A Guide to

Monitoring Subsurface Gas

Landfills are sites where waste materials are disposed by burial, and the biogenic gases produced on these sites are known as 'landfill gases'. Landfill gases are produced in the subsurface layer of landfills during the decomposition of buried waste materials. The gas is approximately made up of 60% methane (CH4) and 30% carbon dioxide (CO2), with trace amounts of other organic vapours and gases. The proportion of these compounds, as well as the overall quantity and rate of gas production, depends on the stage of decomposition, the operational conditions, density, composition, and age of the buried waste material[7].

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Gas migration

In a previous guide [1] it was stated that uncontrolled subsurface gas migration and emission from anthropogenic sources such as landfill, abandoned coal mining or contaminated land due to current or past industrial processes, poses a number of risks to the environment as well as human health & safety because of the risk of an explosion or acute/chronic health problems all potentially leading to fatality!

Clearly these potentially catastrophic outcomes must be avoided and whether a landowner, developer or regulator the objective is identical; namely to ensure that any existing or proposed development remains or is undertaken safely.

There have been a number of 'reference cases' where if the geology had been known, the gas migration could have been predicted and hence the problems avoided i.e. the methane explosion at Loscoe [2] and the carbon dioxide (CO_2) intrusion into housing in Gorebridge [3]. And whilst there were no fatalities, the impact on the inhabitants and the costs involved were significant.

So, the challenge remains for environmental consultants, civil engineers and other professionals charged with site investigation how to gather sufficient data to in order to provide a risk assessment and make recommendations on mitigation works or building design features.

The ultimate objectives of the monitoring work must be determined prior to selection of monitoring installation, locations for sampling points and choice of instrumentation. According to a joint NHBC and RSK Environmental Group publication [4] a preliminary risk assessment (PRA) and an Initial Conceptual Site Model (ICSM) are currently considered best practice when making these decisions.

The ICSM shows all known site features and supports the identification and assessment of pollutant linkages, which describes all relevant characteristics of the site detailing all identified or possible combinations of sources, sensitive receptors and pathways between the two. The description of source–pathway–receptor linkages at the site is crucial to the ICSM. The ICSM is used to design and focus subsequent investigations, including intrusive site works e.g. boreholes, to meet the objectives of the overall investigation.

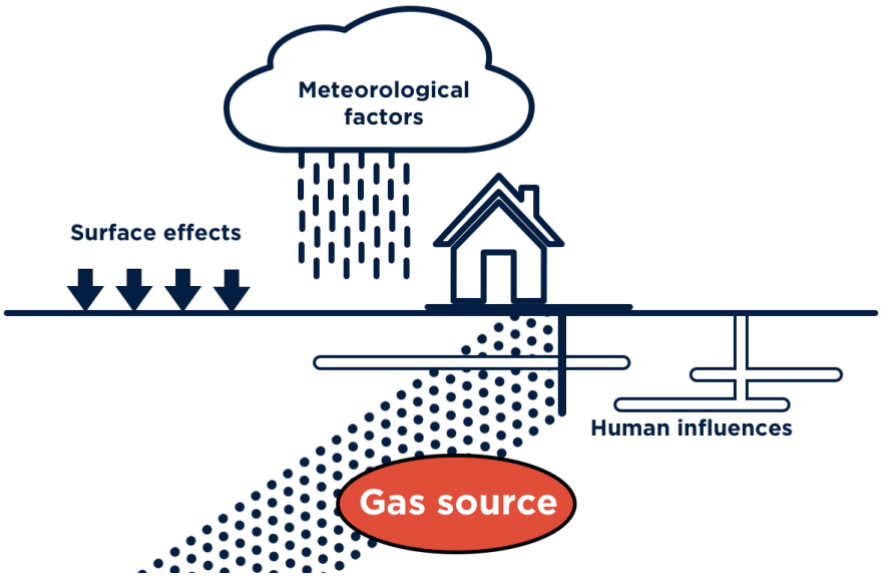

Figure 1: Simple Diagrammatical Initial Conceptual Site Model for a Hypothetical Site

(Diagram concept from: CIRIA Report 151, 1995)

Frequency of measurements

According to CIRIA [5], the ground gas monitoring rounds should:-

- encompass varying climatic conditions (specifically atmospheric pressure), including at least one period of falling pressure and one after/during heavy rainfall; Regular monitoring rounds over a period of stable conditions will determine the existence of variations in ground gas presence that are not due to changes in weather
- Where regular fluctuations in the water table occur (e.g. in tidal regions), ground gas monitoring should be carried out throughout the cycle to determine influences on the ground gas regime and the presence or absence of a time lag in response to such water table changes.

Furthermore, the UK Department of the Environment (DoE) suggested that monitoring should be carried out at barometric pressures below 1,000mb, when the pressure is falling. This is applicable to both landfill and non-landfill sources, and is most useful where the ground gas driver is convection.

Bearing in mind the potential temporal variables, as a minimum, the NHBC would require six ground gas-monitoring rounds over a three-month period. In many cases, however, substantially longer periods of ground gas monitoring could be required to enable the effects of the worst temporal conditions to be defined.

Unattended, continuous monitoring

The type of data required would suggest a requirement for continuous, unattended monitoring. This would require the instrumentation to have the following key features and capability:-

- Rugged, waterproof construction
- Battery powered, with several months capacity between maintenance visits
- Intrinsically safe due to the nature of the gases being monitored in the event of an instrument fault
- Multiple gas sensing i.e. methane, carbon dioxide, carbon monoxide, oxygen, hydrogen sulphide, total VOCs
- Environmental sensing i.e. atmospheric (and borehole) pressure and temperature, borehole water level
- Datalogging with output for PC or telemetry for remote interrogation of data

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References

1. *A Guide to Subsurface Ground Gas Migration*, Ion Science Ltd, April 2018.
2. *Lessons from Loscoe: the uncontrolled migration of landfill gas*. G. M. Williams & N. Aitkenhead, Quarterly Journal of Engineering Geology and Hydrogeology (1991) 24 (2): 191-207. Published: May 01, 1991
3. http://www.nhslothian.scot.nhs.uk/MediaCentre/PressReleases/2017/Documents/Gorebridge%20Report.pdf
4. http://www.nhbc.co.uk/NHBCpublications/LiteratureLibrary/Technical/filedownload,29440,en.pdf
5. Construction Industry Research and Information Association (CIRIA) Report 150. Raybould et al., 1995
6. Waste Management Paper 27 (DoE, 1991)
7. Subsurface Landfill Gas Monitoring, Published: 7th Mar 2013, AWE Magazine, Felix Nwaishi

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