LANDFILLS – WHERE DO THE RISKS REALLY LIE?

Anthony Kortegast: BSc, BE (Hons), MEnvEngSc (NSW), CPEng, Int PE, FENGNZ, FIEAust, Accredited Environmental Auditor (Industrial Facilities), Victoria[1]

Daniel Tan: BSc (Civil), MSc (Geotechnical), GCI-ICP[2]

Caroline Turnbull: BE (Nat Res) M (Sust)[3]

ABSTRACT

The environmental and financial risk associated with modern, engineered landfills tends to be assessed by regulators through a conservative lens. In some cases this has led to restrictive consent conditions being set for New Zealand landfills and significant financial bonds being required. In other locations, including some states in Australia, the USA and the UK, similar processes have led to regulation and the formulation of landfill financial assurance processes. Experience gained since the emergence of modern landfills in Australasia in the early 1990s suggests that the engineering risk associated with modern, engineered landfills tends to be somewhat over-estimated. Conversely, the risk associated with the day to day operation of landfills and their potential for amenity impact is sometimes underestimated, with this area of risk being scale and location-specific. This paper reviews the frequency of significant landfill environmental incidents, with a focus on Australasia, and reassesses the risk context associated with their engineering and operation. The likelihood of scenarios resulting in catastrophic engineering failures that could result in early site closure is assessed and this is compared with operational risk and consequence. Current local and international regulation and guidance for setting landfill financial assurances is reviewed and suggestions are made for a possible framework for improvement.

[1] Technical Director – Environmental Engineering, Tonkin & Taylor Ltd, 105 Carlton Gore Road, Auckland (+64 9 355 6000)
[2] Team Leader – Environmental Engineering & Management, Tonkin & Taylor Ltd, 2 Hunter Street, Wellington
[3] Environmental Engineer, Tonkin & Taylor Ltd, 95 Coventry St, Southbank, Melbourne

Introduction

Landfill regulators tend to have two primary concerns in relation to the risk associated with landfills. Firstly, they fear that something catastrophic could occur that could result in significant financial exposure. In addition to the risk of public concern being aired, regulators fear the onus will ultimately fall on them to deal with the aftermath in the event the site becomes "orphaned" through commercial failure of the owner under such circumstances.

Secondly, they fear that the site owner may declare bankruptcy of the landfill enterprise or simply shut the gate and walk away at some stage. Alternatively, they worry that the owner will not have the cash to deal with costs resulting either from an incident during the operational life, or for final closure and ongoing aftercare costs.

In summary, they simply worry that the owner could either disappear entirely (including on the day the landfill closes), or not have the financial capacity to deal either with issues during the operating life, or with closure and aftercare costs. Across various jurisdictions, regulation and actual practice suggests this concern applies particularly to commercially owned landfills, as opposed to those run by local authorities, but not entirely.

Hence a common requirement is that money is made available to cover these costs – a landfill financial assurance or "Bond". Typically this is by way of a "recognized financial instrument" such as an escrow cash deposit or a surety Bond, so that the provision is sufficient, secure and available when and if required. In normal circumstances, with a reputable owner / operator (be they private sector or public), all of the cost elements that are of concern to the regulator are typically provided for and managed. Commercially the aim is to insure for/ and or provide adequately for potential risks of significance, as well as final closure and aftercare costs. Normally the cost of aftercare is accrued, whether or not a Bond is in place and the way this is handled once closure occurs will vary, depending on the nature of the site owner entity.

So what's the problem? In short, depending on the jurisdiction, applicable law, the nature of the owner entity and the level of engineering risk, approaches do vary widely, even within New Zealand. Leaving aside jurisdiction, ownership and legal framework considerations, a primary factor in setting Bonds, in New Zealand at least, relates to the assessment of engineering risk.

In some cases this is assessed very conservatively and "worst case scenarios" are required to be costed for in terms of setting a Bond for the operational phase. This approach, arguably, is flawed as the level of risk associated with a well-engineered modern landfill is actually quite low, unless poor operational management is allowed to occur. That is at least to an extent, something that is able to be controlled by the regulator.

Historic landfill failures and risks

The literature confirms that between 1973 and 2015, worldwide there were about 20 large scale landfill failures (Blight, 2008, Koerner and Wong, 2011, Yin et al., 2015). Some of these landfill failures resulted in serious environmental and economic impacts. However, where the impacts included loss of life, most such failures were associated with unlined sites. Some of these sites are referred to in the literature as landfills, but on closer examination they turn out to be un-engineered containments: that is, dumpsites.

Most large and damaging failures have been associated with mass sliding of large volumes of waste. Most have occurred either in tropical climates with heavy rainfall, and/or were associated with liquid waste disposal, a failure to manage leachate or storm water, or serious over-building of waste slopes. Known examples in this category include the Payatas, Dona Juana and Bandung sites, and more recently the 2015 Shenzen waste slope failure that killed 77 people and destroyed 33 houses (Yin et al., 2015).

There have also been examples of significant impacts not involving fatalities, and not including mass sliding of waste. An example is the well-known Brooklyn Greens case in Victoria. There issues arose as a result of the physical encroachment of a new housing estate. This resulted in houses, roads and services being constructed within tens of meters of a closed landfill that was un-engineered, with no liner system, and no active landfill gas control in place. Landfill gas migration pathways developed as a result of the nearby construction of road and drainage infrastructure. This occurred following closure of the “landfill, but resulted in widespread lateral migration of landfill gas and a declared emergency that forced the temporary evacuation of a number of houses and a significant number of people. It also resulted in front page news, the need for the installation of extensive post-closure LFG control measures, a major lawsuit involving a number of parties (including the regulator), and a Royal Commission of Enquiry. Fortunately, no injuries or loss of life occurred.

In the USA a number of significant failures occurred historically, starting with the famous Kettleman Hills Hazardous landfill slope failure in 1988. That failure occurred at a geomembrane - lined site: the first such major failure recorded. At around 12 ha, was significant in terms of the amount of waste that slid and the physical damage caused, and as a result it was extensively investigated. The learnings resulted in significant improvements to landfill design and leachate management practices that have since carried through into modern landfill design and operational practice.

Despite the specifics, these sorts of incidents have tended to result in both the public and regulators, being very wary of the level of risk associated with landfills, but such dramatic examples tend to distort the picture.

Instances of modern landfills being subject to large scale slope failures or other damaging events have become less common in recent decades. This is due in part to advances in engineering materials understanding, which have led in turn to improved landfill design techniques, as well as driving improved landfill management. With few exceptions, design or operations-related failures at modern, engineered landfills have been small in scale compared to the larger recorded historic dumpsite, or early engineered landfill failure events. In recent decades most have been associated with liner interface failures, induced either by poor leachate management (Koerner and Wong, 2011), or in the case of California, by inadequate resistance to earthquake (Augello et al., 1995). This includes in relation to partly filled cell areas with temporary slopes.

In the cases identifiable from the literature over the last 20-25 years, and while the event may have been commercially significant for the site owner, none is known to have led to actual site closure or abandonment. In all cases, the damage was repaired, without major involvement of the regulator, and the site continued normal operations. Some of the cases led to further technical lessons being learned and associated advances in landfill engineering design. This includes in relation to the introduction of geosynthetic clay liners (GCLs) in the late 1980s. Examples include the Chiquita Canyon, Lopez Canyon and Bradley landfills, all of which were extensively studied after the 1994 Northridge earthquake (M_w= 6.7) (Augello et al., 1995). Some 22 sites were assessed, the closest (Sunshine Canyon), being located 7km from the earthquake epicenter. Most of the sites that were assessed sustained no damage, with several suffering moderate-severe, but nonetheless repairable damage. In most cases the damage was limited to displacement of the final cover soils. Liner damage was generally minimal, as was damage to other site infrastructure.

This finding has significant implications for assessing risk-based scenarios in relation to landfill Bonds. In New Zealand, loading as a result of earthquake shaking is often a critical consideration. The Californian example demonstrates that at a modern, engineered and managed site, the risk of mass-waste displacement is demonstrably lower than the risk of localized surface cover soil movement. This confirms that modern, cellular landfill constructions that are subject to good operational practice (in relation to leachate management and liquid waste acceptance and management), are relatively strong, frictional and hence stable landforms. In general they pose a negligible risk of catastrophic failure – which is usually associated with mass movement along a weakened or wetted interface. Even under significant earthquake shaking, a modern landfill is unlikely to suffer more than localized liner damage or cover soil displacement, all well within the scale of being repairable. A worst case scenario for a site located very close to an active fault movement, would be the need to repair and reinstate part of the containment system, but almost certainly, not all of it.

Issues associated with landfill gas migration, or other amenity issues such as odour, or leachate treatment can be managed and are often scale related. There are no recorded instances in the literature where these issues resulted in early site closure at a properly managed, modern site. Furthermore, environmental outcomes in relation to many of these operational issues are usually able to be in some way controlled, monitored, or influenced by the regulator.

Discussion

Based on a trend that started in the 1990s, a number of the larger landfills in New Zealand have been required by regulators to formulate a Bond based on “worst case” assessments associated with extensive slope veneer or waste mass sliding failure scenarios part way through landfill life. While this might be done on a risk-cost basis, the analysis (including the seismic aspect of that analysis), is invariably conservative. Such assessments take no account of the management practices being applied, or the inherent value associated with the site continuing to operate. Even in the low likelihood that a slope failure did occur, at a well-designed and managed site in practice this would usually be of limited extent. The inherent “value” of a large modern landfill site is such that the risk that this would result in total site closure, is very low indeed. Furthermore, in New Zealand, regulators have the ability under the Resource Management Act 1991 (RMA) to recover costs in the event that the consent holder fails to act and remedy the situation at an operational site.

The question should then arise: why the extreme conservatism? Why are regulators requiring substantial Bonds to be put in place for events that almost certainly will not occur? With the benefit of hindsight, it is pretty clear that in the past this was driven to a significant extent by a lack of performance data and the general level of public concern that was aimed at landfills in general. However, things have moved on, more information performance data are available, and we should now be asking whether our local requirements are in line with overseas practice, much of which has developed more recently and hence considers the evolution of waste containment industry best practice, as described elsewhere in this paper.

Overseas practice

Two key jurisdictions to look to for guidance in this regard are the USA and the UK. This is because their regulatory practices are mature, rigorous and well-tested commercially. Their respective agency guidance in other areas is widely referenced and used internationally. In part this has resulted from need as both respective agencies have a very large number of landfill sites of all types, which they need to regulate.

The USA operates under a Federal Environment Protection Agency (USEPA). The USEPA does not, by default, adopt a highly risk averse position in relation to landfills, but does apply a uniform approach in requiring financial assurances. This approach takes account of both engineering risk and commercial risk. Under the USEPA regulatory framework owners/operators of municipal solid waste landfills are:

"…*required to demonstrate that they will be able to pay for the required closure and post-closure activities, as well as any corrective action that might become necessary due to releases of contaminants into the surrounding environment".*

Title 40, US Code of Federal Regulations (CFR), Part 258, Subpart G provides guidance on the financial assurance criteria for landfill closure and aftercare as well as mechanisms on how to assess them.

In the UK, landfill financial assurance is also mandatory and the associated requirements are set out in *Guidance on Financial Provision for Landfill, Environment Agency UK, 2011.* The requirements are based on a number of key principles:

- The Bond must be sufficient, secure and available when required.
- The Bond must be sufficient to meet the Owner's permit obligations, including closure and aftercare for the defined Bond period (that is, it is time-variable)
- The Bond must be regularly reviewed
- The quantum of the bond needs to be developed and agreed before a permit is issued.

The UK guidance likely represents appropriate, "modern" practice that we could apply in the New Zealand context. It adopts a sensible forward time planning horizon, takes account of the site's current state, takes appropriate account of risk, and incorporates regular review.

Regular review reduces the need for long term financial forecasting and inflation adjustment, both of which carry a high degree of uncertainty. Based on the EAUK guidance the process for developing a Financial Assurance (Bond) would generally be as follows:

- Cast forward 5 years and assess the state of the landfill at that point (for most owners this is part of routine whole of life modelling in any event).
- Calculate the landfill closure costs required at that point (capping and other infrastructure - $ Total A).
- Calculate the aftercare costs at that point (a time series total in NPV terms [there are rules associated with this] – $ Total B). In the case of a putrescible waste landfill the required aftercare period that is required to be considered is 60 years (we currently commonly adopt 30). This is a function of the EU landfill directive and based on what we know now, is probably appropriate. By way of comparison, Title 40, US Code of Federal Regulations (CFR), Subpart F, Section 258.61 stipulates 30 years as a guide but allows for the period to be decreased if the owner or operator can justify that the period is sufficient to protect human health and the environment, or lengthened if it is deemed necessary for similar reasons.
- Assess risks and identify hazards associated with the particular site and the stage of development that it is at (this will vary over time). For example, if a site is located in a high seismic environment and/or has a large extent of temporary slope or uncapped area in the forecast period, this might result in an allowance being made for some additional cap replacement or associated works. If the site was not in a highly seismic environment, or was projected to be in a relatively stable, low-risk form over the period being considered, then allowance for cap maintenance only might be sufficient. The same applies to other elements of site infrastructure. This is $ Total C.

The EAUK guidance directs what costs are to be included and the level of calculation detail required. The calculations include contingency and are all in current day dollars. Inflation is not provided for as the amount is regularly reviewed – any inflationary effect over the immediate Bond period is therefore taken to be covered by contingency. The Bond amount is then simply $ A + $ B + $ C. In practice this aligns closely with the USEPA approach.

The aim of both agencies is to develop a robust, conservative cost assessment, ***but importantly, an assessment with a sensible forward time and hence risk horizon***. Under the UK guidance, regular review means that after 5years (say), the next forecast is done, again in the cost dollars of the day, and the Bond amount is re-set.

In the UK the intent is for the regulator to not have to access the Bond funds. This is different to New Zealand where Bond Agreements do envisage situations where the Bond would be paid across to the regulator. While in practice this is unlikely, this could be envisaged in the event of commercial failure, and New Zealand landfill Bonds are often set up this way. However, the underlying intent is fundamentally the same – ensuring sufficient funds are available to deal with risks, closure costs and post closure costs, and that the funds are sufficient, secure and available when needed.

In the UK, the Bond is typically provided by way of escrow, or a cash deposit being made with the agency – with the cash ultimately flowing the other way in that case. In the case of local authorities being the permit holder, there is more latitude for how the Bond is provided based on the financial strength of the local authority and centered on the local authority entering into a performance agreement and accruing the associated liability.

In the case of private sector owners, the EAUK will not accept provisioning in accounts, parent company guarantees, overdrafts or annually renewed insurance, as being adequate mechanisms.

New Zealand past practice

It is evident that in the past New Zealand consent authorities have exercised a significant amount of conservatism and local discretion in relation Bonds: particularly with regards to the situations/risks they are required to cover. It is also clear that the private sector tends to be treated differently to local authorities, which to an extent mirrors overseas practice. In New Zealand, this distinction appears to occur regardless of the local authority's size or financial standing, and regardless of the assessed risk, or the standards of engineering or environmental management being applied at a particular site. In some cases, public perceptions and concerns raised by submitters during consent processes also appear to have been factors in commissioners and regulators determining the scope of some Bonds.

In some cases, surrender of the Bond to the regulator is based on an “all or nothing scenario”, which in practice is very unlikely to ever arise. Under the New Zealand legislative framework (primarily the RMA), the only circumstance under which such a Bond could ever be called upon by a regulatory authority is:

- The consent holder failing to act in response to an incident, ignoring regulator instructions, public reaction and the negative publicity associated with doing so; and
- Legal remedies pursued by the consent authority under the RMA and through the Environment Court to get the consent holder to act, proving ineffective.

Given the maximum level of financial exposure in any situation is likely to be less than $50 million, this all seems an implausible scenario.

Financial certainty is the core consideration in relation to the requirement to provide a Bond. This applies to both private sector companies and local authorities. In the case of a local authority owner, there also seems to be little sense in diverting ratepayer funds to provide a cash Bond or associated debenture, where there is the ability to provide an enforceable undertaking associated with appropriate long term financial provisioning. This would align with UK/USA practice.

Conclusions

In the past, the approach in New Zealand to the provision of landfill financial assurances (Bonds) has been handled in part conservatively, and generally inconsistently. This has led to distortions associated with what have proven in some cases to be largely unfounded concerns over engineering risk, inconsistencies in the way public sector facilities are assessed and treated (usually with no Bond requirement at all), and ultimately significant cost being expended to maintain large Bonds sums, for no tangible benefit.

A sensible way forward would be to align New Zealand practice with the best of the UKEA and USEPA practice and associated guidance. This would result in a more consistent approach to setting and reviewing Bond amounts, with the aims of more appropriately managing risk and ensuring funds are available when and if needed. The need to cost for unreasonable or unfounded risk scenarios would be avoided, and there would be more certainty around the right level of funding being available when required. Costs to facility users, including ratepayers, would likely reduce as the costs associated with providing Bonds would overall be lower in the event that a more consistent approach with more commercial flexibility was adopted.

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