Government of Western Australia
Department of Health

Managing risks to human health from landfill gases

Purpose

This position statement focuses on managing landfill gas (LFG) risks in proximity to landfill sites. LFG, comprised principally of the hazardous ground gases methane and carbon dioxide, presents a potential explosive and asphyxiant risk to people within buildings, structures and below-ground infrastructure in proximity to landfill sites. Methane is the primary risk driver due to being explosive and an asphyxiant. Carbon dioxide can also present significant asphyxiation hazards.

This position statement has two key components:

- the purpose and use of separation distances as an effective mitigation strategy around operating and closed landfills
- assessing proposed land use and development within close proximity of a closed landfill.

While this position statement is not intended to be applied to the assessment of LFG risks to existing developments, the assessment framework may nonetheless be of value where there is a concern that an unacceptable LFG risk exists at an established development site.

Department of Health (the Department) position

Our intention is that all risks associated with landfill sites are considered early in the land-use planning process to enable appropriate zoning and separation of incompatible land uses be identified and managed. Ideally early recognition of hazards during formulation of the project's business case allows future costs and feasibility considerations to occur prior to considerable investments of unfeasible or unprofitable projects.

The Department supports the separation of landfill sites from sensitive land uses (receptors) to protect them against the range of human health, amenity and psychosocial risks associated with operational and closed landfills. The minimum separation distance may be set simply, transparently, quickly, cost effectively and conservatively through land use planning conditions and operator licence conditions during operation and post-closure.

Development of sensitive land uses in proximity to operational landfills is not supported given the high likelihood of impacts to receptors and the difficulty in determining future LFG risks during the operation and progressive rehabilitation of the landfill.

Separation distances are used for three purposes:

- To provide minimum separation between operational and closed landfills from sensitive land uses to reduce LFG and amenity risks.
- To reduce restrictions on the practical operation of a landfill by avoiding close proximity of incompatible land uses.
- To provide a trigger in the land use planning process for assessing LFG and amenity risks to proposed development at less than the minimum separation distance to a closed landfill.

Separation distances are not a replacement for best practice LFG management or operational management of odour, dust, litter and noise. These matters must be managed to prevent emissions beyond the landfill boundary.

Where development is proposed at less than the recommended separation distance from a closed landfill, a public health assessment (PHA) is required to determine public health, safety and amenity impacts on the proposed development. For the assessment of landfill gas risks, a landfill gas risk assessment (LFGRA) will be required as part of this PHA.

Developing single residential lots or other sensitive land uses with access to soils, such as schools, and childcare centres, on a closed landfill site is likely to be unacceptable in the short to medium term. Ground stability, LFG and leachate management, and LFG migration are factors that make such development unsuitable. These factors will persist for many decades after the closure of a landfill and when individual sites may be suitable for these land uses is highly site specific. Development of closed landfills for these land uses may be acceptable in the longer-term post closure. In particular once active LFG and leachate management have ceased and after extensive investigations show that the site is suitable for the proposed uses.

The department supports a commitment by landfill operators and owners for the management of landfill gas, leachate, offsite amenity and maintenance of landfill infrastructure beyond the operational (filling) phase of a landfill until such time that they do not present an unacceptable risk to human health or amenity. Risk tolerance criteria will be outlined in supporting guidance. Obligations to mitigate risks are to be retained by the landfill operator or transferred to the subsequent landowner/occupier for post closure management.

This approach aligns with the *Public Health Act 2016* to apply the principles of sustainability, the precautionary principle, proportionality and intergenerational equity in the assessment of human health risks.

Recommended minimum separation distances for mitigating landfill gas risk

- For closed landfills which accepted putrescible wastes, a 500m separation between the closest cell or waste filled area and any development comprising surface buildings or structures, confined spaces or subsurface structures and services is supported.

- For closed landfills which accepted only inert waste with good supporting evidence, a separation of 200m between the closest cell or waste filled area and development comprising surface buildings or structures, confined spaces or subsurface structures and services is supported.

For operational landfills, odour, dust and other amenity impacts are likely to be the primary risk driver for informing appropriate separation distances. The setting of these separation distances falls outside of the scope of this position statement.

Assessment of proposed development within landfill buffers

Separation distances are an effective prevention measure to protect human health and avoid incompatible land uses around operational landfills and to require assessment of LFG and amenity risks to proposed sensitive developments around closed landfills. The purpose of a minimum separation distance is to provide an effective means to mitigate risk without the need for detailed assessment or implemenation of LFG protection measures at the proposed development. The department notes that LFG protection measures are subject to potential design flaws, poor construction, improper construction verification or complacency in their monitoring and maintenance. In some instances, the required gas protection measures are not installed.

LFG generation is cumulative and increases to a peak as more waste is accepted at the landfill and then reduces over time for many decades. During this generation cycle, volumes of LFG generated a long time after the peak and after the landfill has closed can still pose a hazard to human health.

The rate and quantity of LFG generated primarily depends on the amount of waste, its organic carbon content, the length of time since deposition, moisture in the landfill; and the efficacy of LFG management, leachate management and progressive rehabilitation (staged closure of the landfill).

LFG is ~99.5% by volume methane and carbon dioxide. The remaining ~0.5% is comprised of various trace gases; many of which are highly odourous at very low concentrations and give LFG its distinctive odour. Several of these trace gases are hazardous to human health, though occur in very low concentrations. The trace gas of primary concern for human health and odour is hydrogen sulphide. Carbon monoxide can be produced where a landfill has subsurface hotspots in the waste mass. These trace gases typically cause amenity impacts due to odour and are rarely hazards to human health. The main hazards to human health from LFG are acute and are explosion (methane) and/or asphyxiation (methane and carbon dioxide).

If not appropriately managed, LFG can move laterally and then vertically through pathways in the soil and geology into buildings and structures and subsurface services and structures. LFG can also move through the backfill in subsurface services towards receptors or accumulate within these structures. LFG enters buildings and structures typically via service entry points (water, sewer, telecommunication etc), cracks or defects in the building floor or through parts of the building in contact with the ground, such as wall cavities. For a risk to exist, there must be a source generating LFG, credible pathways for it to move through and a receptor (human or pet).

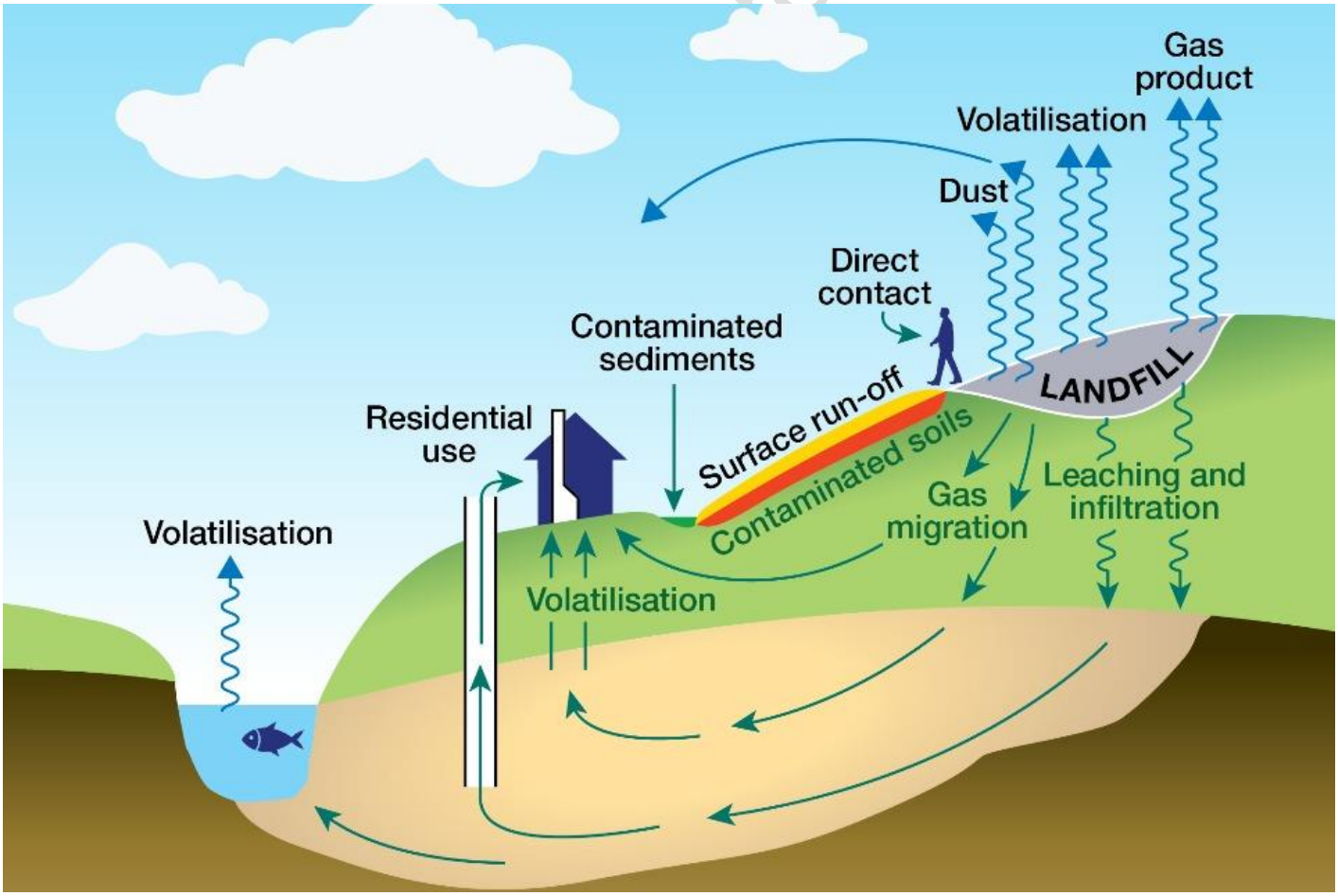

Figure 1 Conceptual model of landfill exposure sources and pathways[1]

Any proposal for development at less than the mimium separation distance from a closed landfill site will require a landfill gas risk assessment (LFGRA) addressing the current and future LFG risks

[1] Image from Impacts on health of emissions from landfill sites - GOV.UK (www.gov.uk)

through collection of LFG monitoring data and development of a conceptual site model (CSM). The CSM includes the characteristics of the landfill, the credible pathways and the receptor(s). The LFGRA must account for the variables affecting LFG generation, and equally importantly, those affecting its movement along pathways towards identified receptors. These variables are both spatial (space dependent) and temporal (time dependent). The source-pathway-receptor linkages (or lack of) and the monitoring data must be examined using the CSM to identify the current and future LFG risks to the receptor(s). For closed landfills, assessing future risks is typically acceptable where no significant changes to the site, such as construction of the landfill cap, are anticipated.

The level of identified LFG risk informs the need for and type of gas protection measures proportional to the risk (if required) at the proposed development within the landfill separation distance. . Gas protection measures must be designed and installed by a suitably qualified and experienced professional. Their installation and construction quaity assurance must be validated by an independent, qualified third party.

The LFGRA must be undertaken in accordance with guidance provided in *Managing Risks to Human Health from Landfill Gases, Landfill Gas Risk Assessment* (DoH, 2024).
Where the specifics of the closed landfill indicate potential for impacts to amenity from odour, dust and noise, the PHA must include these in determining the suitability of the proposed development..