Project Report	
Environmental Impact Assessment for Bluemethane Chloe	
Project	Process optimisation for environmental impact assessment during aquatic methane recovery in wastewaters.
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1 Introduction

Bluemethane's mission is to cut methane emissions from liquids at global scale. Methane escapes from wastewater treatment, anaerobic digestion, reservoirs and other liquid systems, largely unmeasured and unmanaged. Bluemethane exists to make these emissions visible, preventable and economically recoverable - turning methane from an infrastructure liability into a measurable operational value stream.

Chloe is Bluemethane's pilot-scale plant designed for the removal of residual methane from post-digested sludge through a closed degassing system. The technology targets residual dissolved and entrained methane released during post-digested sludge handling, with the aim of reducing fugitive methane emissions and associated greenhouse gas impacts from wastewater treatment facilities.

Chloe was evaluated during a multi-week pilot trial at Cotton Valley Wastewater Treatment Works, operated by Anglian Water Services. Cotton Valley sewage treatment works serves a population equivalent of 2.57 million and treats 22,240 tonnes of dry solids per year. Anglian Water is the largest water utility in the UK by geographic area, and serves six million customers.

The trial was implemented as a controlled, pilot-scale process integrated within the existing sludge treatment infrastructure, ensuring representative operating conditions without disrupting routine plant operations. The primary objective of the trial was to quantify the contribution of methane degassing achieved by Bluemethane Chloe to overall on-site carbon emissions reduction.

In the context of methane emissions from sludge digestion and digestate handling, the prevailing operational practice at many wastewater treatment plants is not the use of active post-treatment technologies, but rather passive management through extended digestate storage. Digestate is typically held in open top tanks long enough to allow a substantial proportion of the methane to be released to atmosphere, and to ensure methane concentrations are low enough to ensure sludge stability for safe downstream dewatering operations.

As a result, methane emissions during this stage are largely unmanaged and represent a significant, point source of greenhouse gas emissions. By contrast, Chloe is designed as a low-energy, closed degassing system focused on methane capture at source, offering a potentially lower-impact alternative for methane management within wastewater treatment works.

Environmental monitoring formed an integral part of the trial. Key parameters, including gas composition, methane concentrations, and relevant process indicators, were routinely monitored using a combination of real-time instrumentation and manual sampling. An Environmental Impact Assessment (EIA) was conducted by integrating the results from continuous monitoring systems and targeted sampling campaigns carried out over the multi-week trial period, in order to evaluate potential environmental and on-site impacts associated with the deployment of Bluemethane's technology, either adverse or beneficial impacts.

This document presents the results of the Environmental Impact Assessment of Chloe at Cotton Valley Wastewater Treatment Works and constitutes the main deliverable of the CIEIF grant awarded in July 2024.

2 System overview

Bluemethane Chloe is located after the primary digester, before the secondary digester at the Wastewater Treatment Works of Cotton Valley at the bioresources centre (Figure 1).

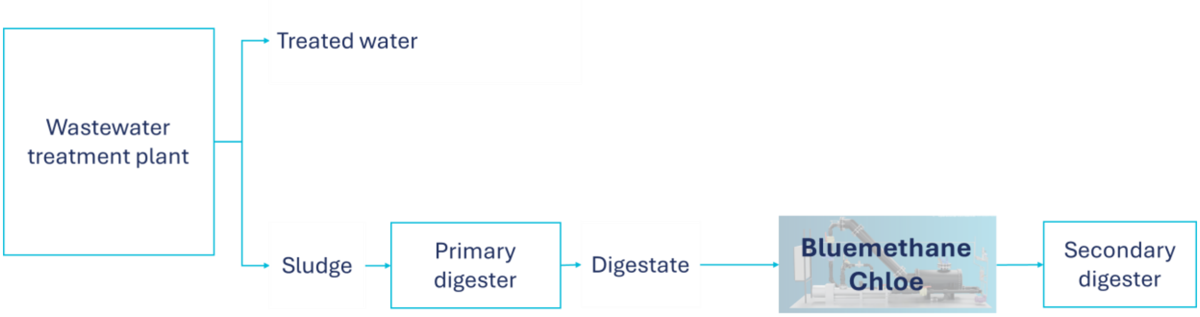

Figure 1. General layout of the location of Bluemethane at Cotton Valley

The primary digester is the main anaerobic digestion unit, where organic matter is biologically broken down and biogas, including methane, is produced and collected. The resulting digestate is then transferred through Bluemethane Chloe before entering the secondary digester which functions primarily as a storage and holding tank for digestate.

Bluemethane Chloe is fed with post-digested sludge (or “digestate”). An initial pressure drop induces primary degassing, after which a weak vacuum is applied. The sludge then passes through a primary separator, where increased turbulence promotes the transfer of dissolved biogas from the liquid phase to the gas phase. Final degassing is completed in a secondary separator tank (Figure 2).

Figure 2. General schematics of the Bluemethane degassing system, Chloe

For the purposes of this demonstration, Bluemethane Chloe is containerised. This container (Figure 3) houses Bluemethane Chloe including her real-time monitoring system and a control panel (Figure 4).

Figure 3. Photo of Chloe installed inside a shipping container

Figure 4. Control panel of Chloe outside at the entrance of the shipping container

3 Objectives

- Develop a comprehensive methodology for EIA of Bluemethane Chloe technology applicable to various environments in line with the CIEIF grant proposal and subsequently, understand the impact of our process on the environment.
- Quantify the value the system adds to the process such as additional energy from biogas.
- Quantify impacts on the downstream sludge on the microbial health, methane production potential and dewaterability.
- Quantify the impact on the release of climate-relevant gases, and noxious gases.

4 Methodology

The assessment of environmental impacts associated with the operation of Chloe was based on a combination of continuous real-time monitoring and periodic manual sampling campaigns. This approach covers operational, environmental, and emissions-related parameters, including those not captured by automated instrumentation.

The trial was conducted for a 10-week period operating 5-8 hours per day from Monday to Friday, from 24 April to 30 June 2026.

4.1 Real-time monitoring

A real-time monitoring system was deployed to continuously measure key operational and environmental variables during the trial period. These parameters provide high-resolution data on process performance, energy use, and gas characteristics, which are critical for evaluating environmental impacts and system efficiency. The monitored variables in Bluemethane Chloe include:

1. Liquid flow rate
2. Liquid temperature
3. Gas flow rate
4. Gas composition (continuous, real-time analysis)
5. Gas temperature
6. Gas pressure
7. Energy consumption

4.2 Sampling campaigns

Certain variables required manual sampling and laboratory analysis, as they cannot be reliably measured by the real-time monitoring system. Each instance of fieldwork involving human intervention, testing, and sample collection is referred to as a sampling campaign. Sampling activities were conducted periodically by one or two trained operators. Liquid and gas samples were collected:

Liquid sampling points were located at the inlet and outlet of Chloe, enabling comparative analysis of treatment performance.

Gas sampling points were located on the gas line downstream of the vacuum pump, where biogas is captured, ensuring representative sampling of emitted and recovered gases.

The combination of inlet and outlet sampling allows for quantification of the capturing efficiency, changes in methane production potential, nutrient concentrations, noxious compounds, climate-relevant gases attributable to the operation of Chloe, microbial analysis and the impact on dewaterability.

Methane capturing efficiency was determined from dissolved methane measurements at the Chloe inlet and outlet. Liquid sludge samples were collected in sealed vials, and methanogenic activity was immediately stopped using a methanogenesis inhibitor to prevent further methane production prior to analysis. Dissolved methane concentrations were then quantified by gas chromatography. Methane recovery efficiency was calculated as:

$$\text{Methane capture efficiency (\%)} = \frac{C_{inlet} - C_{outlet}}{C_{inlet}} \times 100$$

where $C_{inlet}$and C_{outlet} are the dissolved methane concentrations measured in the sludge entering and leaving Chloe, respectively.

To assess whether degassing affects the sludge's capacity to continue generating methane downstream, methanogenic activity curves (methane concentration over incubation time, obtained by manual sampling and GC analysis) were used as an in-house proxy for Residual Biogas Potential (RBP), the standard measure of this property (Figure 5). the fitted logarithmic trend (R^2 = ~1.00, n = 4) indicates a strong monotonic correlation between the two measures, supporting the use of methanogenic activity curves as a surrogate for RBP.

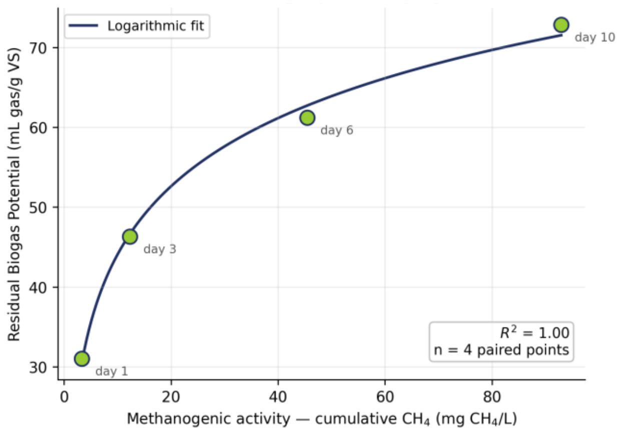

Figure 5. Relationship between the methanogenic activity proxy (cumulative methane, mg CH_4/L, incubated at 21 °C) and the standard Residual Biogas Potential (RBP, mL gas/g VS, assayed at 37 °C) for control sludge from a previous project.
Each point is a matched incubation day (days 1, 3, 6 and 10)

Measurements of non-methane VOCs (NMVOCs) were conducted by a third-party laboratory using certified equipment and a dedicated methodology (see Appendix 1). This approach utilised intermediate bulk containers (IBCs) configured to simulate full-scale digestate storage tanks, enabling representative assessment of emissions under controlled and reproducible conditions (See Appendix 1: VOC measurement methodology).

Microbiological analyses were conducted to assess the presence of indicator organisms at both the inlet and outlet of the Bluemethane Chloe system during one operational day.

The microbial assessment was undertaken as a comparative screening exercise to evaluate whether passage through Bluemethane Chloe resulted in any measurable change in selected microbial indicators. Given the approximately 21-day retention time of the upstream digestion process, digestate characteristics were expected to vary only gradually over time; therefore, consecutive daily samples would not be independent observations. The sampling approach was considered proportionate to the objectives of this demonstration-scale assessment.

4.3 Environmental Impact Assessment (EIA) – Key Focus Areas

The Environmental Impact Assessment aims to evaluate the potential environmental impacts associated with the operation of Bluemethane Chloe within the defined system boundaries. In line with EIA principles, the assessment considers both potential beneficial and adverse environmental effects. As Chloe operates as a fully enclosed and controlled process within the Cotton Valley WWTP, direct environmental impacts on the surrounding community are not expected. The assessment therefore focuses on the environmental aspects most relevant to the operation of the technology, including:

Climate-relevant gases, including methane and carbon dioxide, assessed to determine greenhouse gas emissions reduction and climate impacts.

Noxious/odorous gases, such as ammonia and VOCs, assessed to evaluate potential air quality impacts.

Nutrients, relevant to water quality, nutrient retention and downstream environmental effects.

Microbial health, assessed to determine whether operation of the system alters microbiological indicator parameters in the treated digestate.

Noise generation was considered as a potential environmental aspect associated with the operation of the Bluemethane Chloe system. During the pilot trial, no dedicated noise measurements were undertaken. Chloe operates as a containerised process using electrically powered equipment and was installed within an operational wastewater treatment facility where existing treatment processes contribute to baseline site noise levels.

No noise-related incidents, complaints, or operational concerns were reported during the trial. Based on the scale of the equipment and its integration within an established industrial environment, the noise impact is expected to be low relative to existing site activities. Future commercial deployments may include site-specific noise assessments where required by local permitting, planning, or environmental regulations.

4.4 System boundaries

The system boundary for this assessment includes the operation of the Bluemethane Chloe degasser within the Cotton Valley WWTP during the 10-week trial period, covering digestate degassing and methane capture. Upstream digestion processes and downstream digestate management are excluded, ensuring that the assessment focuses on the environmental performance of the degassing technology (Table 1).

Table 1. System boundaries and exclusions

Boundary Type	Included	Excluded
Spatial Boundary	· Cotton Valley Wastewater Treatment Plant (WWTP) site · Physical footprint of the Bluemethane *Chloe* degasser unit · Digestate inlet and outlet connections to existing plant infrastructure · Gas collection lines and immediate handling equipment	· Upstream wastewater collection and sewer network · Anaerobic digestion infrastructure beyond the degasser interface · Downstream digestate transport, storage, land application, or disposal outside the WWTP boundary* · External energy generation or grid infrastructure · Surrounding community (excluded because Chloe operates as a fully enclosed and controlled system and is not expected to result in direct environmental impacts beyond the WWTP boundary)
Temporal Boundary	· Duration of the Chloe degasser operational trial during steady state conditions at Cotton Valley WWTP (from 24 April to 30 June 2026)	· Construction of the WWTP · Long-term operation of the plant beyond the trial · End-of-life or decommissioning of the WWTP or the degasser.

**Although downstream digestate transport, storage, land application and disposal are outside the spatial boundary of this assessment, the potential for continued methane generation during these stages was considered by comparing the methanogenic activity of Chloe inlet and outlet samples. Methanogenic activity curves were used as a proxy for Residual Biogas Potential (RBP), representing the potential for future methane generation under the incubation conditions assessed (see section 4.2). They should not be interpreted as measurements of actual downstream methane emissions, which depend on site-specific factors including storage duration, temperature, digestate management practices and end-use conditions*

4.5 Baseline

To evaluate the environmental impacts of the Bluemethane Chloe system, the baseline was defined as the inlet conditions of the digestate entering the unit, representing the state of the sludge prior to degassing treatment.

These baseline conditions are directly compared with outlet measurements to quantify changes in gas composition, dissolved methane, and other relevant parameters attributable to the system.

This approach enables the isolation of the effects of the degassing process within the defined system boundaries in comparison to the representative conditions during conventional digestate handling (storage in open tanks).

5 Results

5.1 Biogas recovery and emissions avoidance

The primary environmental benefit of Chloe is the capture of residual biogas from post-digested sludge that would otherwise be emitted to atmosphere during digestate storage.

Continuous, real-time monitoring of gas composition, gas flow rate, and sludge throughput during the trial enabled direct quantification of biogas recovery (Figure 6). Across stable operating periods, Chloe achieved an average biogas recovery of approximately 200 L biogas per m^3 of sludge treated, demonstrating consistent methane capture under representative plant conditions.

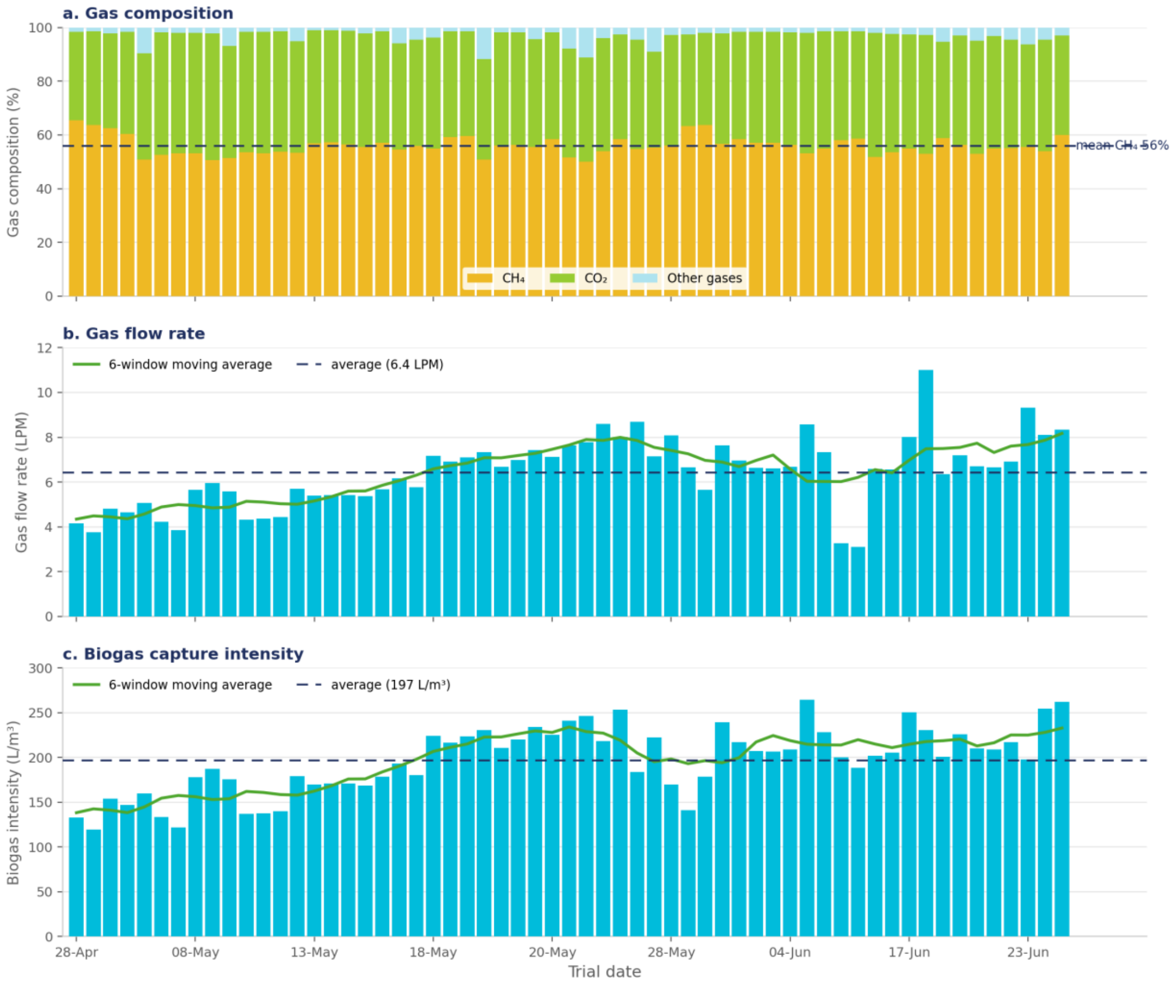

Figure 6. Results from the real-time monitoring system during stable operation periods across the 10-week trial a. gas composition, b. gas flowrate, c. biogas capture intensity

It is possible to scale up the results above and estimate the greenhouse gas (GHG) emissions avoided.

Based on a total sludge volume treated at Cotton Valley, Anglian Water on 2025:

Annual sludge volume:

- 200,000 m^3 sludge/year

Annual biogas captured by Chloe

From 200 L biogas / m^3 sludge, this is 0.20 m^3 biogas / m^3 sludge

40,000 m^3 biogas/year

For a biogas composition of ~ 60% CH_4:

- Methane captured:
  24,000 m^3 CH_4 per year

Using methane density (~0.67 kg/m^3):

- **16 tonnes CH_4 per year avoided**

Using Global Warming Potential (GWP_{100}) = 28:

- **450 t CO_2e per year avoided**

This indicates that, under conventional digestate handling without Bluemethane Chloe, annual emissions could be up to approximately 450 tonnes CO_2e higher than in the scenario where Bluemethane Chloe is implemented in one single site.

The pilot-scale installation vents the captured gas following monitoring and quantification. The full-scale system will recirculate the recovered gases to the anaerobic digestion process for beneficial energy recovery. Consequently, the captured methane will be converted into useful energy, reducing greenhouse gas emissions and improving overall resource efficiency

Bluemethane Chloe captured approximately 60-65% of the residual volume of methane present in the inlet stream. The remaining fraction was not recovered and may be emitted downstream; however, the overall methane emissions are substantially lower than under the baseline condition without methane capture, resulting in a net environmental benefit.

5.2 Methane production potential

Curves were compared between the Chloe inlet (baseline) and outlet (after degassing) across successive operating campaigns (Figure 7). The inlet and outlet curves were comparable throughout, tracking one another within experimental variability at each incubation point, indicating no appreciable difference in residual methane potential between the untreated and degassed sludge. This corresponds to a neutral effect of the degassing step on downstream methanogenic activity, neither an increase nor a reduction. The result is consistent with the operating principle of Chloe, which recovers dissolved and entrained methane through physical means alone, without chemical dosing; the microbial (methanogenic) community and substrate availability are therefore not expected to be materially altered by the process.

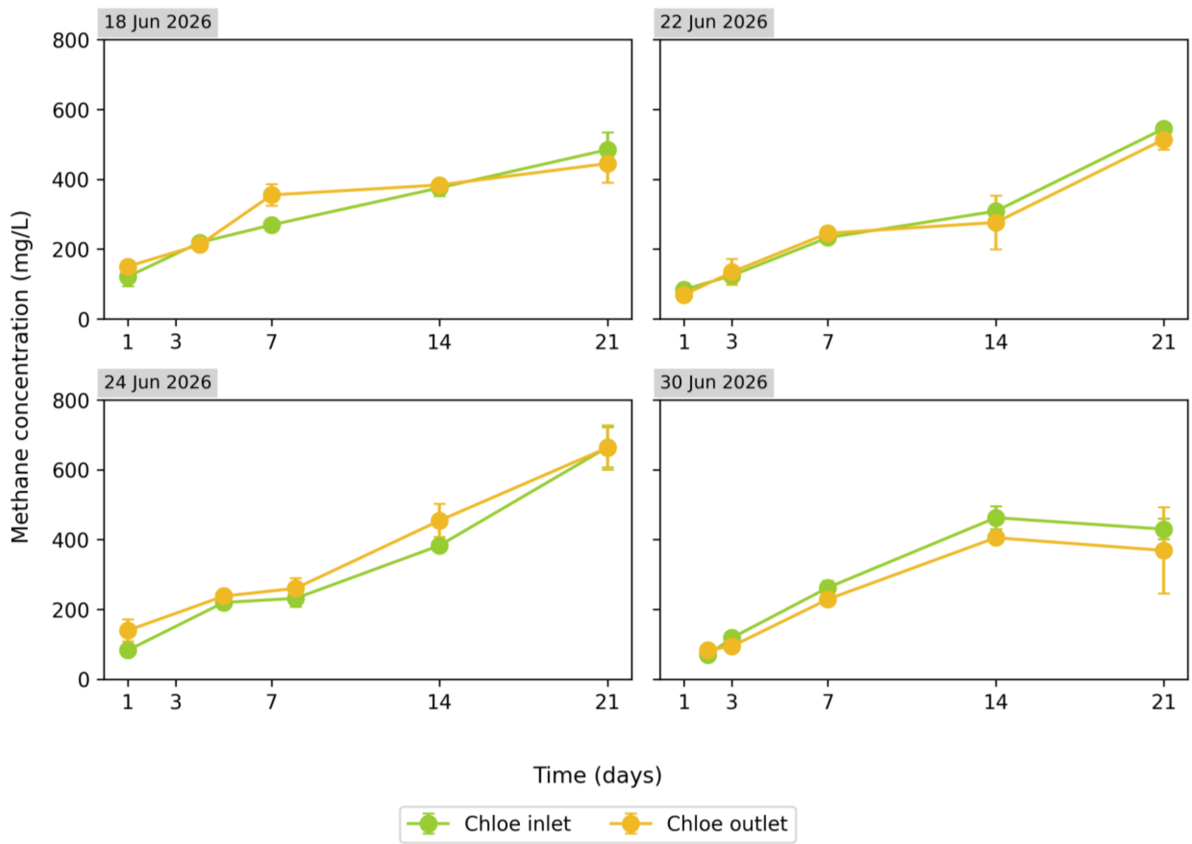

Figure 7. Methanogenic activity curves during stable operation at several dates across the 10-week trial period.

The methane production rate, taken as the slope of the methanogenic activity curves over the 21-day incubation, averaged 21.8 ± 4.4 mg CH_4 L^{-1} d^{-1} at the inlet and 19.3 ± 5.3 mg CH_4 L^{-1} d^{-1} at the outlet across campaigns (mean ± SD, n = 4). The outlet rate was comparable to, and marginally lower than, the inlet, indicating that degassing does not increase the residual methane-generating potential of the sludge, consistent with a physical process that does not adversely affect the methanogenic community.

5.3 Energy balance

Energy demand is a key consideration for greenhouse gas mitigation technologies, as additional consumption can reduce net environmental benefits. During the pilot trial at Cotton Valley Wastewater Treatment Works, the energy consumption of Chloe was continuously monitored and compared with the energy potential of the recovered biogas.

Results show that Chloe operates with a positive energy balance (Figure 8), with the energy content of the captured biogas exceeding the electrical energy required for system operation over a representative period. This demonstrates that methane mitigation is achieved without introducing significant indirect emissions, supporting Chloe's suitability as a low-energy solution for managing residual methane from post-digested sludge.

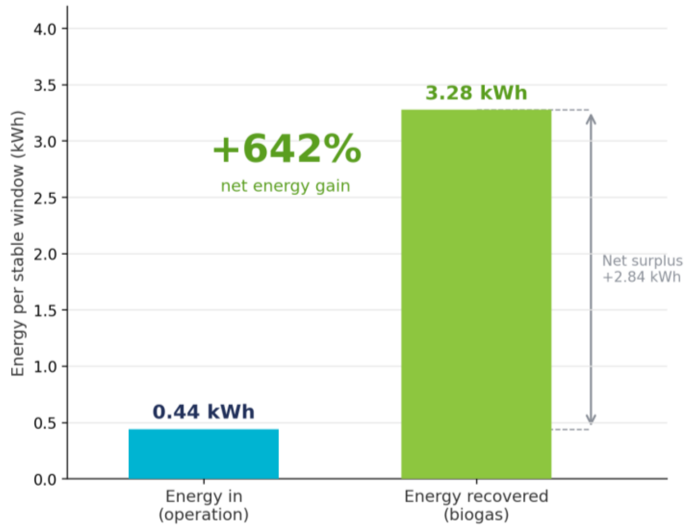

Figure 8. Average energy recovered during stable periods across the 10-week trial (energy in versus energy recovered).
This energy balance relates to operational performance only and should not be interpreted as a whole-life assessment of the technology.

It is possible to scale up the results above and estimate the energy recovery:

- Energy consumed (inlet / operation): 0.44 kWh
- Energy recovered (biogas / outlet): 3.28 kWh
- Net energy surplus: 3.28 – 0.44 = 2.84 kWh
- Energy ratio (output/input): ~7.45 times greater
- Net gain: **+642% relative to input energy**

5.4 Noxious/odorous gases

5.4.1 Ammonia

The results indicate that Bluemethane Chloe does not contribute to increased ammonia emissions to the atmosphere during digestate storage. Ammonia fluxes measured at the outlet were comparable to those observed at the inlet (Figure 9), suggesting that the degassing process does not promote the transfer of ammonia from the liquid to the gas phase under the operating conditions tested.

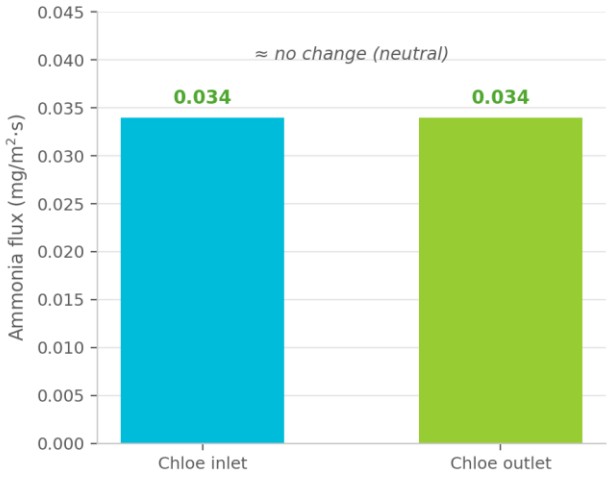

Figure 9. Ammonia at the inlet and outlet from one day of operation of Chloe

When comparing operational scenarios, ammonia emissions are expected to be similar with and without the implementation of Bluemethane Chloe, indicating a neutral impact of the system on ammonia release.

5.4.2 Nitrous oxide

During stable operation these species account for effectively the entire stream (median closure ≈100%), with oxygen near zero, confirming a normal anaerobic biogas dominated by CH_4 and CO_2. Any unaccounted fraction lies within the analyser's resolution of a few percent (Figure 10). Nitrous oxide, if present, would occur at ppm concentrations (two to three orders of magnitude below this resolution) and therefore cannot constitute a material component of the stream. This is consistent with the process biochemistry: under the anaerobic, methanogenic conditions in the digester, reactive nitrogen is emitted as ammonia (measured directly, Figure 9), not as N_2O, whose formation requires the nitrifying/denitrifying conditions of the aerobic water line, outside this system boundary.

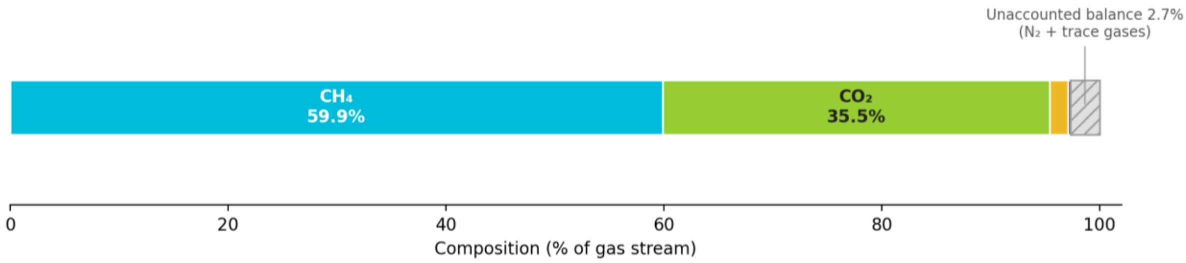

Figure 10. Bluemethane Chloe biogas composition measured during stable operation. Six days of confirmed sealed, steady-state operation (O_2 ≈ 0); unused sensor and air-ingress periods excluded. N_2O is expected negligible because, under anaerobic methanogenic conditions, reactive nitrogen is emitted as ammonia (measured), not N2O.

5.4.3 Hydrogen sulfide (H_2S)

To be completed after measurements at CV

5.4.4 Volatile Organic Compounds (VOC)

At the point of treatment, the non-methane VOC concentration at the Chloe outlet was lower than at the inlet on the dates shown, decreasing from 104 to 98 mgC/m^3 (−6%) on 22 May and from 188 to 104 mgC/m^3 (−45%) on 16 Jun. This indicates that the degassing process removes a fraction of the VOC at source, alongside the methane it recovers, with the extent of removal varying according to the inlet VOC load.

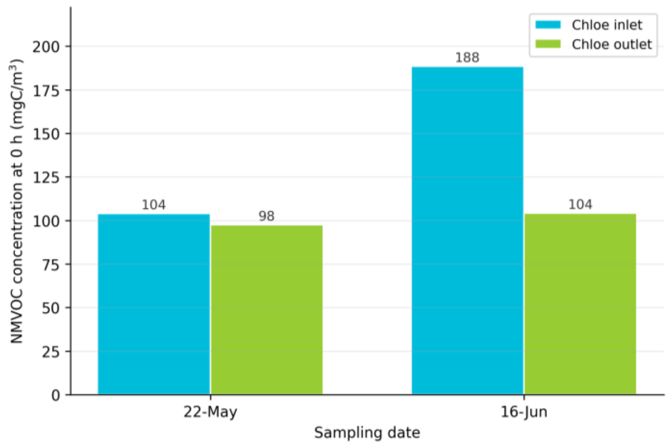

Figure 11. Non-methane Volatile Organic Compounds (NMVOC) at the inlet and outlet from two different days of operation of Chloe

These results indicate a positive impact in terms of VOC emissions reduction, including odorous and noxious compounds, following the implementation of Bluemethane Chloe compared to passive digestate handling.

5.5 Nutrients

Given that Bluemethane Chloe does not involve the addition of chemicals, the concentration of dissolved nutrients in the digestate is not expected to be significantly affected by the treatment process.

This assumption is supported by the ammonium results, which show that its concentrations at the inlet and outlet are very similar. This behaviour was consistently observed over the multi-week monitoring period, indicating that the system does not alter nutrient levels in the treated sludge (Figure 12).

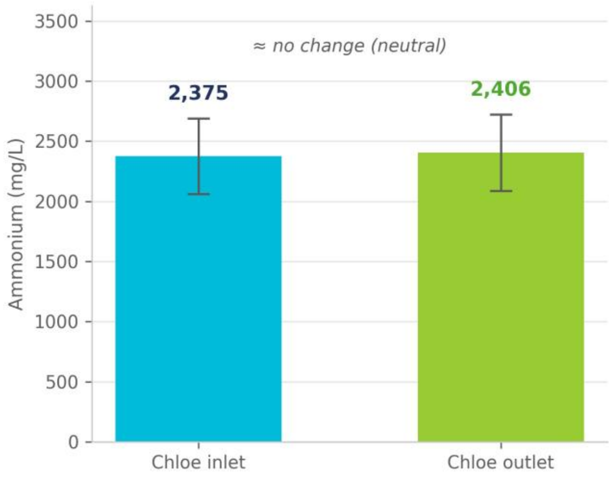

Figure 12. Ammonium concentration at the inlet and outlet from multiple days of operation of Chloe

5.6 Microbial health

Neither *Salmonella* nor *E. coli* were detected in any of the samples analysed, with measured concentrations of 0 cfu/g at both the inlet and outlet (Table 2).

Table 2. Salmonella and E. coli presence at the inlet and outlet from one day of operation of Chloe

	Salmonella (cfu/g)	E. coli (cfu/g)
Bluemethane Chloe inlet	0	0
Bluemethane Chloe outlet	0	0

These results indicate that the treated stream entering the Chloe unit did not present detectable contamination by these organisms under the operating conditions assessed.

Additionally, the digestate had previously undergone thermal hydrolysis and anaerobic digestion treatment, processes that are expected to significantly reduce pathogen levels. The results obtained during the assessment were consistent with this expectation and did not indicate any effect attributable to Chloe operation.

The findings indicate that the Bluemethane Chloe system did not adversely affect the measured microbial health parameters. As no pathogens were detected in either the inlet or outlet samples, the results suggest that the system did not introduce microbiological contamination and that the microbiological quality of the sludge was maintained throughout treatment.

5.1 Dewaterability

From theory, keeping pH below 9.0 would be unlikely to negatively impact polymer demand for dewaterability (coming from discussions with dewatering specialists), and sludge mixing during Chloe and Brutus would be expected to aid dewatering. The pH in Brutus remained below 9.0 throughout the trial, and the sludge was mixed in both Chloe and Brutus.

Preliminary dewaterability testing conducted by Thames Water indicates that the addition of sodium hydroxide in Brutus increased polymer demand in the dewatering process (*Table* 3). The polymer dose rate required rose progressively across the treatment configuration, from 17.5 kg/TDS at the inlet to 26.2 kg/TDS (after Brutus). Over the same sequence, achievable cake dry solids fell from 24.98% to 21.36%.

Table 3. Dewatering trial results (Thames Water, preliminary) — polymer dose rate and cake dry solids for digestate across the treatment stages

Sample Source	Sludge type	Sludge % dry solids	Sludge volume (ml) used	Polymer type used	Polymer Concentration (%) solids	Polymer dose rate (kg/TDS as active)	Cake Dry solid (%)
Inlet to Brutus	Liquid	6.78	200	Liquid (emulsion) -48% active	0.61	17.5	24.98
Outlet of Brutus	Liquid	6.81	200	Liquid (emulsion) -48% active	0.61	26.2	21.36
Outlet of Chloe	Liquid	6.77	200	Liquid (emulsion) -48% active	0.61	20.2	23.71

5.2 Noise

No noise-related concerns, complaints, or operational issues were identified during the demonstration period. Based on the scale of the equipment and its location within an operational wastewater treatment facility, the noise contribution from Chloe is expected to be small relative to overall site noise levels. However, as no formal measurements were undertaken, this should be considered a qualitative assessment rather than a quantified conclusion.

6 Discussion

The EIA identified several beneficial environmental impacts associated with the operation of Bluemethane Chloe. These include the reduction of greenhouse gas emissions through methane capture, recovery of renewable energy from the captured biogas, and a reduction in measured NMVOC concentrations at the point of treatment. Together, these benefits demonstrate that the technology not only avoids adverse environmental effects but can also provide measurable environmental improvements compared with conventional digestate handling practices.

The results indicate that Bluemethane Chloe targets a significant and previously unmanaged source of methane emissions associated with passive digestate storage. By actively removing dissolved and entrained methane, the system shifts emissions from an uncontrolled release to a captured and recoverable stream.

The positive energy balance confirms that a substantial fraction of residual methane remains available at this stage of treatment, highlighting an inefficiency in passive digestate storage and demonstrating the potential for simultaneous emissions reduction and energy recovery.

Air quality results suggest that the process selectively enhances methane removal without significantly affecting more soluble compounds such as ammonia. NMVOC measurements showed lower concentrations at the Chloe outlet than at the inlet on the sampling dates assessed. Although the magnitude of the effect varied between sampling campaigns, the results suggest that the degassing process can remove a fraction of NMVOCs alongside methane.

The absence of changes in nutrient concentrations and microbial indicators confirms that the process remains physical in nature and does not adversely affect the microbiological quality or nutrient characteristics of the digestate.

Regarding climate relevant gases, N_2O was not directly quantified during the trial; therefore, its contribution is treated qualitatively and considered negligible based on gas composition closure and the anaerobic methanogenic process conditions. Positively, the demonstrated reduction in methane emissions supports the broader environmental objectives of UK environmental permitting and wastewater sector regulation, which seek to minimise pollution and improve the environmental performance of treatment assets.

By capturing methane that would otherwise be released to the atmosphere, the Bluemethane Chloe system can support water utilities in meeting environmental permit objectives and demonstrating implementation of pollution prevention measures, while supporting corporate greenhouse-gas reduction commitments. The technology is also consistent with the principles underpinning the Industrial Emissions Directive (IED) and associated Best Available Techniques (BAT) guidance, which promote the prevention of emissions at source, efficient use of resources, and the adoption of techniques that deliver a high level of environmental protection. As such, Chloe represents a practical measure for reducing the environmental footprint of sludge and wastewater treatment operations without generating significant adverse environmental impacts.

Bluemethane Chloe operates as a compact, containerised process with a limited number of electrically driven mechanical components, principally a vacuum pump and associated process equipment. During the trial, the system operated within the active operational area of the Cotton Valley Wastewater Treatment Works, where background noise from existing treatment processes and site activities was already present.

Before drawing a firm conclusion on full-scale dewatering impact, further controlled testing with polymer suppliers is needed to optimise polymer selection and dosing . More tests are needed with polymer suppliers to trial different polymers and dosing regimens under controlled laboratory conditions.

Recognising that noise is a relevant environmental consideration, site-specific noise assessments will be considered for future commercial installations where required by permitting or planning processes.

7 Conclusions

The pilot trial of the Bluemethane Chloe system at Cotton Valley Wastewater Treatment Works demonstrated measurable environmental benefits through the capture of residual methane from post-digested sludge. Under representative operating conditions, Chloe recovered approximately 200 L of biogas per m^3 of sludge treated, corresponding to the recovery of approximately 60-65% of the residual methane entering the system. The recovered biogas contained approximately 60% methane by volume. When scaled to site operations, this corresponds to an estimated reduction of approximately 450 t CO_2e per year compared with conventional passive digestate storage.

The system operated with a positive energy balance, with the energy content of the recovered biogas significantly exceeding the energy required for operation. This demonstrates that methane emissions reduction can be achieved while simultaneously recovering useful renewable energy.

No significant adverse environmental impacts were identified within the scope of this assessment. Ammonia emissions were unchanged, NMVOC measurements indicated lower concentrations at the outlet than at the inlet on the sampling dates assessed, and nutrient concentrations remained stable.

Microbiological analyses detected no *E. coli* or *Salmonella* in either inlet or outlet samples, indicating that operation of Chloe did not introduce microbiological contamination under the conditions tested.

Overall, the assessment concludes that the operation of Bluemethane Chloe provides beneficial environmental outcomes through greenhouse gas emissions reduction, renewable energy recovery, and improved management of fugitive methane emissions, without generating significant adverse environmental effects within the defined system boundaries.

8 Peer reviewing

This report was independently reviewed by two professionals with relevant qualifications and experience in environmental assessment and infrastructure projects:

- **Monica Andrea Bonilla-Rodríguez**, Civil Engineer, MSc in Engineering, with professional experience in the environmental and technical evaluation of infrastructure, energy and mining projects. At the time of review, Monica was affiliated with **Servicios Ambientales y Geográficos S.A. (Environmental and Geographical Services)**.

- **Juan Sebastián Navas-Guzmán**, BSc Environmental Manager, MSc in Natural Resources Management, with professional experience in environmental impact assessment, environmental management, and environmental permitting for civil engineering and infrastructure projects. At the time of review, Juan Sebastián was affiliated with **Universidad Nacional de Colombia (National University of Colombia)**.

Both reviewers were independent of the Bluemethane project team and provided technical comments on the assessment methodology, interpretation of results, and report content.

9 Acknowledgements

The authors would like to acknowledge the support of the Climate Intervention Environmental Impact Fund (CIEIF) for funding this Environmental Impact Assessment.

Gratitude is also extended to Anglian Water Services for providing site access and sludge supply for the pilot trial.

The authors further acknowledge Thames Water for conducting the *E. coli* analysis, Live Lab for *Salmonella* testing, and Olfasense for the analysis of volatile organic compounds (VOCs).

The authors would also like to thank the peer reviewers, Monica Bonilla-Rodríguez, Juan Sebastian Navas-Guzmán for their valuable input and technical feedback.

10 Appendix 1: VOC measurement methodology

Non-methane Volatile Organic Compounds (NMVOC) emissions were assessed following the methodology developed by Olfasense UK.

Sampling was conducted using a controlled headspace approach designed to simulate emissions from covered sludge storage tanks under representative operational conditions. Digestate samples from the inlet and outlet of the Bluemethane Chloe system were collected in intermediate bulk containers (IBCs) filled to approximately 85% volume, resulting in a defined headspace of approximately 150 L.

To ensure consistent and repeatable emission conditions, each IBC headspace was continuously ventilated using compressed air at a controlled flow rate of 10 L/min, corresponding to approximately four air changes per hour. This ventilation regime reflects typical low airflow conditions applied in covered sludge tanks for emissions control.

Following filling, the system was allowed to stabilise for approximately one hour to reach steady-state conditions. Stability was verified through continuous monitoring of methane concentrations prior to sample collection.

Air samples were then collected from the headspace via the ventilation outlet using the lung sampling method into Tedlar bags over a period of approximately five minutes per sample. Subsamples of the collected air were analysed on-site for NMVOC concentrations.

NMVOC concentrations were measured using a photoionisation detector (PID), which provides a bulk measurement of volatile organic compounds in the sampled air. The method does not identify or quantify individual VOC species and therefore no VOC speciation data were obtained. The PID is configured to measure non-methane volatile organic compounds; methane does not contribute to the reported NMVOC signal under the measurement conditions employed. Consequently, results are reported as total NMVOC concentration (mgC/m^3) rather than concentrations of individual compounds.