GUIDANCE DOCUMENT #586

Division of Materials & Waste Management
October 2014 (originally published on May 29, 2004)[1]

Unstable Slope Advisory for Solid Waste Landfill Facilities

Applicable Rules

MSW: OAC 3745-27-19(E)(1)(c)

ISW: OAC 3745-29-19(E)(1)(c)

RSW: OAC 3745-30-14(E)(1)(c)

Tires: OAC 3745-27-75(E)(19)

C&DD: OAC 3745-400-11(E)(1)

DMWM Cross-Referenced guidance document:

#660 *Geotechnical and Stability Analyses for Ohio Waste Containment Facilities*

Purpose

This document outlines the operational and construction practices of material placement for maintaining stable waste slopes and the structural integrity of engineered components.

Applicability

This document applies to operating municipal (MSW), industrial (ISW) and residual (RSW) solid waste landfills, scrap tire monofills, and construction and demolition debris (C&DD) landfills.

Background

Operational and construction practices have a profound impact upon the stability of waste slopes and in maintaining the integrity of the engineered components. Excavated and constructed slopes (including waste slopes) can fail if sound operating and construction practices are not followed.

Several incidents involving failure of slopes and damage to engineered components have occurred at solid waste landfills around the state. Each incident can, in part, be attributed to construction and operational errors, specifically over-steep waste slopes. The operators at the facilities where these failures occurred placed waste at a grade that exceeded the shear resistance of the affected material, or the shear forces induced by waste placement exceeded the shear resistance of one of the geosynthetic and/or soil interfaces. Additionally, each of these facility operators incurred significant cost to assess and repair damage to the engineered components of the facility.

Slope stability analyses on final, interim and internal slopes are a requirement in the solid waste rules. All the landfill rules also require the owner or operator to maintain the integrity of the engineered components of the landfill facility and repair any damage to or failure of the components.

The following suggestions are not regulatory requirements but, adherence is highly recommended to help avoid slope failures, the resulting costly repairs to engineered components of the facility, violations for failing to maintain the integrity of the engineered components, and operational violations which could occur as a result of a failed engineered component.

Procedure

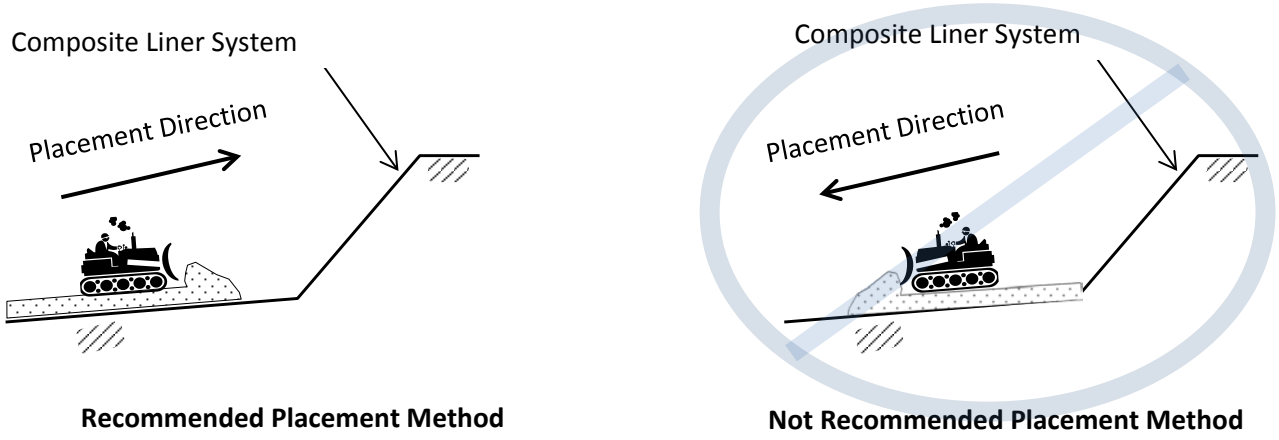
CONSTRUCTION

[1] Note: This document was originally published on the date noted above. DMWM re-issued the document to make it consistent with current formatting and publication standards after evaluating the content and determining it is still relevant and appropriate. No substantive changes were made to the document.

Unstable Slope Advisory for Solid Waste Landfill Facilities

Drainage layer sand, frost protection material and the select waste layer should only be placed while advancing up slope relative to the bottom composite liner grade similar to that shown in Figure 1. This is especially true on perimeter containment berms. At Ohio facilities, placing drainage material from the top down or laterally across a containment berm has caused anchor trench pullout, ripped flexible membrane liners, and failure through the recompacted soil liner.

Figure 1



WASTE PLACEMENT

In cells where geosynthetics have not been installed (e.g. C&DD, RSW, scrap tire monfills) the maximum grade of waste placement should be determined from a slope stability analysis that incorporates appropriate shear strength values of the waste and the natural underlying materials. The shear strength of the natural materials should be obtained from testing site specific natural material at site specific normal stresses. For C&DD and RSW facilities, the maximum slope for the cap is 25%, DMWM recommends waste placement does not exceed this slope.

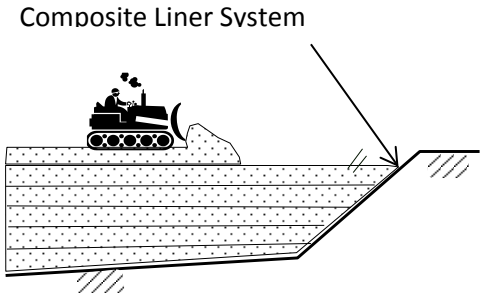
In cells where geosynthetics have been installed, the geosynthetics are usually the weakest component (with the exception of some industrial wastes) and will dictate the maximum grade of waste placement. As with drainage layer sand, frost protection material and placement of the select waste layer, waste should initially be placed in thin nearly horizontal layers starting from the lowest area of the phase or cell and advanced up slope relative to the bottom composite liner grade (see Figure 1). Pushing waste in a direction that is down slope with the bottom liner grade can cause stresses in the geosynthetics or result in an interface failure that can compromise the composite liner system.

Waste should continue to be placed in thin nearly horizontal layers (see Figure 2) until sufficient normal stresses can be developed that will maintain the structural integrity of the liner system for waste placement at a steeper grade. This steeper slope can only be determined through a stability analysis which incorporates both the appropriate shear strength values of the waste and natural underlying materials as stated previously (for unlined cells), and the interface frictional values obtained from testing site specific geosynthetics and soils at site specific normal stresses. Waste placement at a steeper grade can also create failure planes through waste and where intermediate cover is placed.

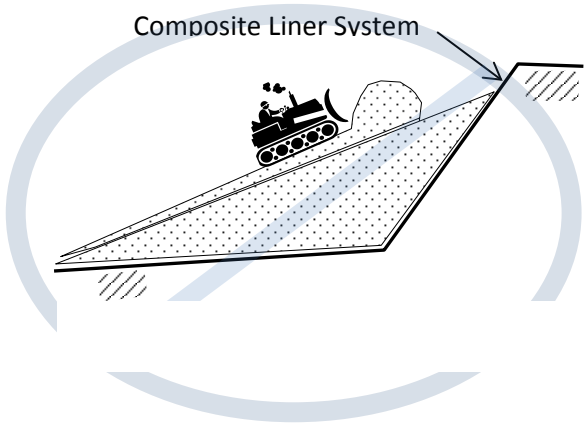
The recommended placement method may require changes in phasing and construction of a haul road into the bottom of the cell, which in turn may require an alteration or modification to the PTI (or C&DD license), depending upon the extent of the changes. It should be pointed out that construction of a haul road into the bottom of a cell has its own attendant concerns for maintaining the integrity of engineered components, consequently its design and construction should be thoroughly evaluated.

Figure 2

Unstable Slope Advisory for Solid Waste Landfill Facilities



Recommended Placement Method



Steep waste slopes have also been a cause of slope failure and destruction of composite bottom liner systems, resulting in significant remediation costs. The heterogeneous nature of MSW and the materials disposed in MSW landfills (such as ISW and RSW wastes), makes it very difficult to determine accurate and plausible shear strength values. ISW and RSW typically exhibit shear strength characteristics significantly less than that of MSW. One failure occurred in Ohio at a residual waste landfill with slopes of 5 horizontal to1 vertical (5:1) and resulted in waste material sliding into an adjacent uncertified cell. A slope of 3:1 is about the maximum feasible grade for MSW and about the maximum feasible final grade of a landfill given the limitations of the interface strengths with cap systems, equipment limitations, and difficulties with increased erosion and cover and cap maintenance. For detailed information on designing stable slopes see #660 *Geotechnical and Stability Analyses for Ohio Waste Containment Facilities*.

SATURATION

Saturation can dramatically affect shear strength. Failures have occurred through waste, intermediate covers on a steep slope, and in drainage layers on the side slope.

Slope stability analyses should evaluate saturated conditions. Selection of intermediate cover materials and placement should take into consideration the creation of failure planes. In another state, a slope failure occurred because a thick layer of wood chips was used as a cover material over a steep slope. The wood chips were eventually covered by subsequent layers of waste, but they had become saturated and eventually failed, resulting in a large waste slide. Granular drainage layer on the side slopes, left exposed during a long period of time, can become saturated and fail. The designer can account for the effects of exposure and saturation by designing the drainage layer to accommodate the maximum head predicted for the fifty year, one hour storm event. To mitigate saturation, the owner or operator can place the select waste layer (or a four foot thick lift of waste) up the exposed drainage layer on side slopes, if the slope stability analysis indicates waste placement will be stable.

Summary

Operational and construction practices have significant impact on the stability of waste slopes and in maintaining the integrity of engineered components. Additionally, interim waste slopes are often the most critical slopes at landfills. Therefore, DMWM recommends implementing the following practices at all landfills, as appropriate.

- Drainage sand, frost protection material, select waste and initial lifts of waste should only be placed while advancing up slope relative to the grade of the bottom composite liner system.
- In cells where geosynthetics have been installed, waste should be placed in thin nearly horizontal lifts (exclusive of the select waste layer).
- The maximum grade of waste placement for interim and final slopes of waste should be determined from a stability analysis.
- In general, waste slopes should not exceed 4:1 for C&DD and RSW, or 3:1 for MSW or ISW. However, given material limitations, the maximum allowable slope may need to be flatter.

Unstable Slope Advisory for Solid Waste Landfill Facilities

- Industrial and residual solid wastes should be evaluated on an individual basis to determine maximum waste placement grades for that particular waste and should not exceed 3:1.
- The effects of saturation should be evaluated and measures taken to address the loss of shear strength that occurs.
- Changes to the facility (e.g. a change in phasing or haul road construction) may require a permit alteration or modification or a license modification. Consult with the appropriate district office or license authority (for C&DD facilities) for additional information on modifications, alterations and license requirements.

Contact

If you have questions regarding this document or would like additional information, please contact:

Central District Office DMWM Supervisor (614) 728-3778

Northeast District Office DMWM Supervisor (330) 963-1200

Northwest District Office DMWM Supervisor (419) 352-8461

Southeast District Office DMWM Supervisor (740) 385-8501

Southwest District Office DMWM Supervisor (937) 285-6357

Central Office Authorizing Actions and Engineering Unit (614) 644-2621

Disclaimer

This document is intended for guidance purposes only. Completion of the activities and procedures outlined in this document shall not release an owner or operator from any requirement or obligation for complying with Ohio Revised Code (ORC) Chapter 3734 or 3714 as appropriate, the OAC rules adopted thereunder, or any authorizing documents or orders issued thereunder, nor shall it prevent Ohio EPA from pursuing enforcement actions to require compliance with ORC Chapter 3734 or 3714, the OAC rules, or any authorizing documents or orders issued thereunder.