LEVIN LANDFILL – LESSONS LEARNED AND PROGRESS MADE

Phil Landmark, Senior Civil Engineer, MWH New Zealand Ltd, 06-350 9404, phil.s.landmark@mwhglobal.com
Joel Dykstra, Drainage Engineer, Horowhenua District Council, 06-366 0923, joeld@horowhenua.govt.nz

INTRODUCTION

Levin Landfill, like many landfills, has had its challenges. Unlike most landfills, however, it has been subject to an investigation by the Parliamentary Commissioner for the Environment (PCE), and the review of its resource consent was closely scrutinised by the Neighbourhood Liaison Group (NLG). Nevertheless, in tackling the challenges, and making design and operational improvements, the Horowhenua District Council (HDC) has learnt a number of valuable lessons.

This paper explores the lessons learned through the resource consent review process, provides details of investigations undertaken of the existing liner configuration, gives an overview of recommended design changes, and discusses operational improvements that have been adopted as part of good landfill practice.

REVIEW OF RESOURCE CONSENT (ref. 2)

Background

The Levin Landfill is located on Hokio Beach Road, about 6 km west of Levin, and has been operating from the site since the 1950s. Resource consent was granted in 2004, following which the old landfill was closed and capped and a new landfill was constructed on another part of the site.

In 2004 concerns were raised to the PCE about the landfill. The following year the PCE recommended a review of the resource consent which was followed in 2007 by a formal investigation, including a technical review. The PCE’s final report (ref. 9) included recommendations that the consent be reviewed as a matter of priority.

The consent review was notified in September 2008. Given the complexity of the issues a lengthy and costly formal hearing would have been the norm. However, all parties agreed to participate in a mediation type process through pre-hearing meetings, rather than proceeding directly to a formal hearing.
The Review Process

At the beginning of the review process there was a lack of trust between the submitters and both councils, and proceeding directly to a hearing would have prevented any form of reconciliation. Six pre-hearing meetings were held altogether. In time, however, a level of honesty entered the discussions which enabled the pre-hearing meetings to move beyond the parameters of the review to discuss every aspect of the consent and submitters’ real concerns. These focussed around: the submitters and other interested parties not being treated as stakeholders with the NLG being a select group; consent conditions not being implemented as intended, or adequately monitored and enforced; and concern of the effect of leaching from the old, unlined landfill on the local environment, and how effective environmental monitoring would be to help address any effects.

Ngāti Pareraukawa extended an invitation to hold the first pre-hearing meeting on the marae located close to the landfill. This was accepted by HDC and other submitters and proved to be a critical step in opening doors of reconciliation in the pre-hearing process. The marae provided an excellent atmosphere and, while debate was still frank and heated, discussions progressed enabling options for addressing concerns to be collaboratively investigated. A further development was that HDC, as a gesture of good will, had agreed to change a number of the consent conditions which were technically beyond the scope of the review. Additionally, late in the proceedings, the submitters signed off their rights to be heard, provided that Ngāti Pareraukawa were satisfied that their concerns were met.

HDC agreed to open the NLG meetings to anyone in the community who is interested, and provide all the monitoring data and details of any new landfill initiatives at those meetings. Horizons Regional Council (HRC) will participate to give an overview of compliance. NLG members can also raise matters for discussion. The NLG will be the conduit for all parties to keep abreast of any future landfill developments and it will enable the HDC and NLG members to work constructively together as was achieved at the pre-hearing meetings.

Key Changes to the Resource Consent

The consent conditions were painstakingly reviewed through the pre-hearing meetings. Whilst no evidence was found of significant adverse effects arising from the landfill
operations, the consent changes provide for specific monitoring requirements that will enable accurate identification of significant adverse effects on water quality. Additional background monitoring bores were installed, and a mass contaminant loading assessment is required annually to determine in advance what effect the old landfill may have on the Hokio Stream. The consent changes will clearly establish whether an effect is from the old landfill, or from the new, lined landfill.

Other new conditions looked at the capping of the landfill. Overall the review has resulted in more stringent conditions (including compliance) to ensure the landfill operates in a manner that mitigates adverse environmental effects.

**Present Function of the NLG**

Today the NLG comprises twenty-six members, though not all of the members are actively involved. The relationship between HDC and the NLG members has matured since the consent review, and now allows for open discussions.

The NLG meets with HDC and HRC every six months and discussions focus on operational and environmental monitoring matters. Requests have been made for information regarded by HDC as being commercially sensitive. However, only information which has been released publically by HDC has been made available.

Site visits have been arranged annually for the NLG members so that they can appreciate the scale and scope of the landfill operations. This year a site visit coincided with the construction of Stage 3 and gave the NLG members the opportunity to appreciate the various infrastructural elements that make up a landfill. During HDC’s review of its Waste Management and Minimisation Plan the NLG was identified as a stakeholder group and was consulted with, having the opportunity to influence the long term future of solid waste management within the District.

**CHANGES TO LANDFILL DESIGN**

The Levin Landfill has a geocomposite liner consisting of an HDPE geomembrane overlying a geosynthetic clay liner (GCL). The base and side slope areas have different protection and leachate collection layers. The original resource consent conditions required the side slope protection layer to consist of a protective layer of sand 300mm thick, placed progressively as
the landfill rises. It was envisaged that the side slope sand protection layer would be placed in incremental lifts of 5m. Severe wind and rain erosion of the first lift of Stage 1A demanded a re-think and it was decided to place the protection layer progressively ahead of the waste as part of the landfilling operations. Stages 1A and 2 have been constructed in this manner. This has caused the side slope liners for those stages to be exposed for several years.

Overseas research (ref. 6) has shown that GCL panels placed beneath geomembranes that are exposed for months to years may become dehydrated and/or experience shrinking or necking of the GCL. Such issues are more likely for landfills where the overlap of GCL panels is limited and where stresses within the liner system can cause tension within the GCL.

The side slope liner design had not been changed as part of the consent review process because a large overlap (i.e. 400mm) was specified for GCL panels at Levin Landfill. Additionally, limited tension is generated in the GCL at Levin Landfill because the liner configuration has an overlying single-sided textured geomembrane with smooth side up which allows waste to slip down the liner, thus limiting tensile forces within the geomembrane, and therefore within the underlying GCL.

Both Stages 1A and 2 have triangular-shaped areas of exposed HDPE liner. As part of the design process for Stage 3, HDC agreed to have the Stage 1A geomembrane liner cut open in order to determine if there has been any necking or dehydration of the underlying GCL. This was done in two places on the exposed liner (in the middle and at the toe of the slope, as shown in Figure 1) with samples of GCL being taken from the GCL overlap areas (see Figure 2).

The investigations showed no evidence of any necking of the GCL at either site but it was clear that moisture, presumably from the GCL and in-situ soil, had collected on the underside of the

Figure 1: Side slope area on Stage 1.

Figure 2: Cutting a sample of GCL at Site 1.
HDPE and had run down the slope.

The samples were tested for moisture content (ref. 11) at a soils laboratory with the results indicating that the GCL was dehydrated.

<table>
<thead>
<tr>
<th>Estimated water content of bentonite alone (%)</th>
<th>Upper GCL, Site 1</th>
<th>Lower GCL, Site 1</th>
<th>Upper GCL, Site 2</th>
<th>Lower GCL, Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>83.6</td>
<td>21.9</td>
<td>8.3</td>
<td>9.9</td>
<td></td>
</tr>
</tbody>
</table>

By comparison a standard specification for GCLs (ref. 4) indicates that the maximum moisture content for GCL delivered ex-factory should be 35%. Chevrier et al (ref. 3) reports that initial bentonite water contents are around 10-15%.

The results show that the GCLs at Site 2 are dehydrated in comparison to uninstalled GCLs. Research has shown that in-situ GCL hydration appears to be a function of the subgrade material, temperature and confining pressure. Anderson et al (ref. 1) showed in laboratory tests that GCLs placed on a subgrade with an initial moisture content of only 5% caused GCLs to reach only 12-18% of the maximum hydration over 22 weeks.

Laboratory testing of the landfill subgrade soils was undertaken for Stage 1A of the landfill in 2004. The results indicated water contents varying between 0.5% and 2.3%. Given the dry nature of the sand seen beneath the GCL at both test locations one questions how hydrated the GCLs would become even if they were confined immediately after installation. Nevertheless, the result for the upper GCL layer at Site 1 shows that there is sufficient moisture available to hydrate the GCL to a reasonable degree. Additionally, it is also apparent from the flow patterns seen on the upper surface of the GCL that some moisture movement has occurred along the GCL and geomembrane interface. This gives further confidence that there is sufficient moisture available to hydrate the GCL.

Despite the general dehydration of three of the GCL samples it was gratifying to note that there was no indication of any necking or shrinkage of the GCL sheets. The GCL overlap remained around the originally installed 400mm width and there was no sign of lateral movement of the GCL sheets though the upper GCL at Site 1 showed signs of scuffing from movement up and down the slope. This is most likely on account of movement of the overlying geomembrane over the GCL due to thermal expansion and contraction.
Based on the observations made on site and the test results it was concluded that the existing design does not present a risk to the integrity of the landfill liner, but it was decided to follow good practice and cover HDPE / GCL side slope liners as part of their construction in future. This requires two fundamental design changes at Levin. Firstly, the side slope length needs to be limited by benching the slope to improve the stability of the protection layer; and secondly; the type of cover material needs to be resistant to erosion by wind and rain. Figure 3 shows the design of the side slope protection layer and Figure 4 shows the benching of side slopes during construction of Stage 3.

The side slope protection layer consists of a 300mm thick layer of sub-rounded drainage gravel placed on a geogrid which is underlain by a thick geofabric. The protection layer extends for the full bench height.

The combined effect of slope angle, smoothness of liner and weight of the protection layer requires geogrid reinforcement to support the protection layer. The geogrid is anchored separately from the liner system. When the waste pile reaches within about 2 metres of the edge of the bench, the geogrid will be relaxed and the protection layer removed to expose the geomembrane to allow the next section of liner to be constructed up slope.
The design of the side slope liner system was carried out using a method suggested by Qian et al (ref. 10) for calculating tension stresses due to unbalanced friction forces. HDC commissioned Tonkin & Taylor (T&T) to review the landfill design and through that process T&T suggested that the stresses generated within the geomembrane be checked using the method proposed by Kodikara (ref. 5). This has been done confirming that the geomembrane stress will be acceptable. The required thickness of the geofabric has been calculated using a method recommended by Koerner (ref. 7). The calculation shows that the geofabric should have a mass per square metre of about 600 grammes which can be provided by Polyfelt TS007.

In order to prove that the proposed design can be constructed on the side slope liner a trial section of gravel protection layer was constructed in late 2012 on the exposed geomembrane of Stage 1A (Figure 5). The trial section extends to a height of 6 metres which is the maximum bench height of Stage 3. The trial section has remained stable in place since being constructed.

OPERATIONAL IMPROVEMENTS

The landfill is operated under contract to MidWest Waste Disposals Ltd who has maintained a consistently high standard of operation since their contract commenced. Figure 6 shows Stage 2 of the landfill nearing its full capacity.

HRC carries out inspections approximately every 6 months and assesses the operations against the relevant consent conditions. For the past three years the inspection reports have noted full compliance with the consent conditions.

On occasions the inspections have highlighted minor operational issues such as the need to spray for weeds and maintain stormwater drains. These issues were dealt with immediately and have not reoccurred at the following inspection.
Additionally, HRC assesses the quarterly environmental monitoring reports that are prepared by MWH on behalf of HDC. The reports have not highlighted any areas of concern.

The capacity of the Levin Landfill does not trigger the National Environmental Standard (ref. 8) for air quality (projected capacity is less than 1 million tonnes). As such, there is no legislative requirement to install a landfill gas flare. However in 2011 HDC installed a landfill gas flare which collects and destroys an estimated 40% of the total methane produced by the landfill. (The flare can just be seen at the left hand side of Figure 6). The flare was installed to mitigate HDC’s obligation under the Emissions Trading Scheme. Since the installation of the flare the price of emissions units has dropped significantly and there is no economic advantage to having the flare installed and running. Nevertheless, HDC has made a conscious decision to continue operating the flare for the environmental benefits that ensue from doing so. Calculations show that the flare decreases CO₂ equivalent emissions by about 15,600 tonnes per year.

Another example of good practice at the landfill is the recent integrity testing of the landfill liner. As part of the construction of Stage 3 the liner was tested by TRI Australia using the dipole method, understood to be the first test of this kind in New Zealand. This method identifies gross defects in the HDPE liner that may have occurred during installation by using high voltage DC electricity. During the dipole testing no defects were identified. The dipole integrity test was not required by law or resource consent conditions. However, being good practice, it was considered appropriate and it has assured HDC that the liner had no defects at the completion of installation.

CONCLUSIONS

The PCE report was the catalyst for the resource consent review. The report reflected that the local community were deeply affected by what was happening with the landfill consent which prompted HRC to try a more inclusive mediation style approach which allowed all the parties to be heard. The format was then driven by all the participants and exceeded everyone's expectations by leading to a unique pre-hearing process that had the participants of the pre-hearing meetings being able to direct the destiny of the review. Within that process Ngāti Pareraukawa were able to provide a unique environment and atmosphere to restore the ailing relationships. Ultimately a participatory approach has resulted in an
outcome that all parties have accepted as workable, appropriate, and targeting the submitters’ concerns. The problems have not gone away, but an inclusive process of resolution is in place that unites rather than divides the stakeholders.

It is considered that the review process has resulted in an outcome which directly addresses the concerns of the local community, particularly those who submitted, and provides a positive example of how the local community can effectively and directly participate in the decision making process.

Since the consent review the NLG has continued to operate effectively. Whilst parties do not always agree on all matters, dialogue is maintained and discussions are generally constructive. Through the NLG forum, HDC has provided information beyond its consent requirements.

Additionally, whilst the landfill site would not “tick all the boxes” for siting a landfill in terms of the CAE Landfill Guidelines, HDC has chosen to continue with the landfill and operate the existing asset in accordance with good practice. The landfill operator has maintained a high standard of operations which meets resource consent requirements. HDC has committed to capturing and flaring off landfill gas because of the environmental benefits, despite not being required to do so through regulations or resource consent conditions.

HDC volunteered to investigate the liner system used for Stages 1A and 2, even with the risk that discovering issues might be embarrassing and financially costly to it. The investigations showed that the integrity of the liner system for those stages is intact, but design changes have been accepted for the side slopes in order to meet standards of good practice. Stage 3 has recently been successfully constructed with an amended side slope design. The liner system has been tested using a state-of-the-art electric dipole method, confirming the integrity of the liner following construction.

The Levin Landfill is an asset to Horowhenua District Council and provides financial benefit when compared to other available disposal options, such as exporting waste out of the district.
REFERENCES

1) Anderson, R., Rayhani, M.T., Rowe, R.K.; 2011; *Laboratory investigation of GCL hydration from clayey sand subsoil*; Geotextiles and Geomembranes, Elsevier.


6) Koerner, R.M., Koerner, R.G; 2005; *White Paper No. 5 - In-situ separation of GCL panels placed beneath exposed geomembranes*; Geosynthetics Research Institute; Drexel University, Philadelphia.


8) National Environmental Standard for Air Quality


11) Standards New Zealand; 1986; *NZS 4402: 1986 Test 2.1 Determination of the water content in soils*; Wellington, New Zealand.