

Natural Resources Wales Technical Review Of Landfill Gas Management Systems

**Hafod Landfill Gas Review
Permit No: BS8621IW**

20/21 August 2015 10:00hrs

Note: Summary of findings and actions sent by e-mail; 25/08/2015 at 14:55

Introduction

Following a site meeting at 10.00 hrs. between Ian Craven (Cory Area Manager), Graham Ball (Cory Landfill Gas Manager) and Ian Oakes (IR Technical Specialist and inspecting Officer), Tony Roberts (Landfill Gas Technical Specialist) and Aled Zachary (IR Compliance Officer) of Natural Resources Wales, where the plan for conducting the audit and previous audit actions and follow ups were discussed, the site was audited using a Gazomat Methane Detector for emissions detection and a GA2000+ analyser for measuring gases within the gas management infrastructure.

The audit focussed on the benches of the main batter and the older part of phase three. Some of the most critical perimeter monitoring infrastructure was assessed and gas readings taken from a number of the wells on the following day.

Summary

Levels of emission were detected across phase three which are still giving cause for concern. The current tipping area showed high emissions in the air over a consistent period and area. This area urgently requires improved extraction infrastructure. Although there are now 10 pumps in the 'new' wells which is welcomed by NRW, there are still problems with extracting gas at depth (due to well blockage) which was the original intention of installing these wells. Immediate consideration should

be given to the installation of some deep infrastructure to access gas at depth as this does not appear to have been achieved with the drilling of the new wells.

The average gas flow in March 2015 was 627M3/hr. (Normalised to 50%) the reading taken on the 21st August 2015 was approximately 570M3/hr. (Normalised to 50%). This shows an apparent decrease in gas capture volume (see table below). This appears to reflect the level of emission detailed in the emissions report below.

Many of the wells on site are either switched off, have low or no flow or have some form of blockage. This should be addressed by a thorough appraisal of all wells on site and a programme of analysis, re-instatement or de-commissioning and replacement should be undertaken.

Some perimeter wells are showing high methane with the ratio of methane to CO₂ being close to that of landfill gas. This is still a cause for concern and proposals should be put forward to look into the reduction in migration by gas field adaptation where possible.

Main Findings

Note: A summary of the main initial findings was forwarded for action on 25th August 2015, four days after the audit took place.

1. The surface emissions detected using the Gazomat methane analyser were significant as specified in the e-mail concerning this issue sent to you by Aled Zachary on the 20th August.

ACTION: Cory to submit a plan for the installation of new wells in and around the current operational areas with timescales for the cessation of filling and the installation of the new infrastructure. Plan to be submitted by Friday the 4th September. **To date a plan of action to install agreed infrastructure has not been received. This should be submitted without delay.**

ACTION: Cory to investigate the options for reducing emissions from phase three by addressing the following;

a) Wells on the Northern batter (all benches) which are not fully functional to be investigated and repairs/re-sealing to be instigated where possible. NRW does however recognise the access issues for plant and machinery in this area. This work should now have been completed as requested in the original e-mail summary. **Please provide a report of actions and outcomes completed to date.**

b) Submit an up to date set of results for gas quality and perched leachate levels in gas wells 32 - 44 (including leachate removal rates where possible.). **This action is now complete.**

c) Investigate the installation of new deep trial wells, with wider bore piping to allow for ease of blockage removal and pump installation and removal. Please include the results of this investigation in the report to be submitted by the 5th September. **To date this report has not been received. Please submit this report as soon as possible**

d) Consider the installation of additional pin wells in areas identified with high emissions which are not included in the plan for the operational area.

e) Reseal the capping areas identified in the emissions report within 4 weeks of the date of this e-mail.

2. Graham Ball to submit the latest gas balancing data within 10 days of the date of the audit. **New well dip data and levels received but gas balance data not yet submitted.**

3. Graham Ball to submit latest as built drawing within 10 days of the date of the audit. **This action is now complete.**

4. There was positive pressure of +28.1 in well HFOPNW25. The well was switched off. **ACTION:** Please investigate the reason for the positive pressure build up in this well with lack of extraction as a matter of urgency. Where site staff are aware of positive pressure in gas wells or pipework in the gas field, please inform NRW officers before any future inspection starts.

5. Many of the wells were off or had low flow (see well table below). Many such wells showed high gas quality and others an oxygen to balance gas ratio close to that of air. **ACTION:** These wells should be subject to investigation to restore flow where possible or decommission and replace where necessary.

6. The gas extraction well table at the end of this report gives the readings and comments of issues that came to light during the audit in terms of the wells inspected and analysed during the two days.

ACTION: Review the findings and undertake actions required in this table within 8 weeks of the date of this report.

7. **ACTION:** Leachate trapped behind the plastic capping on the central part of the second bench of the Northern main batter requires de-watering and a drainage solution installed.

8. Many wells appear to have either proximal or distal air ingress problems.

ACTION: All wells where the levels of oxygen and balance gas indicate a localised air leak should have the head works and bentonite seal checked.

9. Some wells have high H₂S levels: **ACTION:** wells they should be checked for positive pressure, location and the atmospheric conditions on a rolling basis. This data should be used to inform the daily site specific risk assessment.

12. **ACTION:** Where wells show pressure readings close to or at that of mains pressure then they should be investigated accordingly and checked for partial or complete blockage.

13. **ACTION:** Where H₂S Levels are off the scale on the portable GA2000+ gas analyser, a bag sample should be taken and lab tested. Results should be forwarded to NRW upon receipt.

14. Sample points were missing on several well heads. **ACTION:** Please fit functional sample taps to all well heads.

Landfill Gas Treatment Compound

The flows and gas quality at the gas utilisation compound were taken during both of the last 3 reviews of the site gas management system. The results are reproduced below:

Flow	Normalised Flow	CH4 %	CO2 %	O2 %	Balance %	CO ppm	H2S ppm	Diff Pressure mb
Flow at compound 19/11/14								
620m3/hr.	594	48	36.1	1.0	14.7	51	125	-94.9

Post Review

Flow at Compound M3/hr. 19/02/15	Flow Normalised to 50% CH4	CH4 %	CO2 %	O2%	Balance %	CO ppm	H2S ppm	Diff Pressure mb
580	534	46.2	36	1.5	16.2	44	107	-79.7
Flow at Compound Averaged Over March 2015	Flow Normalised to 50% CH4							
640m3/hr.	627	49	35	1.4	14.8			

Gas Compound Readings 21/08/15

Flow at Compound M3/hr. 21/08/15	Flow Normalised to 50% CH4. M3/hr.	CH4 %	CO2 %	O2%	Balance %	CO ppm	H2S ppm	Diff Pressure mb
579	570	49.3	37.5	0.7	12.3	14	94	-81.2

The bulk gas flow and quality have reduced by approximately 60m³/hr. (when normalised to 50% CH₄ for direct comparison) when compared to the readings (produced as an average) for March 2015.

The electronic flow meter requires re-calibrating so the results were an estimate taken from the Manometer reading. ACTION: Re-calibrate the electronic flow meter within 4 weeks of the date of this report.

Landfill Gas Extraction Field

On the 20th of August a walkover survey of phase three including the various benches on the main batter and the new tipping area was undertaken using the Gazomat methane detector. Concurrently the gas infrastructure was inspected and well gas readings taken in the same areas. The following day a selected number of the perimeter wells were inspected and sampled followed by the remainder of the new wells in phase three.

Levels of methane emission ranged from 15 to 192,000ppm (19.2%) with the highest ambient concentrations at the juncture of the new cell and the plastic capping.

ACTION: Added gas extraction infrastructure is urgently required in this area as agreed on site during the review.

ACTION: Existing infrastructure should be checked for blockages, air leaks and perched leachate and remedial action taken where any or all of these issues are noted.

The emissions section below shows that there is still a relatively high level of point and non-point source emission at the site. Emissions ranged from 15 to 192,000ppm with high ambient levels of gas close to the new cell. This would indicate that the site has more gas to collect.

ACTION: Instigate further infrastructure improvements and other outstanding recommendations in this and previous reports to ensure maximum landfill gas collection efficiency at the site.

Comments on the gas field infrastructure and actions can be found in the findings section above and the landfill gas well table of results below.

Emissions findings and comments are listed below in the Emissions Survey section.

Emissions Survey

Survey of the 2nd Bench of the Northern Flank (Temporary Capped):

- At the bottom of the western side slope extension up to 15ppm methane was detected (ambient) at the start of the audit.
- Adjacent to HF005CU1 an emission of up to 1500ppm Methane was detected.
- Adjacent to the spur of HFOPNW03 from the gas main an emission of 2.5% (**25,000ppm**) was detected from the temporary cap
- An emission of 5000ppm to the left of HFOPNW04 from a breach in the temporary plastic cap was recorded.
- Up to 6000ppm around the boot detail of HFOPNW05 was detected
- Around 5.2% methane detected (**52,000ppm**) from a tear in the plastic capping to the left of where HFOOLMP3's gas line spurs onto the gas main.
- Around **10,000ppm** from a tear in the seam between temporary capping sheets located between HFWOOW031
- Up to **10,000ppm** detected where the temporary capping meets the eastern side slope.

Summary: These emissions suggest the area under the temporary cap is under extracted.

Survey of the 3rd Bench of the Northern Flank (no cap / clay covered):

- Up to **20,000ppm** from the base of HFOOPNW25. No apparent flow (NAF) on this well, although the valve was fully open.
- Up to 250ppm detected from the cracks in the clay cover adjacent to the above too
- HFOOGW037, no emissions of note (150ppm), good flow
- HFOOGW041, no emissions, gas well has pump in but NAF
- HFOOW040, no significant emissions, pump in and flow
- GW36, no significant emissions, pump in although I couldn't discern whether the well had flow
- Up to 2.0% (**20,000ppm**) detected round LMP01, odour present around this infrastructure
- HFOOW039, no significant emissions, pump in and flow
- HFOOW20, up to 350ppm from base and NAF – well to monitor for potential leachate entrainment?
- Up to 5000ppm recorded from the base of LMP2
- Up to 19.2% (**192,000ppm**) from the crest of the plastic capping adjacent to HFOOLMP2. Lack of gas extraction infrastructure in this area.
- Around 20ppm ambient recorded from the surface between LMP2 and HFOOW035
- HFOOW035, no emissions recorded, pump in and flow
- HFOOW018, no emissions recorded, flow
- Around **60ppm ambient** recorded from the surface between HFOOW018 and HFOOW033
- HFOOW033, no emissions recorded, pump in, although flow not perceivable.
- Up to 250ppm was recorded from the surface to the west of GW32 (around the area of leachate outbreak)

- 16% gas (**160,000ppm**) from a tear in temporary plastic cap adjacent to HFOOHZ08 spur into the gas main.



- Up to 60ppm from the surface by the spur of HFPN515A, this increased to 200ppm further up the flank and 170ppm (both ambient) on the flank above Gas Manifold 7
- Around the crest of the operation area with the northern flank levels of between **300 – 1200ppm** were detected (ambient)

Summary: These findings suggest that landfill gas is under extracted from Cell 3. Leading to the high emissions readings detailed. Of particular concern are the levels of surface emission detected around HFOOPNW25 and in particular the level of emissions recorded from the Northern and Western flanks adjacent to the current tipping area. Left unchecked these areas could be a significant source of methane emissions and have potential for odour generation.

Extraction Wells GA2000+ Readings and Comments – Hafod Landfill 20/18/15 – Infrastructure Survey.

Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments
SECOND BENCH ON PLASTIC CAPPING								
Gas Compound Readings 21/08/15	49.3	37.5	0.7	12.3	-81.2	14	94	Electronic flow recorder not yet calibrated: Action: Calibrate electronic flow meter ASAP FLOW: 579 (estimated at manometer)
HF005CV1								Valve fully open – full of condensate. No apparent flow. ACTION: Check drainage and sealing or propose replacement where possible.
HFOPNW01	56.6	38.3	0	3.8	-100		Off Scale	Valve open but no flow H2S off scale. ACTION: Lab sample H2S and ensure correct safety measures are in place on still days and that the well is checked for positive pressure. Check drainage and sealing or propose replacement where possible. Well at mains pressure.
HFOPNW02	58.7	41.6	0.3	0	-1.76	0	16	Well shut off, some cross interference note.
HFOPNW03	13.3	10.1	15.6	61.3	-0.33	0	1	Well shut off, some cross interference note. Well full of air.
HFOPNW04	59.8	40.5	0.1	0	-100.7	0	264	High H2S

Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments
HFOPNW05	58	41	0.5	0	-101	0	67	No flow – at mains pressure -Investigate
HFOPNW06	63.4	36.5	0.6	0	-101	0	141	Closed valve No flow
HFOPNW07	49	33	0.6	15.8	-27.3	0	2	Just cracked –some flow –good well
HFOOW029	57.3	45.7	0.3	0	-0.67	27	18	Shut off – No flow
HFOPNW08	8.5	8.7	15	67	-11	13	1	Well is full of air. ACTION: Re-seal
HFOPNW09	50.4	40.1	0.8	8.5	-80	8	2	Well cracked open deformed pipe at main close to electro-fusion coupling. ACTION: Repair deformity in affected pipe. Good flow valve open 30%
HFOOW10	42.2	31.2	0.6	25.9	-38.7	7	54	Good flow
HFOOW11	29.5	26.7	4	39.7	32.4	6	1	Some flow but high balance gas indicating proximal air leak
HFOOW12	49.8	36.3	0.3	14.1	-97.1	3	32	Cracked, close to mains pressure, no flow. Bubbling was heard in the pipe and appeared blocked. ACTION: De-water pipe and check for air leaks when flow is re-instated.
HF LMP3	43.7	32.7	3.4	20.1	-23	4	3	Well shut off, liquid under plastic tear in plastic cap close by with 5% methane emission. ACTION: Investigate reason for shut off and de-water area under cap. Re-seal tear in cap
HFOOW21	33.1	37	3	17.1	-2.2	16	1	Well cracked open – flow

Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments
HFOOW031	57.3	44.7	0.3	0	-101.2	14	310	At mains pressure – no flow. ACTION: Investigate the reason for high gas quality and no flow.
NEW PIN WELLS ON EASTERN SIDE								
HFOPNW22	32.5	28.4	3	36.1	+0.13	3	6	Well switched off
HFOPNW13	55.2	39.2	0.2	5.4	-43.9	2	75	30cm tear at vale around pipe going under cap at this point. ACTION: Repair tear.
HFOPNW23	29.1	26.1	1	45	-8.79	0	1	Well Cracked. Well installed on eastern side of cell three to address previous issues with emissions in this area
HFOPNW24	55.9	34.8	0.8	8.5	-80.6	1	1.5	Well cracked open
HFOPNW25	58.4	41.9	0.3	0	+28.1	5	1	OFF Positive pressure. ACTION: requirement for infrastructure improvement in this area still remains.
HFOPNW26	59	40.5	0.4	0	-11.3	5	460	Cracked. High H2S
HFOPNW27	47.7	35.1	0.2	16.9	-27	4	138	Cracked – Good flow
MID UPPER BENCH ABOVE PLASTIC								
HFOOHZO1	60.6	40.4	0.4	0	-100	12	243	Horizontal well at mains pressure. High H2S
HFOOW037	50.2	38.3	0.4	10.9	-10.3	10	86	Good flow
HFOPNW14	58	42.9	0.2	0	-99.5	5	38	Open full limited flow. At mains pressure ACTION: Investigate the well for blockage with water or replace.

Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments
HFOOHZ02	23	15.3	13.3	48.8	-99	4	87	Close to mains pressure – low methane ACTION: Investigate reasons for low methane and high balance.
HFOPNW15	58.2	40.9	0.6	0.2	-99.3	18	236	Open – Flow. Close to mains pressure. High H2S
HFOOW040	61	42	0.2	0	-99.8	26	368	Open – Flow. Close to mains pressure. High H2S
HFOOW019	61.9	41.1	0.1	0	-98.2	22	457	Open – Minimal flow. Close to mains pressure.
HFOOGW36	57.8	43.1	0.5	0	-89.8	37	300	Open - Flow
LMP02A	54.6	34	2.5	9.2	-99.2	13	133	Open -Flow
HFOOHZ03	61	60.4	0.1	0	-99.3	18	165	Valve fully open – No flow.
HFOOW030	59.2	42.9	0.3	0	-97.4	14	207	Valve open blockage suspected. ACTION: Check well for blockage
HFOLMP01	50	38.2	2.2	9.4	-0.6	19	33	OFF
HFOLMP01A	65	42.8	0.3	0	-36	83	353	OFF – High H2S
HFOOW039	45.9	35.9	1.1	17	-6.7	32	86	Flow
HFOOW020	63	43	0.3	0	-97.8	25	OFF SCALE	High H2S. ACTION: Please bag sample and provide accurate analysis of the levels in this well.
HFOOHZ06	61.3	43.2	0.7	0	-96	OFF SCALE	161	Horizontal well showing high CO. Please re-test with H2S filter and lab sample to confirm CO reading is anomalous or otherwise.
Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff	CO	H2S	Comments

					mBar	ppm	ppm	
HFOOHZ07	27	19.7	9.2	44.1	-39.6	47	1	OFF
HFOOWO35	45.5	35.9	1.1	17.4	-76	100	215	Slightly cracked open
HFOOHZ08	63.2	38.1	0.5	0	-95.9	45	139	Horizontal well – No flow- High gas quality.
HFOOW0018	51.4	37.3	0.3	11	-49.8	95	255	Flow – High H2S
HFOOW038	60.4	40.2	0.5	6	-95.9	30	459	Minimal flow – High H2S – High gas quality
HFOOW032	54.7	37.1	0.6	7.3	-45.3	34	281	Open – Good flow – High H2S (Floating debris)
HFOOW033	49.7	34.3	1.9	14.1	-30.8	42	110	Open - Flow
HFOPNW20	37.9	38.1	1	31	-30.3	30	79	Open - Flow
HFOPNW16	46.8	32.3	1.8	18.5	-95.3	22	43	Open. ACTION: Check for condensate
HFOPNW15	47.4	32.1	1.8	18.5	-95.3	22	5	Open - Flow
HFOPNW14	62.8	38.5	0.4	0	-94.4	25	265	Open – Flow – Enriched gas
HFOPNW13	63.8	40.2	0.3	0	-58.5	21	148	Open – Flow – Enriched gas
HFOPNW01	56.4	39.9	0.2	3.6	-92.6	22	116	Open – Flow – Enriched gas
GAS WELLS ON THIRD BENCH OF PHASE THREE								
HFOOWO40								Not measured – warm – good flow
Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments

HFOOW041	60	40	0.7	0		23	327	Warm pipe-Off at manifold. ACTION: High quality gas and warm pipe indicates the production of good quality gas within the area of this well. Please investigate the reason for the wellbeing closed.
HFOOW043	53.1	40.6	0.1	6	-78.2	19	77	Open - Flow
HFOOW044	50.9	38.9	1.1	9	-18.5	3	63	New sample point required
HFOOW045	53.4	40.5	1.3	4.8	-79.4	0.1	33	New sample point required
HFOOW046	54.4	45.1	0.5	0	-60	16	87	Open – Good flow
HFOOW042	60	41.6	0.3	0	-78.7	12	192	Open - Flow
PERIMETER MONITORING WELLS 21/08/15								
GB10a	15.4	3.7	0.9	80	+0.07	0	0	
GB10b	24.7	8.2	0.2	66.7		0	0	
GB11	0.1	0	20.9	79	-0.1	0	0	
GB9	26.6	29.2	0.1	44	0.17	0	0	
GB8	6.4	16.8	4.4	72.3	-0.25	0	0	
G7a	17	24.3	0.1	58.5	-0.26	0	0	
Monitor ID	CH4 %	CO2 %	O2 %	Balance	Diff mBar	CO ppm	H2S ppm	Comments

G7b	0.1	0	21.1	78.8	0.3	0	0	
G6a	0.1	0	21.2	78.7	0.3	0	0	
G6b	0.1	0.2	21	78.7	-0.37	0	0	
G5	0.1	0.2	21.2	78.7	0.37	0	0	
J	52.1	35.05	0.4	12	-0.35	0	0	
I	1.3	1.1	19.9	77.7	-0.37	0	0	
H	0.1	4.7	15.4	79.8	-0.39	0	0	
4a	16.6	20.8	3.7	58.5	-0.41	0	0	
4b	32.4	28	2.2	37.3	-0.41	0	0	
G	0.1	3.1	16.1	80.7	-0.4	0	0	
F	0.1	2.4	18.5	79	-0.5	0	0	
E	0.1	3.3	17.3	79.3	-0.43	0	0	
3	10	16.1	5.5	68.2	-0.46	0	0	
D	0.1	3.6	18	75.3	-0.46	0	0	
C	0.1	3.5	16.419.2	80	-0.44	0	0	
2	0.2	1	12.4	79.5	-0.48	0	0	
B	0.1	6.4	14.9	82.1	-0.46	0	0	
A	0.2	4.1	7.2	80.8	-0.49	0	0	
1	16.4	14.9	0.7	61.7	-0.46	0	0	

Perimeter Monitoring Wells

1. Some bungs were loose. Where bungs are fitted due consideration should be given to replacement with a plastic sealed fitting.
2. Some of the sampling valves require replacement. **ACTION:** Check all sampling valves and replace faulty units.
3. Some perimeter wells are showing high methane with the ratio of methane to CO2 being close to that of landfill gas. This is still a cause for concern and proposals should be put forward to look into the reduction in migration by gas field adaptation where possible.

Tony Roberts

Landfill Gas Technical specialist.

07/10/2015