The Use of Geosyntheticsin Major Metropolitan Landfills in Perth, WA – Two Case Studies

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1. INTRODUCTION

According to the latest available data approximately 8 million tonnes of waste was generated in Western Australia during 2008/2009, the majority of which was generated in the Perth Metropolitan area. Of this total only 2.6 millions tonnes was recycled with the remainder still going to landfill. Even though recycling activities are on the increase, due mainly to an increase in the landfill levy, it is clear that there is still a great need for well designed and properly managed landfill sites within the Perth Metropolitan area. All of the major landfills in the metropolitan area utilise geosynthetic materials to some extent due to regulatory requirements or lack of suitable natural construction materials. The use of various geosynthetics at two metropolitan landfill sites, namely South Cardup Landfill and Tamala Park Landfill, are described in this article.

2. REGULATIONS

The Environmental Protection Act 1986 and Environmental Protection Policies set out the governmental policies and objectives for waste management in Western Australia (WA). In addition Best Practice documents are available to provide guidelines on how the environmental objectives can be achieved (DEC, 2005; EPA, 2010). Based on the draft position statement recently issued by the Department of Environment and Conservation (DEC) all new and existing landfills in WA have to be sited, designed, operated and rehabilitated in accordance with the Victoria Best Practice document (EPA, 2010).

In accordance with the Environmental Protection Act both South Cardup Landfill (SCL) and Tamala Park Landfill (TPL) are classified as Class II (DEC, 1996) putrescible landfills and therefore require a liner system that will limit seepage to no more than 1000 litre/hectare/day. An appropriate liner system to achieve this requirement would typically be a compacted clay liner.

2. SOUTH CARDUP LANDFILL

The South Cardup landfill is located approximately 42 km to the south of Perth off South West Highway in the Shire of Jarrahdale Serpentine. The site is owned and managed by West Australian Landfill Services (WALS) which is jointly owned by Sita Environmental Solutions and Hanson Australia. The site is zoned as rural and is licensed to accept Class II waste.

The natural topography is relatively steep as the landfill is located at the foothills of the Darling Range. Stage 1 of the landfill has been constructed on the hill slopes, whereas Stage 2 is located in an old quarry. Stage 3 is located in between Stage 1 and 2 and has a large volume of airspace relative to its footprint due to its inverted cone shape. During the development of the landfill, geosynthetic materials have been used in the liner systems for the individual cells, the most recent of which was Cells 7 and 8 (construction completed in 2008 and 2010 respectively). In addition a variety of geosynthetics have been used in the capping systems of the closed sections of the landfill.

Typically an acceptable liner system required for a Class II landfill would be a compacted clay liner. However during the development of the last two stages (Stage 2 and 3) which commenced in 2004, WALS opted to install a higher specification liner system than what is required by installing a composite liner system in both Stage 2 (Cell 5 and 6) and Stage 3 (Cell 7 and 8).

The Stage 2 basal liner system consists of an underdrainage system, followed from the bottom up by a Geosynthetic Clay Liner (GCL), a 2 mm thick high density polyethylene (HDPE), a non-woven cushion geotextile with a mass exceeding 600 g/m^2, and a 300 mm thick drainage aggregate layer covered by a separation geotextile.

The Stage 2 side slope liner consisted of a minimum 3 m wide (horizontal measurement) engineered fill liner in conjunction with a GCL, 2 mm thick HDPE and non-woven cushion geotextile layer with a mass exceeding 600 g/m^2. Drainage aggregate was placed by WALS as part of the operations on an ongoing basis.

Stage 3 basal liner system is also a composite liner system similar to the Stage 2 liner. The liner system comprises, starting from the bottom, an engineered natural soil layer consisting of low permeability soil, a GCL and a 2.0 mm thick HDPE geomembrane liner. This is followed by a cushion geotextile with a mass of 1000 g/m^2 below a 300 mm thick leachate aggregate layer. The mass and strength properties of the cushion geotextile were governed by the thickness of the waste within Stage 3, which is located at the deepest section of the final landfill.

Figure 1South Cardup Landfill, Stage 3 Cell 8 construction

The South Cardup landfill has an extensive groundwater monitoring network with monitoring wells both upstream and downstream of the site and to date no contamination originating from the landfill has been detected.

An extensive stability analysis was carried out for Stage 3 due to the relative steepness of the topography and the final height of the waste in this area. Based on the outcome of the stability analysis the decision was made to make use of a high strength GCL in combination with a double textured geomembrane, in critical areas.

During 2011 the northern face of Cell 7 reached a height whereby the lower section of the slope could be capped. This face of the landfill is the most visible from the nearby road (South West Highway) compared to the other areas of the landfill. The aesthetic appearance of the landfill was thus a large factor in the design and for this reason additional measures were incorporated into the design to limit erosion and thereby improve the appearance.

These measures included the inclusion of an erosion control blanket as well as fibre rolls parallel to the slope to dissipate the energy of the run off water and thereby limit erosion. In addition several drains were placed at a slope of 1:100 across the slope to drain towards a collector and diversion drain located along the edge of the landfill which was lined with a separation geotextile and rip rap. The construction of the capping works was completed in early 2012.

3. TAMALA PARK LANDFILL

Tamala Park landfill is owned and operated by the Mindarie Regional Council, which has six member councils that dispose of their waste at the landfill site as well as at the associated Resource Recovery Facility located in Neerabup. The Tamala Park landfill is located 35 km north of the centre of Perth and is licensed to accept Class II waste. The site has been divided into two stages of which Stage 1 has been filled and closed, capped and is in the process of being revegetated. Stage 2 is the current active disposal area and has been divided into three phases, with the last phase (Phase 3) having been constructed in 2009/2010. Various geosynthetics have been used in the construction of the various stages of the landfill, with the most recent work (from 2009 onwards) including the basal liner of Phase 3, Piggyback liner over a section of Stage 1 (to utilise previously unutilised airspace) and capping of the northern most section of Stage 2.

To generate airspace extensive excavation has taken place on the site with the floor of Stage 2 being approximately 20 m below ground level with the lowest point (sump invert) being a minimum of two meters above the highest recorded water table. The basin of Stage 2 Phase 3 has been lined with a composite liner system, while the side slopes (1V:~2.5H) will be lined with compacted clay placed in horizontal layers with a minimum horizontal width of 3 m.

The liner system for the basin has been constructed on in situ compacted limestone and consists of GCL, followed by 2 mm HDPE, a cushion geotextile, 300 mm thick leachate aggregate layer and a separation geotextile. Two sumps have been included in the design with a sloping gutter joining the sumps. Should one of sumps fail, the majority of the liquid would then still be able to overflow to the remaining sump along the gutter. The sumps and the gutter have been lined with an additional layer of GCL to provide an additional safeguard against damage and subsequent leakage from these areas.

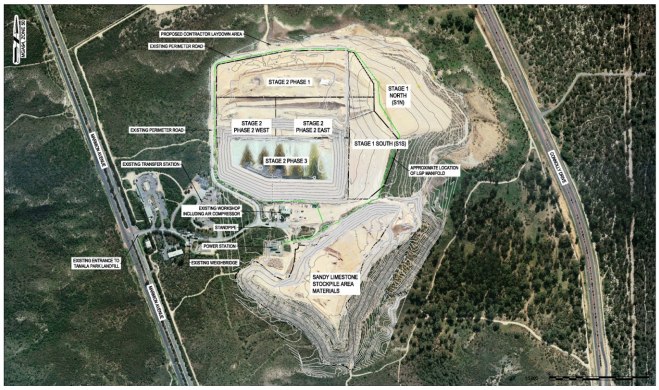

Figure 2 Tamala Park Landfill, Stage 2 Phase 3 basal liner

During construction the cushion geotextile layer was changed from one 1350 g/m^2 layer to two 720 g/m^2 layers due to supply issues. Prior to the alternative being accepted, cylinder tests were carried out using the site materials (i.e. HDPE and leachate aggregate). The result of the test was positive and indicated that a maximum strain of less than 3% could be expected which was deemed acceptable.

Figure 3 Tamala Park Landfill, Stage 2 Phase 3 basal liner

A section of the landfill required an extension across the previously closed Phase 1 area of the landfill. To be able to place waste in this area a piggy back liner was required that would be able to withstand future settlement as active gas extraction is still taking place in Phase 1, which will enhance settlement. The previous capping system for Stage 1 incorporated a geomembrane liner, thus the additional piggy back liner was designed with a single geomembrane layer (Linear Low Density Polyethylene (LLDPE)) placed on top of compacted general fill underlain by a gas extraction system. The geomembrane liner was covered with a cushion geotextile and leachate drainage aggregate that connects with the leachate collection system of Stage 2.

Figure 4 Tamala Park Landfill, Piggyback extension geomembrane and cushion geotextile installation

The capping layer for the northern most section of the landfill consists of, from the bottom up, a gas collection layer, single textured LLDPE geomembrane layer, a sandy drainage layer, separation geotextile and 2.5 m of sand and limestone growth medium. The side slopes of the final profile have a maximum slope of 1V:5H which assisted in providing a stable of the capping system, in conjunction with the use of a textured membrane and sandy material at the upper interface.

4. CONCLUSION

Various geosynthetics have been used throughout both the landfills discussed above either because of it being cost effective, technically superior to natural materials or for ease of construction. In future the use of geosynthetics is expected to continue and possibly expand to include an even wider variety of materials.

5. REFERENCES

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