

DESIGN OF A CONTEMPORARY MSW LANDFILL

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Introduction

Modern landfills are a layered system of components designed to either act as a barrier to migration of liquids or collectors that channel the flow of liquids or gases from the cell. General design procedures (1) and guidelines (2, 3) for these components has been established by US-EPA for hazardous waste facilities covered by Subtitle C of the Resource Conservation and Recovery Act. This paper reviews these guidelines as they apply to MSW landfills in general and the recently completed Rowan County, North Carolina, landfill in particular. Additional long-term MSW landfill design considerations addressed include (1) longterm exposure of the components prior to placement of the waste and (2) stormwater versus leachate control.

Design Considerations

The design of a landfill liner will be both site specific and dependent upon the particular state regulations. State regulations are typically either prescriptive, i.e., having specific design criteria, or performance based. Virginia is an example of prescriptive regulations with double liners and collection systems mandated. North Carolina is an example of performance based permitting with the liner configuration being site dependent. The Rowan County landfill has nearly 30 feet of fine grain soils separating the waste from the underlying ground water table. For this reason, a single composite liner was selected.

The primary environmental objective in landfill design is control of leachate that is generated as liquids drain from the waste or as precipitation percolates through the waste. Common referred to as a "bathtub," modern landfills rely on maximizing containment by using multiple liners. The most efficient arrangement of

components to provide this containment with a single composite liner includes the following components:

- 1) A leachate collection/removal (LCR) system designed to minimize the hydraulic head acting on the liner and
- 2) A composite liner formed of
 - A synthetic membrane overlying
 - Compacted clay layer.

The composite liner maximizes containment because the mechanism for liquids moving through each barrier layer is different: synthetic membrane pass liquids through penetrations or by diffusion, while clay layers pass liquids based on Darcy's Law. Thus the membrane aids the clay liner by limiting the head acting on it and protecting it from chemical attack. Conversely, the clay liner significantly limits the flow of liquids through penetrations that may occur in the membrane. Current hazardous waste landfills and some MSW landfills, e.g., New York, utilize two composite liners and collectors beneath the bottom of the landfill.

Sideslope Stability---Construction of the basic collector/composite liner system on the sideslope of a landfill is complicated by the low coefficient of friction associated with membrane liners. The Rowan County landfill used a 60-mil HDPE liner that has a typical coefficient of friction with granular soils of 13-16 degrees. The 3:1 sideslopes (18.4 degrees) desired at Rowan would therefore have been unstable. To prevent such sliding, a roughed HDPE sheet was tested and found to have a coefficient of friction of 26 degrees with the granular drainage soils. This produced a factor of safety against sliding greater than 1.5.

In addition to sliding, the stability of the sideslope drainage layer is influenced by the erodibility of the granular soils forming it. Many new landfills use a plastic drainage net, geonet, on the sideslope to eliminate both sliding and erosion problems. Use of a geonet does however leave the sideslopes exposed to potential damage from equipment placing waste, and to significant daily temperature fluctuations. The latter having significant environmental stress cracking implications for HDPE. Fortunately, at Rowan a nearby quarry had a significant quantity of a coarse sand screening having a low percent fines. These coarse, angular sands are very resistant to erosion and thus made an ideal sideslope drainage media. The long-term survivability of the sideslope drainage layer is significantly impacted by the control of surface water on the site. During recent months the drainage layer has weathered significant rains with no visible sign of distress. However, at one location on the sideslope and prior to establishing final grade and contours, water was allowed to flow into the landfill from adjacent lands. This river of water did erode the sand drainage layer. Obviously such an inflow of water

is also bad from an environmental perspective and must be avoided during operation of the landfill. As with any design, all peripheral drainage must be designed to divert stormwater away from the landfill.

Sideslope Filter---The MSW cannot be placed immediately atop the granular drainage layer or clogging of the drain will occur. At Rowan, a nonwoven geotextile was used to envelope the sand and act as a filter to prevent fines from migrating and clogging the collector. The geotextile on the bottom of the landfill was covered by a 12-inch soil operations cover. The sideslopes are not covered with soil, however, due to sliding considerations. This leaves the geotextile on the sideslope exposed to direct sunlight and susceptible to ultra violet degradation. With a projected landfill life of more than 5 years, the sidewall filter geotextiles will be exposed for a significantly longer period of time than normally acceptable.

Specifications for the Rowan side slope filter fabric call for residual strengths of the geotextile, after 5 years exposure, equal to typical 4-oz (ounce per square yard) nonwovens. The actual geotextile used, manufactured by Polyfelt, weighed 16-oz and had both chemical and carbon black UV stabilization to limit degradation. The use of geotextiles in areas having such extended exposure times is unprecedented. Only time will confirm the ability of geotextiles to survive such exposure.

Stormwater Collection---The Rowan County landfill is nearly 19 acres that is subdivided into 8 subcells as shown on Figure 1. Having a life expectancy of 5-7 years, this means that many of the subcells will be free of waste for many years. Stormwater entering these cells will be free of waste and does not require treatment. With leachate treatment cost ranging from \$.04-.06 per gallon, considerable operation savings will result from keeping the stormwater separate from the leachate. At Rowan this is accomplished by a surface stormwater collection system that is formed by the top of the operational cover placed atop the leachate collection system. Drainage pipes that penetrate the subcell berms tie each subcell into this surface system. As waste is placed in a subcell, these pipes are removed so that surface water from an active cell cannot enter the surface stormwater system. When waste is placed in the final subcell, the single stormwater drainpipe leaving the landfill will be removed or plugged.

Within an active subcell, leachate enters the LCR system by percolating through the operational cover layer and a leachate manhole that is opened when a subcell becomes active. Both the stormwater and leachate collection systems rely on gravity flow. The stormwater is discharged directly to a large sediment/stormwater storage basin while the leachate goes to a lined surface impoundment. At the surface impoundment, the leachate is aerated prior to being pumped to a nearby water treatment facility.

Construction Considerations

A full Construction Quality Assurance (CQA) program was maintained for all phases of the landfill construction. This program focused on the proper installation of the HDPE liner and the geosynthetic filters. All seams on the HDPE liner were tested. The majority of the seams were double-hot-wedge seams that were pressure tested by inflating the interstitial space between the parallel seams. The limited extrusion welds were tested using a vacuum box where accessible and an arc test when access was limited. Destructive seam tests were taken at the start and completion of each weld. Additional destructive tests were taken based on a visual inspection of the seam. The destructive samples were tested in the field by the installer, Plastic Fusion, and later by the Westinghouse Geosynthetic laboratory.

Placement of the clay embankments was monitored for density and moisture content of the clay. The clay was placed 2-3% wet of optimum at 95% of Proctor maximum density. Originally planned for remolding and recompaction to a depth of 12 inches, the clays forming the bottom of the landfill were essentially left intact. This clay surface was carefully examined for potential high permeability seams and a layer of bentonite board was placed over any zone of concern.

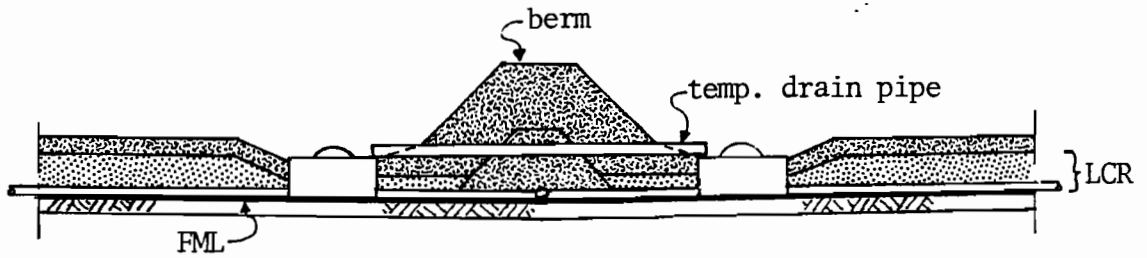
Summary

This paper presents a brief summary of the significant design considerations for the Rowan County Landfill. As one of the first synthetically lined MSW landfill in North Carolina, this facility demonstrates some of the difficult design problems that MSW facilities inherit from Subtitle C landfills. Uncertainties as to the effect of prolonged exposure of geosynthetic components can only be answered by time. Having a cost in excess of \$5 million the Rowan landfill is an typical facility by today's standards. Nationally MSW landfills cost average \$200K to \$600K per acre compared to the \$280K per acre at Rowan. Such significant expenditures demand an experienced design team.

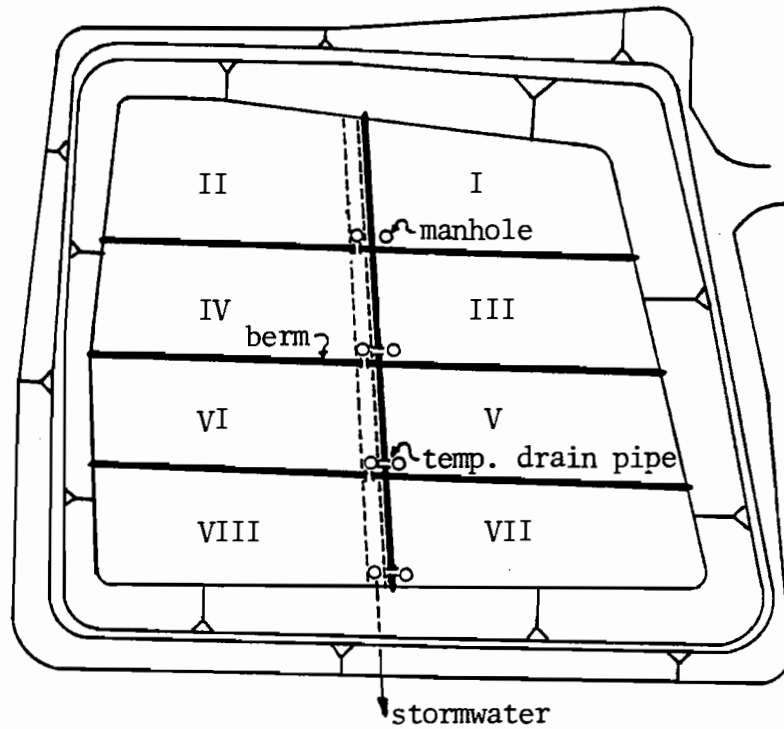
References

- 1) Richardson, G.N. and R.M. Koerner, Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments, US-EPA, EPA/600/S2-87/097, Feb., 1988.
- 2) EPA, Minimum Technology Guidance on Double Liner Systems for Landfills and Surface Impoundments, 2nd Version, US-EPA, May 24, 1985.

- 3) EPA, Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments, EPA/530-SW-89-047, July, 1989.



Cross-section at Manholes



Plan View

Figure 1 SURFACE STORMWATER COLLECTION