



Natural Resources Wales Technical Review Of Landfill Gas Management Systems

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Brookhill Landfill Gas Review and Methane Emissions Survey

Please find the Landfill gas and Methane Emissions Survey conducted on the 23rd of October 2013 included in this report along with a description of the background to the programme.

Background

The U.K. Government has set a target of a unilateral 34% reduction of greenhouse gases (GHG) by 2020 compared to 1990. The Welsh Government climate change strategy includes a target to reduce greenhouse gas emissions by 3% every year. Natural Resources Wales' business plan for 2013-14 includes reducing methane emissions from landfill sites as a resilience priority. Natural Resources Wales makes a commitment to reduce methane emissions from landfill in order to help meet the Government's overall GHG reduction target.

This technical audit has been carried out as a key part of the strategy to reduce methane emissions from active landfill sites in Wales.

As part of the ongoing audit and review programme an element of best practice and benchmarking of landfill in Wales will be included in our approach, to establish a consistent standard of operation and a better estimate of emissions and extraction efficiencies as well as to address sites with known local issues such as:



- i) significant numbers of odour complaints received from the general public;
- ii) evidence of lateral landfill gas migration beyond the site boundary.
- iii) other issues such as high trace gas levels and evidence of thermal events.
- iv) High Hydrogen Sulphide and associated health and safety issues

Please find the Landfill gas and Methane Emissions Survey conducted on the 23rd of October 2013, with a list of comments and actions.

Review

The first site visit took place on the 22nd October 2013 and involved Officers from the Natural Resources Wales Specialist Landfill Gas Group, accompanied by staff from FCC (The permit holder) and Infinis (The gas contractor)

The team inspected the gas treatment compound, followed by the gas field and working areas.

Some of the perimeter monitoring boreholes were inspected and samples taken.

All sampling was performed with a calibrated Geotechnical Instruments GA2000+ and a Gazomat methane analyser.

Please find a list of comments and actions below:

GAS PRODUCTION RATE, EXTRACTION EFFICIENCY AND GASSIM MODELLING

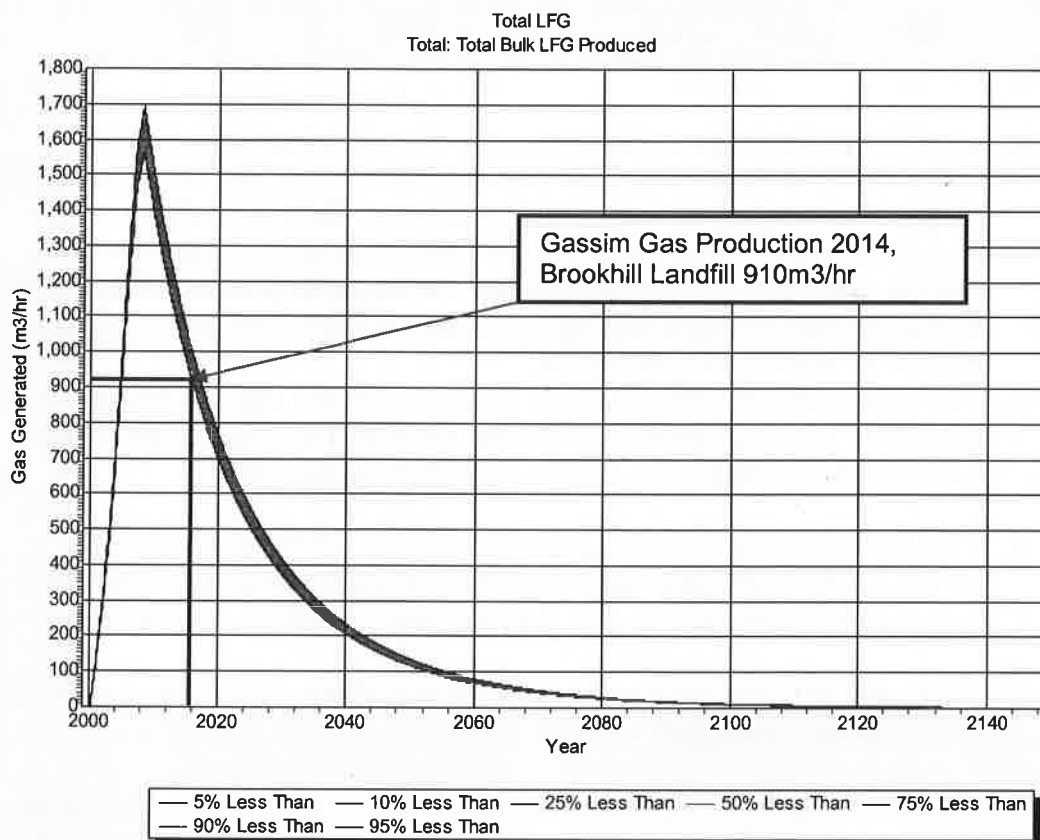
Figure 1 below shows the bulk gas generation curve produced using the Operator's data in Gassim, NRW's preferred gas production modelling tool. The modelled waste input is around 1.5 million tonnes of HCl waste (composition being around 60% domestic, 40% commercial so it is very biodegradable). The main issues are numbered as follows;

1. The moisture content is run 'Average' rather than 'Wet'. This may mean that the gas production rate has been underestimated as all of North Wales is designated as wet or super wet as far as Gassim modelling is concerned. We do recognise however that the site has been capped for some time.
2. The site has accepted a total of approximately 1.5 million tonnes of waste. At a range of 6m³-10m³, of gas/tonne per year this equates to 1027m³/hr-1712m³/hr at this point in time. The lower of these figures is 117m³/hr more than the Gassim estimate of 910m³/hr. For the sake of circumspection the lowest figure has been used for calculation of extraction efficiency.



3. The gas extraction rate at the site on the day of the audit was 420m³/hr @ 50% CH₄ (see results table below). This means extraction efficiency at the site is likely to be in the order of 46%. Using the lower figure in Gassim (run average for moisture content).
4. This extraction efficiency is unacceptable at a capped landfill of this nature with relatively recently tipped active waste. Reference LFTGNO3 (Landfill Technical Guidance Note) which recommends a target efficiency of 85%.
5. Taking 85% of the total Gassim estimate for gas production at this time would give a gas collection rate of 774 m³/hr a deficit of 353m³/hr.
6. The findings of the audit concur with the serious under extraction of gas at the site as demonstrated above, this situation must be remediated quickly in order to comply with the requirements of the Landfill Directive and the Welsh Governments Climate Change Programme.

Figure 1 Brookhill Gassim Model



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H:\My Documents\GasSim\brookhill pi reporting 2012 TW.gss



GAS MANAGEMENT COMPOUND

(Actions in bold)

1. Gas flow and quality were read from the digital readout in the landfill gas compound. Quality was then recorded from the bulk gas stream entering the compound. The results are presented in table 1 below

Table 1 Gas Management Compound Readings

Sample Point	CH4	CO2	O2	BAL	DP	CO	H2S	Flow (m3/hr)
SCADA	45.9	41.54	1.0					420 (range 300-500)
Post Booster	51.1	38.5	0.8	9.4	+180	0	28	
Gas Main	50.8	38.7	0.8	9.6	-29.5	0	47	

2. Landfill gas flow was oscillating wildly varying by several hundred m3/hr either side of 400m3/hr (see results above). The SCADA and the manometer on the gas train were oscillating. **This is likely to be a result of condensate blockages in the extraction infrastructure. Please conduct a thorough review of the infrastructure and clear any blockages and re-lay pipes to correct falls (where necessary) within 10 weeks of this report.**
3. The gas quality registered at the SCADA readout was 45.9% and in the gas main, 50.8%. **Please ensure the monitoring equipment is re-calibrated with 4 weeks of the date of this report.**
4. During the review it was noted that the pilot light to the flare is permanently lit. **Please confirm this is the case and provide the approximate volume of gas that the pilot light uses in m3/hr**
5. **What are the emergency arrangements at the site in the event of a mains power outage?**
6. There are silaceous deposits on the top of the enclosed flare. **What are the levels of siloxane in the inlet gas and what is the effect on engine maintenance?** Where engine efficiency is compromised this can result in the degradation of emissions.
7. Check pressures across knockout pots in the compound, **drain pot and clean filters where necessary.**



GAS EXTRACTION FIELD

1. There are some areas of the site that have very poor spatial coverage with regard to gas extraction wells, especially for a deep site such as this. This was subsequently discussed with the site representative on the day of the review. **Please submit an up to date as built drawing showing plans for improved coverage in areas with sparse coverage and gas wells intersecting at 20m (on average) radii providing full site coverage. Please investigate and submit proposals for drilling new wells for improved coverage in these areas within 6 weeks of the date of this report.**
2. Please refer to table 2 below for gas well performance. **Ensure the issues raised therein are addressed and the measures taken (or to be taken) are reported to Natural Resources Wales within 8 weeks of the date of this report.**
3. The extraction system as examined on the day of the report **showed 27 wells off**, with no apparent flow or other functional defect where gas could not be extracted from the site. **This means that approximately half** of the gas extraction system is not functional. **This is unacceptable and a plan of action to address remediation of the gas field should be submitted within 6 weeks of the date of this report.**
4. As the NRW predecessor body, The Environment Agency conducted a Landfill Gas Audit at Brookhill on the 28th Sept 2010. **The flow measurement device after the booster was fluctuating around 800m³/hour. This is nearly a 50% drop in flow in just 3 years. No modelling system or calculation could justify this as a drop in production rates. The extraction system has therefore degraded to 50% of its efficiency in 2010. This is clearly unacceptable and must be addressed as a matter of urgency.**
5. Surface emission readings from the capped flank close to the surface water drainage lagoon were very high and indicate an advective flow horizontally through a hole in the cap. (see the Landfill Gas Emissions Survey and NGR for location therein). **Please investigate these point source emissions and submit a plan for remediating existing wells, drilling relief wells in this area and resealing the cap where the releases to air are occurring.**
6. Positive pressure was found in two of the wells and a leachate (LC2B) well using the GA2000+. **These wells should be de-watered and correctly sealed immediately to re-gain control of the gas in this area and re-establish a negative pressure head. Where necessary relief wells should be drilled in these areas post sealing.**



7. A gas well dipping programme on wells where it is possible to remove head-works and perform a meaningful dip reading must be undertaken. This may help to identify further wells suitable for the pumping of perched leachate. **Please submit the dipping results (depth to water, depth to base and depth to slotting) along with a definitive list of those wells which already have pumps installed as soon as practicable.**
8. For wells blocked (either partially or fully) with perched leachate, it is essential that these wells are pumped and de-silted where appropriate to maintain extraction efficiency. **Please specify how many pumps are available and how many gas extraction wells (aside from leachate wells) have working pumps inserted. What is the quantity of leachate extracted from the wells on a weekly basis?**
9. **Please provide the last three months gas balancing data as requested during the review.**
10. Head-works on older wells on site are unsuitable for dipping or pump access and many were retrofitted to bent pipe-work. **Many of these wells are off or have reduced efficacy. Wells where this is evident should be decommissioned and new wells drilled judiciously to avoid air circulation connections with old wells.**
11. 63mm pipe-work can be prone to under cap settlement, blocking with condensate and deformation. **Please check the extraction lines particularly between well head and manifold for evidence of reduced efficacy and make repairs or replace where appropriate.**
12. Condensate was detected across the gas field. Condensate in pipe-work can affect flow and cause surging in the system, where it is severe it can cause complete blockage of parts of the gas field. **Please ensure the areas referenced in table 2 below are targeted and the system as a whole is checked for condensate issues. Pipe-work should be laid to the correct falls and drain under gravity wherever possible.**
13. Leachate extraction well LC2B has loose fittings on head-works allowing gas to escape under positive pressure. The gas plume from this well extends downwind to eastern batter. **Leaking fittings must be repaired immediately and gas extraction restored to the well to alleviate positive pressure. Consideration should be given to the drilling of a relief well in this area**



PERIMETER MONITORING

1. Methane above trigger level was detected in off -site perimeter boreholes. BH.19 and 23 showed levels of 13.9 and 2.1 respectively. **Please investigate these breaches and re-assess the efficacy of the LFG collection system in this part of the site.**
2. **What is the current monitoring frequency for perimeter monitoring wells?**
3. The well close to the site entrance well no.19 is flooded. **Please ensure that water from the haul road is diverted around this well and check (dip) the annulus for flooding.**
4. Gas was detected in several areas (see Methane Emissions Survey below) emanating directly from the ground close to perimeter monitoring wells. **This is indicative of lateral migration from the site and as such may represent an increased risk as it is so close to the industrial estate. Please review monitoring frequency and actions required in the site Gas Management Plan in the light of these findings and submit a report detailing the actions taken and too be taken within 4 weeks of the date of this report.**

T Roberts/T Ward/N Herbert November 2013



Table 2. Methane Emissions Survey Sheet – Brookhill Landfill

Site	Brookhill Landfill;	Date	22/10/2013	Time	in: 10.00 out: 15.30
Instrument	Gazomat Inspectra TDL (Serial No.: 1470311)				
		Background reading	1.8ppm	Time	10.10
Weather conditions:	Blustery and showery			Atm. Press.	mb
Survey Undertaken by:	Tony Roberts, Neil Herbert, Ty Ward, Alison Soper. (Natural Resources Wales Officers)				

General comments / observations
This emissions survey follow up is being carried out as a key part of Natural Resources Wales' strategy to reduce methane emissions from landfill sites in Wales. The objectives of the site review include Being operated and maintained so as to maximise gas collection efficiency and minimise fugitive landfill gas emissions. Treating the gas in a manner that minimises point source emissions. An ATEX certified, Gazomat Inspectra Laser Methane Analyser was used to perform emissions testing at the site.

Survey Results (only readings >10 ppm recorded)				
Point ref.	Time	Methane Reading (ppm. unless stated)	Feature and / or Grid Reference	Description / Comment
1.		5	Gas Extraction Plant Compound	Low level emission from auto-analyser discharge
2.		15	GW19	Check for leaks and seal
3.		15	In the air on Eastern side of the site downwind	Slight odour followed by detection of the CH ₄
4.		15,400	LC2B	Loose fittings on head-works allowing gas to escape under positive pressure. Gas plume extends downwind to eastern batter. Leaking fittings must be repaired



				immediately and gas extraction restored to the well to alleviate positive pressure. Consideration should be given to the drilling of a relief well in this area.
5.		1150	LC6	Emission detected from holes in the concrete ring. This must be sealed ASAP and any concomitant improvements in the gas extraction field expedited. Please retrofit a gas sample tap onto the headworks.
6.		8	Drainage ditch on Western Slope	8ppm methane detected in drainage ditch at base of western slope
7.		260 - 43000	Area of bare grass on Western batter 10m from drainage ditch. Approximate Grid Reference: SJ 27791 65606.	Gas odour by pond thought to be linked to bare patch on western slope. Methane ranged from ~ 260ppm up to 43,000ppm over the area of the back. Also significant concentrations in the grass surrounding this area. (215 – 263ppm)
8.		17-5ppm	Perimeter monitoring well 23	A reading of 17ppm was detected by the Gazomat emanating from the gravel on the pathway approximately 20m from perimeter monitoring well 23. Any gas migrating in this area creates a potential hazard as it is directly adjacent to Catheralls Industrial Estate
9.				



Table 3 Extraction and Leachate Well Readings and Comments GA2000+ (Wells with no flow or off are marked in yellow)

Monitor ID	Date Taken	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments
GUP (Flare compound)	22/10/13	51.1	38.5	0.8	9.4	+180*	0	28	*NOTE: NAF=NO APPARENT FLOW*
									Barometric pressure 975mb Flare on standby, pilot only *Reading taken post booster Flow oscillating between 300-500m3/hr; Approximate reading 450m3/hr Compound analyser readings known to be incorrect and require calibration. A separate emergency standby flare is located outside the compound (open type) Engine in separate compound; output ??? Kwe Automatic engine/flare switchover.
315mm inlet	22/10/13	50.8	38.7	0.8	9.6	-29.5*	0	28	*Reading taken pre-booster; 20m from compound. Suction bouncing slightly.
GW18	22/10/13	60	44	0.5	0	-2.6	0	110	Fully open, NAF. Suspect water blockage Combined groundwater m. point?
R4	22/10/13	60	44	0.8	0	0.5	0	95	Leachate dip point, not connected. Repair tefen valve.
GV20	22/10/13	58.8	44.5	0.5	0	-0.6	0	68	Off at manifold.

GV19	22/10/13	67	36.3	0.3	0	-0.6	0	0	Off at manifold.
GV17	22/10/13	55.7	42.3	0.6	1.2	-27.5	0	46	On at manifold, slight flow. Close to leachate well.
GV13	22/10/13	59.8	41.5	0.7	0	-28	0	27	Off at manifold. Cross interference?
GW16	22/10/13	55.4	38.9	0.4	5.2	-14.5	0	45	NAF – Combined groundwater m. point?
GV15	22/10/13								Unable to sample, suspect NAF
GV14	22/10/13								Flow, no sample point fitted
GV12	22/10/13								No sample point fitted, control valve requires replacement
LC3.1	22/10/13								Manifold. On, flow and condensate
GV12+R3	22/10/13	49.7	37.9	3.2	8.9	-26.4	0	55	Manifold. On, flow and condensate
GV9.1	22/10/13								Manifold. Off
LC1B	22/10/13	53.1	38.8	0.4	7.6	-25	0	43	Manifold. On, flow and condensate
GV9	22/10/13	61.9	41.9	0.2	0	-25.8	0		Manifold. On, flow, partial blockage?
GV10	22/10/13	64.4	38.2	0.3	0	-27	0	6	Cracked, good flow
GV11	22/10/13	61.7	43	0.3	0	-22.5	0	8	Cracked, flow
GW8	22/10/13	0.4	0	20.8	0	-5.4	0	0	NAF. Cross interference? Combined groundwater m. point?
GV6	22/10/13	44.6	34.3	2.5	18.4	-25.8	0	7	On at manifold
GW3.1	22/10/13	66.3	42.3	0.5	0	-28	0	30	NAF Combined groundwater m. point?
R1	22/10/13	59.6	39.8	0.8	0	-26	0	31	Positive pressure when turned off. Replace tefen valve.
R1B	22/10/13								Positive pressure when turned off?
GW5	22/10/13	35.8	24.9	6	33.3	-26	0	0	Nearby air leak suspected Combined groundwater m. point?
GV4	22/10/13	65.2	39	0.3	0	+10.7	0	69	Positive pressure. No control valve at wellhead.
GV3	22/10/13	60.4	36.5	1.8	1.4	-26	0	12	



GV4	22/10/13																	Manifold. Off
GV5+R1	22/10/13																	Manifold. On
GV8	22/10/13																	Manifold. On
GV6	22/10/13																	Manifold. On
LC2+GV2.2	22/10/13																	Manifold. Off
No ID?	22/10/13																	Manifold. On
GV2	22/10/13																	Manifold. Off
GV1	22/10/13																	Manifold. Off
GV25	22/10/13	58	41.2	0.3	0.4	-26	0	36										No control valve
GV24	22/10/13	48.2	38.6	1.9	11.3	+3.4	0	1										Positive pressure. No control valve possible blockage in tap at wellhead
R6.1	22/10/13																	Manifold. Off
GV22	22/10/13																	Manifold. Off
GV23	22/10/13																	Manifold. Off
GV24	22/10/13	49	39.3	1.1	10.5	-26.2	0	11										Manifold. On
B+C	22/10/13	54.2	40.4	0.3	4.9	-25.8	0	65										Manifold. On
GV29+L6B	22/10/13																	Manifold. On
GV27+28	22/10/13																	Manifold. On
GV26	22/10/13																	Manifold. On
GV25	22/10/13																	Manifold. On
GV29	22/10/13	56	41.3	0	2.7	-24.8	0	94										Open
GV28	22/10/13	53.4	40	0.2	6.3	-22.7	0	70										Open
GV27	22/10/13	56.8	43	0.7	0	-20.8	0	85										Open, good flow
LC6	22/10/13	59.5	43.9	0.6	0	-	0	70										Off. Cracked open during sampling to show air leak, programmed to be fixed.

LC6B	22/10/13	45.7	38.3	0.4	15.5	-25	0	26	Open, flow
GV30	22/10/13	43.6	37.1	0.1	19.2	-13.6	0	76	Open, flow
GV31	22/10/13	54.4	41.1	0.9	3.2	-24.7	0	16	NAF
GV32	22/10/13	52	39.3	0.9	7.7	-25	0	33	NAF
GV33	22/10/13	55.5	33.3	0.4	0.4	-5.9	0	24	Cracked
GV34	22/10/13	47.1	35.5	0.4	16.9	-19.5	0	23	Open
Pin 1	22/10/13								Off
Pin 2	22/10/13								Off
Pin 3	22/10/13								Off
Pin 4	22/10/13								Off
Pin 5	22/10/13								Off
Pin 6	22/10/13								Off.
Perimeter monitoring points									Note 0.4% vol methane on analyser prior to testing.
19		10 (13.7)	0.7	15.6	73		0	5	Monitoring point head works flooded Point re-sampled; second reading increased to 13.7%vol methane Requires further investigation
18		0.5		20.9					
23		2.1	3.6	14					
24		0	0	20.9					

