Surface Water Management System Modeling and the Effect on Percolation in Sizing the System

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The subtropical weather in Florida, and more specifically in south Florida, drops as much 60 inches of rain over land in a year period. Short term storms with high intensity are very bothersome to landfill operators for management of water running off their slopes. Also, long-term storms can potentially drop up to 22 inches (Ref., rainfall charts in the Environmental Resource Permit Information Manual, Volume IV by the SFWMD) of rain over parts of south Florida within a 72-hour period. Management of surface water runoff at landfills is possible through large dedicated systems constructed at the landfill perimeter and beyond. Surface water management systems not only have to meet capacity requirements, but also treatment requirements that are built into the state regulations. With landfill operators wanting to keep their final slopes unclosed for as long as possible in order to pursue future lateral expansions (i.e., future cell constructions might overlay existing cells), the business of sizing the surface water management system becomes more complicated. On one hand, the land is needed to permit lateral expansions to the landfill footprint to increase permitted airspace; and on the other hand, the size of the surface water management system for a larger landfill footprint requires larger areas for retention and/or detention of surface water. Optimization of surface water management systems has been an important factor during the past decades as available landfill airspace is rapidly being consumed. Parameters that must be considered in the optimization of the surface water management systems are many, and some are based on natural characteristics of soils involved, while others are based on applicable rules and regulations set by state agencies such as the Water Management District and the Florida Department of Environmental Protection, and/or local drainage authorities.

One of the parameters that has been proven to be of substantial impact on the storage capacity of a surface water management system is the percolation rate of storm water into the ground and surficial aquifer. Many of the existing permitted surface water management systems for landfills in Florida do not consider percolation of storm water into the ground as currently designed. The South Florida Water Management District (SFWMD) specifically allows percolation of storm water into the ground during and after the storm event. On numerous occasions, the authors have used this feature in the rules to incorporate percolation of water in perimeter ditches and retention/detention ponds into the ground in the hydraulic models designed for several landfills in Florida. Specific percolation tests are normally performed to determine vertical hydraulic conductivity of soils at the bottom of retention/detention areas. There are also specific test procedures prescribed by the SFWMD to determine the horizontal hydraulic conductivity of the surficial aquifer that receives surface water through soils at the bottom of surface water management systems. Then, percolation rates of storm water under various hydraulic heads in the perimeter retention/detention areas (i.e., perimeter ditches and ponds) are calculated and incorporated into the hydraulic model used for the facility design.

The authors have used the generally accepted model by the SFWMD entitled “Advanced Interconnected Channel and Pond Routing” (adICPR) for many years for the design and permitting of surface water management systems for landfills. adICPR allows flow through channels and culverts in both directions, which makes it very suitable for horizontal flow through surface water management systems with horizontal perimeter ditches at landfills in coastal areas, such as the majority of the Florida environment. adICPR also allows infiltration of surface water in the ground to be modeled by using certain features in the software. The percolation rates are a function of hydraulic head in the system and vary as water depth varies throughout the storm period and after completion of the storm. The authors’ experience with the design of surface water management systems has proven that the size of the retention/detention ponds can be significantly reduced by considering percolation of storm water into the ground.

One example of this application of percolation rates is a recent modification that was performed for a large landfill in South Florida. The surface water management system was

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previously designed and permitted by others without consideration of percolation into the ground in the hydraulic model. Based on the hydraulic results, the permitted design required a 41-acre detention pond to be constructed by the time the entire permitted footprint of the landfill was constructed. The authors modified the design and incorporated percolation of storm water into the ground in the hydraulic model. The new hydraulic results indicated that an 8-acre detention pond should be sufficient to handle runoff from the same landfill footprint. The model and all supporting calculations were submitted to the permitting agency, and the permit was obtained within a short period of time. The savings associated with this optimization (i.e., reduced construction costs) were significant for the client, especially considering the fact that the original design had the pond being constructed in several phases, while the new design involved a single construction event for the 8-acre pond that would serve the landfill throughout its remaining life.

Reuse Road Constructed in Pasco

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As part of recent efforts by the Pasco County Solid Waste and Public Works departments, the Hinkley Center for Solid and Hazardous Waste Management, and the University of Florida, a one thousand foot section of test roadway was built using bottom ash from the Pasco waste to energy facility. Test sections of ash base, ash amended concrete and asphalt were constructed, as well as supporting concrete and asphalt control sections. Ash was used as a twenty five percent replacement of the aggregate within the asphalt and concrete and as a one hundred percent replacement of the road base course. Prior to use in the roadway, the ash was screened to achieve the appropriate particle size and aged for three months to reduce leaching. Ageing of the ash allows carbon dioxide to react with the material, stabilizing certain trace metals within the ash. Batching of both the ash amended concrete and asphalt was successful, with plant operators reporting no significant differences when utilizing the material. Fifteen groundwater wells have been placed adjacent the roadway to monitor any potential impacts to the surrounding groundwater. Additionally, lined test patches *(see photo)* were constructed to extract leachate from under the roadway surface.

The reuse road has been in operation for a period of one month. The ash amended and control concrete slabs have been instrumented to measure temperature and strain *(see photo)* and further structural testing is ongoing at the University of Florida civil engineering materials laboratories and the Florida Department of Transportation. Environmental testing using the newly adopted EPA LEAF methods is being conducted at UF's solid and hazardous waste management laboratories. This project represents a comprehensive effort to examine ash recycling and increase knowledge on opportunities for responsible reuse of this waste stream.

Control and "Ash-Crete" roadway test sections

Ash base being placed in lined test patch

Instrumentation placed in concrete slab

"Ash-fault" roadway construction