cover large areas, field constructed connections along their sides and ends are necessary. This guide addresses such connections. Even further, the ends of the geocomposites must eventually terminate by attachment to pipes, sumps or swales. These are also made in the field by construction personnel. The following situations are presented in this guide illustrating various connections and attachments which we currently consider to be best-available-practice;

- connection of overlapping geocomposites on their ends and sides
- geocomposite to horizontal pipe connection
- geocomposite to vertical pipe connection
- geocomposite termination in sumps and swales

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- geocomposite termination within landfill anchor trenches

1.2 This guide addresses many different types and configurations of geocomposite drainage materials. All of them, however, are characterized by having a geotextile(s) bonded, attached, or laid upon a drainage core. The geotextile can vary, but for reasons of their versatility and economics, needle-punched nonwoven polypropylene fabrics are the most widely used. Much greater variation is in the drainage core. Biplanar and triplanar geonets are commonly used in waste containment applications; see Figure 1a. They are all made from high density polyethylene. Stiff three-dimensional meshes (made from polypropylene or nylon), and built-up polymer columns, cuspatations, and dimples (made from polystyrene or polyolefins) are also available. They are commonly used in transportation and private development applications; see Figure 1b. The manufacturing of geocomposite drainage materials is very active with new products, and variations of existing products, being developed on a regular basis.

(a) Geonet composite drains

(b) Other geocomposite drains

Figure 1. Various types of sheet drainage geocomposites.

1.3 Regarding the design of drainage composites there is a wealth of knowledge available. GSI's key word data base indicates that forty-three references are available focusing on the required flow rate or transmissivity in myriad applications. An even greater number of references (seventy-eight in our data base) is available for calculation of the required flow rate or permittivity of the covering geotextile.

1.4 Regarding standardized testing of drainage cores for allowable flow rate or transmissivity, one has a choice between ASTM D4716 or ISO 12958. The allowable flow rate or permittivity of geotextiles is addressed in both ASTM D4491 and ISO 11058.

1.5 Of course, the issue of a design value counterpointed against a test value is the customary factor-of-safety (FS) upon which each component (drainage core and geotextile) is selected for a particular project. The tacid assumption, however is that field installation is such that the design and testing is representative of the field installation. As such, this paper attempts to present proper field installation of connections and attachments of drainage composites to one another, to various outlet systems such as pipes, sumps and swales, and to anchor trenches.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

D4491 Water Permeability of Geotextiles by Permittivity

D4716 Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

D7005 Determining the Bond Strength (Ply Adhesion) of Geocomposites

2.2 ISO Standard

12958 Geotextile and Geotextile Related Products – Determination of Water Flow Capacity in Their Plane

2.3 References

Hwu, B.-L. and Koerner, R. M. (1990), "Geocomposite Sheet Drain Joining," Jour. of Geotextiles and Geomembranes, Vol. 9, pp. 501-506.

Koerner, R. M. and Koerner, G. R. (2009), "Geocomposite Drainage Material Connections and Attachments," Proc. GRI-22 Conference, Salt Lake City, Utah, pp. 59-65.

Koerner, R. M. (2012), Designing With Geosynthetics, 6th Edition, Xlibris Publ. Co., 2 Vols., 914 pgs.

3. Summary of Guide

3.1 This guide presents recommended details of five different situations encountered with the connections and attachments of geocomposites to one another or to other materials and systems. The geocomposites addressed are all involved with the drainage of liquids or gases. As such, they are indeed drainage geocomposites. The drainage cores are biplanar or triplanar geonets or a myriad of other core types including three-dimensional meshes and built-up polymer columns, cuspations, and dimples. All of these drainage cores are covered with one or two geotextiles usually bonded to the core at the manufacturing facility. The geotextiles are most often needle-punched nonwovens although any other type could be used depending upon the specific design. They are supplied to the job site in rolls of various lengths and widths.

3.2 The five situations presented in the paper are the following:

- Connection of overlapping geocomposites on their ends and sides (Figure 4).
- Geocomposite to horizontal pipe connection (Figure 5).
- Geocomposite to vertical pipe connection (Figure 6).
- Geocomposite termination in sumps and swales (Figure 7).
- Geocomposite termination within landfill anchor trenches (Figure 8).

3.3 The recommended sketches associated with each situation are not theoretically derived, but are subject to the various caveats given in the guide. They are also based on what GRI feels is best-available-technology as seen over many years of observation.

4. Conditions and Caveats

In the suggested installation details to be presented in this guide there is considerable subjectivity taken on the part of the GRI authors. *In fact, this is an opinion guide, pure and simple.* As such, a few caveats regarding our assumptions are in order.

4.1 Butt joining of upgradient-to-downgradient drainage cores is not appropriate for any of these materials. The reason for this is that even a slight separation of the two ends will allow the covering geotextile(s) to intrude into the open space greatly decreasing the allowable flow rate. Overlapping ends of all drainage geocomposites are required in all applications.

4.2 Liquid flow within an upgradient geocomposite core discharging to an overlapped downgradient geocomposite core or drainage pipe cannot have an imbedded geotextile(s) within the flow area. The upgradient core must empty directly into the dowgradient core or pipe without flow passing through an intervening geotextile.

4.3 The upper and/or lower geotextiles must be capable of being hand stripped off of the geocomposite core. This has direct bearing on the adhesion of the geotextile(s) to the drainage core. In this regard, specifications should be limited to a maximum peel strength; perhaps 175 N/m (1.0 lb/in.). There should obviously be a minimum peel strength as well so as to prevent an interface slide from occurring; perhaps 87 N/m (0.5 lb/in.). See Figure 2 for the peel testing of a geotextile from a biplanar geonet core.

4.4 There can be no exposed drainage core directly against soil, either above or below, at any location. There must be the specified type of geotextile between the drainage core and soil to prevent intrusion of soil into the drainage core. If necessary, the bonding of additional geotextile to the composite's geotextile can be made by heat bonding, adhesive, or sewing.

Figure 2. Peel testing of a drainage composite per ASTM D7005.

Note 3 - It is generally accepted that field patching of areas where destructive samples had been taken using extrusion fillet seaming is less desirable than the original seam which was made by hot wedge welding.

4.5 The mechanical joining of the sides and ends of rolls of geocomposite drainage materials is usually done with electrical ties; see Figure 3. The main purpose is to provide fixed positioning so as to achieve sheet flow throughout the area to be covered. The spacing of these electrical ties is quite arbitrary but a consensus for biplanar and triplanar geonets appears to be about 220 mm (9.0 in.) at the ends and 1.5 m (60 in.) along the sides. These values also seem reasonable for three-dimensional mesh cores, but not for cores with columns, cuspations and dimples. Manufacturers literature should be followed for these latter products.

4.6 The bonding of geotextiles to other geotextiles has been done by many methods. Heat burnishing use a plate or shoe, use of an adhesive, and actually sewing are all acceptable as long as the bonding is continuous. Strength, per se, is not particularly important.

4.7 The various connections and attachments to follow apply to geonets (biplanar and triplanar, the latter requiring flow orientation to be appropriate) and three dimensional meshes. The built-up polymer sheet cores have unique characteristics insofar as their joining is concerned.

Figure 3. Plastic ties joining sides of a biplanar geonet.

5. Suggested Methodology

The sketches presented in this main section of the guide are considered to be best-available-technology by the authors. Each situation conforms to the "caveats" presented in the previous section. At the outset, however, we do realize that it is far easier to sketch various situations than it is to fabricate them (continuously under all weather conditions) in the field.

5.1 Connection of Overlapping Geocomposites on Their Ends and Sides

Figure 4 shows an overlapped geocomposite with the upgradient end overlapping the downgradient end. For the sides of the rolls which is placed, upper or lower, is not important. The recommended lengths of overlap ("L") are 300-450 mm (12-18 in.) for ends and 100-150 mm (4.0-6.0 in.) for sides. One other consideration has to do with the roll ends being factory supplied or cut in the field. The manufacturers of geocomposites usually leave an excess of 300 mm (12 in.) of unbonded geotextile for complete coverage purposes. Field cut geocomposites have no such excess geotextile.

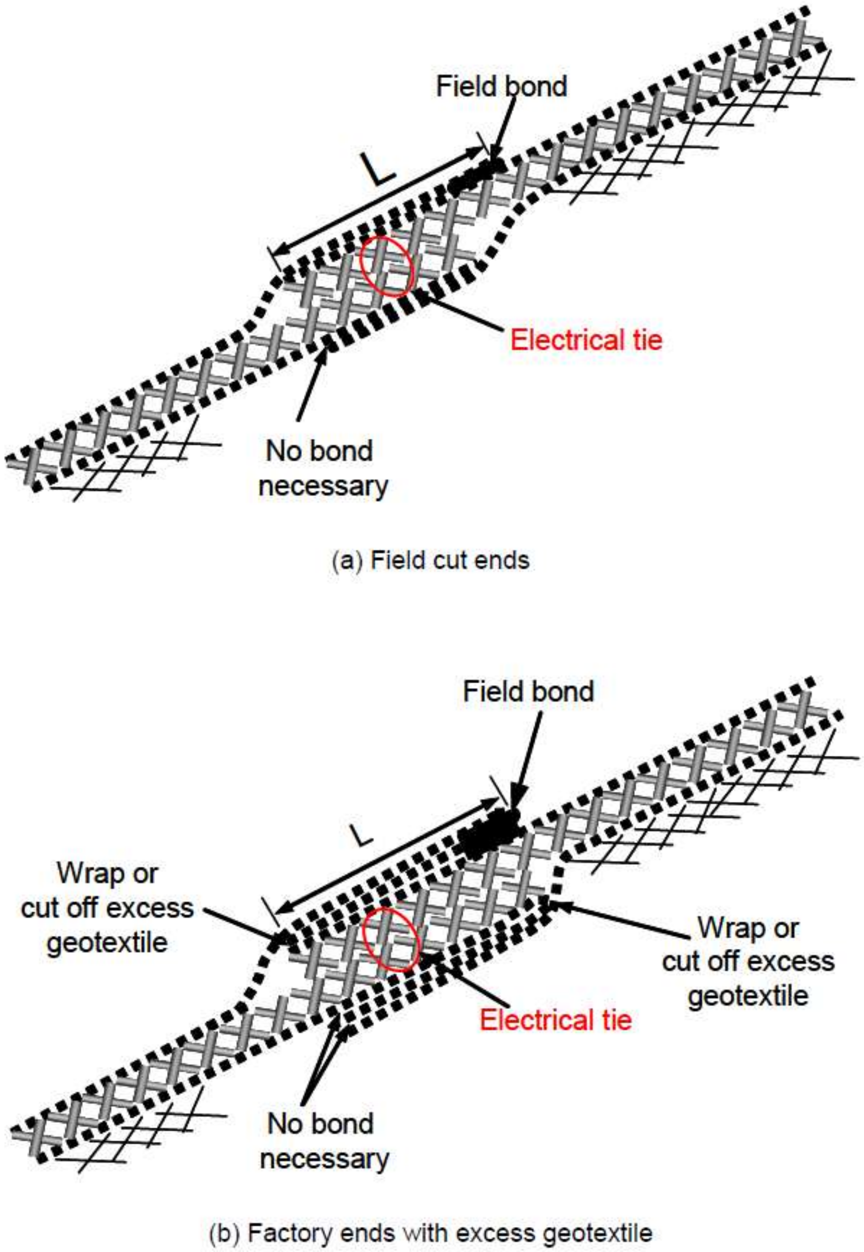
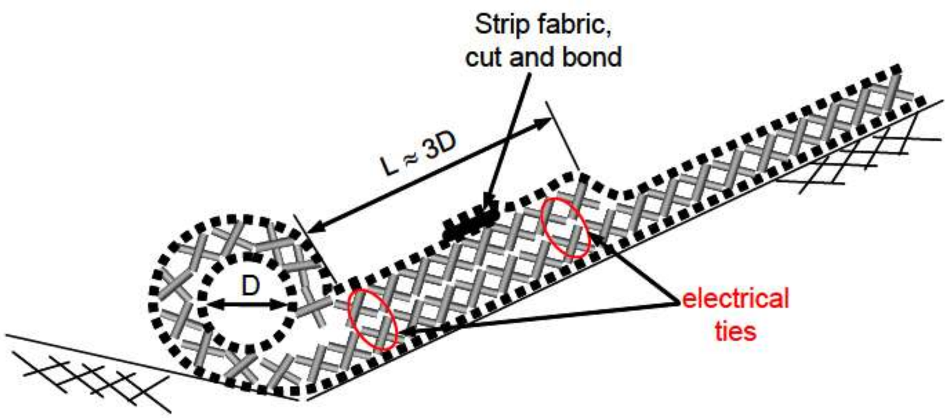


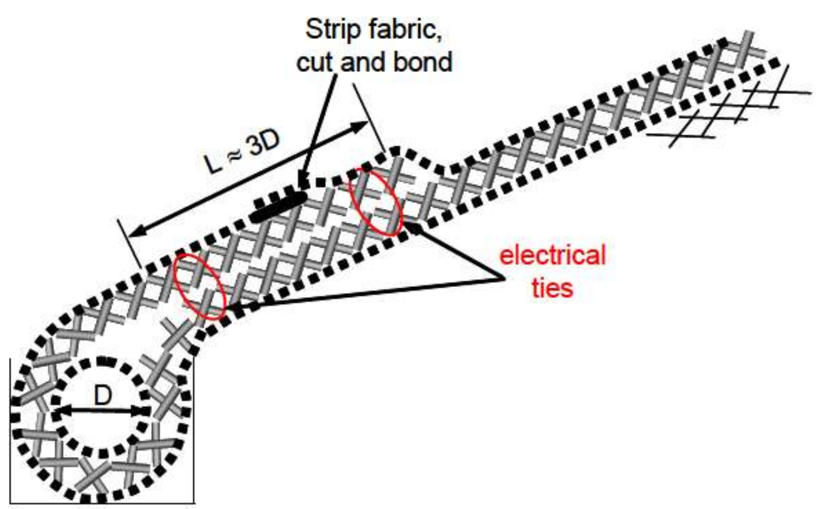
Figure 4. Recommended overlapping of geocomposite drainage materials.

5.2 Geocomposite to Horizontal Pipe Connection

Geocomposites very often empty their flow into a horizontally placed perforated drainage pipe. The drainage pipe is usually corrugated HDPE with slots in the valleys of the corrugations. However, where external stresses are high, the drainage pipe is often solid wall HDPE or PVC pipe with holes drilled in it at uniform spacings. Whatever the pipe type, the geocomposite drainage core should wrap around the entire pipe with no intervening geotextile in the flow transfer area. Figure 5a gives the desired, but admittedly difficult, preferred detail. The geocomposite's upper geotextile must be stripped off the drainage core, greatly trimmed, and then bonded to the reverse side of the geocomposite with its geotextile intact after wrapping around the pipe. The overlap distance "L" should be approximately three times the encapsulated drainage pipe diameter. Also note that plastic electrical ties are necessary to hold the geonet together particularly for thick biplanar and all triplanar geonet composites. Generally, two ties are necessary to minimize the air space around the encapsulated pipe. This same detail can also be followed if the drainage pipe is located in a trench at a lower elevation than the exiting geocomposite drain; see Figure 5b.



(a) Drainage pipe on a slope

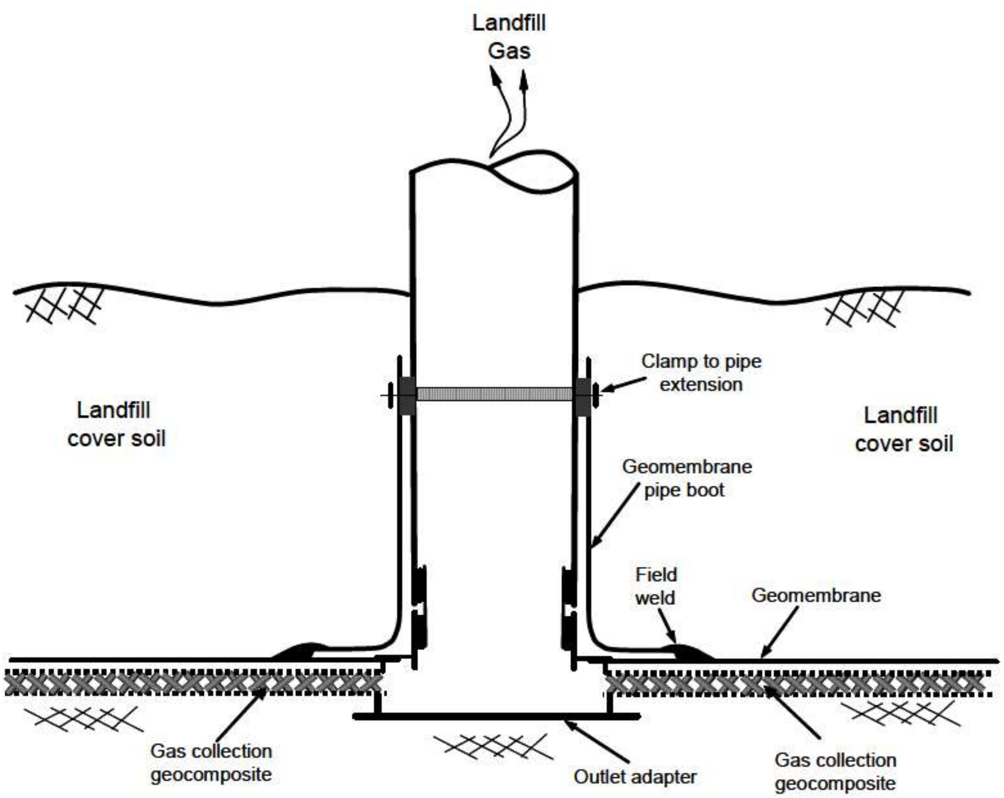


(b) Drainage pipe in a trench

Figure 5. Recommended geocomposite to horizontal drainage pipe condition.

5.3 Geocomposite to Vertical Pipe Connection

A geocomposite drainage system is often used for the collection and transmission of gas under the final covers of solid waste landfills. This drainage composite is located immediately beneath the geomembrane in the cover system. Figure 6a shows the typical situation. Fortunately, commercially available adapters are ideal for these connections; see Figure 6b. A force fit by opposing flanges of the adapter snugs up the geocomposite and allows for full exit of the gases (or liquids). The final extraction is from solid wall pipe (HDPE or PVC) stantions which penetrate the overlying topsoil, cover soil and geomembrane. A geomembrane pipe boot prefabricated to fit over the connection's shaft is necessary for a proper seal of the geomembrane.



(a) Cross section of adapter and geomembrane pipe boot

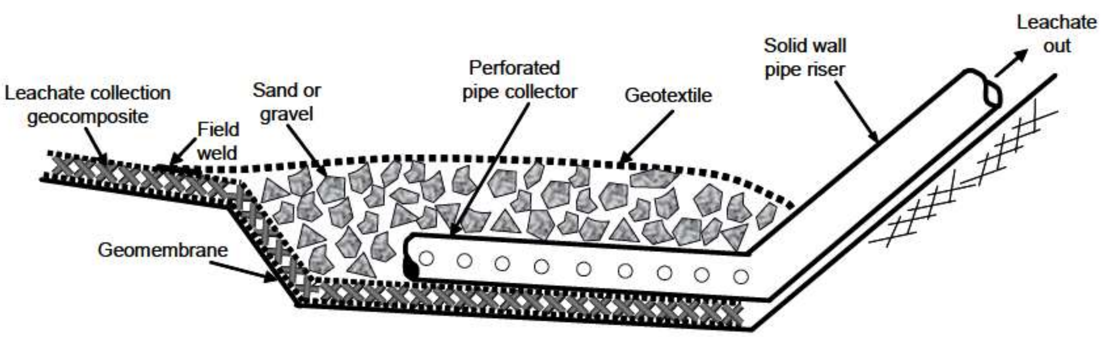
(b) Photograph of a typical adapter without geomembrane boot (compl., Drain Great™)

Figure 6. Recommended geocomposite to vertical pipe connections.

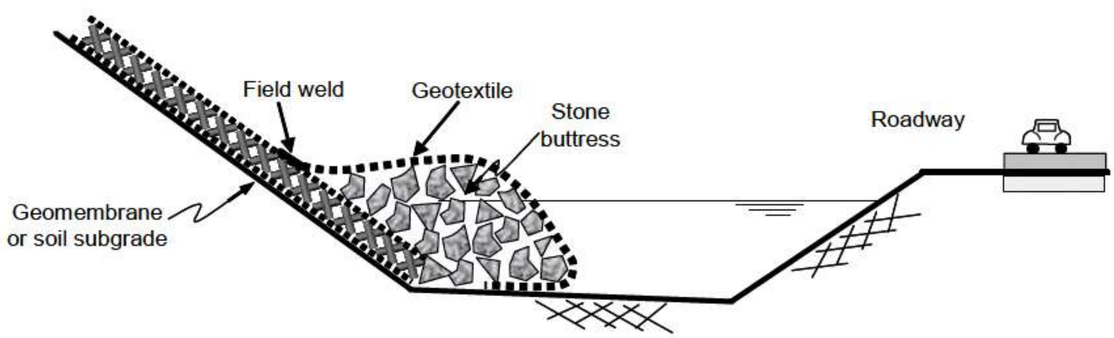
5.4 Geocomposite Termination in Sumps and Swales

Liquid being conveyed by a drainage geocomposite is often emptied in an open area such as a landfill sump or a highway swale. Figure 7a shows the general configuration for leachate removal when exiting into a landfill sump area. Since regulations limit the head on the geomembrane, the leachate must be removed by a submersible pump within a solid wall removal pipe. The drainage geocomposite should cover the entire sump area where it serves a secondary function as a protection for the geomembrane against the coarse gravel generally used as indicated. The geotextile(s) should be left on the drainage core throughout since it will help in filtering out fines leaving the geonet free of sediments.

Figure 7b shows the general configuration for water draining from a slope and emptying into a swale adjacent to a roadway. (Alternatively, it could end by emptying into a drainage pipe as shown in Figure 5). It is important that roadway maintenance operations do not cause a blockage of the exiting core, but otherwise the situation is quite straightforward.



(a) Recommended termination of geocomposite in a landfill sump for subsequent removal



(b) Recommended termination of geocomposite in a swale adjacent to a roadway

Figure 7. Recommended geocomposite terminating into an open collection area.

5.4 Geocomposite Termination Within Landfill Anchor Trenches

Geocomposites are used in three different locations for liquid (water or leachate) drainage purposes in solid waste landfills; (i) surface water drainage above a geomembrane in the final cover, (ii) leachate collection above the primary geomembrane beneath the solid waste, and (iii) leak detection between primary and secondary geomembranes beneath the waste if a double lined system is designed. Note that the gas collection geocomposite shown in Figure 6 is in addition to the three situations described here. In most cases geotextiles will be bonded to both the upper and lower surfaces of the geonet or drainage core. Figure 8 shows one possible strategy for terminating these three liquid drainage geocomposites in their respective anchor trenches.

For the geocomposite drain in the landfill cover the termination can be in a horizontal pipe (recall Figure 5b) or in a drainage swale (recall Figure 7b). One type of alternative to a pipe could be a geocomposite edge drain (Koerner, 2012), but these are seldomly used by landfill designers. For the geocomposite drain terminations beneath the solid waste mass the entire geocomposite generally enters the anchor trench along with its accompanying geomembrane. This is more for physical anchoring (to prevent the geocomposite from sliding downslope) than for drainage purposes. There is no overriding reason to seal off the ends of the geocomposite since capillary rise of moisture is not possible for these products.

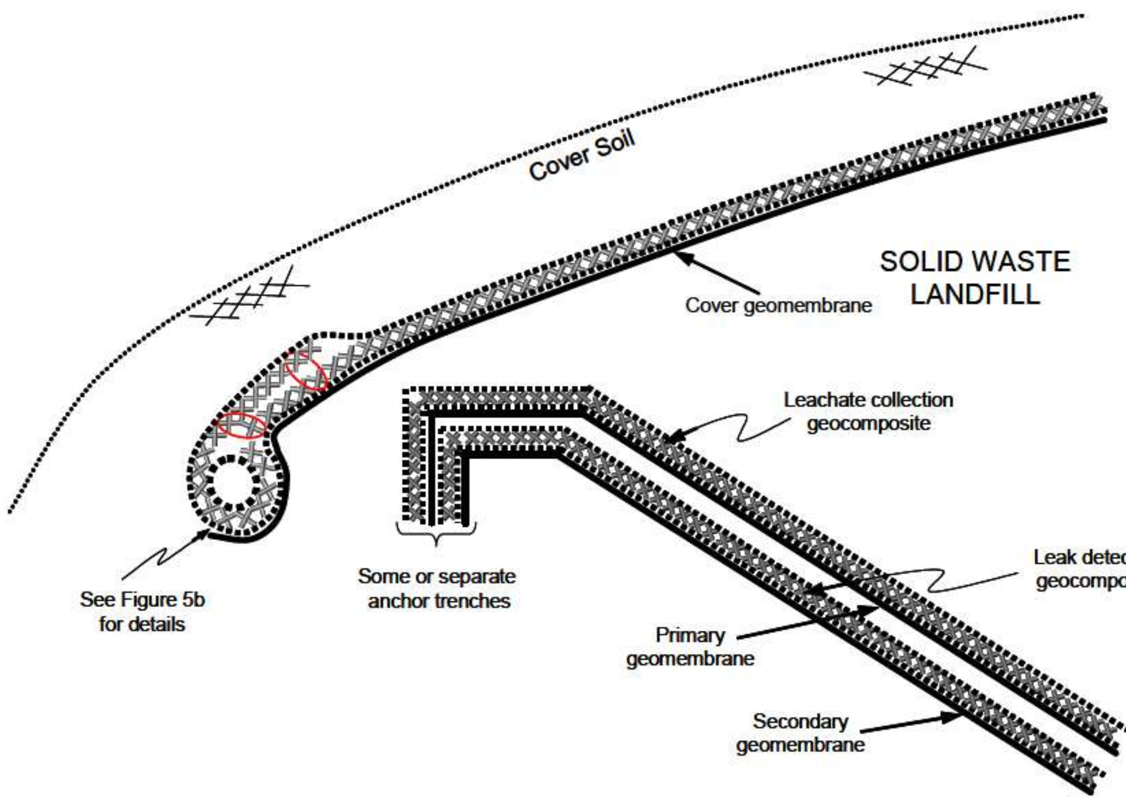


Figure 8. Recommended termination of geocomposites at the boundary and anchor trench of solid waste landfills.