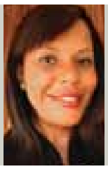
World-class landfill cell at the Holfontein disposal site



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BACKGROUND

Jones & Wagener Consulting Civil Engineers (J&W) were appointed by EnviroServ Waste Management to design and supervise the construction of Cell 9 at the Holfontein H:H Disposal Site (Holfontein) in Springs, Gauteng.

The conceptual design commenced at a time when the Department of Environmental Affairs (DEA) were in the process of updating barrier standards from the present standards as described in the Department of Water Affairs and Forestry's *Minimum Requirements for Waste Disposal by Landfill* (Second Edition 1998) document. The *Minimum Requirements* do not stipulate double composite lining systems for waste cells, only for hazardous waste lagoons. The new *Draft National Standard for Disposal of Waste to Landfill* (Notice 432 of 2011) would place a landfill site such as Holfontein in the Class A category, which requires a double composite lining system.

A composite lining system is one in which a highly impermeable layer of either compacted clay material, enhanced soil or a geosynthetic clay liner acts together with a geomembrane liner placed in intimate contact with it to provide an impermeable system to infiltration of liquids.

DESIGN

After a review of the barrier system proposed by the *Draft Standards*, EnviroServ together with J&W reached a conclusion to adopt these for Cell 9, even though the less stringent *Minimum Requirements* lining system would have been acceptable. The inclusion of a secondary composite liner offers superior environmental protection when properly designed. Another revi-

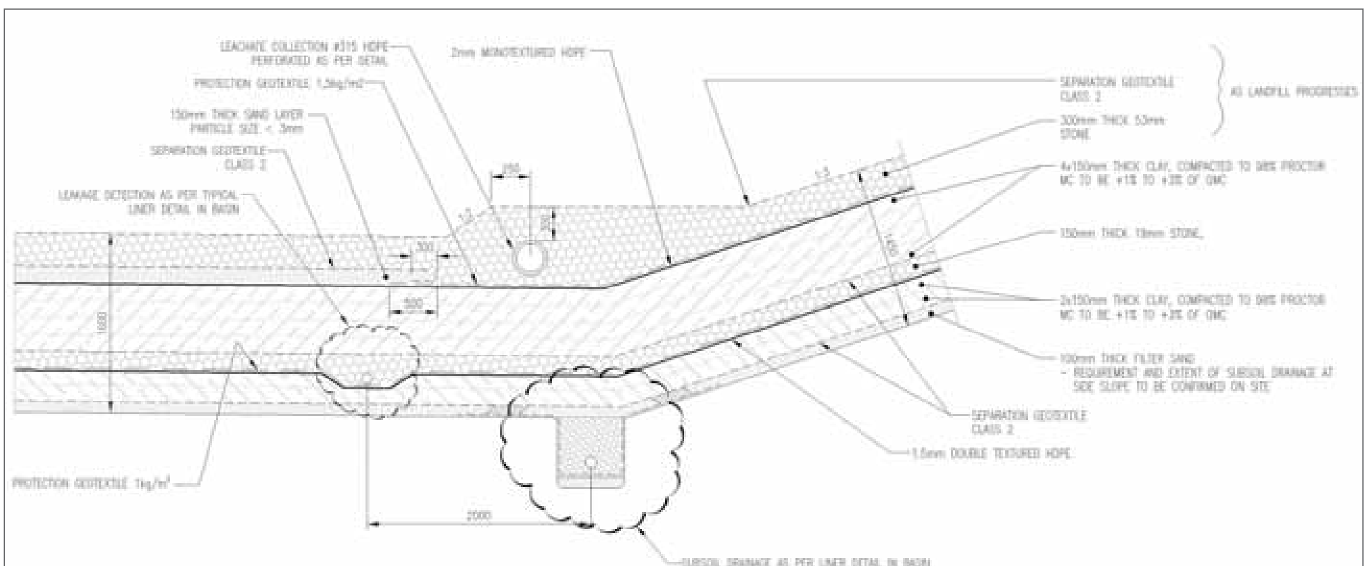

Figure 1 Lining system of Cell 9 at EnviroServ's Holfontein landfill site

sion on the proposed barrier standards of a Class A site that improves on the *Minimum Requirements* for a hazardous site is the addition of a separation geotextile layer above the leachate collection drainage layer. This has been the norm in most of J&W's designs and would have been included for Cell 9 as with previous Cells even if the design had been based on *Minimum Requirements.* A subsoil drainage system, not required by regulations, was also included. The sand was specifically designed to be compatible with the base material in order to effectively filter the material and drain away any perched groundwater that may intersect the base of the landfill. The layer is also extended onto the slope at locations that have been preidentified and those found to be wet during construction. The lining system of Cell 9 is shown in Figure 1.

As much as the addition of a composite liner in the secondary system offers improved environmental protection, it yields some complications in the design and construction of such liners. These are discussed below.

Stability

The use of geosynthetics in any lining system introduces weak interfaces between the different layers of the lining system. The stability of the system and waste body during construction, initial filling and final landform level will depend on the weakest interface shear strength and how this is affected by the driving and resisting forces. It is good practice to design the lining system such that the weakest interface lies above the primary geomembrane liner. This would result in any movement occurring above the liner and not damaging the liner system. It is also best practice to perform site-specific interface shear tests during the design, or as confirmation of assumed design parameters, prior to construction. Such tests should be carried out at normal loads that are representative of the final height of the landfill, as well as appropriate moisture conditions at the interface. For Cell 9 shear box tests were carried out at an accredited international laboratory for all potentially weak interfaces in order to identify the weakest interface, the mode of failure and appropriate protection layers over the geomembrane liners. A battery of stability analysis was then conducted using stability analysis software. The results guided the specification of the asperity height of the textured geomembranes to be used, as well as where a protection sand rather than a protection geotextile could be used. The value that the testing and analyses added to the design cannot be overemphasised.

Drainage of leachate

The success of the lining system is dependent on the efficiency of the leachate drainage layer. A layer that functions well will drain leachate away from the waste body without building up a head above the primary liner. Should a leak develop, the leakage detection system should act in a similar manner to drain away the liquids without developing a head on the secondary barrier system. For Cell 9 the leachate collection and leakage detection outlets were designed to drain to a compartmentalised lined concrete sump outside of the Cell. Riser

Civil Engineering August 2013 | 21

pipes were also designed as an additional measure to be used during maintenance of the sump. The outlet points were identified as critical positions where leaks are most likely to occur. For this reason the outlets were designed to be both structurally sound, to prevent shearing of the outlet pipes due to overburden pressure, and leak proof with gaskets and battens onto concrete and tertiary lining cover systems above this. The inclusion of the secondary geomembrane resulted in two penetrations of the leachate collection outlet. A sketch of the construction sequence for the primary penetration detail is shown in Figure 2.

Anchor trench arrangement

A large berm around the Cell would be required to be able to fit two anchor trenches for the primary and secondary systems. The liners could not be anchored in one anchor trench due to the thickness of the clay layers which would result in a very wide berm that would consume potential airspace. This airspace had been allocated for the site between all future cells considering only one anchor trench as per *Minimum Requirements*. As the Cell was to lie adjacent to two existing cells to the south, both with different lining systems, and a future cell that would have a similar design to Cell 9 to the north, this resulted in four different anchor trench arrangements on berms. The arrangement also allowed for construction of contaminated stormwater drainage channels. To preserve space, the secondary geomembrane is anchored slightly beneath the primary geomembrane and a cover strip is welded on top of the berms to complete the lining between all cells.

Other measures

Besides the three complications described above, other measures were designed and are being implemented for temperature monitoring and leachate/stormwater separation measures in order to commission Cell 9 in two halves while preventing excessive leachate production. An aerial photograph of Cell 9 taken at the end of May 2013 during construction is shown in Figure 3.

PROJECT STATUS

The construction of Cell 9 is expected to be completed in September 2013, and EnviroServ may only commence landfilling within the Cell in the dry season of 2014. ◻

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Figure 3 Aerial view of the construction of Cell 9

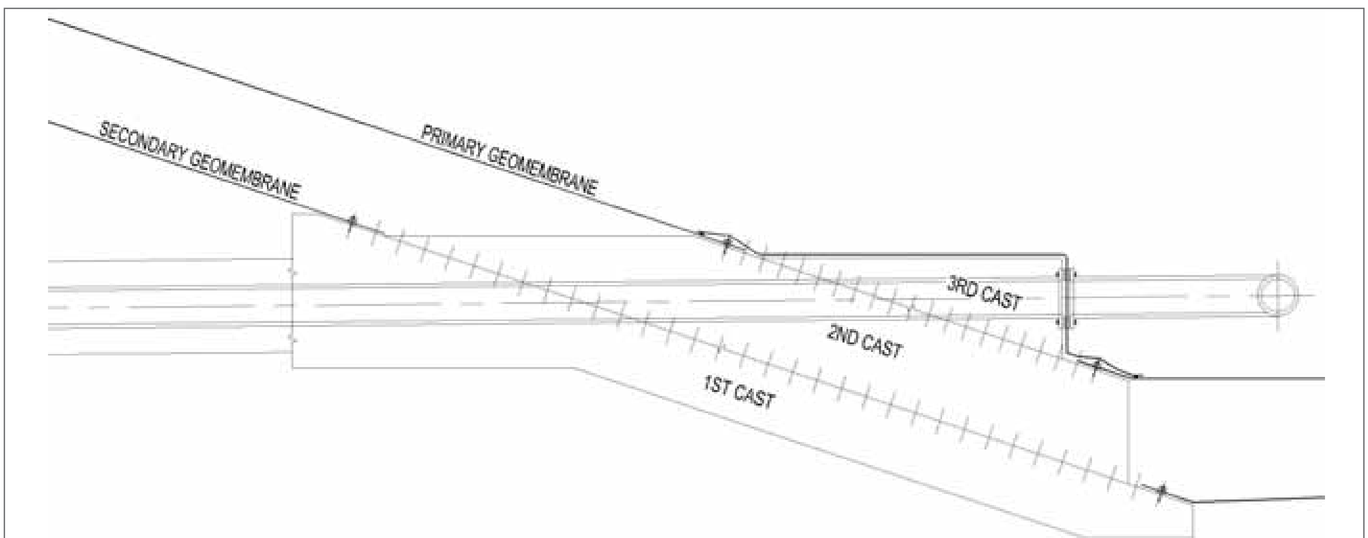

Figure 2 Primary penetration detail of Cell 9