

STORMY WEST LANDFILL SITE (Closed)

ENVIRONMENTAL MONITORING REPORT 2025 July 2026



July 2026



ENVIRONMENTAL MONITORING REPORT 2025

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Some of the interpretation within this report is based upon information taken from previous reports and external sources at the time of the report issue. Full reliance is placed upon the accuracy of such information, and whilst due diligence is employed, any responsibility for incorrect information from these sources cannot be accepted.

NON-TECHNICAL SUMMARY

This report presents 2025 environmental monitoring data for the closed Stormy West Landfill Site near Pyle, South Wales. The site operated between 1985 and 1996 and has now been closed for almost 30 years. The evidence indicates that landfill-attributable impacts to monitored groundwater and surface-water receptors remain low, but several matters require attention: replacement of the ageing flare, continued surveillance of GBH03 perimeter gas, verification of B5 and perimeter borehole collar levels, and development of a risk-based route toward eventual permit surrender.

Key findings from the 2025 monitoring include:

Topic	Regulator summary of 2025 findings
Water quality	No landfill-attributable deterioration identified; continue routine monitoring.
Surface water	Kenfig Pool and Pyle Spring show no landfill-attributable impact; continue monitoring, with Pyle Spring zinc tracked as a likely non-landfill issue.
Groundwater	Containment supported by ammonia and chloride evidence; verify B5 collar and continue A48 trend review.
Landfill gas	Declining gas quality and constrained flare operation; replace existing flare with enclosed low-CV unit.
Perimeter gas	GBH03 remains below action threshold but above investigation threshold; continue surveillance and add to quarterly water-quality sampling.
Permit strategy	Generic gas completion thresholds are decades away; begin risk-based surrender planning with NRW.

- **Water Quality:** Monitoring shows effective containment of landfill leachate. Groundwater quality parameters remained stable throughout the year at the principal downgradient monitoring points. An isolated ammonia reading at the A48 borehole early in the year was not repeated and is not attributed to the landfill. Zinc elevated at Pyle Spring is not from the landfill — the source concentration inside the waste is far lower than at the spring, which is physically inconsistent with a landfill origin.
- **Landfill Gas:** The gas management system continues to operate under a batch-burning regime. Perimeter monitoring shows methane generally below detectable levels at most points, with no significant off-site migration. Gas quality is declining, and the existing flare is approaching the limit of its operating window. A replacement low-calorific-value flare is required.
- **Groundwater Levels:** Levels showed a pronounced seasonal cycle, driven by an exceptionally wet autumn. The multi-year step-change observed between 2022 and 2023 appears to have stabilised. The leachate level inside the waste mass continues a gradual long-term rise that warrants further investigation.
- **Surface Water:** Monitoring points at Pyle Spring and Kenfig Pool showed no indication of impact from landfill operations.
- **Leachate Quality:** Leachate continues to improve and dilute, consistent with progressive stabilisation of the waste mass.
- **Compliance:** Based on the analysed parameters, the site is operating within expected environmental parameters, with no significant contamination detected in surrounding groundwater and surface water bodies. NRW has mandated replacement of the ageing flare.

The data indicates that the Stormy West Landfill site has a low probability of causing any significant environmental impact due to emissions and/or discharges. The site continues to progress through the latter stages of waste biodegradation, as evidenced by both leachate quality improvements and changing patterns in landfill gas generation.



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1. INTRODUCTION

EnviResource Consulting Ltd has prepared this report on behalf of Landcare (Manchester) Limited in accordance with the annual reporting responsibilities required by Environmental Permit EAWML34009. This report presents the environmental monitoring data from the Stormy West landfill site and its potential impact upon the surrounding area. The site has been closed for almost 30 years.

The monitoring information is presented as a summary of water quality, landfill gas emissions, groundwater levels, and receptor surveillance in and around the site boundary. The report also uses the 2025 evidence base to support three regulatory propositions: leachate remains contained, landfill gas is declining and requires infrastructure replacement rather than increased abstraction, and eventual permit surrender will need to be planned on a site-specific, risk-based basis.

Groundwater analyses are compared with drinking-water quality standards as a conservative screening benchmark, because water pollution represents the higher-risk environmental pathway for old landfills of this type at this late stage of biodegradation. The comparison is not intended to imply that groundwater in the immediate vicinity is used, or is likely to be used, for potable supply. For landfill gas, the monitoring results have been assessed against relevant historic industry standards and best-practice guidance, including WMP27 and LFTGN03.

The data collected during the 2025 monitoring period has been abridged and reproduced within tables within the appendices. Full laboratory results are presented in Appendix A; gas data in Appendix B.

2. BACKGROUND INFORMATION

The Stormy West Landfill Site was designed and operated under the principle of dilute and disperse, which allowed the products of biodegradation to be potentially rendered harmless by dilution, attenuation and interaction with the natural assimilative capacity of the limestone strata and hydrogeological pathways present within and beneath the site.

The site, prior to being landfilled, had been a disused limestone quarry. The void was filled and raised with a mix of household, industrial, commercial and some Special (at that time) Wastes as permitted by the Planning Permission and Waste Disposal Licence No. 5 (now Environmental Permit EAWML34009), issued by the then Regulatory Authority, Ogwr Borough Council. These waste types were landfilled between 1985 and 1996, during which approximately one million cubic metres of void space was filled.

An active gas extraction system utilising a high-temperature burner/flare was constructed in the early 1990s. The site has been fully restored for several decades with a low-permeability clay cap, which is seen to be in good order. Since 2016 the restoration layer has supported an approved Solar Panel Electricity Generation System. Recent analytical results continue to indicate a change in the dynamics of the landfill site, possibly due to reduced infiltration caused by the presence of the solar panel cover.

Gas flaring is currently managed in batch burns of approximately three days per week duration, with the system turned off to allow re-charge for the remaining four days. Early 2026 data confirms that sustainable flaring periods are becoming more constrained as gas generation continues its natural decline.

3. LEGISLATIVE OVERVIEW

The principal environmental legislation governing the operation and any subsequent environmental impact of facilities is the Environmental Protection Act 1990 and regulations issued under it, including the Environmental Permit.

Publications such as NRW (ex. EA) guidance documents and previous DOE Waste Management Papers (WMP) as appropriate have been referenced. It is worthy of note that this site, due to the date of closure in 1996, does not fall under the Landfill Regulations 2002.

Regarding groundwater, the 1998 EC Directive on the Quality of Water Intended for Human Consumption (98/83/EC), implemented in Wales by the Water Supply (Water Quality) Regulations, has been used for test results comparison purposes, although it is highly unlikely that the groundwater in the immediate vicinity would be used for potable purposes.

For landfill gas monitoring, the site follows the requirements set out in the Environmental Permit and industry best practice guidance (LFTGN03, LFTGN05). LFTGN03 aftercare criteria establish that permit surrender requires demonstration that in-waste gas concentrations have reliably declined to $\leq 1.5\%$ v/v CH₄ and $\leq 5\%$ v/v CO₂.

NRW correspondence during 2025 established that enclosed flare replacement is mandatory. Failure to replace will lead to permit non-compliance scores. A gas report was submitted to NRW in October 2025 providing the technical basis for flare specification. No NRW Compliance Assessment specific to EAWML34009 was conducted during 2025; CAR_NRW0049476 relates to a separate permit at the same location and does not apply to this AEMR.

4. GENERAL ENVIRONMENTAL SETTING OF THE SITE

Historic hydrogeological surveys indicated that the predominant groundwater flow direction in the vicinity of the Stormy West site is north-westwards or westwards, although limited information has suggested the flow could reverse under certain circumstances. It was also postulated that ultimate groundwater discharge was to the Bristol Channel, with flows passing at depth beneath Kenfig Pool — the reasoning behind monitoring at this location in addition to Pyle Spring. These monitoring locations became a permit requirement and have been monitored accordingly since.

Previous studies suggest there is significant attenuation of leachate coupled with a high dilution factor, increasing exponentially a short distance from the landfill perimeter.

Receptors. The nearest natural sensitive receptor is Kenfig Pool (SAC/SSSI/NNR), approximately 5 km to the west, designated for its hard oligo-mesotrophic chalk-lake plant communities and sensitive to nutrient enrichment. Dwellings lie to the south of the site and represent potential receptors for both groundwater quality and landfill gas migration; the A48 borehole and southern perimeter gas wells provide surveillance in this direction. Pyle Spring, a natural groundwater discharge between the landfill and the Village Farm Industrial Estate, is monitored as a surface-water receptor.

Stormy West lies approximately 1.2 km WNW of Cornelly Quarry, one of the deepest quarries in Wales. Publicly available information indicates that quarry dewatering occurs, but the abstraction regime and any quantitative relationship with site groundwater levels have not been verified by joint monitoring. The CSM therefore treats quarry influence as a working interpretation rather than a confirmed control on groundwater flow. Under that interpretation, current groundwater flow is directed southwest, away from Kenfig Pool; if dewatering ceased in future, flow would be expected to relax toward the regional southwards direction toward the Bristol Channel. That southwards relaxation would be further from Kenfig Pool but directed toward dwellings south of the A48. Protection of those dwellings therefore rests on demonstrated leachate containment, as indicated by ammonia and chloride at background in downgradient boreholes, and on the monitoring network's ability to detect any change promptly.

While quarrying activities have the potential to influence local groundwater dynamics, monitoring data from 2019–2025 shows that groundwater level fluctuations at the site also correlate strongly with regional precipitation patterns. The rise observed between 2022 and 2023 followed the recovery from severe drought conditions and has since stabilised (see §5.6).

Conceptual Site Model. The refined CSM is presented in Appendix E and summarised below.

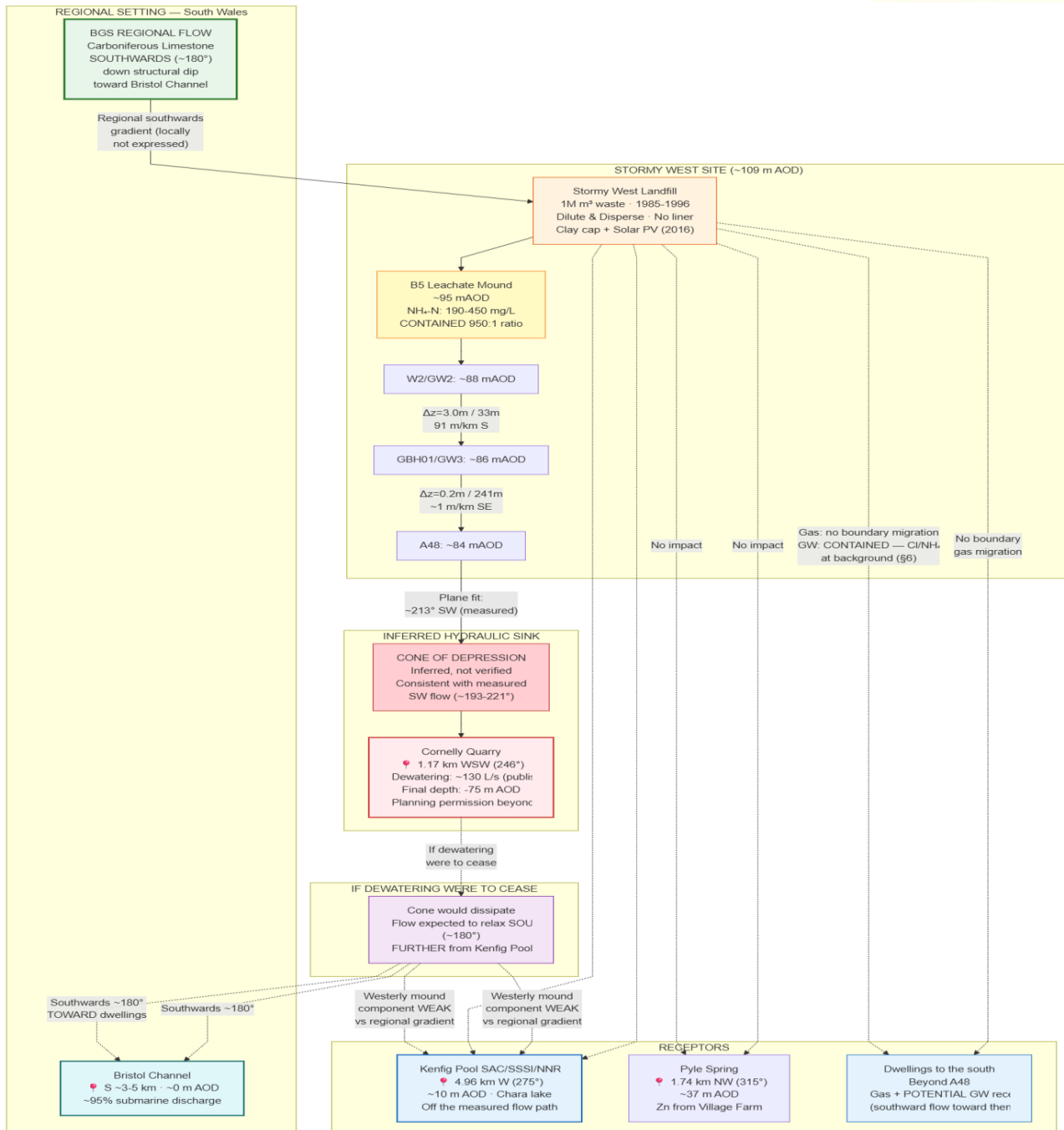


Figure 1: The CSM shows the measured groundwater flow direction (SW, ~213°) toward Cornelly Quarry under current conditions. Were dewatering to cease at some future point, flow would be expected to relax southwards toward the Bristol Channel — further from Kenfig Pool than under current conditions, but directed toward the dwellings to the south. Both the regional and post-cessation southwards flow directions (~180°) pass toward the dwellings, as does the measured SW flow, which has a substantial southerly component. The quarry's causal role in the observed gradient is a supposition of the CSM and is not verified by pumping or piezometric data. No leachate migration toward any receptor has been detected (§6).

Table 1: Conceptual Site Model — Source–Pathway–Receptor Linkages and Risk Assessment Summary (2025). summarizes the key source–pathway–receptor linkages for the Stormy West Landfill Site under 2025 monitoring conditions, including the working Conceptual Site Model (CSM) interpretations for regional groundwater flow, receptor surveillance (Kenfig Pool, Pyle Spring, and southern dwellings), and the adjacent Cornelly Quarry dewatering regime.

Source	Pathway	Receptor	Assessment
Landfill leachate (dilute-and-disperse)	Groundwater flow — current interpretation SW, captured by postulated quarry cone; regional BGS direction southwards (~180°) toward Bristol Channel	Kenfig Pool (SAC/SSSI/NNR); dwellings to the south	Kenfig Pool (275° W): protected by flow direction — both current SW and post-cessation S bearings steer groundwater away from the Pool. Dwellings to the south: the regional and post-cessation flow directions (~180°) are directed toward the dwellings, and even the current SW flow has a substantial southerly component. However, no leachate impact is detected — containment confirmed independently by ammonia (attenuating) and chloride (conservative tracer) at background in all downgradient boreholes. Protection of the dwellings rests on containment, not on flow direction.
Landfill gas	Lateral migration through unsaturated zone / cap	Site boundary / atmosphere; dwellings to the south	Managed via active extraction and flaring; batch burning in operation; perimeter gas largely at background
Village Farm Industrial Estate	Groundwater flow to spring discharge	Pyle Spring	Statistically confirmed as non-landfill zinc source (inverse concentration gradient)
Cornelly Quarry (active dewatering — postulated)	Cone of depression may capture local groundwater, drawing it SW	Regional flow regime; Kenfig Pool	CSM interpretation: SW flow directs groundwater away from Kenfig Pool. Post-cessation, southwards relaxation expected — further from the Pool

5. MONITORING AND SAMPLING DATA

In line with the requirements of the Permit, the data measured and recorded from various monitoring points in and around the site comply with guidance documents and are within permitted limits. The testing protocol has been based, as with previous annual reports, upon the requirements of the Permit and relevant historical regulatory standards.

The locations of the monitoring/sampling points used routinely to obtain samples are presented in Appendix plans. Four complete quarterly water quality sampling rounds were achieved during 2025 (March, June, September, December). All samples were analysed by Normec, an accredited laboratory.

The sampling and testing determinants for water quality remain as reported in previous years (pH, conductivity, BOD, COD, ammonia, chloride, metals suite, VFA, etc.). Monitoring frequencies were:

- Leachate — quarterly full analysis at one location (B5), with field parameters at intervening visits
- Groundwater — quarterly analysis at three locations (A48, W2/GW2, G1/GW3)

- Surface water — quarterly analysis at Pyle Spring and Kenfig Pool
- Landfill gas — monitoring at the flare inlet during batch burns throughout the year; weekly perimeter borehole checks; manifold leg checks

Full analytical results are presented in Appendix A. Standards used for assessment are in Appendix D of previous reports / equivalent reference tables.

5.1 Leachate Samples

There is one leachate monitoring point (gas well B5) located centrally within the waste mass. The analytical results are presented in Appendix A. Review of this data continues to exemplify the expected general trend toward the pertinent Landfill Completion Criteria presented within WMP No. 26A.

Table 2: Leachate results — annual comparison. All results in PPM (mg/litre) except Conductivity (µS/cm) (LT – Less Than). 2025 values are annual means from quarterly rounds.

Determinand	Spec. limits	2025	2024	2023	2022	2021	2020
Conductivity	LT 4000	3575	3075	5029	5720	5698	5667
Ammonia (as N)	LT 5	225	253.5	278	418	475	355
Chloride	LT 2000	315	292.5	243	543	593	403
COD	No specified limit	223	210.3	443	525	545	528
TOC	LT 10	68	56.3	45	138	142	127
Potassium	LT 120	102	88.3	110	175	183	185

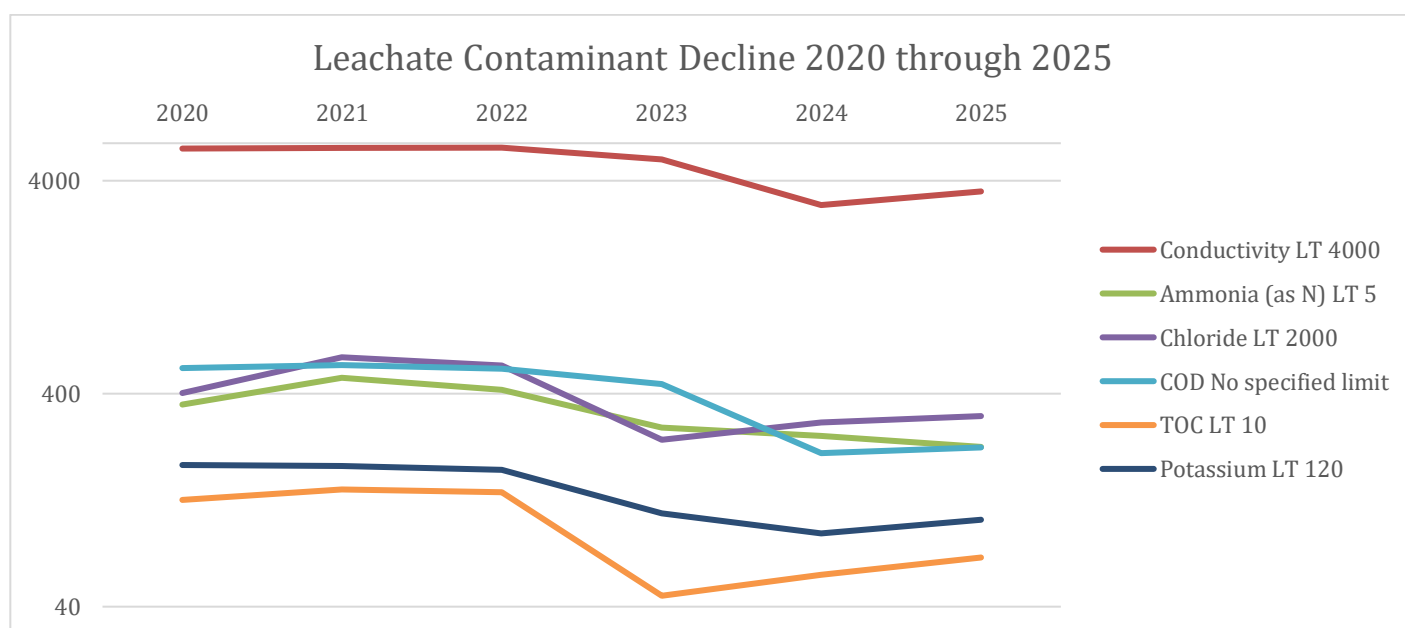


Figure 2: Multi-Year Leachate Quality Parameter Trends (2020–2025) Multi-year trend analysis for principal leachate determinands ($\text{NH}_4\text{-N}$, Cl , COD , and Electrical Conductivity) at central well B5. Concentrations show progressive long-term decline consistent with late-stage methanogenic stabilisation.

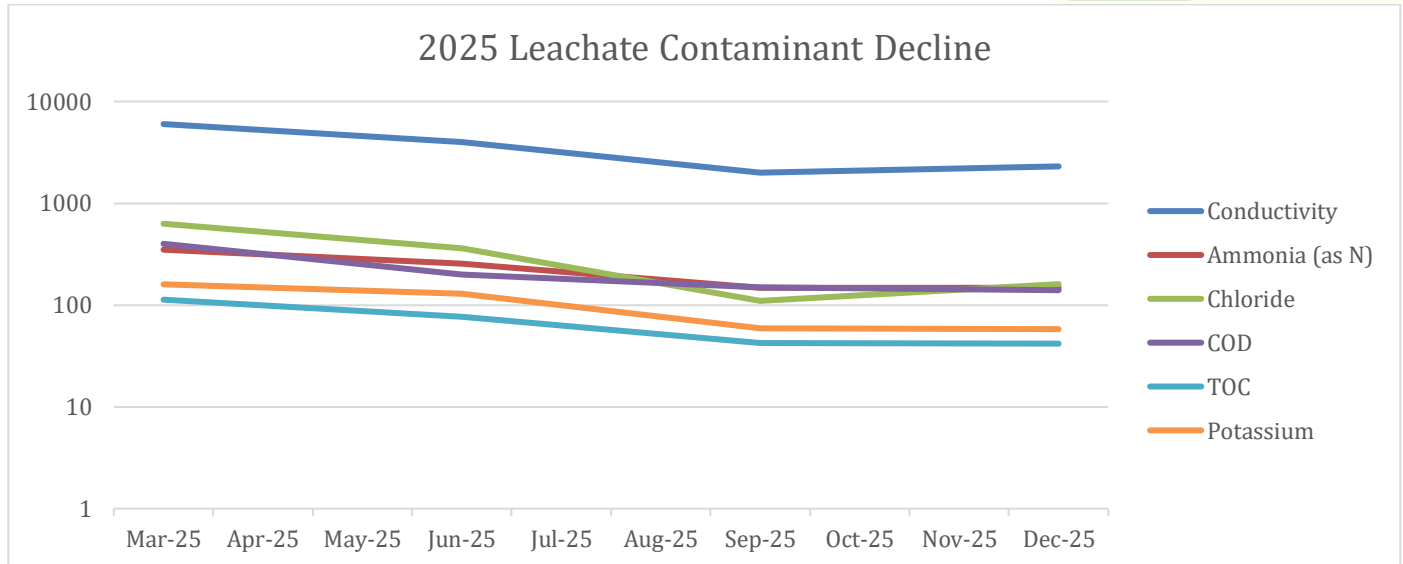


Figure 3: Note: 2025 ammonia declined from 450 mg/L in Q1 to a plateau of 190 mg/L in Q3–Q4 (58% reduction within the year). Conductivity and chloride showed parallel declines over the year. See Appendix A for full quarterly data.

The three most frequently identified pollutants from a landfill leachate are Ammonia, Chloride and COD. From the long-term record, the potential for these to cause harm continues to drop over time. Within 2025 specifically, leachate ammonia declined substantially before plateauing; chloride declined similarly; COD continued its multi-year downward trajectory.

This downward trend is as expected for the site, with the waste mass continuing through the latter stages of waste biodegradation from anaerobic methanogenesis towards aerobic oxidation. This is also evidenced by declining landfill gas production (see §5.4) and the consistent absence of volatile fatty acids above laboratory detection limits — confirming the waste mass is firmly in the methanogenic phase.

Field parameters recorded at B5 between quarterly rounds (conductivity, pH, temperature, leachate level) are presented above. They show seasonal dilution during the wet autumn, consistent with a hydraulically connected dilute-and-disperse system. The longer-term rise in leachate head at B5 is discussed in §5.6.

5.2 Surface Water

Two relatively distant surface water monitoring/sampling points are required to be monitored:

- **Kenfig Pool:** an expanse of still water lying to the west of the landfill site with significant amenity and conservation designation.
- **Pyle Spring:** a small stream which lies north-westerly, skirting the edge of the Pyle industrial/factory estate down-strata of the site. (It is worthy of note that this water source could also be affected by industrial operations performed upon this estate.)

Both locations have been referred to within Section 4 and, as expected, results obtained from both sources have generally not deviated from previous years. Surface water quality remains good with no indication of impact from the landfill site.

Table 3: Surface Water results – Pyle Spring

Key Determinand	Spec. limits (WQS)	2025 Mean	2024	2023	2022	2021
Conductivity	LT 1000	463	470	438	450	468
Ammonia (as N)	LT 4	0.06	0.10	0.11	0.19	0.17
Chloride	LT 200	27	25	25	32	31
COD	LT 30	12.3	5	14	20	11
Zinc (µg/L)	—	88.0	>10	>10	—	—

Table 4: Surface Water results – Kenfig Pool. All results in PPM (mg/litre) except Conductivity (µS/cm) and zinc (µg/L). Full quarterly data in Appendix A.

Key Determinand	Spec. limits (WQS)	2025 Mean	2024	2023	2022	2021
Conductivity	LT 1000	228	253	255	255	245
Ammonia (as N)	LT 4	0.05	0.05	0.04	0.02	0.05
Chloride	LT 200	30	30	36	39	19
COD	LT 30	13.8	12	13	15	12

Zinc at Pyle Spring. Zinc concentrations at Pyle Spring in 2025 were statistically distinct from all other groundwater and surface-water locations, including the leachate itself. The mean Pyle Spring concentration (88 µg/L) was approximately seventeen times the leachate mean (5.2 µg/L), which is physically inconsistent with a landfill origin under the observed concentration pattern.

Furthermore, refined geological mapping (CSM v5) confirms complete stratigraphic separation between the two systems: Pyle Spring issues as baseflow from a shallow perched groundwater system within the Triassic marginal facies, isolated from the deep leachate-bearing Carboniferous Limestone aquifer by the low-permeability Mercia Mudstone / Penarth Group aquitard (10–50 m thick).

Highway runoff along the adjacent A48 corridor—a well-documented regional source of dissolved zinc from tyre wear, brake pads, and galvanised infrastructure—represents the primary working hypothesis for this local elevation, with historic land use at the nearby Village Farm Industrial Estate retained as an unconfirmed secondary possibility. Neither potential source is deemed connected to the landfill system, though the sampling point will remain under routine surveillance.

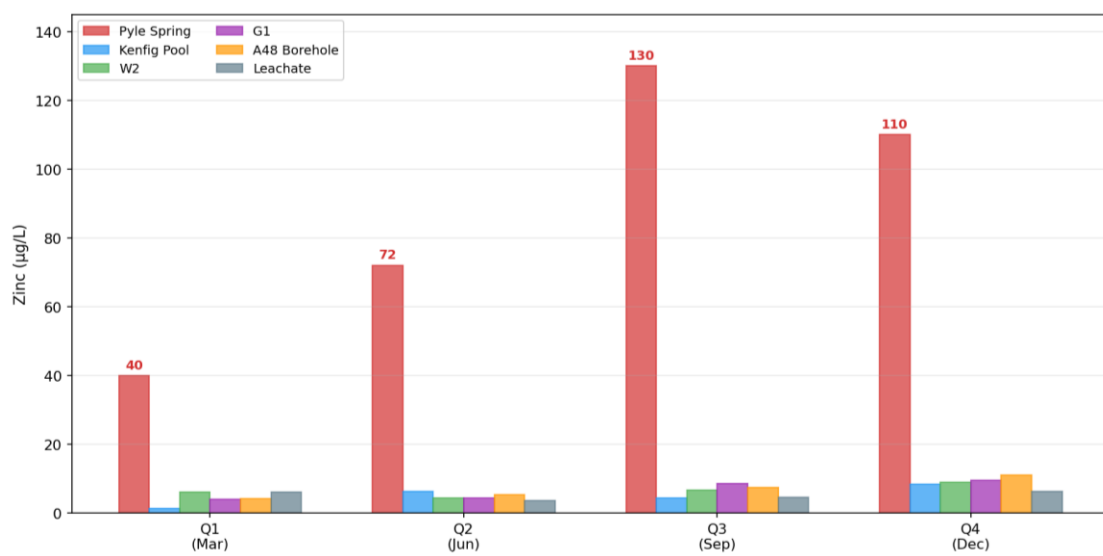


Figure 4: Zinc Concentrations by location 2025. Grouped quarterly dissolved zinc concentrations (µg/L) across all six monitoring points. Pyle Spring (annual mean 88.0 µg/L) significantly exceeds leachate

inside the waste mass (mean 5.2 µg/L). This inverse concentration gradient eliminates the landfill as the zinc source.

5.3 Groundwater

There are three principal groundwater monitoring/sampling points located around the site:

- **A48:** a borehole located adjacent to the A48 dual carriageway, south of the site, bordering fields used for agriculture. This borehole also provides surveillance toward dwellings south of the site.
- **W2 (GW2):** a borehole located within the site car park area, southwest of the edge of the original quarry workings but outside the landfilled area.
- **G1 (GW3 / GBH01):** a borehole located near the site entrance at the outer extremity of the overall site area, further south than W2.

*Table 5: Groundwater results — key determinands (annual means / comparison) *2025 A48 annual mean excluding Q1 anomaly. Q1 recorded an isolated spike of 60 mg/L NH₄-N at A48 — discussed below. †A48 chloride showed a rising trend through 2025, uncorrelated with leachate.*

Determinand	Spec. limits	2025	2024	2023	2022	2021
A48						
Ammonia (as N)	LT 0.5	0.02*	0.02	20.1	12.6	1.8
Manganese	LT 0.05	low	0.01	0.81	0.01	0.63
Potassium	LT 12	low	3.7	13	11	1
Chloride	LT 250	56–110†	—	—	—	—
W2 / GW2						
Ammonia (as N)	LT 0.5	≤0.82 / mostly <0.2	0.01	2.8	0.43	0.03
G1 / GW3						
Ammonia (as N)	LT 0.5	<0.2	0.01	2	0.02	0.2

It is important to note that certain determinands exceeded required limits in previous years, most notably at A48 in 2022 and 2023, particularly influenced by drier periods when reduced groundwater volumes resulted in less dilution. The 2024 results showed marked improvement. The 2025 results continue this position: every determinand at the principal downgradient points is comfortably within relevant compliance thresholds from Q2 onwards.

A48 Q1 ammonia anomaly. The Q1 A48 borehole recorded ammoniacal nitrogen of 60 mg/L, an isolated result two to three orders of magnitude above subsequent readings at the same point and above all other groundwater locations. The result is not interpreted as leachate impact because chloride did not co-vary as expected for a leachate source, intermediate boreholes W2 and G1 showed no corresponding elevation, and the value returned to background by Q2 and remained there. The event should nevertheless remain in the regulatory record as an unexplained anomaly, with continued trend review at A48 during 2026.

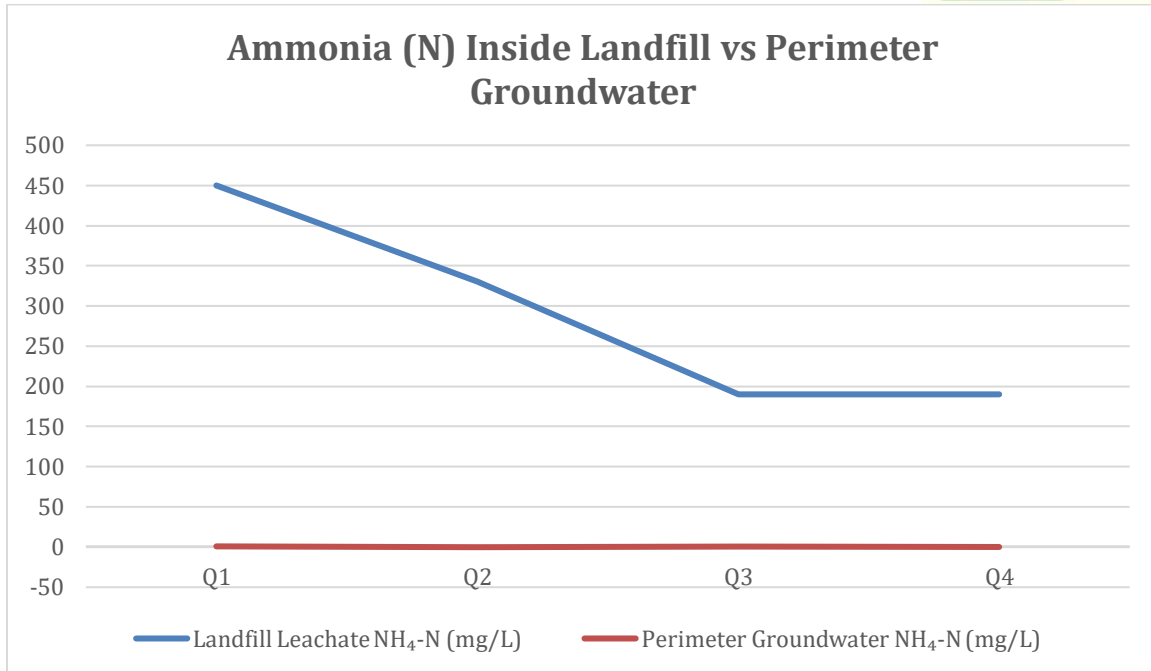


Figure 5: A48 Borehole Q1 Ammoniacal Nitrogen Anomaly vs. Intermediate Monitoring Points Comparative quarterly ammonia hydrograph showing the isolated Q1 spike at borehole A48 (60 mg/L) alongside flat background levels at intermediate boreholes W2 and G1. Rapid return to background by Q2 and lack of co-varying chloride confirm the event was a transient boundary anomaly rather than leachate migration

Chloride as conservative tracer. Chloride does not biodegrade or attenuate significantly during groundwater transport and is therefore the most reliable single indicator of leachate migration. Leachate chloride declined over the year; groundwater chloride at W2 and G1 remained at background levels across all four quarters despite the elevated leachate source early in the year. This provides high-confidence evidence that leachate is not migrating to the monitored groundwater receptors. A48 chloride showed an independent rising trend, potentially related to road de-icing salt, and does not appear to correlate with declining leachate trend.

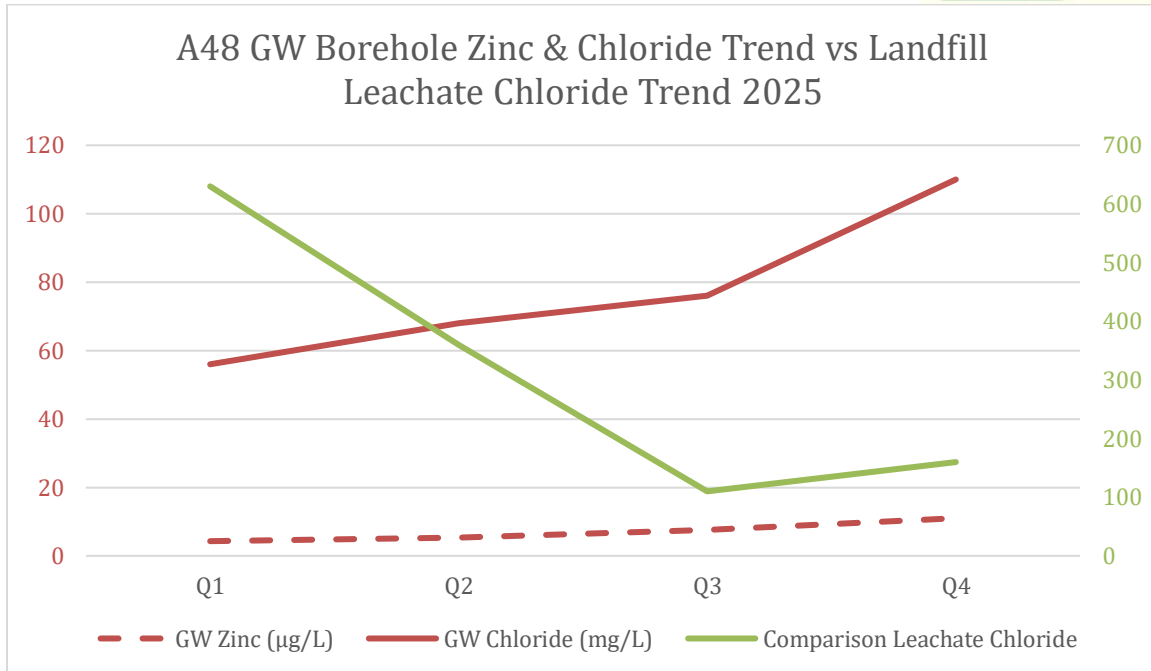


Figure 6: A48 Borehole Dissolved Zinc and Chloride Trends (2025) Dual-axis trend plot displaying co-rising zinc (4.3 to 11.0 µg/L, $r^2 = 0.941$, $p = 0.030$) and chloride (56 to 110 mg/L) at borehole A48. Neither trend correlates with declining leachate chloride, pointing to a road de-icing salt and highway runoff origin

Containment summary. Leachate containment is demonstrated independently by two chemical indicators: ammoniacal nitrogen (attenuating tracer) remaining at near-background levels in groundwater from Q2 onwards, and chloride (conservative tracer) remaining at background at W2 and G1 throughout. The dual-indicator evidence provides high confidence that the landfill is not impacting the surrounding water environment. Full data tables are in Appendix A.

5.4 Landfill Gas Monitoring

5.4.1 Flare Monitoring

The gas management regime changed between 2024 and 2025. During 2024 the flare was operated continuously, resulting in substantial atmospheric air ingress and diluted methane readings. During 2025 a batch-burning regime was adopted (approximately three days on, four days off), yielding low oxygen at the flare inlet and methane concentrations representative of actual waste gas quality. The 2024 and 2025 flare datasets are therefore not directly comparable. December 2024 readings taken under accumulated-gas conditions were consistent with the 2025 mean, suggesting in-waste gas quality has been broadly stable across the two reporting years prior to the early-2026 decline noted below.

Early 2026 half-year data (mean 20.2% CH₄) confirms an annual methane decline rate of ~1.5 percentage points—approximately double the rate projected by the conservative baseline model ($k = 0.04 \text{ yr}^{-1}$). This empirical step-down indicates that in-waste gas generation is following an accelerated decay trajectory with a site-specific effective decay constant of $k \approx 0.06\text{--}0.08 \text{ yr}^{-1}$.

While this faster decline rate significantly shortens the long-term active gas management window and accelerates the timeline for eventual permit surrender engagement with NRW, its immediate operational impact is critical: with more than a third of H1 2026 readings now falling below 19.5% CH₄, the existing flare is routinely operating below its viable combustion threshold. Replacing the current unit with an enclosed low-CV flare capable of sustained combustion down to ~10% CH₄ is therefore an immediate operational necessity rather than a deferred planning item.

Table 6: Comparison of Flare Operation and Monitoring Parameters (2024 Continuous vs. 2025 Batch Burning). This highlights the operational differences between the 2024 continuous-run regime (characterized by high atmospheric air ingress and diluted methane readings) and the 2025 batch-burning regime (low oxygen ingress representing near-true waste gas composition), detailing why the two annual datasets are sampling artefacts and cannot be compared directly.

Parameter	2024 (Continuous)	2025 (Batch)
Mean CH ₄ (%)	6.7	21.7
Mean O ₂ (%)	6.7	1
Measurements (n)	56	68
Regime	Continuous run	~3 days on / 4 off
Gas represents	Diluted ~30-50% air	Near-true waste gas

Sixty-eight flare gas measurements were recorded across 2025 under batch-burning conditions. Monthly means are presented below and in full in Appendix B.

Table 7: Landfill gas monitoring summary – Flare (2025 monthly means)

Month	Mean CH ₄ (%)	No. Samples	O ₂ Context
January	19.9	6	Low
February	22.4	7	Low
March	22.8	7	Low
April	20.9	10	Low
May	26.3	7	Low
June	17.7	6	Low
July	20.1	5	Low
August	28.4	2	Low (limited data)
September	22.0	6	Low
October	24.0	3	Low
November	18.8	3	Low
December	20.5	6	Low
Annual mean	21.7	68	—

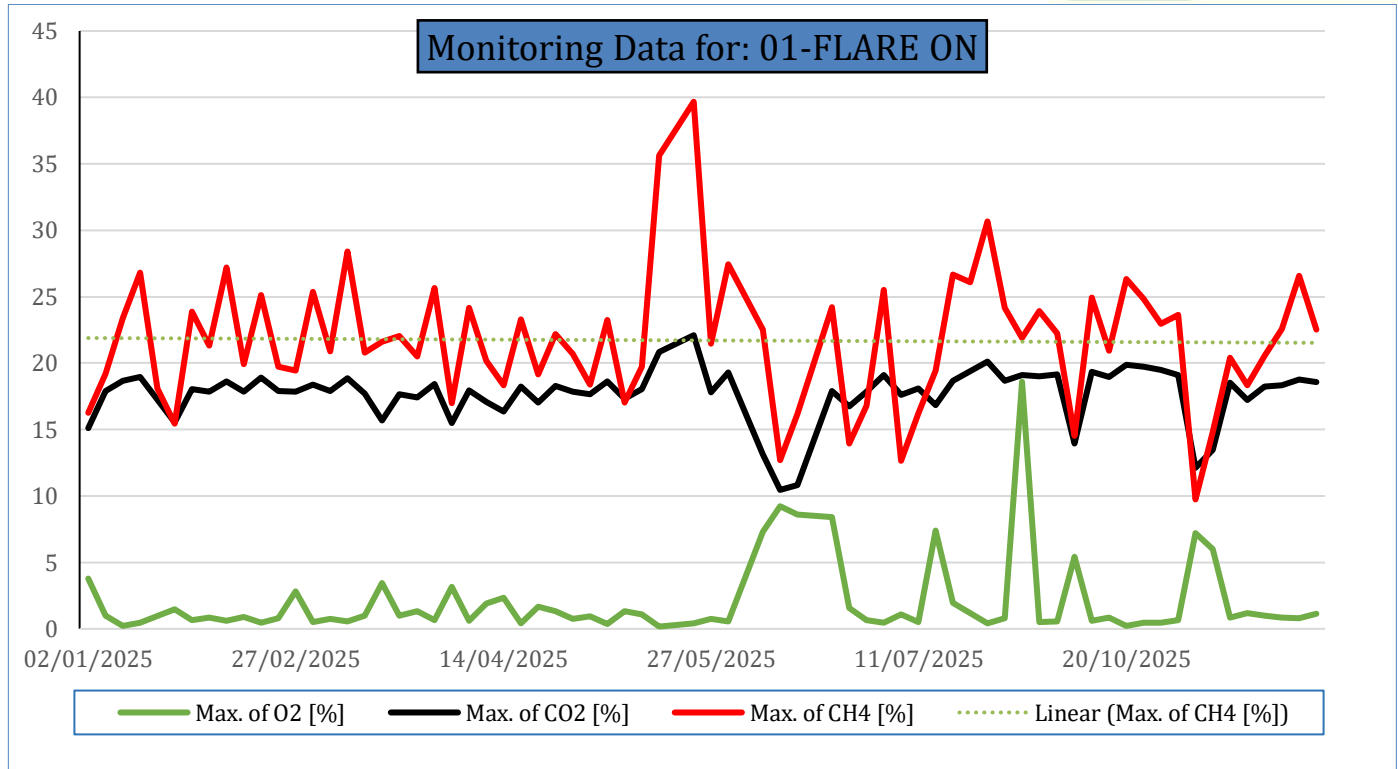


Figure 7: Monthly Mean Flare Inlet Methane Concentrations (2025) Monthly mean methane concentrations derived from 68 batch-burning flare inlet measurements in 2025 (annual mean 21.7% CH₄). Methane concentrations sit below the conventional enclosed-flare minimum (~30% CH₄), with a flat within-year trend reflecting minor annual decay relative to monthly environmental variability

No within-year decline is statistically detectable (expected: modelled annual decline is small relative to monthly variability). The batch-burning pattern itself is a diagnostic indicator — the flare cannot sustain continuous combustion and must shut off to accumulate gas. This is the clearest empirical signal that the site is in the mature-to-declining phase of gas generation.

Early 2026 half-year data (mean ~20%) indicates the decline rate is approximately double that assumed by the conservative LandGEM projection used previously. This accelerates the offtake timeline and is favourable for eventual surrender planning, but it also means the existing flare (minimum operable methane ~19.5%) is now routinely below viable operating conditions.

5.4.2 Gas Projection

Forward projection uses the LandGEM first-order decay model. Full parameters and extended projections are in Appendix C.

Table 8: Projected Landfill Gas Production (selected years). Table 8 presents forward gas modeling using the LandGEM first-order decay model, comparing the compliance-safe conservative baseline ($k = 0.04 \text{ yr}^{-1}$) against the empirical accelerated trajectory ($k \approx 0.06 \text{ yr}^{-1}$) derived from recent batch-burning data.

Year	$k = 0.04$ (Conservative)	Best estimate (accelerated)	Sustainable flaring
2025	21.7% (measured)	21.7%	Batch ~2.5–3 d/wk
2026	~21%	~20% (measured H1)	Constrained
2030	~18%	~15%	Limited
2035	~14%	~11%	Approaching low-CV limit
Low-CV threshold (~10%)	~2043	~2033–2038	Transition to passive
Surrender ($\leq 1.5\% \text{ CH}_4$)	~2091	~2076–2086	—

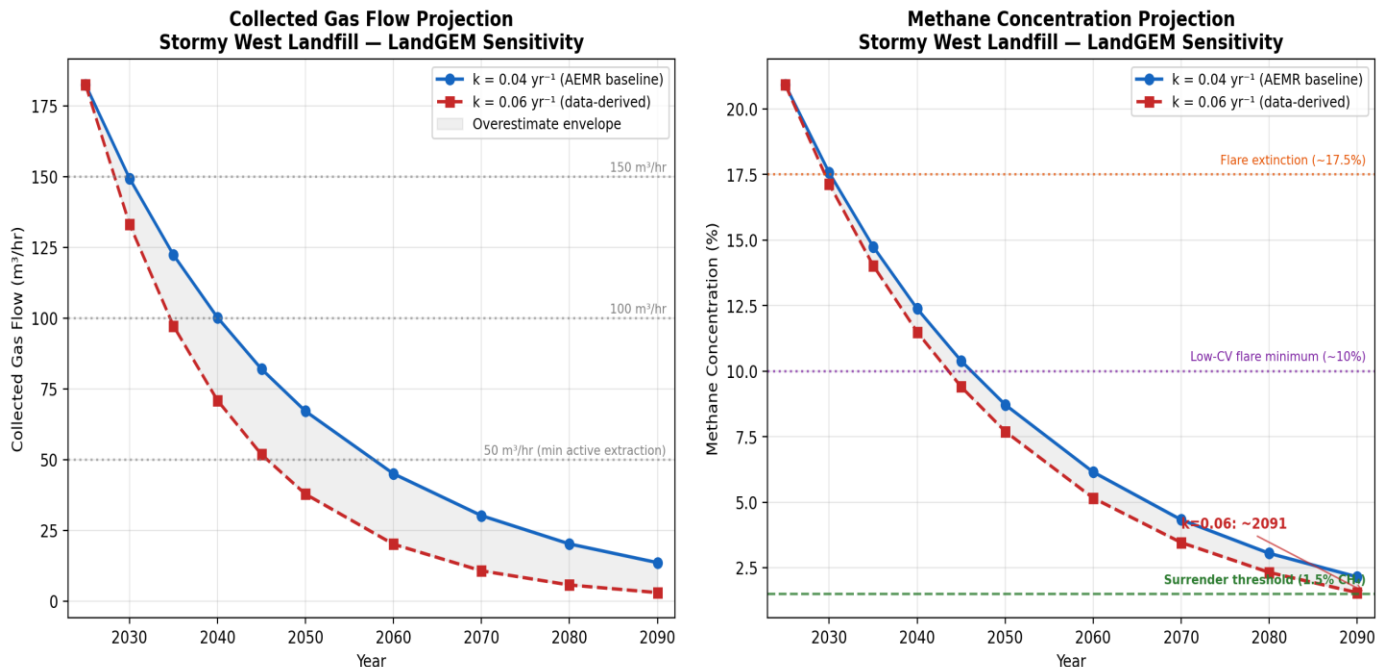


Figure 8: Collected Gas Flow and Methane Concentration Projections (2025–2090) LandGEM first-order decay sensitivity comparing conservative baseline ($k = 0.04 \text{ yr}^{-1}$) and data-derived accelerated ($k = 0.06 \text{ yr}^{-1}$) trajectories. Key operational thresholds are indicated, including flare extinction ($\sim 17.5\text{--}19.5\% \text{ CH}_4$), low-CV flare envelope ($\sim 10\% \text{ CH}_4$), and the LFTGN03 generic surrender criterion ($1.5\% \text{ CH}_4$).

Two phases are identifiable: (1) active flaring with a low-CV-capable enclosed flare until methane falls below approximately 10%; (2) transition to passive management (venting, biofiltration, or biocover). The existing unit cannot combust gas below $\sim 19.5\%$ methane; more than a third of early-2026 readings have already fallen below this threshold. Flare replacement is an immediate operational necessity, mandated by NRW.

5.4.3 Perimeter Gas Monitoring

Perimeter gas monitoring boreholes (GBH01–GBH11 and A48) are designed to detect lateral migration of landfill gas beyond the site boundary — including toward dwellings to the south. The 2025 monitoring data shows:

- Most perimeter boreholes maintained methane at or near background throughout the year

- GBH03 (north-eastern perimeter) showed elevated methane above the 5% investigation threshold for many of the monitoring visits, with a full-year mean of approximately 8% and a maximum below the 20% action threshold
- Gas volume at GBH03 is limited (rapid purge on measurement), consistent with a discrete preferential pathway rather than sustained flow
- No consistent pattern of increasing methane that would indicate significant lateral migration to the boundary
- All other perimeter locations, including those between GBH03 and off-site receptors and those facing dwellings to the south, recorded methane at background

Full perimeter data are in Appendix B. GBH03 warrants continued surveillance and addition to the quarterly water quality sampling programme (Recommendation 2).

5.4.4 In-waste Gas Wells and Manifold Legs

In-waste wells and the four manifold legs (A–D) showed variable gas quality across the site, consistent with waste mass heterogeneity. Leg B was the most reliable producer; Leg A experienced chronic air-ingress issues linked to pipework integrity. System adjustments were made throughout the year. Detailed leg performance is in Appendix B.

The landfill gas monitoring data for 2025 indicates that the gas management system is functioning effectively within the constraints of a declining resource. Perimeter monitoring indicates no significant lateral migration beyond the site boundary.

5.5 Rainfall Data

Rainfall data has been analysed to understand the influence of precipitation on leachate generation and groundwater levels. For 2025, the primary data source is the NRW Llety Brongu raingauge (Station 1095, ~8.3 km NNE of the site). This replaces the Pennard station dataset introduced in the 2024 AEMR (which retrospectively established the 2019–2024 multi-year rainfall record). Pre-2024 AEMRs did not incorporate formal weather station datasets, relying instead on qualitative descriptions of seasonal dry periods and cap infiltration. A formal comparison confirmed that the transition to Llety Brongu maintains robust year-on-year comparability (Appendix G).

Table 9: Monthly rainfall totals 2025 (Llety Brongu). Full monthly series and heavy-event listing in Appendix G. Annual total is the highest in the available monitoring record (2019–2025) and approximately 40% above 2024.

Month	Total Rainfall (mm)
January	165.6
February	103.0
March	36.4
April	116.0
May	59.4
June	240.0
July	84.8
August	89.2
September	304.0
October	186.0
November	318.4
December	348.8
Total	2,051.6

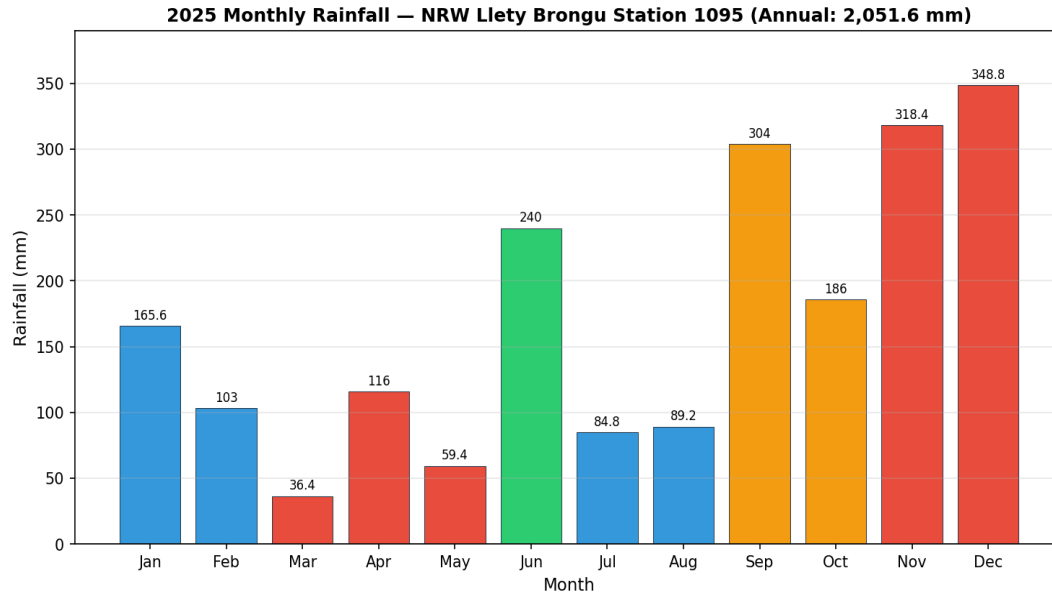


Figure 9: Monthly Rainfall Totals — NRW Llety Brongu Station 1095 (2025) Monthly precipitation totals for 2025 recorded at the NRW Llety Brongu raingauge (annual total: 2,051.6 mm—the wettest in the 2019–2025 record). Highlights the contrast between the dry spring (March: 36.4 mm) and the wet autumn/winter period (over 50% of rainfall in Sep–Dec).

The year was characterised by a dry spring followed by an exceptionally wet autumn and early winter. Thirty heavy rainfall events of at least 20 mm/day were recorded, most of them in the final four months. This seasonal contrast helps explain the observed groundwater recession and rebound, the dilution of leachate conductivity, and the rise in leachate level inside the waste mass.

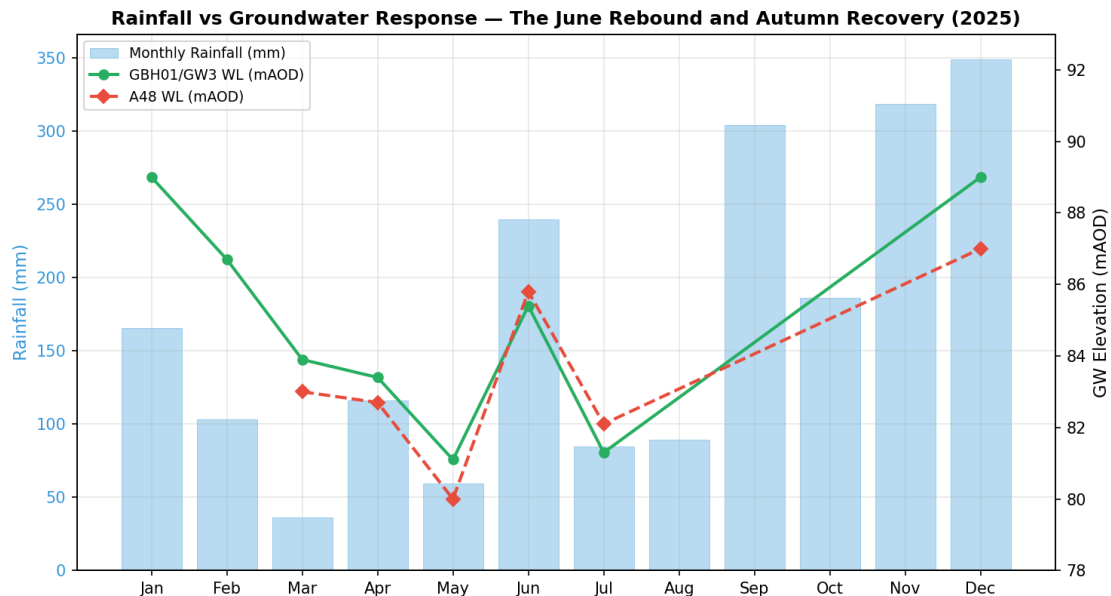


Figure 10: Monthly Rainfall vs. Groundwater Elevation Response (2025) Superimposed hydrographs for boreholes GBH01/GW3 and A48 against monthly rainfall totals. Illustrates rapid aquifer recharge response following heavy June rainfall and the autumn recovery, confirming dynamic hydraulic connectivity.

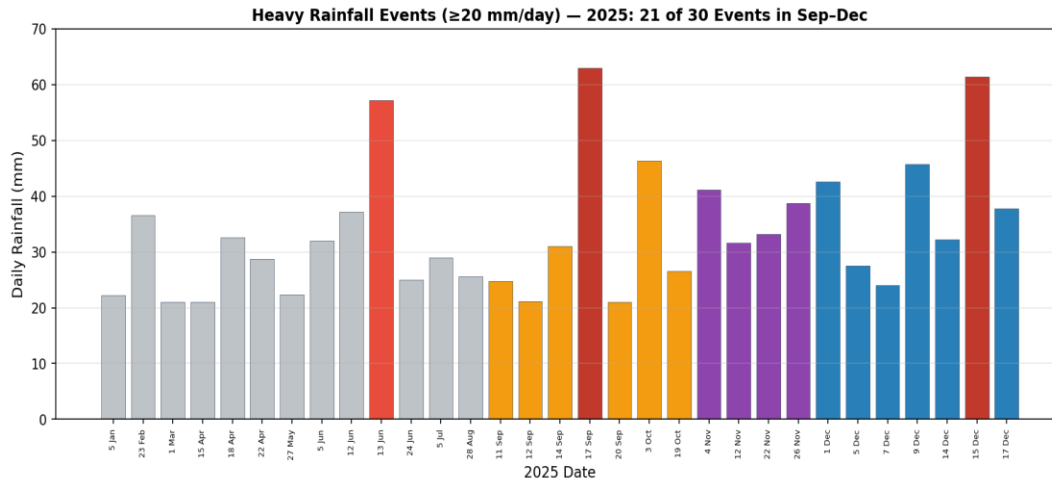


Figure 11: High-Intensity Rainfall Events (≥ 20 mm/day) in 2025 Daily rainfall events exceeding 20 mm/day during 2025. 21 of the 30 heavy rainfall events occurred between September and December, driving rapid groundwater table recovery and in-waste leachate dilution.

A clear relationship exists between rainfall events, groundwater levels, and leachate chemistry. Groundwater levels respond to rainfall with a typical lag of weeks; leachate dilutes as rainwater infiltrates the waste mass. The A48 monitoring point remains among the most sensitive to rainfall patterns. Critically, despite the extreme wet-weather stress test of 2025, groundwater quality at the monitoring points did not deteriorate — containment held.

Some components of the within-year leachate chemistry declines may reflect rainfall-driven dilution rather than solely waste stabilisation. The 2026 monitoring year, if meteorologically more typical, will help isolate the stabilisation signal.

5.6 Groundwater Levels and Flow Direction

Groundwater levels are monitored at boreholes around the site perimeter and within the waste mass. Collar elevations for key boreholes were confirmed by survey on 1 May 2025 (Appendix F). B5 and A48 collars remain accepted historic values pending formal survey.

Table 10: Groundwater Rest Levels (annual means, mAOD). GW2 historic values recalculated to 2025 survey collar (+0.65 m). †B5 2025 is a Q4 spot measurement, not a full annual mean.

Location	2019	2020	2021	2022	2023	2024	2025
A48	84.7	86.8	82.3	80.5	87.4	86.9	84.4
W2 / GW2	88.0*	88.3*	87.4*	82.5*	89.0*	88.0*	87.6
GW3 / GBH01	83.7	85.7	86.1	85.5	87.8	86.1	84.6
B5 (leachate)	93.5	93.5	93.7	93.6	94.4	95.3	~95.9†

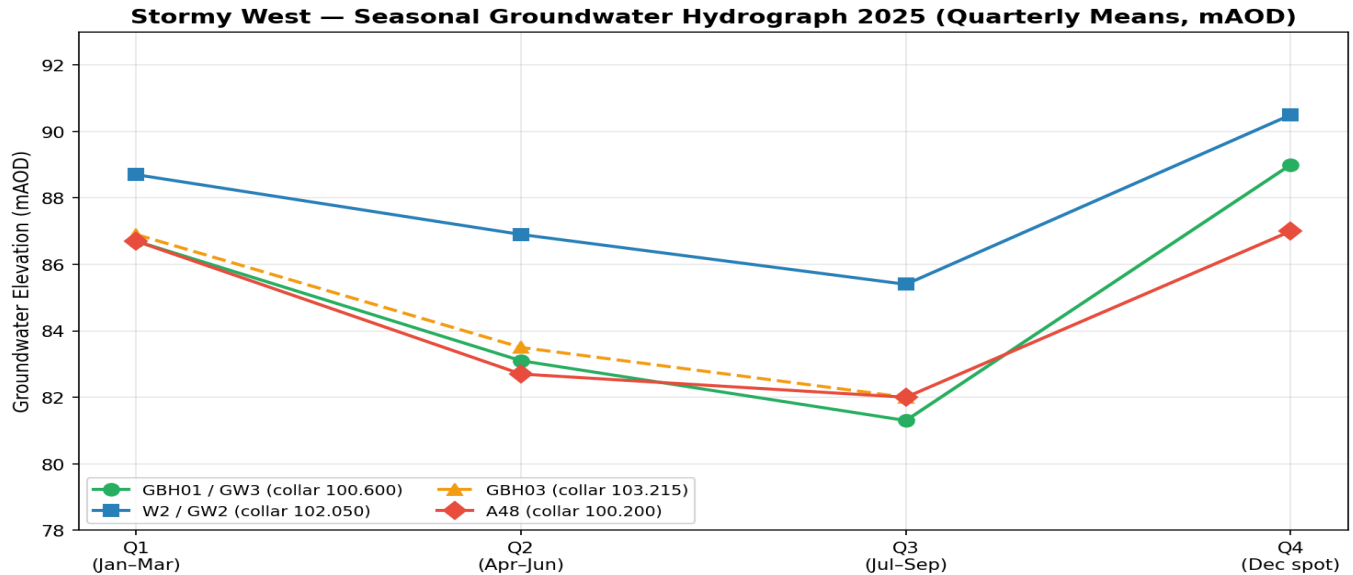


Figure 12: Seasonal Groundwater Hydrograph by Monitoring Borehole (2025) Quarterly mean groundwater rest levels across perimeter monitoring boreholes (GBH01, W2, GBH03, A48). All boreholes exhibit consistent seasonal cycling (winter high, spring/summer recession, autumn recovery), with up-gradient borehole W2 maintaining the highest elevation throughout.

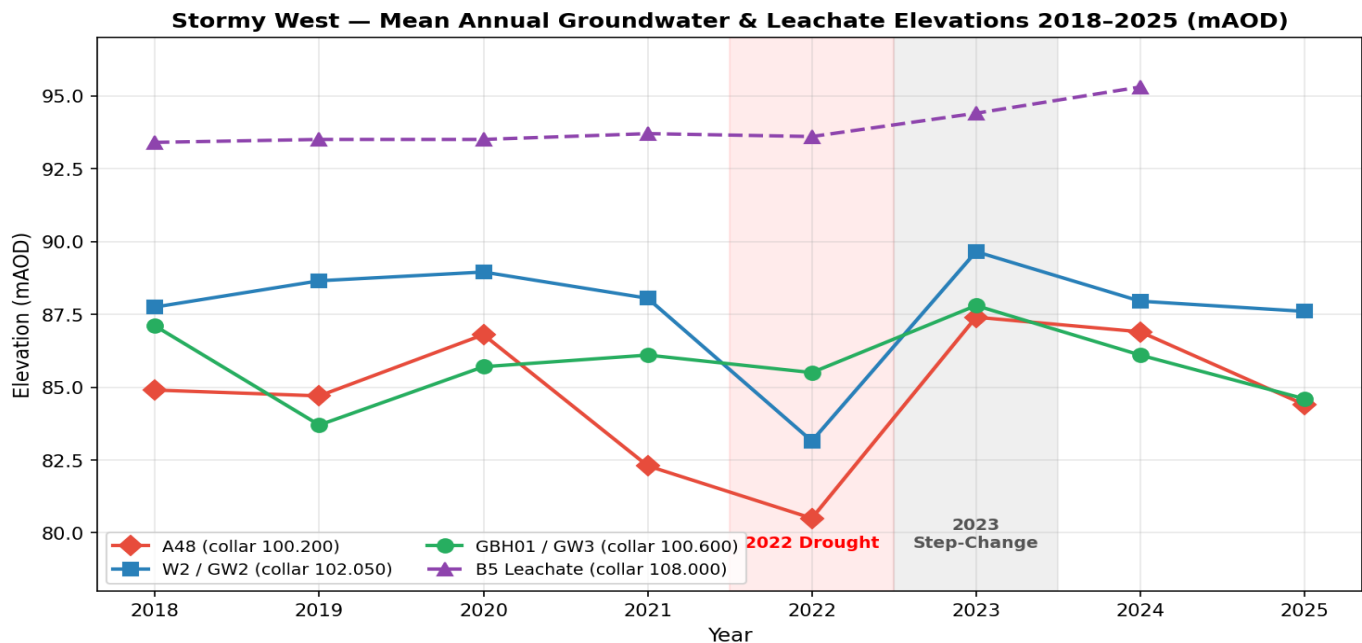


Figure 13: Mean Annual Groundwater and Leachate Elevations (2018–2025) Multi-year trend analysis showing the 2022 drought drawdown and 2023 recovery step-change across groundwater points, followed by stabilization in 2024–2025. B5 leachate level (dashed line) displays a distinct multi-year upward trajectory (+2.45 m since 2022).

Pattern analysis. Significant fluctuations occurred between 2019 and 2025, with a substantial decrease in 2022 followed by recovery in 2023. The 2025 data shows annual means within 1–2 m of the 2023–2024 envelope — the post-2023 step-change appears to have stabilised. Seasonal amplitude during 2025 was pronounced (approximately 7–12 m depending on borehole), driven by the extreme rainfall distribution described in §5.5.

Correlation with regional precipitation remains strong: the 2022 drought year aligns with the significant drop; recovery tracks the return of above-average rainfall. The CSM postulates that altered dewatering

at Cornelly Quarry may also have contributed to the 2023 step-change; this remains an interpretation, not a confirmed mechanism. If the quarry influence were continuing to intensify, a continuing trend rather than stabilisation would be expected — it is not observed.

Groundwater flow direction. A three-point plane fit of annual mean elevations at GBH01, W2 and A48 (surveyed collars) yields a predominant flow bearing toward the southwest in six of seven years 2018–2024 (excluding the 2022 drought anomaly). This direction is toward Cornelly Quarry and away from Kenfig Pool. The regional BGS direction for South Wales Carboniferous Limestone is southwards toward the Bristol Channel. At site scale, the CSM interprets the quarry cone as currently overwhelming the regional gradient. Four-point verification including GBH03 is consistent. Full methodology and year-by-year bearings are in Appendix F.

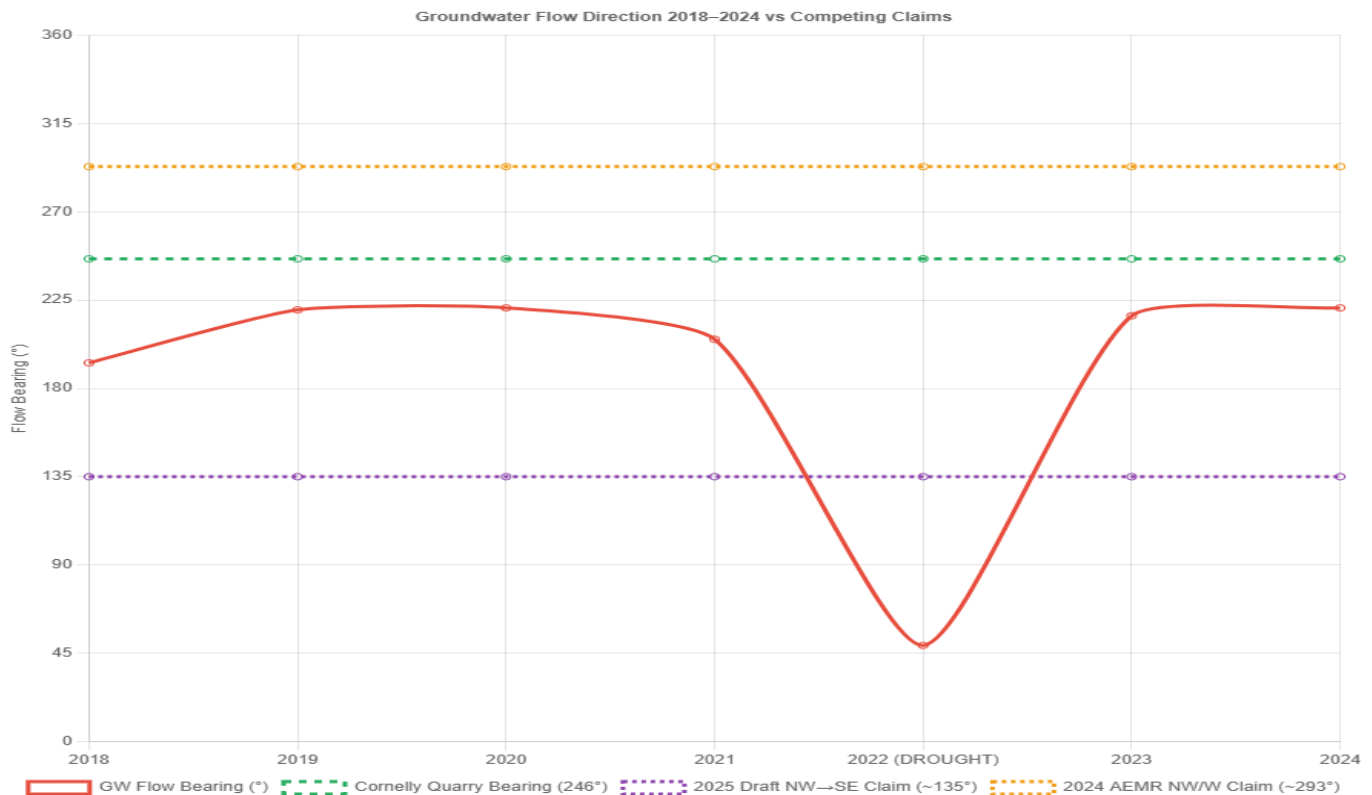


Figure 14: Calculated Annual Groundwater Flow Bearings (2018–2024) Three-point plane fit bearings derived from annual mean elevations at GBH01, W2, and A48. Southwest flow directions ($\sim 193^{\circ}$ – 221°) dominate in 6 of 7 years, directed toward Cornelly Quarry and away from Kenfig Pool, with the 2022 drought year acting as an isolated anomaly ($\sim 49^{\circ}$ NE).

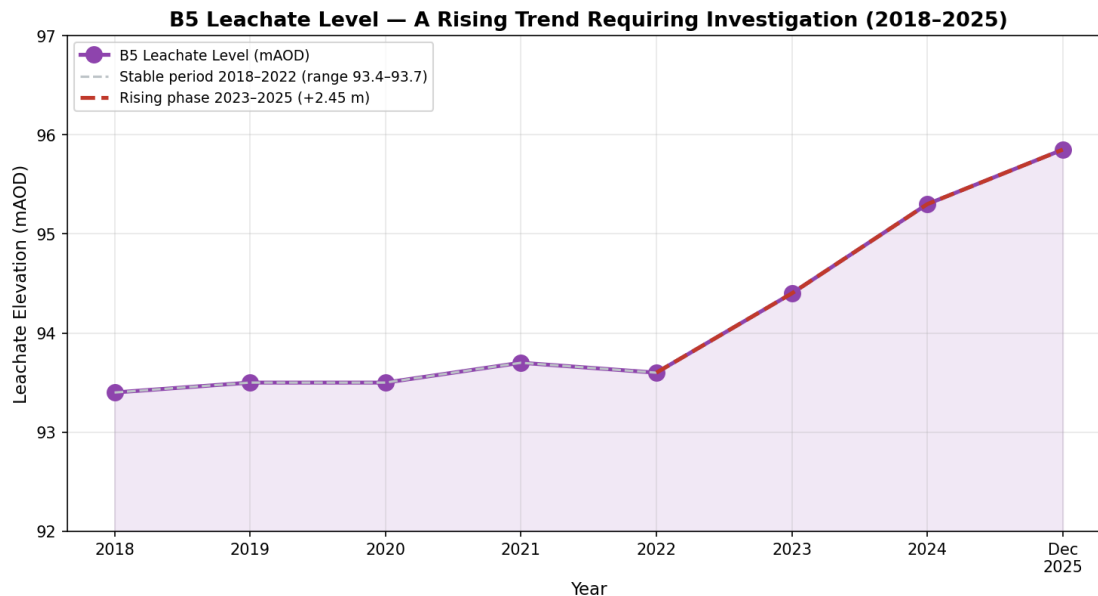


Figure 15: B5 leachate level — rising trend. The mean annual leachate level at B5 has risen by approximately 1.9 m between 2018 and 2024, with most of the increase occurring in 2023–2024, and a further rise indicated by the Q4 2025 spot reading. The trajectory is not explained by seasonal cycling alone.

Four mechanisms could contribute (not mutually exclusive): collar settlement (cannot be ruled out until surveyed); cap degradation increasing percolation (consistent with declining leachate solute concentrations and operational observations of air ingress during batch burns); and altered basal hydraulic boundary conditions (CSM-postulated link to quarry dewatering — mechanistically coherent but unverified without quarry pumping data). Settlement of a bedrock-founded well would tend to mask rather than exaggerate a true rise. Recommendation 3 addresses the collar survey.

Cornelly Quarry — CSM interpretation. Under the CSM interpretation, current SW-directed flow steers groundwater away from Kenfig Pool. Were dewatering to cease at some future point (quarry planning permission extends beyond 2033; no cessation is currently proposed), flow would be expected to relax southwards — further from Kenfig Pool still, but directly toward the dwellings to the south. Unlike Kenfig Pool, which is protected by flow direction, the dwellings' protection rests on the demonstrated containment of leachate: chloride (conservative tracer) and ammoniacal nitrogen remain at background in all downgradient groundwater boreholes throughout 2025, irrespective of flow direction (§5.3). Were the flow regime to change, the existing borehole network along the southern perimeter provides the means to detect it; the aquifer responds to hydraulic change within weeks (§5.5), and monitoring would capture any emerging signal within the same year. Dwellings to the south remain relevant receptors for both water quality and gas; the A48 borehole and southern gas wells continue to fulfil that surveillance role.

6. CONCLUSION/ASSESSMENT

Based on the comprehensive monitoring data collected throughout 2025, the following conclusions can be drawn regarding the environmental performance of Stormy West Landfill Site:

Water Quality Assessment:

- No significant concentrations of toxic or phytotoxic determinands have been identified in any water samples attributable to the landfill.

- Groundwater quality results show no significant divergence from 2024 and previous improved years for mobile and soluble determinands, with most parameters well within specified limits from Q2 onwards.
- Leachate quality continues to improve, with decreasing concentrations of key contaminants compared to previous years and a within-year ammonia decline to a plateau, suggesting ongoing stabilisation of the landfill.
- The significant difference in chemical composition between leachate and groundwater monitoring points indicates effective containment of landfill leachate. Dual-indicator evidence (ammonia and chloride) provides high confidence.
- Zinc at Pyle Spring is not from the landfill (inverse concentration gradient).
- The A48 monitoring point showed an isolated ammonia spike in Q1 that is not leachate-related, and independent zinc/chloride trends more plausibly linked to road drainage.
- Dwellings to the south of the site are potentially downgradient on both the current SW flow direction and the regional/post-cessation southwards direction. No landfill impact is indicated — leachate containment is confirmed by ammonia and chloride at background in all downgradient boreholes, and the monitoring network can detect any change in the groundwater regime promptly.

Landfill Gas Management:

- The landfill gas management system is functioning within the constraints of a declining resource, under a necessary batch-burning regime.
- Perimeter gas monitoring indicates no significant lateral migration of landfill gas beyond the site boundary, with most perimeter boreholes at background. GBH03 shows limited elevated methane below action thresholds.
- Despite system operation, early 2026 data showing methane routinely below the existing flare's minimum confirms that flare replacement is urgently required. Based on LandGEM projections (conservative and accelerated scenarios), regular low-CV flaring may become unsustainable between approximately 2033 and 2043, with minimal gas generation for surrender purposes decades thereafter. This timeline supports long-term planning for transition to passive gas management and potential risk-based permit surrender.

Groundwater Levels:

- Significant seasonal fluctuations were observed during 2025, driven by extreme rainfall distribution.
- The post-2023 step-change appears to have stabilised.
- Flow direction determination (plane fit) supports a SW bearing in most years — consistent with the CSM interpretation of quarry influence, and away from Kenfig Pool.
- B5 leachate level continues a long-term rise requiring collar survey and continued monitoring.
- Elevated groundwater levels during wet periods may be beneficial in reducing leachate migration potential from the site.

Surface Water Impact:

- Surface water monitoring points (Pyle Spring and Kenfig Pool) showed minimal impact from landfill operations, maintaining good water quality throughout the year with all landfill-attributable parameters well within specified limits.

Site Management:

- The engineered cap with solar panel installation continues to function, reducing infiltration and subsequent leachate generation, though gradual cap ageing is a working hypothesis for increased percolation.

- The site is progressing through the latter stages of waste biodegradation, as evidenced by leachate quality improvements, absence of VFAs, and declining landfill gas generation.
- NRW has mandated replacement of the open flare with a modern enclosed low-CV unit.

Overall Environmental Impact:

- Based on the analysed parameters, the site operates within expected environmental parameters, with no significant contamination detected in the surrounding groundwater and surface water bodies.
- The data indicates that the Stormy West landfill site has a low probability of causing any significant environmental impact due to emissions and/or discharges.
- The extremely wet conditions of 2025 provided a natural stress test; containment held.

In summary, Stormy West Landfill Site continues to show improving environmental performance, with no landfill-attributable deterioration identified in monitored groundwater or surface-water receptors during 2025. The site is in the later stages of biodegradation, as shown by improving leachate quality, absence of volatile fatty acids, and declining landfill gas generation. The main regulatory issues are therefore management of decline: replacing ageing gas infrastructure, verifying the B5 leachate-level trend, maintaining surveillance of GBH03 and A48, and developing a realistic risk-based route toward eventual permit surrender.

7. RECOMMENDATIONS

Recommendation 1: Procure and Install Enclosed Low-CV Flare

Priority: Critical

The existing flare is operating at the limit of its capability. NRW has mandated replacement. The replacement unit must be capable of sustained combustion at methane concentrations down to approximately 10%, with integrated temperature monitoring and data logging to address the current LFTGN05 verification gap. Procurement and installation should proceed without delay.

Recommendation 2: Complete Borehole Collar Survey and Strengthen Groundwater Surface Analysis

Priority: High

Survey remaining unverified perimeter borehole collars so the full network can contribute to the annual plane-fit analysis. Add GBH03 to routine quarterly water quality sampling. Marginal cost; uses existing infrastructure.

Recommendation 3: Survey B5 Collar

Priority: High

The B5 leachate well collar is an accepted historic value. The apparent long-term rise in leachate level cannot be reliably interpreted until the collar is verified. Include in the next borehole height survey round.

Recommendation 4: Develop a Risk-Based Surrender Plan

Priority: High

Under passive decline, gas-based surrender against the generic LFTGN03 threshold sits decades away. NRW guidance provides for site-specific risk-based completion criteria. A draft plan grounded in demonstrated leachate containment, clean groundwater record, and continued gas management should be prepared for discussion with NRW at an appropriate juncture.

Recommendation 5: Adopt Accelerated Decay Trajectory for Planning

Priority: High

The 2025→2026 monitoring data indicates gas is declining faster than the conservative LandGEM assumption. The accelerated trajectory should inform flare specification life, financial provisioning, and surrender engagement. Formal recalibration with the full 2026 dataset should be completed for the next AEMR.

8. APPENDICES

Appendices A to J provide the supporting monitoring data, modelling assumptions, regulatory correspondence, CSM material, and uncertainty records used in this AEMR. They should be read as the evidential basis for the interpretations in Sections 5 to 7, rather than as standalone narrative sections.

- **Appendix A** — Water Quality Monitoring Data Tables
- **Appendix B** — Landfill Gas Monitoring Data Tables
- **Appendix C** — Gas Projection Modelling
- **Appendix D** — Regulatory Correspondence Summary
- **Appendix E** — Conceptual Site Model Diagram
- **Appendix F** — Groundwater Level Monitoring Data
- **Appendix G** — Meteorological Data — 2025
- **Appendix H** — Risk Assessment Matrix
- **Appendix I** — Contradiction and Verification Log
- **Appendix J** — Uncertainty Matrix and Resolution Pathway

Appendix A: Water Quality Monitoring Data Tables

A.1 Zinc Concentrations — Full Quarterly Results

Location	Q1 (µg/L) 29/03/2025	Q2 (µg/L) 22/06/2025	Q3 (µg/L) 21/09/2025	Q4 (µg/L) 13/12/2025	Mean	SD	CV (%)
Pyle Spring	40.0	72.0	130.0	110.0	88.0	40.0	45.5
Kenfig Pool	1.3	6.4	4.5	8.4	5.2	3.0	58.6
W2	6.2	4.4	6.7	9.0	6.6	1.9	28.7
G1	4.1	4.4	8.6	9.6	6.7	2.8	42.4
A48 Borehole	4.3	5.3	7.5	11.0	7.0	3.0	42.3
Leachate	6.1	3.7	4.6	6.4	5.2	1.3	24.4

Table note: Full quarterly zinc concentrations at all six monitoring locations. Laboratory: Normec. All values in micrograms per litre (µg/L).

A.2 Ammoniacal Nitrogen — Leachate and Groundwater

Quarter	Leachate NH ₄ -N (mg/L)	Max GW/SW NH ₄ -N (mg/L)	Containment Ratio
Q1	450	60	7.5:1
Q2	330	0.11	3,000:1
Q3	190	0.20	950:1
Q4	190	0.05	3,800:1

Table note: Leachate ammoniacal nitrogen compared with maximum concentration recorded at any groundwater or surface water location. The containment ratio is the leachate concentration divided by the maximum groundwater/surface water concentration. The Q1 ratio of 7.5:1 reflects the isolated A48 ammonia spike (see §5.3). From Q2 onwards, containment ratios of 950:1 to 3,800:1 confirm complete containment of leachate ammonia within the waste mass.

A.3 Statistical Test Results — Pyle Spring Zinc vs. All Other GW/SW

Test	Statistic	p-value	Significant at $\alpha = 0.05$?
Welch's t-test	t = 4.077	p = 0.027	Yes
Mann-Whitney U	U = 64	p = 0.003	Yes

Table note: Both parametric (Welch's t-test, not assuming equal variance) and non-parametric (Mann-Whitney U) tests confirm that Pyle Spring zinc concentrations are statistically distinct from the pooled groundwater and surface water group (Kenfig Pool, W2, G1, A48 Borehole). The inverse concentration gradient (PS mean 88.0 µg/L vs. leachate mean 5.2 µg/L) eliminates the landfill as the source.

A.4 A48 Borehole Zinc Trend Analysis

Parameter	Value
Q1	4.3 µg/L
Q2	5.3 µg/L
Q3	7.5 µg/L
Q4	11.0 µg/L
Linear regression slope	+2.25 µg/L per quarter
r²	0.941
p-value	0.030
Significance	Yes ($\alpha = 0.05$)

Table note: The A48 Borehole exhibits a statistically significant increasing trend ($p = 0.030$). Whilst absolute concentrations remain low and below regulatory concern thresholds, the trend direction warrants continued monitoring in 2026.

Appendix B: Landfill Gas Monitoring Data Tables

B.1 Monthly Mean Methane Concentrations — Full Year 2025

Month	Mean CH ₄ (%)	SD (%)	Measurements (n)	O ₂ Context
January	19.9	4.4	6	Low — batch burning
February	22.4	3.1	7	Low — batch burning
March	22.8	3.0	7	Low — batch burning
April	20.9	2.8	10	Low — batch burning
May	26.3	8.5	7	Low — batch burning
June	17.7	4.7	6	Low — batch burning
July	20.1	6.0	5	Low — batch burning
August	28.4	3.3	2	Low — limited data; treat with caution
September	22.0	3.8	6	Low — batch burning
October	24.0	2.8	3	Low — batch burning
November	18.8	7.8	3	Low — includes frozen-condition anomaly (9.7% on 21/11)
December	20.5	4.0	6	Low — batch burning

Table note: Monthly mean methane concentrations measured at the flare inlet under batch burning conditions. All measurements were taken with oxygen content below 1%, indicating minimal atmospheric dilution and representative in-waste gas quality. The August mean is based on only two readings and should be treated with caution. The November mean is depressed by a single reading of 9.7% recorded on 21 November 2025 when frozen Tefen points prevented normal gas accumulation; excluding this operational anomaly, the November mean would be approximately 23.3%. Full dataset comprises 68 individual measurements.

B.2 Annual Gas Statistics — Full Year 2025

Parameter	Value
Mean CH ₄	21.7%
Standard Deviation	5.0%
Coefficient of Variation	23.1%
Minimum monthly mean	17.7% (June)
Maximum monthly mean	28.4% (August, n=2 only)
Maximum reliable monthly mean	26.3% (May, n=7)
Measurements (n)	68
Linear regression slope	−0.009% per month
r ²	0.0001
Significant within-year trend?	No
Operational regime	Batch burning (approx. 3 days on / 4 days off)
Typical O ₂ at measurement	<1%

Table note: Summary statistics for the full 2025 gas dataset (68 measurements). The absence of a detectable within-year trend ($r^2 = 0.0001$) is consistent with the LandGEM-projected decline rate of approximately 0.8 percentage points per year, which is an order of magnitude smaller than the month-to-month variability (SD 5.0%) and cannot be detected within a single year's data. At least three to five years of consistent batch-burning data will be required to confirm the modelled decline rate empirically.

B.3 Operational Context — 2024 vs 2025 Comparison

Parameter	2024 (Continuous Run)	2025 (Batch Burning)
Flare CH₄ mean	6.7%	21.7%
Flare O₂ mean	6.7%	<1%
Number of measurements	56	68
Measurement represents	Diluted gas with ~30–50% air ingress	Near-true waste gas quality
Comparable readings	Dec 2024 accumulated-gas readings: 18.4–25.7% CH ₄	Full year: 21.7% mean
Inter-year comparison	Not directly comparable — dilution artefact	Reliable baseline

Table note: The 2024 flare data is not directly comparable to 2025 data due to the fundamentally different measurement conditions. The 2024 continuous-run regime produced readings heavily diluted by atmospheric air (mean O₂ 6.7%). The 2025 batch burning regime, with gas allowed to accumulate before measurement, yields readings with minimal dilution (O₂ <1%) that are considered representative of actual waste gas composition. December 2024 readings taken under conditions similar to the 2025 regime (gas accumulated before measurement) produced values of 18.4–25.7% CH₄, consistent with the 2025 mean of 21.7%, suggesting broad stability in in-waste gas quality across the two years.

B.4 Perimeter Gas Monitoring — GBH03 Summary (2025)

GBH03 was the only perimeter borehole to record methane above background during 2025. Methane was detected above the 5% v/v investigation threshold at 36 of 49 routine monitoring visits across the year. The full-year mean was approximately 8% CH₄, with a maximum of 15.9% (26 September 2025). Concentrations never approached the 20% action threshold. Oxygen depletion during elevated methane readings (typically O₂ 2–9%, versus 20.9% atmospheric) confirmed landfill gas origin.

The gas volume entering the borehole is small: concentrations peak momentarily when the borehole is first opened and then decline rapidly as the gas analyser purges the borehole atmosphere, indicating a limited and discrete migration pathway rather than a sustained flow. A seasonal pattern is apparent, with higher readings in late summer to early autumn and lower readings in winter.

All other perimeter boreholes (GBH01, GBH02, GBH05, GBH06, GBH07, GBH08, GBH11, A48) recorded methane at or near background (<0.15% CH₄) at every visit throughout 2025. GBH04 is permanently blocked and its readings are not representative. (note: GBH09 and GBH10 do not exist)

Appendix C: Gas Projection Modelling

C.1 LandGEM Model Parameters

Parameter	Value	Source
Model	LandGEM v3.02 (first-order decay)	US EPA
k (CH₄ generation rate constant)	0.04 yr ⁻¹	Stormy West LFG Status Report (REV 2, Sept 2025)
L₀ (CH₄ generation potential)	100 m ³ /t	Stormy West LFG Status Report (REV 2, Sept 2025)
Collection efficiency	75%	Assumed (site-specific)
Baseline CH₄ (2025)	21.7%	Measured — 68 batch-burning measurements, full year 2025
Baseline flow rate (2025)	180 m ³ /hr	Measured (flare system data)

C.2 Annual Projections — 2025 to 2035

Year	Projected CH ₄ (%)	Projected Flow (m ³ /hr)	Relative Energy Content (% of 2025)
2025	21.7	180	100
2026	20.9	173	96
2027	20.1	166	92
2028	19.3	159	89
2029	18.5	153	85
2030	17.7	147	82
2031	17.0	141	79
2032	16.3	135	75
2033	15.6	130	73
2034	14.9	125	70
2035	14.2	120	67

Table note: LandGEM projection using parameters in Table C.1. The 2025 baseline of 21.7% CH₄ is the mean of 68 batch-burning measurements with low oxygen ingress and is considered the most reliable estimate of current in-waste gas quality. The 2024 flare data (mean 6.7% CH₄, mean O₂ 6.7%) is not used as a comparator, being an artefact of continuous-run atmospheric dilution. Relative energy content is calculated as the product of CH₄ concentration and flow rate, indexed to the 2025 baseline. All projections are model-derived estimates with inherent parameter uncertainty, particularly in the *k*-value.

C.3 Key Future Thresholds

Threshold	CH ₄ (%)	<i>k</i> = 0.04 (Conservative)	Best Estimate (<i>k</i> ≈ 0.06)
Existing flare minimum	19.5	~2027	Already reached (2026)
Low-CV flare minimum	~10	~2043	~2033–2038
LFTGN03 surrender criterion	≤1.5	~2091	~2076–2086

Footnote:

*The *k* = 0.04 projection is retained as the conservative, compliance-safe basis for formal AEMR reporting. The "Best Estimate" range is derived from the 2025→2026 observed decline rate of ~1.5 pp/yr, as presented in the Gas Management Status Report (July 2026). This faster rate is supported by direct, methodologically consistent monitoring data and is recommended as the basis for the operator's internal planning and NRW surrender engagement.

Appendix D: Regulatory Correspondence Summary

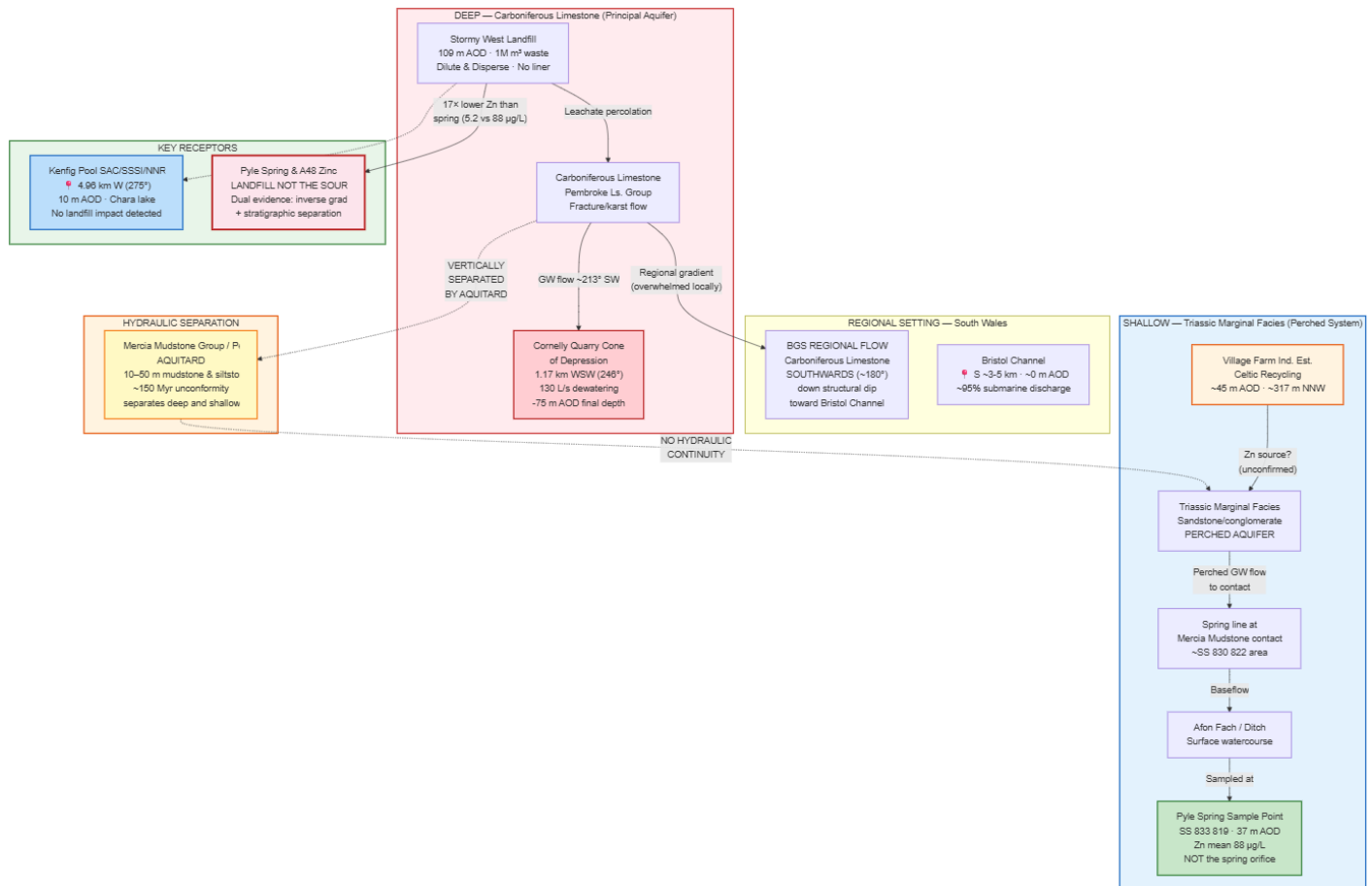
Date	From	To	Subject	Key Content
June 2025	NRW	Operator	Flare replacement	NRW confirms enclosed flare replacement is mandatory. States that failure to replace will lead to non-compliance scores.
August 2025	Operator / NRW	—	Gas management meeting	Meeting held to discuss gas trajectory, flare specification, and replacement timeline.
11 Sept 2025	NRW	Operator	CAR_NRW0049476	Compliance Assessment Report. No non-compliance found, "no further action intended."
October 2025	Operator	NRW	Gas report submission	Technical gas report submitted providing basis for replacement flare specification.
November 2025	NRW	Operator	Permit surrender	NRW directs operator to "Contact NRW to discuss permit surrender." Deadline: 30/11/2025.

Table note: Summary of key regulatory correspondence during the 2025 reporting year. This is not an exhaustive log; it captures the principal exchanges relevant to the compliance position and recommendations in this report.

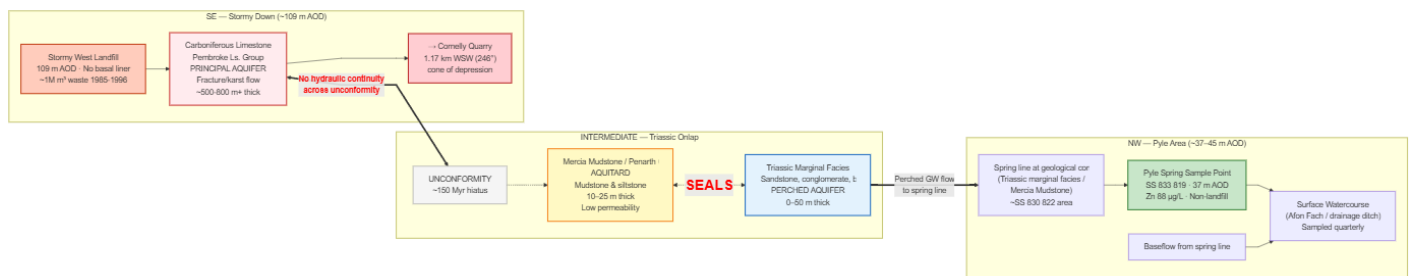
Appendix E: Conceptual Site Model Diagram

The CSM diagram suite, presented in full in the accompanying Conceptual Site Model Report v5 (July 2025), comprises four figures:

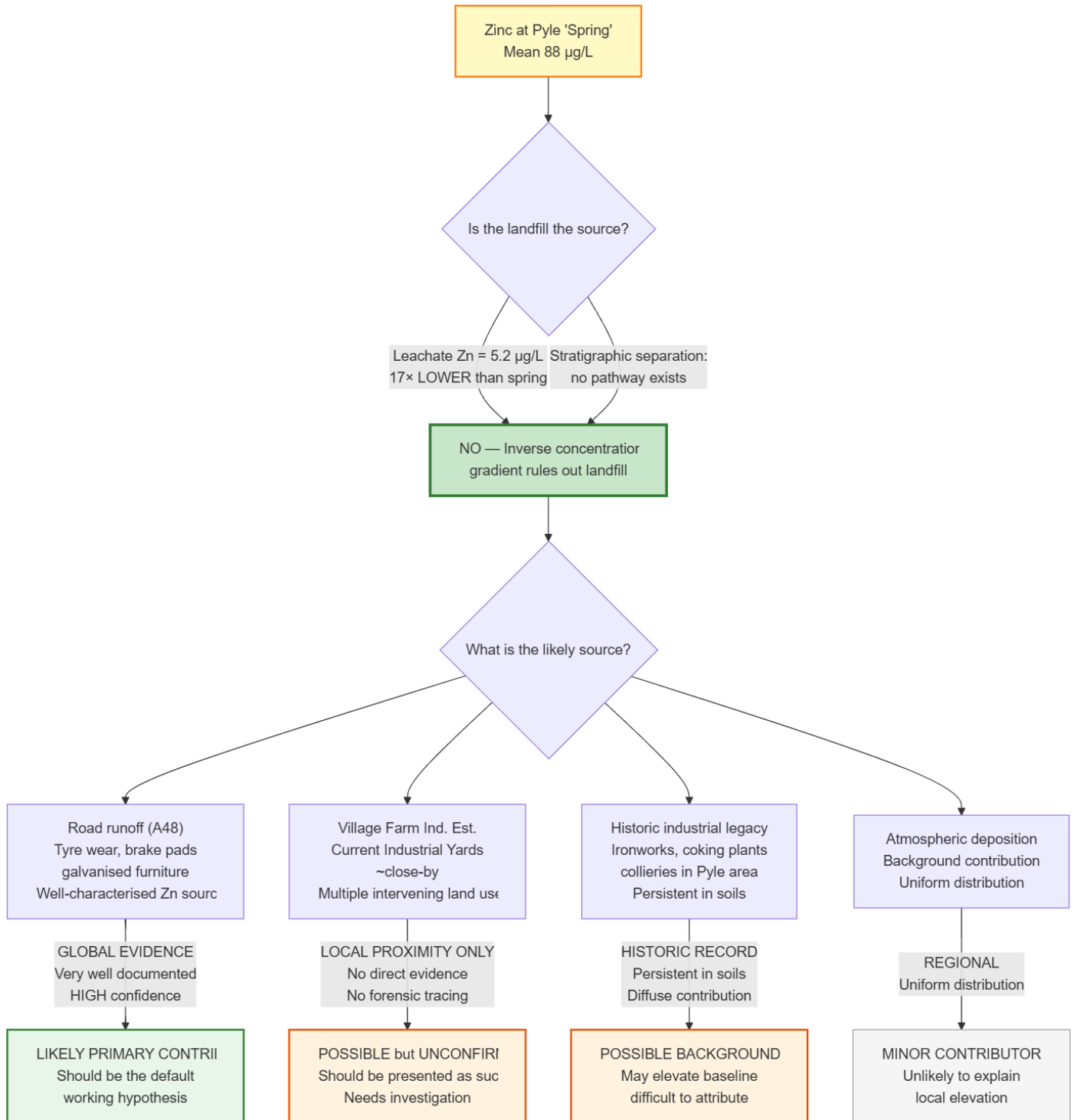
- Figure 1:** Complete Source–Pathway–Receptor Schematic — showing the SW groundwater flow direction ($\sim 213^\circ$) toward Cornelly Quarry (1.17 km WSW, 246°), the regional southwards flow ($\sim 180^\circ$) toward the Bristol Channel, were dewatering to cease at some future point, flow would relax southwards toward the Bristol Channel — further from Kenfig Pool than under current conditions.

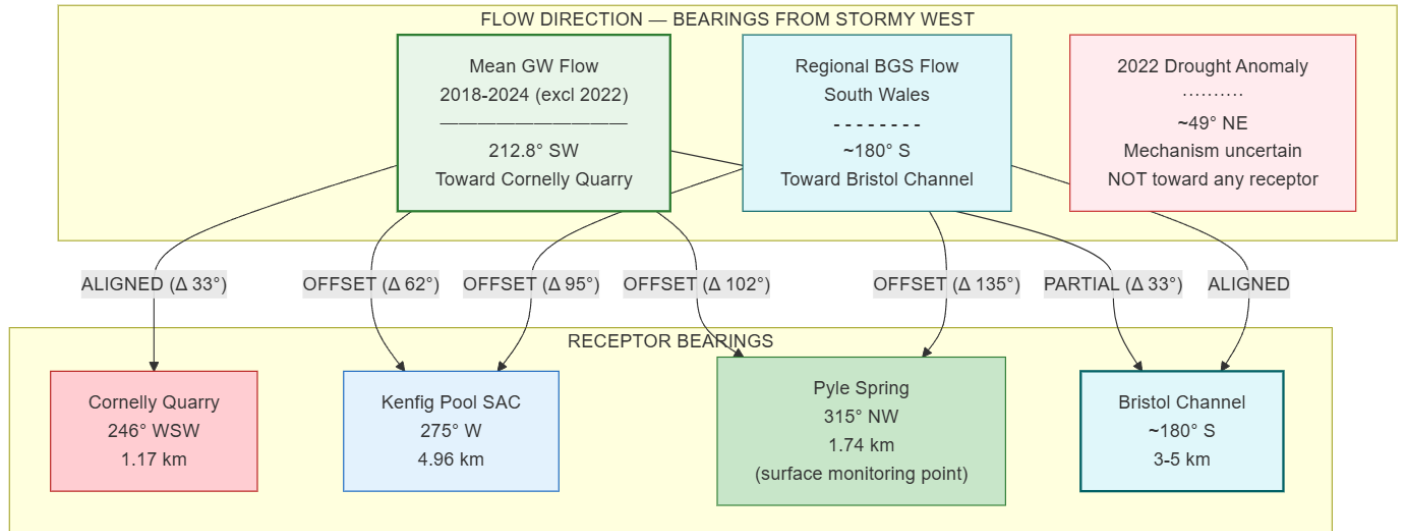


- Figure 2:** Stratigraphic Cross-Section — NW–SE Transect



- Figure 3:** Pyle 'Spring' Zinc Source Attribution Decision Tree





The CSM identifies the following elements:

- **Sources:** Stormy West Closed Landfill (unlined, dilute-and-disperse), Village Farm Industrial Estate (industrial land— alternative zinc source), Cornelly Quarry (1.17 km WSW, 246°)
- **Pathways:** Groundwater flow — CURRENT: SW (~193–221°) captured by quarry cone; REGIONAL: Southwards (~180°) toward Bristol Channel per BGS; POST-QUARRYING: Predicted to relax southwards as quarry cone dissipates — away from Kenfig Pool (275° W). Landfill gas migration (CH₄ ~22%, declining), leachate plume (contained, NH₄ at 190 mg/L plateaued), spring discharge (Pyle Spring Zn 88 µg/L mean — non-landfill source)
- **Receptors:** Kenfig Pool (SAC/SSSI/NNR — Zn 5.2 µg/L, low; post-quarrying risk assessed as lower than current), Pyle Spring (Zn 88 µg/L — elevated, confirmed non-landfill), Boreholes W2 and G1 (Zn <10 µg/L), A48 Borehole (Zn 7.0 µg/L mean), Leachate monitoring (NH₄ 450→190 mg/L, 58% decline, plateaued)
- **Engineering Controls:** Existing gas flare (181/182 m³/hr, 99.5% utilisation, batch 3d on/4d off), Replacement enclosed low-CV flare (NRW mandatory, ≥10% CH₄ capable)
- **Regulatory Framework:** Permit EAWML34009, NRW correspondence confirming flare replacement mandate, Surrender pathway under discussion

Appendix F: Groundwater Level Monitoring Data

F.1 Collar Elevations

Borehole	Collar (mAOD)	Survey Basis
GBH01 (GW3)	100.600	1 May 2025 survey
GBH02	102.460	1 May 2025 survey
GBH03	103.215	1 May 2025 survey
GBH04	103.800	1 May 2025 survey
W2 (GW2)	102.050	1 May 2025 survey
A48	100.200	Accepted historic value
B5	108.000	Accepted historic value

GBH02 consistently dry; GBH04 permanently blocked at ~2.42 m bgl. Neither yielded groundwater level data in 2025.

F.2 Quarterly Groundwater Elevations — 2025

Borehole	Collar (mAOD)	Q1 Mean	Q2 Mean	Q3 Mean	Q4 Spot (13 Dec)	Annual Mean	Seasonal Range
GBH01 (GW3)	100.600	86.7	83.1	81.3	89.0	84.6	12.1
W2 (GW2)	102.050	88.7	86.9	85.4	90.5	87.6	7.2
GBH03	103.215	86.9	83.5	82.0	—*	84.9	11.2
A48	100.200	86.7	82.7	82.0	87.0	84.4	10.7

*All values in mAOD. Q1–Q3 means based on 10–13 weekly monitoring visits per quarter. Q4 data is a single spot measurement. *GBH03 is not sampled for water quality; no dedicated Q4 dip measurement was recorded. Seasonal range is the difference between annual maximum and minimum individual measurements.*

F.3 Mean Annual Groundwater Elevations — 2018–2025

Year	A48	W2 (GW2)	GBH01 (GW3)	B5
2018	84.90	87.75	87.10	93.40
2019	84.70	88.65	83.70	93.50
2020	86.80	88.95	85.70	93.50
2021	82.30	88.05	86.10	93.70
2022	80.50	83.15	85.50	93.60
2023	87.40	89.65	87.80	94.40
2024	86.90	87.95	86.10	95.30
2025	84.40	87.60	84.60	—

*All values in mAOD. 2018–2024 means are from the PLR 2022 Report and the 2024 AEMR pivot analysis. *B5 2025 annual mean cannot be computed — only field parameter spot readings are available (see §6.4). The Q4 sampling round recorded a leachate depth of 12.15 m bgl, equivalent to approximately 95.85 mAOD at the accepted collar of 108.000 mAOD.*

Appendix G: Meteorological Data — 2025

G.1 Monthly Rainfall — NRW Llety Brongu Station 1095

(Table as presented in §5.5)

G.2 Heavy Rainfall Events (≥ 20 mm/day) — 2025

G.3 Annual Rainfall Comparison — 2019–2025

Year	Annual Rainfall (mm)	Source	Notes
2019	977.4	Pennard	Qualitative references only (no station data).
2020	1,302.8	Pennard	Qualitative references only (no station data).
2021	2,019.4	Pennard	Qualitative references only (no station data).
2022	555.6	Pennard	Qualitative references only (no station data).
2023	1,413.4	Pennard	Qualitative references only (no station data).
2024	1,465.8	Pennard	From 2024 AEMR
2025	2,051.6	Llety Brongu (NRW 1095)	Wettest in record; station change from Pennard to geographically closer and more representative data set

Note on Historical Meteorological Data Evolution:

- **2015–2023 AEMRs:** No quantitative weather station datasets were cited or tabulated in these reports; environmental interpretation relied on qualitative assessments of dry weather dilution effects.*
- **2024 AEMR:** Introduced quantitative weather correlation using Pennard station data (supplemented by Swansea historical averages) for 2019–2024 totals, with Llety Brongu used for storm event context.*
- **2025 AEMR:** Standardised primary monitoring exclusively to the NRW Llety Brongu raingauge (Station 1095).*

A formal statistical comparison confirmed that Llety Brongu provides superior local alignment for site hydrology while preserving valid multi-year trend analysis across the 2019–2025 monitoring window.

G.4 Barometric Pressure Summary — 2025

Parameter	Value
Annual mean	1,006.6 mb
Maximum recorded	1,029.4 mb
Minimum recorded	984.8 mb (23 Oct 2025)
Annual range	44.6 mb

Spot readings taken at the flare compound during routine monitoring visits; not a continuous record

Appendix H: Risk Assessment Matrix

The following risk matrix synthesises the seven risks identified during the 2025 analytical review. Confidence levels reflect the empirical evidence base available at the time of reporting.

Risk ID	Risk Description	Confidence	Evidence Basis	Trigger / Timeline	Consequence
R1	Gas terminal decline and	High (current CH ₄) /	68 flare measurements	Low-CV threshold	Active flaring ceases below ~10% CH ₄ ; shift

Risk ID	Risk Description	Confidence	Evidence Basis	Trigger / Timeline	Consequence
	flare obsolescence	Moderate (projection)	(2025); LandGEM projection ($k = 0.04$)	(~10% CH ₄) projected ~2043	to passive venting or alternative treatment
R2	Future change to dewatering regime at Cornelly Quarry	Low (near-term) / Moderate (long-term)	Plane-fit analysis (§5.5.4); quarry planning permission beyond 2033; BGS regional flow direction (southwards ~180°); monitoring boreholes positioned along southern perimeter facing the quarry	Not defined — quarry operations expected to continue for the foreseeable future	Under current steady state, SW flow directs groundwater away from Kenfig Pool. Were dewatering to cease at some future point, flow would relax southwards — further from the Pool. Existing borehole network to track groundwater surface annually.
R3	Pyle Spring zinc — non-landfill source attribution	High (statistical exclusion of landfill) / Moderate (source identification)	4 quarterly rounds; Welch's t-test $p = 0.027$; Mann-Whitney U $p = 0.003$; inverse concentration gradient	Ongoing — Pyle Spring zinc persistently elevated	If NRW considers Pyle Spring within landfill's sphere of influence: statistically robust exclusion of landfill as source may require formal acknowledgement
R4	Leachate NH ₄ -N plateau at 190 mg/L	High (containment) / Moderate (future decline rate)	4 quarterly measurements; linear regression $p = 0.053$ (borderline); 950:1 containment ratio	Q3–Q4 plateau confirmed; Q1 2026 data will confirm or refute sustained plateau	If plateau persists: rate of future decline uncertain; may extend leachate management timeline
R5	Flare replacement delay	High	NRW correspondence (June–November 2025); meeting August 2025	NRW has not set hard deadline; 2026 installation expected	Non-compliance scores; delay or complication of surrender pathway
R6	24-hour operation condition tension (Condition 1.3.1)	Moderate	Operational flow data; batch burning schedule; permit condition text; NRW CAR silence	Immediate — batch burning is current operational pattern	If NRW tolerance changes: compliance issue requiring permit variation or engineering response

Table note: Risk assessment matrix for Stormy West Closed Landfill, 2025 reporting year. Confidence levels distinguish between event confidence and mechanism confidence where these differ. All projections are model-derived estimates with stated parameter uncertainty.

Appendix I: Contradiction and Verification Log

The following table records contradictions identified between stored project data (knowledge base entries from Phase 1 scoping) and the verified 2025 dataset. All contradictions have been resolved in favour of the empirical data.

ID	Contradiction	Initial Position	Verified Position	Resolution
C1	Q1 2025 lab results	Knowledge base: "Q1 2025 lab results corrupt"	Q1 data loaded and verified from lab report 25-016134 (29/03/2025). Zinc: PS 40, KP 1.3, W2 6.2, G1 4.1, A48 4.3, Leachate 6.1 µg/L. NH ₄ leachate: 450 mg/L.	Resolved. Q1 data is valid and integrated into all analyses. Knowledge base entry superseded.
C2	Q4 2025 results	Knowledge base: "Q4 results pending (lab delay)"	Q4 data loaded and verified from lab report 25-067879 (13/12/2025). Zinc: PS 110, KP 8.4, W2 9.0, G1 9.6, A48 11.0, Leachate 6.4 µg/L. NH ₄ leachate: 190 mg/L.	Resolved. All four quarters complete. Knowledge base entry superseded.
C3	Reg 61 / LFTGN05 compliance	Knowledge base: "Reg 61: No temp data = compliance gap"	CAR_NRW0049476 found no non-compliance. The temperature data gap is an operational data deficiency (LFTGN05), not a compliance finding by NRW.	Resolved. Distinction clarified: LFTGN05 temperature gap = operational data deficiency (unverifiable compliance position), not a regulatory non-compliance.
C4	NH ₄ -N decline — statistical vs. operational significance	58% decline in leachate NH ₄ -N (450→190 mg/L). Linear regression $p = 0.053$ — not significant at $\alpha = 0.05$.	With $n = 4$, statistical power is inherently low. The magnitude of decline (260 mg/L) is operationally significant regardless. The Q3–Q4 plateau at 190 mg/L (two identical consecutive values) is the primary analytical finding.	Resolved. Decline reported as operationally significant (58% reduction, 260 mg/L) but statistically borderline ($p = 0.053$). Plateau is the more robust finding.
C5	Cornelly Quarry risk characterisation	Initial project scoping assessed the quarry as a "barrier protecting Kenfig Pool," with cessation conceptualised as a gradient-reversal risk.	The plane-fit analysis of site borehole data (§5.6) demonstrates SW flow (~193–221°) toward the quarry. The quarry diverts naturally southwards regional flow (~180°, per BGS South Wales). Post Quarrying flow is predicted to relax southwards — away from Kenfig Pool (275° W). The quarry is recharacterised as a diversion of regional flow, not a barrier protecting the Pool.	Resolved. The risk to Kenfig Pool is assessed as LOWER post-quarrying than under current conditions. The boundary monitoring recommendation remains but its purpose is to verify the southwards prediction.

Table note: Contradiction resolution log. All discrepancies between stored project context and verified 2025 data have been reconciled. The empirical dataset takes precedence over knowledge base entries in all cases.

Appendix J: Uncertainty Matrix and Resolution Pathway

The principal uncertainties identified during the 2025 analytical review, together with the data or intervention required to resolve each, are summarised below.

Uncertainty	Current Status	Resolution Required	Timeline	Priority
Gas decay rate (k-value) accuracy	LandGEM projection uses $k = 0.04 \text{ yr}^{-1}$. Site-specific rate may differ.	Continue monthly gas monitoring; recalibrate LandGEM with 2026–2027 dataset (24–36 monthly data points)	2027	High
Cornelly Quarry GW impact — post-quarrying flow verification	Analysis predicts southwards flow relaxation ($\sim 180^\circ$) toward Bristol Channel — away from Kenfig Pool. Monitoring boreholes are positioned along the southern site perimeter between the waste mass and the quarry.	Survey remaining collars (GBH05, GBH07, GBH08, GBH11, W3); add GBH03 to water quality programme; continue annual plane fit tracking bearing and gradient ongoing	Collar survey next round; expanded fit from Q4 2026	High
NH₄-N plateau significance	Plateau at 190 mg/L (Q3–Q4). Two identical values suggest genuine plateau; third data point needed for confirmation.	Continue quarterly leachate monitoring; Q1 2026 data will confirm or refute sustained plateau	Q1 2026	Medium
Flare temperature compliance (LFTGN05)	No temperature monitoring data exists. Compliance is unverifiable, not non-compliant.	Install replacement flare with integrated temperature monitoring and data logging	Q1 2026 (with flare replacement)	Medium
Pyle Spring zinc source attribution	Statistically excluded from landfill; attributed to Village Farm Industrial Estate (CSM v5) by spatial reasoning and statistical elimination.	Continued quarterly monitoring of Pyle Spring zinc; any future regulatory requirement for formal source attribution to be addressed if raised by NRW	Ongoing	Low

Table note: Uncertainty resolution matrix. Timelines assume continued quarterly water quality monitoring and monthly gas monitoring as per the existing programme. All resolutions are achievable within the existing regulatory framework and do not require permit variations.