

Landfill Aftercare



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ISWA Key Issue Paper on Landfill Aftercare

Summary

Aftercare of closed landfills essentially is the continuation of landfill management activities carried out during operation. It can include monitoring of emissions, groundwater quality, surface water quality and soil, maintenance of the cover, operation and maintenance of leachate and gas collection and treatment systems, safety and accessibility. From a technical and operational perspective it is very similar to management during operation. The main difference is that waste acceptance has stopped and the landfill is no longer generating income to finance management. Consequently aftercare has to be financed differently. The most appropriate approaches are based on the site-specific assessment of required environmental protection. This entails determination of both the required aftercare activities and the required duration of these activities. This in turn depends on what each competent authority would consider to be an acceptable level of residual threat posed by the landfill on its surroundings. The challenge of determining the financial provisions required for landfill aftercare induces long-term risks for landfill owners, operators and society.

Introduction and current state

A generally accepted principle in existing waste management and aftercare regulations states that aftercare (or post-closure care) has to be carried out until the landfill no longer poses a threat to human health and the environment, in which case some inert waste landfills may be exempt or require limited aftercare. This means that human health and the environment are not compromised in the absence of landfill aftercare. It has to be emphasised that this criterion is completely independent of the nature of the landfill. Inorganic compounds in inorganic or hazardous waste landfills may pose a risk for much longer than compounds in mixed waste or municipal waste landfills. In compliance with the polluter pays principle, in many countries, it is advocated that the cost of aftercare is included in the gate fee. In order to allocate aftercare costs to each tonne of waste accepted at the landfill, it is necessary to determine the sum of money necessary for aftercare from the moment the landfill stops accepting waste. This entails the determination of both the required aftercare activities and the required duration of these activities. Many regulations require provisions for a minimum aftercare period of 30 years, and operators usually consider 30 years by default. The amount can vary widely from a percentage of the initial investment for the landfill to a detailed analysis of site-specific aftercare activities including a cost calculation for these activities. The financial provision can be established in the form of a bond or an escrow account. In some countries an accounting provision, certified as an asset by an external auditor, is also accepted. In many countries, in the absence of regulation, the cost of landfill aftercare is not included in the gate fee and financial provisions are not accrued. In these situations the burden of aftercare or the impact to human health and the environment of the uncontrolled emissions falls on society.

Minimum standard

Impact to human health and the environment strongly depends on the type of landfill (engineered or controlled sanitary landfill), the type of waste accepted and the nature of the immediate surroundings of the landfill. A correct and adequate determination of the required aftercare activities should therefore be based on a site-specific assessment. Such an assessment starts with describing history and surroundings, geometry of the landfill, start and end of landfill operation, waste accepted, soil morphology, soil quality, geohydrology, groundwater and surface water quality. The assessment should take account of the standard provisions at the landfill (when present) such as

bottom liner, leachate drainage, leachate treatment, capping, rainwater drainage and discharge, landfill gas extraction, landfill gas treatment, monitoring wells and monitoring drainage. Site-specific measures (when present) such as civil engineering provisions, groundwater extraction, treatment of groundwater, discharge/infiltration of water, provisions against vandalism and monitoring data (leachate, groundwater, landfill gas, settlement, etc.) can also be addressed. Landfill aftercare activities can include:

- Water sampling and analysis: of discharged rainwater, collected and treated leachate, groundwater monitored at piezometers, surface water and extracted groundwater.
- Measurements and visual inspections of settlement, global and veneer slope stability evaluation, thickness of the cultivation layer, erosion, quality of vegetation, groundwater levels, visual inspections, gas measurements and analyses, and (when present) material quality of the sealing (e.g. mineral liner, HDPE membrane, ...).
- Cleansing and maintenance of leachate drainage, piezometers, monitoring drainage and rainwater drainage.
- Maintenance and operation of landfill gas extraction, utilisation and treatment systems, wastewater treatment plant and/or discharge systems, vegetation and cover repairs, safety and accessibility and other maintenance.

Based on design, airspace utilisation projection (anticipated period for filling the total capacity), anticipated waste types and waste disposal planning of the landfill the aftercare activities can be designed and described in an aftercare plan prior to the start of operations at the landfill. The aftercare plan should include a description of the organisation of aftercare, aftercare records, reporting, evaluation, communication and a risk evaluation. Based on such an aftercare plan a cost calculation can be made. During operations the aftercare plan can be updated on a regular basis and additional monitoring data (leachate, groundwater, landfill gas, settlement, etc.) can be addressed.

Time frame

One of the most important aspects for the calculation of the financial provision is the duration of aftercare. Regulations in various countries specify that financial provisions for aftercare shall be made for at least 30 years after the cessation of operations. At the same time these regulations often stipulate that the landfill operator shall be responsible for aftercare as long as the competent authority considers the landfill to pose a threat to human health and the environment. Society's relative importance on various environmental goals could change greatly over 30 years. The landfill operator responsible for extended aftercare could be faced with unanticipated demands when society shifts the environmental goals after the facility has opened. In literature indications can be found that it may take several centuries before specific substances in leachate are below standard thresholds. Although some countries have addressed end of aftercare in their regulations, clear acceptable levels and clear definitions of the methodologies to assess and determine whether the residual threat is acceptable are not available (Laner et al., 2012). This constitutes a considerable financial uncertainty. In practice in many countries landfill operators account for 30 years aftercare, although there is no clarity that aftercare actually ends after 30 years. Few operators of modern landfills have completed 30 years of aftercare and/or petitioned to modify the aftercare period. A lack of criteria and procedures for ending landfill aftercare makes it difficult for regulators to make decisions to end, extend, or reduce the aftercare period (Barlaz et al., 2002).

After-use of closed landfills

Closed landfills provide opportunities to create facilities for walking, running, cycling, mountain biking, horse riding, golf and many more activities. When it is finally 'handed over' to society as a 'safe landscape', a well-designed, constructed and managed landfill provides solutions for more than

just the waste management needs of society. Landfill operators can be considered as temporary users of a part of land, providing a service to the community, until this land will be given back to society for natural or domestic purposes. Of course, the competent authorities may have to impose constraints on ground use before any re-use of a closed landfill. This needs to be regulated by legal documents such as town planning rules and have to fix authorised and prohibited activities on the site. In particular, if waste is not excavated, any removal or destruction of the landfill capping is usually prohibited in order to avoid any impact on the environment. Construction might be allowed if there is no destruction of the capping.

Some kind of monitoring and care may have to continue for more than 30 years after closure. But it is likely that the level of care is comparable to maintenance of parks or other public amenities. For that minimal level of care the term custodial care has been proposed (Morris and Barlaz, 2011). If the after-use of the closed landfill provides a service to society it is justified that society takes care of maintenance costs. Similarly, if someone wants to make more intense use of the land than park/reserve land, then it would be justified that the user pays for that control and monitoring.

Determination of financial provisions

Aftercare costs can be calculated by applying unit costs to each aftercare activity in the aftercare plan. Examples of calculation models are available in many countries. Due to decades of experience both the aftercare activities and the unit costs are well known. It is however very hard to predict which activities need to be carried out at which intensity in order to maintain the required protection of human health and the environment. The main difference between landfill management during operation and aftercare is that the cost of the first can be covered from the annual income whereas the financial provision for the total period of aftercare has to be available when waste disposal stops. Therefore the financial provision has to be equal to the net present value of the estimated aftercare costs.

For calculation of the financial provision based on estimated aftercare costs two very important factors are uncertain. These are duration of aftercare and net interest rate. The interest rate is important since the entire financial provision will not be consumed in year 1. A large part of the provision can therefore generate interest. The financial provision reduces because of the annual expenses, but at the same time also grows a little due to the addition of net interest (interest minus inflation). In practice assumptions are made for both. If for instance it has been estimated that for a specific landfill the cost of carrying out 30 years of aftercare requires € 4 per tonne of waste up front charge at a net interest rate of 3%, the impact of a different time frame or a different interest rate can be calculated.

Although aftercare duration is often regulated for at least 30 years, it cannot be guaranteed that a landfill will no longer pose a health or environmental threat after a 30 year period. There is sufficient scientific evidence that indicates that leachate concentrations autonomously do not drop below acceptable levels within several hundred years. Should the aftercare duration be longer or the net interest rate different, this will have a significant impact on the provision. The higher the interest rate and the lower the duration of aftercare, the more provision remains, thereby lowering the per tonne up front charge. Important to note is that it is not a linear relationship between the provision, the duration of aftercare and interest rate, but an exponential relationship reaching the maximum provision at shorter aftercare duration with higher interest rates.

Depending on the national regulations the estimated aftercare cost can include anticipated changes and reduction of activities or deterioration and replacement of technical landfill elements. For illustration of the dependency on interest rate and aftercare duration in the calculation of the financial provision it is not relevant what is included. Within a range of 3±2% interest and duration

between 30 and 240 years the required financial provision, that covers the very same estimate of aftercare costs mentioned above, can be anywhere between € 3 and € 20 per tonne of waste.

Financing

Several aftercare financial provision schemes exist. They can be a bond, an escrow account or an accounting provision, certified as an asset by an external auditor. An alternative is for the landfill operators to pay an annual levy to the competent authority corresponding to the amount of waste landfilled in the previous year. The competent authority then manages the financial provision. None of these schemes however prevents society from all risk.

Regulations for financial provision can have subtle, but significant financial risks. If, for example, a country requires accrual of financial provisions for 30 years but after 30 years a landfill operator might not be released from regulatory obligations. There may be the situation where there is no money left and the (closed!) landfill cannot generate any income to continue aftercare. The operator may go bankrupt and the burden of aftercare (or environmental impact) can be transferred to society. For example, a public operator has not accrued financial provisions for aftercare then the aftercare will have to be financed from the general budget of the municipality. In both examples the burden of landfill aftercare is transferred to future generations. This is contrary to the intentions of sustainable development. Moreover in most countries regulations do not encourage landfill operators to accelerate stabilisation of the waste mass and shorten the aftercare period.

Concluding remarks

Aftercare is an inseparable element of responsible landfill management. From a technical perspective aftercare activities are well known. To cover the cost of aftercare, financial provisions have to be made during construction and operation of the landfill. Aftercare activities can be determined based on a site-specific assessment of the required level of environmental protection. Decades of experience allow for detailed cost estimates of aftercare activities. Poorly considered assumptions on airspace utilisation projection that affects accrued financial provisions, the duration of aftercare and net interest rate can result in an inadequate estimate of the required financial provision. Uncertainty about the applicable interest rate, time frame of aftercare and lack of criteria and methodology to end aftercare constitute a considerable financial uncertainty for landfill operators. Bankruptcy and the need to finance aftercare from public budgets can result in non-compliance with the polluter pays principle, uncontrolled environmental impact and/or transfer of the burden of landfill aftercare to future generations. Both regulators and operators have a need for the development of criteria and procedures for ending aftercare.

References

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