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LANDFILL FINAL COVER AND MANAGEMENT OF LEACHATE SEEPS BELOW FINAL COVER

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Abstract: Leachate seeping out of landfill slopes is a common occurrence at landfills. Generally, after closure of a portion of the landfill slope, the issue of leachate seeps that was problematic and bothersome prior to the closure is completely forgotten because leachate seeps are no longer visible. The general perception is that the seeps automatically disappear because the closure prevents rainwater from entering into the landfill. This perception may be true if the source of water leading to the seep is within the closed area; but if the source is in an area other than the closed area, the seep underneath the final cover geomembrane continues for a much longer period of time until the actual source is covered by geomembrane at a later date, and this later date could be many years or several decades into the future. In the meanwhile, the seeped liquids pond below the final cover geomembrane at the toe of the slope and potentially create an unstable situation for the slope. To address this issue, a leachate toe drain system may be installed. A leachate toe drain system collects and disposes of liquids flowing down the slope underneath the cover geomembrane. The leachate toe drain system is connected to the nearby leachate collection pipe cleanouts and/or nearby primary sump riser for removal of liquids through the leachate collection sumps.

Keywords: landfills final cover; leachate seep; toe drain;

Introduction

Leachate seeping out of landfill slopes is a common occurrence at landfills. Landfill operators struggle to address leachate seeps and manage liquids reaching the landfill boundary. During the dry season, leachate seeps are normally more manageable, and less effort must be spent by the operator to control liquids on the surface; however, during the wet season with frequent storm events and high precipitation in areas such as Florida, landfill operators constantly work on the slope trying to stop seeps or devise means to control liquids reaching the surface.

Generally, after closure of a portion of the landfill slope, the issue of leachate seeps that was problematic and bothersome prior to the closure is completely forgotten because leachate seeps are no longer visible. The assumption is that the seeps automatically disappear because the closure prevents rainwater from entering into the landfill. This assumption may be true if the source of

water leading to the seep is in the closed area; but if the source is in a different area (i.e., an area that is not yet closed), the seep underneath the final cover geomembrane continues for a much longer period of time until the actual source is covered by geomembrane at a later date.

Background

To handle leachate seeps below the final cover geomembrane, the author developed a collection system and later coined the term "leachate toe drain system" or LTDS. The first LTDS was designed and permitted in 2001, and implemented in 2002, at an extremely wet landfill located in south Florida. Severe leachate seeps from slopes had previously caused significant problems for a closed portion of the landfill slope and caused potential compliance issues for the facility operator. It was very obvious that the source of the seeps was the large open top area of the landfill that was going to remain open for a long time. The author modified the final cover design to incorporate the LTDS for collection and disposal of liquids flowing down the slope underneath the cover geomembrane. The LTDS was designed to be connected to the nearby leachate collection pipe cleanouts and/or nearby primary system riser from the sump. These connections conveyed the collected liquids in the LTDS to the leachate collection system for removal via the leachate collection sumps. The success of the project was the reason for including a LTDS in all future final cover designs by the author.

Leachate Toe Drain System (LTDS)

The LTDS is simply a collection and removal system constructed below the final cover geomembrane at the perimeter of the landfill (Figure 1). The LTDS components are the LTDS geocomposite, pipe, gravel, and geotextile. The pipe encased in gravel and wrapped in geotextile is collectively referred to as the "LTDS burrito". The location of the LTDS is schematically shown in Figure 1.

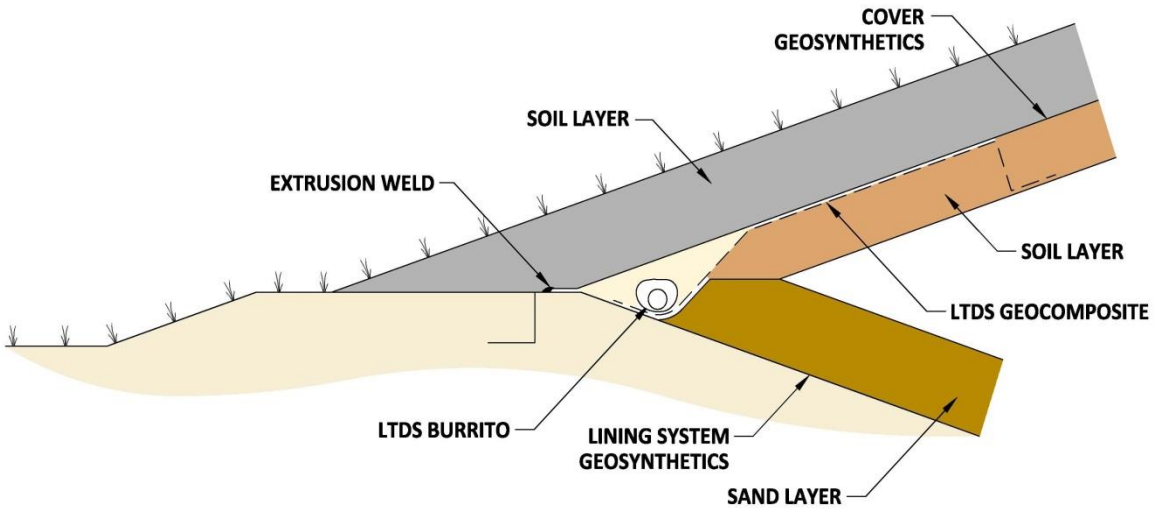

Figure 1. LTDS at Toe of Landfill Slope

To prepare the area for construction of the LTDS, the slope is regraded such that a shallow depression at the toe of the slope can be created within the sand layer previously placed over the landfill bottom lining system and near the top of the lined slope. Normally, the bottom of the depression is set at 1 ft below the top of the lined slope. Photo 1 shows the prepared depression at the toe of the slope.

Photo 1. Depression at Toe of Slope

The LTDS geocomposite is a short-length geocomposite over the lower portion of the slope. The top of the geocomposite is anchored in the prepared slope and the bottom is laid in the depression at the toe of the slope. Photo 2 shows the LTDS geocomposite placed over the lower portion of the slope.

Photo 2. LTDS Geocomposite Over Lower Portion of Slope

The LTDS burrito is then constructed over the LTDS geocomposite inside the depression at the toe of the slope. Photo 3 shows construction of the LTDS burrito in progress and Photo 4 shows the completed burrito.

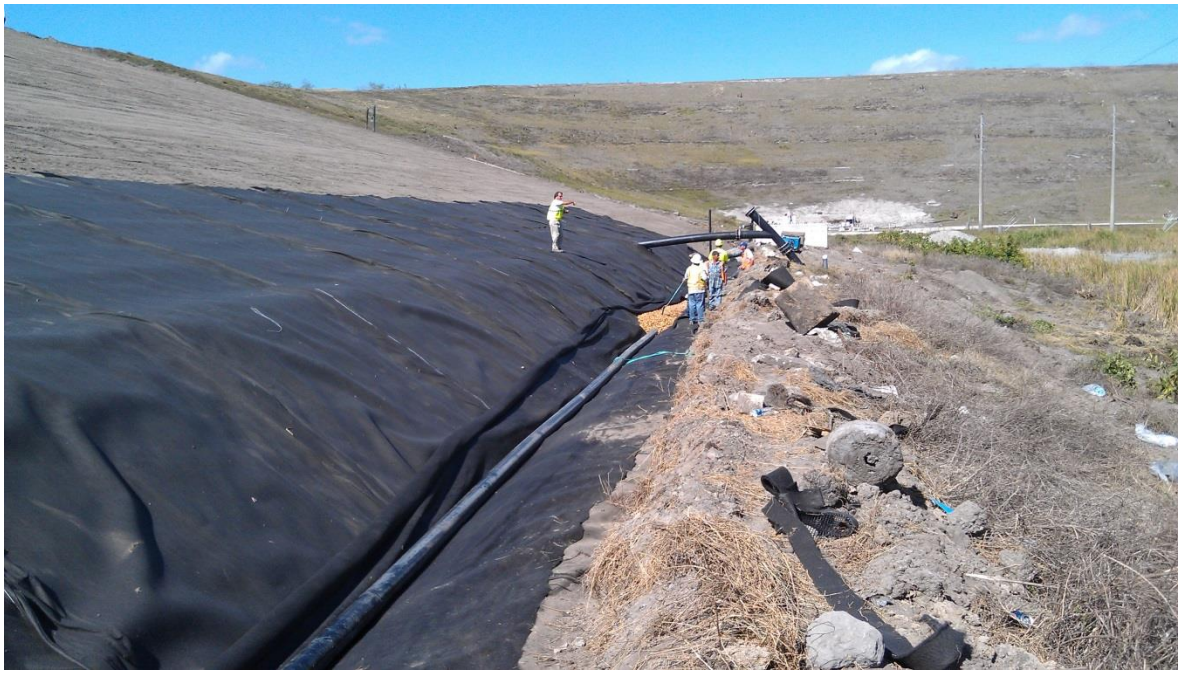

Photo 3. LTDS Burrito Under Construction

Photo 4. LTDS Burrito Completed

After completion of the LTDS, the cover geomembrane is installed over the LTDS geocomposite and the LTDS burrito, where the LTDS geocomposite becomes the sole conduit for liquids below the cover geomembrane flowing to the bottom of the slope. Since the LTDS geocomposite provides a preferential path for the flow of liquids, the liquids directly flow through the geocomposite to the LTDS burrito instead of entering soils at the bottom of the slope where by it would have created a soft and saturated condition at the toe of the slope below the cover geomembrane. The perforated pipe in the LTDS burrito is connected to a cleanout pipe or a specifically designed piping system to convey liquids to a nearby leachate collection sump.

The specific piping system that conveys liquids in the LTDS to the leachate collection sump should be equipped with cleanouts so that the LTDS pipe can be cleaned, if needed. In the case of double lining systems, the pipe that drains the LTDS pipe to the primary sump may have to cross over the detection riser inside the secondary sump (below the primary liner); therefore, the drain pipe grades need to be carefully designed and closely monitored during construction to maintain gravity flow through the pipe.

In the case of sloping perimeter berms, use of a LTDS is highly recommended, otherwise leachate reaching the toe of the slope may flow along the berm under the cover geomembrane and cause serious erosion problems. The berm slope provides an efficient gravity flow for the LTDS pipe. A similar condition may also exist when a lined overlay (liner over a side slope of an existing landfill) is in the design. The LTDS should be extended along the berm, where the overlay liner is anchored.

Leachate Seeps on Slope

If specific leachate seep locations are identified on the slope above the LTDS geocomposite boundary, the seep locations are surveyed prior to disturbing the slope for construction of the final cover. After the slope was prepared and before installation of the cover geomembrane, the surveyed locations are staked for identification on the prepared slope and the LTDS geocomposite panel directly below each seep location is extended up the slope to cover the seep location and is anchored above the seep. The extended geocomposite panel provides a preferential path for liquids coming out of the seep underneath the cover geomembrane to the LTDS burrito. Even if the seep remains active for many years after closure of the slope, the LTDS geocomposite will continue directing liquids coming out of the seep to the LTDS at the toe of the landfill slope for collection and disposal. Photo 5 shows the geocomposite on the slope and connected to the LTDS geocomposite at on the bottom side. The existing seep was located near the top of the geocomposite.

Photo 5. Geocomposite Over Leachate Seep on Slope

Gas Collection

The LTDS pipe can also be used as a gas collection system for the lower portion of the slope. Since the LTDS is below the cover geomembrane, landfill gas in the vicinity of the LTDS burrito can enter the pipe. By installing vertical pipes on the LTDS pipe at approximately 300 ft spacing, vacuum can be applied to the LTDS pipe to remove landfill gas from underneath the cover geomembrane. This will not only reduce gas pressure below the cover geomembrane at the toe of the slope, but it will also increase gas collection efficiency from the lower portion of the landfill slope. For the case of shallow-depth landfills (coastal area landfills) where the closest vertical gas wells may be 150 ft to 200 ft away from the perimeter berm, collection of gas through the vertical

pipes on the LTDS can potentially prevent gas pressure issues at the toe of the slope. Note that the vertical pipes will penetrate the cover geomembrane, thereby requiring the installation of geomembrane boots. Photo 6 shows a vertical pipe installed on the LTDS pipe with gravel being placed around the LTDS pipe. Photo 7 shows the final cover geomembrane over the LTDS and the boot on the vertical pipe.

Photo 6. Vertical Pipe for Gas Collection

Photo 7. Boot on Vertical Pipe at Cover Geomembrane Penetration

Construction

Construction of a LTDS at the time of the construction of the final cover can become more complicated if the landfill slope is overfilled. The excess waste must be shaved back to open space for construction of the depression for the LTDS (as discussed above). Handling leachate during shaving of waste and preparing the depression is another complication. Alternatively, the LTDS can be constructed at the time of construction of a new cell and protected by a sacrificial geotextile (to be kept clean) so that it can be placed in service when the final cover is constructed over the slope above the LTDS at a later date. In that case, the LTDS geocomposite will be placed above the LTDS burrito; therefore, measures must be taken to ensure that no soil is trapped between the LTDS geocomposite and the LTDS burrito that could potentially create a future bottleneck in the flow path of leachate to the LTDS burrito. In any case, sandy soil should be used over the completed LTDS burrito to form a gradual slope over which the cover geomembrane will be installed. Proper grading of the sandy soil prevents development of depressions that might trap water above the cover geomembrane. Photo 8 shows soil placed over the LTDS burrito before the cover geomembrane is pulled over.

Photo 8. Soil Over LTDS Burrito Before Cover Geomembrane Installation

For the LTDS to function properly, it is important that the cover geomembrane be welded to the geomembrane in the bottom lining system. The extrusion weld connecting the cover geomembrane to the bottom geomembrane should be properly vacuum tested to close all openings through which leachate can escape. The author usually takes even additional measures to ensure that leachate cannot escape through even pinholes that might exist in the extrusion welds. Such measures may include placement of dry bentonite powder over the extrusion weld and/or placement of a 3-ft wide strip of geosynthetics clay liner (GCL) over the extrusion weld or over the dry bentonite powder.

Unlined Landfills

If the landfill is unlined, a LTDS may still be constructed, but leachate may escape at the landfill boundary into the environment. Additional site specific measures may be taken by the design engineer to minimize escaping of leachate from the boundary of the unlined landfill.

Standard of Practice

The author has been involved in construction of numerous partial closures at very to relatively wet landfills, and the LTDS included in the closure system has proven to be an important component for keeping the final cover intact and stable on the slope. Since 2002, the author's clients have adopted the LTDS feature as a standard component of their landfills' final cover systems.

Cost

The construction cost of a LTDS varies from project to project depending on the components included in the design. The unit cost of construction may vary from $27 to $35 per linear foot.