

Llanddulas Landfill Site

Annual Monitoring Review

February 2020 to January 2021 inclusive



Prepared by P. Birchall

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1.0 INTRODUCTION

1.1 Background

FCC Environment has, in accordance with Permit condition 4.2.1a, undertaken an annual review of site monitoring data for Llanddulas Landfill collected between the period 1st February 2020 and 31st January 2021. The site is managed under a PPC Permit Ref. BU0800 and Permit Variations CP3332LG and BG3734XX.

Monitoring data has been submitted previously to the Environment Agency, and data represented within the Tables and Appendices of this report focuses on any issues or exceedances highlighted throughout the review, as required, to illustrate trends and support discussion. This report concentrates on those aspects of the monitoring that have been given trigger limits / emission limits by Natural Resources Wales (NRW) and / or other indicators of landfill impact. It does not attempt to present all data collected throughout the review period, but instead assesses whether or not the landfill is having an environmental impact and whether monitoring results are as expected. Instances where various elements of required permitted monitoring have not been carried out are detailed within the relevant section.

1.2 Site Location and Surrounding Land-use

The Llanddulas Landfill (centred at National Grid Reference: SH 904 775) is located to the immediate south-west of Llanddulas village, approximately 5 km to the east of Colwyn Bay (Drawing No. 1).

Llanddulas Landfill is located on an east/north-east sloping hillside with surface elevations falling from approximately 180mAOD, at the site's southern corner, to 120mAOD at the site's entrance tunnel beneath Pentregwyddel Road in the north. To the east of the quarry, the ground level falls steeply away to elevations of between 25 and 30mAOD, which are associated with the Afon Dulas Valley (sometimes referred to as the 'Dulas Gap').

In terms of surrounding land use, agricultural grassland and open pasture lie immediately adjacent to the site's western and southern boundaries, while development associated with Llanddulas village is present along the site's north-eastern boundary. Much of the eastern site boundary lies adjacent to limestone crags that form the upper slopes to the steep valley of the Afon Dulas. This area lies within the 'Llanddulas Limestone and Grwyth Castle Wood' Site of Special Scientific Interest (SSSI), which is of special interest for its limestone grassland, heath and woodland communities.

A worked-out quarry (the 'Lower Quarry') is located to the immediate north-west of the landfill site. This quarry is no longer operational and now holds a series of lagoons. Historically these lagoons were used to treat effluent generated by the on-site mineral processing plant. However, following the cessation of mineral extraction, their operational use has been limited to providing water for dust suppression activities.

1.3 Site History and Development

Quarry operations at Llanddulas have been on-going for over 100 years, with operations beginning within the Lower Quarry located to the immediate south of the old A55 Coast Road. Mineral extraction moved progressively southwards, with the area to the south of Pentregwyddel Road being developed subject to a number of planning approvals.

Phase 1 of the Llanddulas Landfill was developed by Colwyn Borough Council during 1985 and landfilling within Phase 1 was initially completed during 1994. However, further re-profiling occurred within Phase 1C during the latter part of 2001 in order to increase the height of the site and to correspond to the appropriate restoration contours. These operations allowed the capping and restoration of previously unrestored areas of this phase.

During the reporting period the Central area of Phase 3A was operational, the North, Western, North Eastern area and the Southern half are now all capped.

1.4 Geology

The superficial deposits present within the vicinity of the landfill are located to the east and north-east of the site and comprise Boulder Clay. These materials are present within the base of the Afon Dulas valley as well as the western and eastern valley sides. It is anticipated that the greatest depth of this material is located within the Afon Dulas valley, although there is no direct evidence to confirm this. In addition to the Boulder Clay, River Terrace Deposits and Alluvium are also associated with the water course.

The solid geology comprises limestones deposited within the Carboniferous Limestone Series. More specifically, the site is located in the Dyserth Limestone Group. Below the Dyserth Limestone Group and outcropping several hundred metres to the south of the site are the Carboniferous Limestone Basement Beds, which comprise a variable sequence of limestones, sandstones and conglomerates. The local dip of the limestone beds is approximately 15 degrees towards the north-north-east.

There are four main faults located within the vicinity of the site, the details of which are as follows; the Llysfaen and Plas Farm Faults are orientated approximately east to west and traverse the quarry. Both faults dip towards the south at approximately 45 degrees and have around 40m of displacement to the south.

The Llysfaen fault is located to the immediate south of Phases 1 and 3 and north of Phase 2. The Plas Farm Fault effectively defines the southern extent of the currently consented landfill area. The Dulas Gap Fault is orientated north to south and is near vertical with a downthrow of approximately 75m to the east.

The geological map information for the area suggests that this fault truncates the eastern ends of the Llysfaen and Plas Farm Faults. It is probable that the Llysfaen Fault is downthrown by the Dulas Gap Fault. If this is the case, then the surface manifestation of the truncated Llysfaen Fault could be in the location of the Dulas Spring, owing to the dip of the Llysfaen Fault to the south and the 75m downthrow to the east of the Dulas Gap Fault.

The Tyn-y-Caeau Fault located to the east of the Dulas Gap Fault is near vertical and has a 120m throw to the west. It intersects the Dulas Gap Fault to the north of the quarry. In addition to the above, smaller unnamed faults are present to the south of Llanddulas Landfill within the southern end of the quarry. Two sets of vertical joints, parallel to the geological strike are also present.

1.5 Hydrogeology

The site is located within the Carboniferous Limestone Series, which is classified as a “principal aquifer” within the Groundwater protection policy, 2010, owing to the rock potentially possessing significant fracturing and extensive well-developed joint system and the potential for high bulk permeability. This classification is confirmed by the Groundwater Vulnerability Map1 for the area.

The Carboniferous Limestone aquifer is a hard rock where primary porosity is low (less than 1%) and flow through open cavities, such as fractures, fissures and joints, is dominant. The Carboniferous Limestone is mechanically strong, but can undergo solutional weathering (karstification) which, under some circumstances, can produce caves (conduits) through which groundwater can flow preferentially.

Even though preferential routes exist within the Carboniferous Limestone aquifer, an extremely large volume of aquifer will still consist of rock that possesses tight fractures where water flow is extremely slow (i.e. the diffuse zone). The diffuse zone of the Carboniferous Limestone aquifer is generally highly anisotropic, that is to say that hydraulic conductivities vary significantly with direction. Groundwater flow within a karstified Carboniferous Limestone aquifer usually occurs along bedding planes, which are laterally continuous within the rock.

1.6 Hydrology

The main watercourse within the vicinity of Llanddulas Landfill is the Afon Dulas, located approximately 200 to 400m to the east of the site. This watercourse flows in a northerly direction and discharges into the Irish Sea approximately 1.3km to the north-east of the site. The coastline lies approximately 600m and 300m to the north of Phase 1 and the Lower Quarry areas respectively. An unnamed tributary of the Afon Dulas, which flows in an easterly direction, is located over 1km to the south of the site.

Indicative maps, presented on the Environment Agency’s website, suggest that the floodplain associated with the Afon Dulas is extremely limited. Llanddulas landfill does not lie in any indicative flood plain.

2.0 LANDFILL GAS REVIEW

Routine monitoring for off-site landfill gas was undertaken on a fortnightly basis within 33 perimeter monitoring boreholes and monthly in a further 41 in accordance with the requirements of Table S4.5 of the Site Permit issued in June 2016. Perimeter boreholes 2003/1 & 2003/2 remain unmonitored due to being buried in a rock fall. Following the latest Permit issue, monitoring of perimeter boreholes was reduced in the most recent variation to fortnightly for the boreholes in the higher risk (of migration) area of site on the Eastern boundary and monthly for all perimeter boreholes.

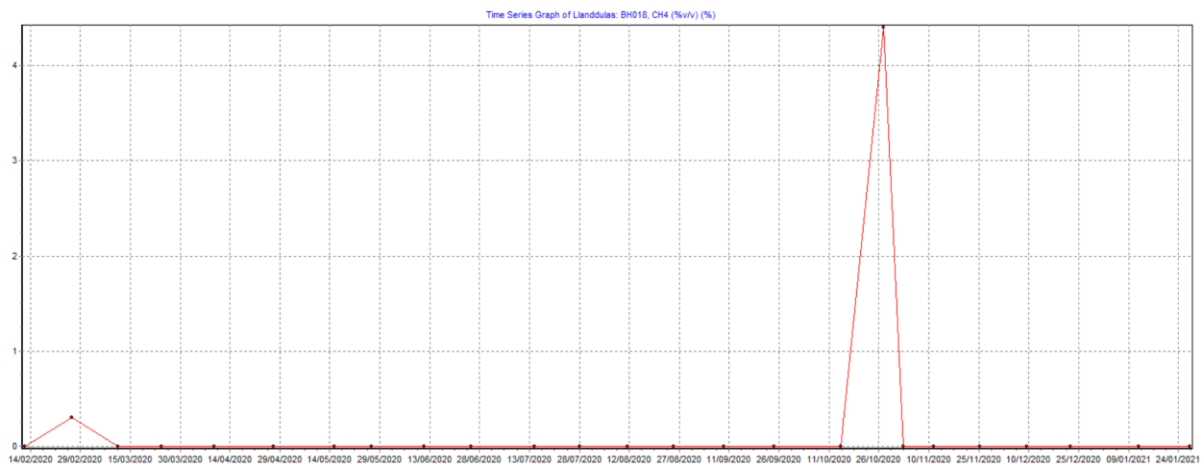
Methane, Carbon Dioxide, Oxygen, relative pressure and atmospheric pressure are all recorded.

The locations of monitoring points are shown on the site monitoring plan, Drawing No. 2.

The trigger levels for landfill gas concentrations are those submitted and agreed with NRW in accordance with improvement condition S1.3.13, agreed with the then EA Wales in November 2012 (CAR form RDR/121105). The trigger limit for methane is 1% (action limit of 0.5%), with the exception being 2.5% in borehole BH40 which has an action limit of 1.5%. Specific actions to be taken if the limits are breached are detailed in the latest version of the site Landfill Gas Management Plan.

2.1 Landfill Gas Data Summary

A single breach of methane was detected in BH18 on the 27th October 2020, recording a concentration of 4.4% (v/v), illustrated below.



There were no further breaches of methane in this or any other borehole throughout the review period.

Since November 2012 (following the agreement of CO₂ Action Limits, as part of the IC13 submission), Carbon Dioxide has no longer been used as a landfill gas migration indicator in the absence of methane.

To summarise, there are no trends of elevated Methane within the perimeter boreholes that would indicate ongoing lateral migration of landfill gas beyond the site perimeter, with the single exceedance recording compliant results thereafter. Elevated readings of Carbon Dioxide are thought to be present because of the localised geology.

2.2 Landfill Gas Management

Landfill gas control currently consists of 1 X 1003kW Jenbacher engine located in the LFG utilisation plant. In addition there is 1 x 1003kW Jenbacher engine, currently stood down, 1 X 2000m³ high temperature flare and 1 X 1000m³ high temperature flare which can provide sufficient gas control should the engines suffer any downtime.

The landfill gas control system was monitored in accordance with Tables S4.1, S4.2 and S4.7 of the site Permit, with a total of 2,217 readings taken throughout the review period. The annual trace gas analysis and engine emissions data are appended to the end of this report. After a review of the data, the following observations can be made.

- The average measured emission concentrations from the combined stack met the standard for NO_x, CO and TVOC as per Table S4.2 of the site permit on Engine 1 (A2).
- The flares ran significantly less than 10% of the time during the review period, and therefore emissions testing was not required.
- Average methane concentrations for the gas extraction wells during the review period were 41.17% (v/v) compared with 39.06% (v/v) in 2019, and average carbon dioxide concentrations were 28.25% (v/v) compared with 28.60% (v/v) in 2019. At the gas plant inlet, methane concentrations averaged 44.48%, slightly higher than the 43.63% (v/v) recorded in 2019, and carbon dioxide averaged 32.18% (v/v) compared with 31.17% (v/v) in 2019.
- Carbon monoxide concentrations at the gas extraction wells averaged 2.93ppm for the duration of the review period, compared with 3.76ppm during 2019, and 2.31ppm at the gas plant inlet, lower than the 4.38ppm recorded in 2019.
- Oxygen readings at the gas extraction wells averaged 2.54% (v/v) throughout the review period, and recorded an average of 1.61% (v/v) at the gas plant inlet. During the previous review period, oxygen readings at the gas extraction wells averaged 2.55% (v/v), and averaged at 1.75% (v/v) at the gas plant inlet.
- Suctions within the field averaged -17.50mbar for the duration of the review period, and at the gas utilisation plant averaged -42.68mbar. During 2019, suction within the field averaged -33.01mbar at the gas utilisation plant averaged -88.66mbar.
- The average flow recorded at the gas utilisation plant during 2019 was 807m³/hr and produced an average of approximately 1281kW of exportable energy per month. During the 2020 review period, average flow was recorded as 589m³/hr and the gas utilisation plant produced approximately 1007kW of exportable energy per month.
- No CO readings taken at any gas wells breached the 100ppm limit. The highest reading recorded was 49ppm in gas well WD270 in December 2020 and again in January 2021.

The effectiveness of the gas management system is tested by monitoring gas compositions at the gas collection and extraction wells. Monitoring of the gas extraction system is carried out in accordance with the requirements of Tables S4.2 and S4.7 of the site Permit. Table S4.7 specifies

that where oxygen levels exceed 5%(v/v), or where the addition of Carbon Dioxide and Methane percentages is less than 80%, an assessment of air ingress shall be undertaken.

There were a total of 2,217 readings obtained during the review period and of these, there were 1055 results which showed a total percentage of Carbon Dioxide and Methane of less than 80% (v/v).

A total of 296 results showed O₂ in excess of 5%, compared to 382 recorded in the previous review period. Assessments of these wells showed that the majority of readings led to the valves at these points being closed or significantly reduced, to prevent any potential oxygen ingress, yet maintaining a degree of gas control. Investigations are actioned when the control limits specified within Table S4.7 of the Site Permit are exceeded and corresponding remedial actions promptly instigated by our gas contractors.

To summarise, the current landfill gas infrastructure is deemed to be adequate for the control of emissions on site, although with decreasing waste inputs with reducing biodegradable content, gas volumes are seen to be declining over previous review periods.

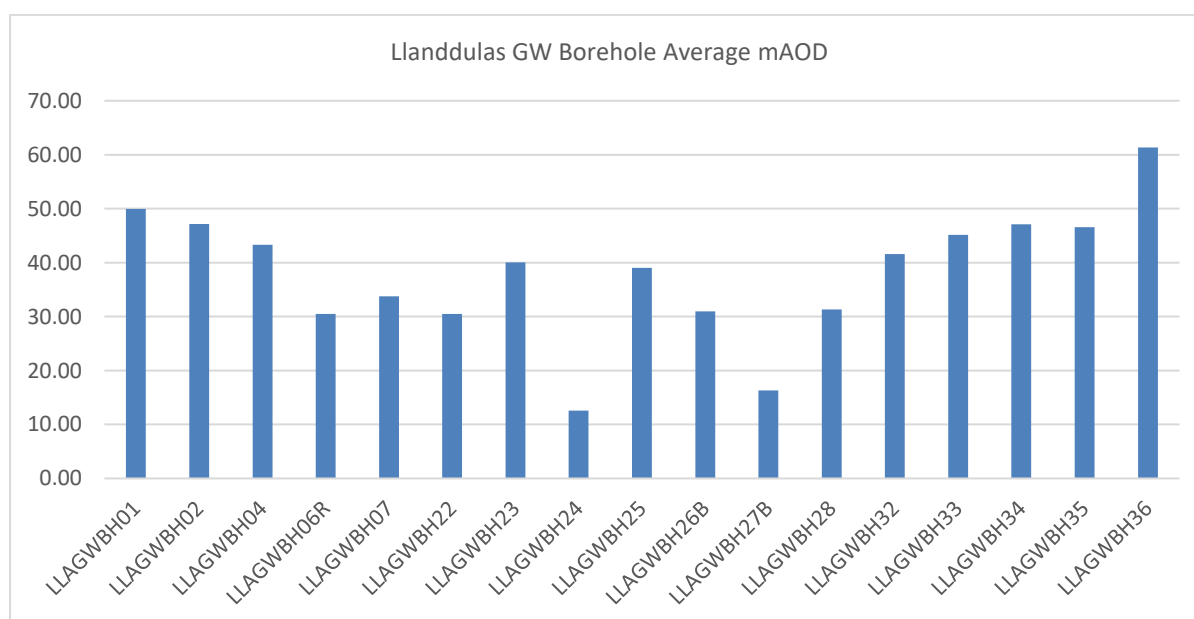
GROUNDWATER REVIEW

3.1 Groundwater Levels

Table S4.10 of the site permit requires that groundwater levels are recorded on a quarterly basis within the up, down and cross gradient groundwater monitoring points.

Summaries of the available groundwater level data are presented below, and average water levels (mAOD) are presented graphically.

GW Borehole	Minimum mAOD	Maximum mAOD	Average mAOD
LLAGWBH01	44.68	56.77	49.94
LLAGWBH02	45.68	47.97	47.15
LLAGWBH04	37.75	52.07	43.32
LLAGWBH06R	30.17	30.74	30.47
LLAGWBH07	32.09	34.9	33.75
LLAGWBH22	27.15	34.54	30.48
LLAGWBH23	40.05	40.05	40.05
LLAGWBH24	12.18	12.93	12.57
LLAGWBH25	36.11	41.39	39.02
LLAGWBH26B	30.21	31.76	30.95
LLAGWBH27B	15.71	17.16	16.32
LLAGWBH28	30.73	32.88	31.30
LLAGWBH32	36.18	48.39	41.61
LLAGWBH33	45.13	45.13	45.13
LLAGWBH34	46.25	47.95	47.10
LLAGWBH35	44.79	48.34	46.57
LLAGWBH36	51.15	71.41	61.34



The groundwater level beneath the site varied between 12.18mAOD in borehole GWBH24 (downstream of groundwater flow across site) located in Llanddulas village to the North-East of site and 71.41mAOD in GWBH36 on the Eastern boundary (although it should be noted the level in this borehole can have a high degree of fluctuation). Borehole GWBH23 is reported as liquid level to top of case of each monitoring visit.

The wide variation in groundwater levels is in part a function of the wide variation in topography across the site ranging between 180mAOD to the south and 30mAOD in the north. It is also possible that proximity to the sea could give rise to tidal fluctuations within the aquifer, especially in the more northerly boreholes. Wide groundwater fluctuations are typical of karstic aquifers and their response to recharge events.

The range in AOD groundwater levels across the boreholes can vary greatly. It is common to observe a wide variation because the nature of recharge event response varies depending on the degree of fissuring or solution cavity exposed to the screened section of the monitoring well.

3.2 Groundwater Quality

Groundwater samples are scheduled to be taken in accordance with the requirements of Table S4.4 and S4.10 of the Site Permit. GWBH34 & GWBH6R were recorded as insufficient liquid to sample throughout the review period. In April GWBH35 was recorded as blocked.

From 2019 to January 2021, several determinants listed in Table S4.8 and S4.10 were not analysed as per the Site Permit requirements, which have been detailed on a schedule notification to NRW. The omissions for Q3 and Q4 of 2020 were also repeated in Q1 and Q2 of 2020. Cadmium, Calcium, Chromium, Copper, Dissolved methane, Iron, Magnesium, Manganese, Nickel, Sodium, TOC, TON, Alkalinity (as CaCO₃), Total Sulphates and Zinc were missing from the analysis for boreholes LLAGWBH4, LLAGW1, LLAGWBH7, LLAGWBH23 and LLAGWBH35.

Once a full year of sampling has taken place during 2021, the 2022 annual review will incorporate a 5 year review of these missing determinants in order to draw discussion to any suspected trends during the missed monitoring.

Also, in Q1 of 2020, the GWBH36 sample was not analysed for Tributyl Tin, which has an EAL assigned.

A review of the monitoring schedule has been completed, with grateful assistance from NRW, and a latest update sent to the laboratory 24/02/2021 after being reviewed by the Regional Environment Manager.

Table S4.4 of the site permit variation contains borehole specific trigger levels for groundwater quality which are detailed below.

Trigger levels for emissions into groundwater			
Boreholes GWBH4, GWBH7, GWBH23, GWBH25, GWBH34, GWBH35 & GWBH36			
Parameter	Limit	Parameter	Limit
Ammoniacal-N	1mg/l	Potassium	12mg/l
Chloride	250mg/l	Phenols	0.5ug/l
Mercury	0.01ug/l	Tributyl Tin	0.001ug/l
Mecoprop	0.04ug/l	Trifuralin	0.01ug/l

The following observations can be made in relation to groundwater quality:

There were no breaches of the site permit specific trigger limit for Ammoniacal Nitrogen, Chloride, Mercury, Potassium, Mecoprop, Tributyl Tin, or Trifuralin throughout the review period.

During the review period, there was a single phenol exceedance observed in borehole GWBH23 in October 2020, recording a concentration of 0.0032mg/l. All other results obtained in this boreholes and all others during the review period were recorded as below the limit of detection (<0.0005mg/l).

A revised HRA was submitted to NRW in January 2020 which proposed several analysis suite changes and frequency changes to both groundwater and leachate monitoring. FCC are awaiting further comment from NRW, but until such a time monitoring shall continue as per the current schedule.

4.0 LEACHATE REVIEW

Leachate levels are recorded on a monthly basis in accordance with Table S4.1 of the most recent Site Permit Variation (June 2016). Leachate samples are scheduled to be collected on a quarterly basis as agreed in writing (April 2013) with Natural Resources Wales.

Locations of the monitoring points can be found on Drawing 2, attached with this report.

The leachate samples are analysed for a range of determinands as specified in Table S4.8 of the Site Permit.

4.1 Leachate Levels

Leachate monitoring within restored and active phases currently occurs at 7 leachate extraction and 7 leachate monitoring points in accordance with the requirements of Table S4.1 of the site Permit. During the review period, all chambers recorded levels below the 2m trigger limit attaining a 100% compliance result. Each leachate chamber is checked weekly by site staff to ensure correct pumping operation and all leachate generated was treated via the on-site LTP.

4.2 Leachate Quality

The leachate quality was scheduled to be monitored in 7 Leachate Collection Points (across phases 1, 2, 3 and 3A) and compared to assessment limits set in the last accepted HRA (summarised below).

Parameter	Limit
Ammoniacal-N	3500mg/l
Chloride	3900mg/l
Lead	120mg/l

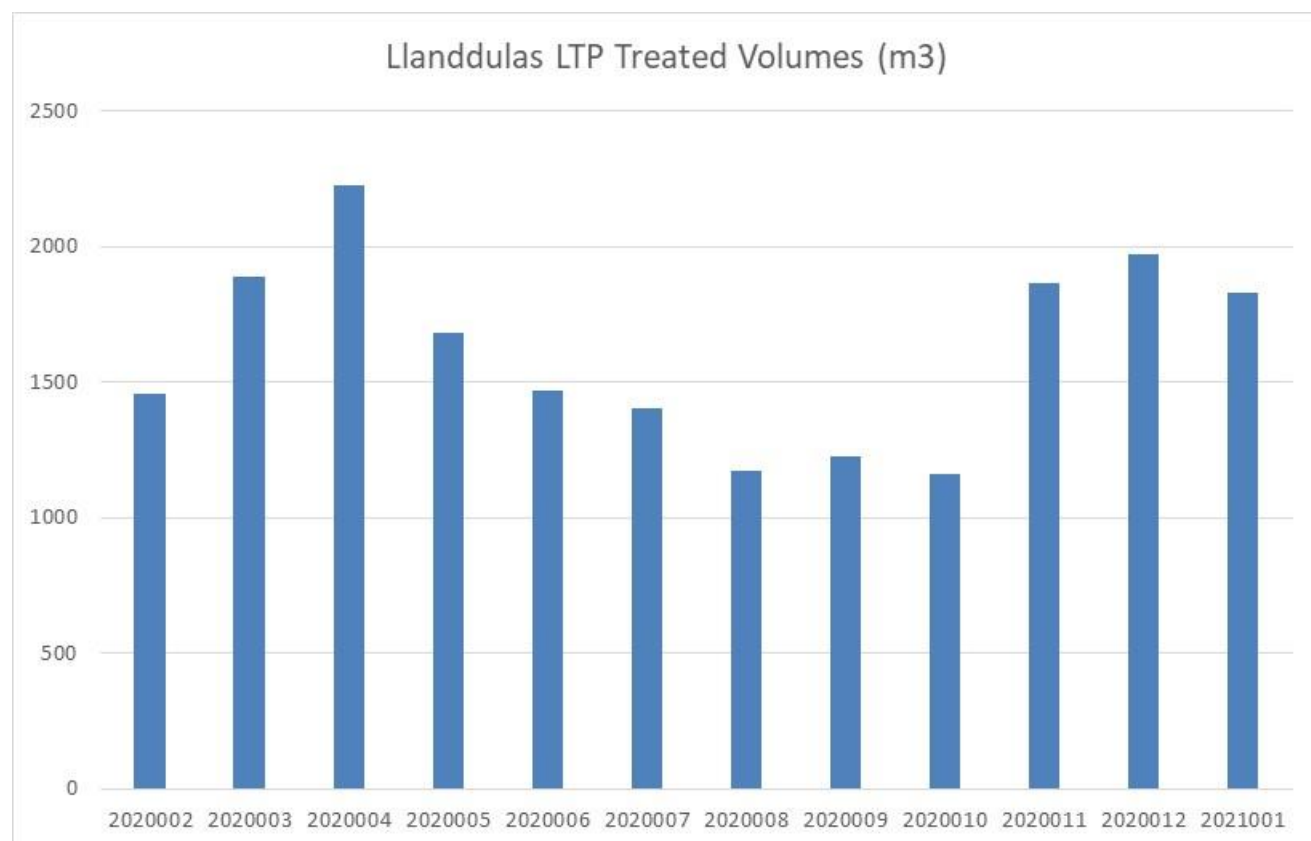
It should be noted that leachate composition will vary with the age and moisture content of the waste.

After a review of the leachate quality data, the following comments can be made:

- Ammoniacal-N concentrations were recorded below assessment level for the duration of the review period, with the highest concentration of 2440mg/l detected in LCP3A, the newest chamber on site. A minimum concentration of 130mg/l recorded in chamber LCP2AR represents the lowest reading on site. An average concentration of 1350mg/l was recorded throughout the review period.
- Chloride concentrations were consistently below the assessment level throughout the monitoring period, with a maximum concentration of 3280mg/l recorded in chamber LCP2BR, a minimum concentration of 246mg/l in chamber LCP2AR, and an average concentration of 2330mg/l recorded throughout the review period.
- All Lead concentrations were consistently below the assessment level throughout the monitoring period. The highest Lead concentration recorded was detected in LCP3 at 0.017mg/l.
- The leachate quality remains as modelled and appears to be typical of a landfill site that received a variety of waste types.

4.3 Leachate Management

A total of 19,356 m³ of leachate was treated at the on-site treatment plant during the review period 01/02/20 to 31/01/21. This total includes imported leachate from either other FCC sites or from landfill sites on Anglesey. Leachate is pumped from 7 collection chambers, 6 monitoring points and in addition a series of pumped 'pots' which range in depth from 10m to 15m. Leachate is also pumped to the LTP from a number of gas wells. Priority is always given to the treatment of on-site leachate when the plant is at full capacity of 150m³/day.



5.0 SURFACE WATER REVIEW

Surface water is scheduled to be sampled in accordance with Table S4.3 and S4.9 of the Site Permit.

There were no emissions through the consented discharge point W1 for the duration of the review period, although this location was sampled on a monthly basis.

Concentrations of ammoniacal nitrogen in the Dulas River and Dulas Valley Spring sampling locations averaged 0.05mg/l. The highest reading recorded for the Dulas Spring was 0.03mg/l in June 2020.

Chloride concentrations averaged 38.9mg/l in all sampling locations, with a maximum concentration of 57mg/l recorded from the Dulas Spring. These concentrations are significantly below the UK DWS limit of 250mg/l. The average of the previous review period was 41.24mg/l.

Results of Mercury were reported above the limit of detection only twice in July 2020, with a maximum reading of 0.00008mg/l. The highest concentration during the previous review period was 0.0001mg/l.

Mecoprop concentrations for the 3 surface water sampling locations recorded a maximum concentration of 0.05ug/l in March and August 2020.

6.0 EMISSIONS TO AIR

6.1 Flux Box/FID Surveys

The Site Permit states that the Operator shall ensure that all appropriate measures are taken to prevent or where that is not practicable to reduce fugitive emissions to air from:

- open surfaces, unfilled, operational and filled landfill surfaces;
- storage areas
- buildings
- pipes, valves and other transfer systems.

Emissions to air are monitored in accordance with the requirements of Tables S4.6 & S4.11 of the Site Permit. A monthly walkover survey of the landfill and all infrastructure is carried out on a monthly basis using a TDL-500 Gazomat Inspectra Laser methane leak detector machine. Details of any exceedances found are reported to NRW and included in the quarterly reports using the TDL breach tracker. Any exceedances of 1000ppm at any point of infrastructure are remediated the same month via co-ordination between FCC and Infinis, with action plans developed and closed out accordingly.

Gas well D317 recorded 3 consecutive breaches of the 1000ppm compliance limit, occurring during months January to March 2020. This was communicated to NRW via a schedule notification.

A monthly perimeter survey of the site is also completed using an FID machine, of which no breaches of assessment limits have been seen throughout the review period.

Quarterly Jerome surveys, concentrating specifically on detection of hydrogen sulphide, were conducted on a quarterly basis throughout the review period, again recording no concentrations approaching any assessment limit.

Annual Improvement Target Review

Energy efficiency continues to increase at the Llanddulas landfill site with the KWh/Tonne ratio for 2020 standing at 3.3 against a target of 4.2. This is in comparison to a KWh/Tonne ratio of 4.3 in 2019. Annual gas oil consumption has reduced by over 25% from 2019 whilst annual tonnages have only reduced approx. 10%.

After reviewing the configuration of static plant a decision was made to park up the Aljon compactor and remove the CAT 963 from site. This has resulted in the reduction of fuel used and has contributed to an annual reduction of 21% in the significance test.

Electricity (office only) has also slightly reduced on site from 73777Kwh in 2019 to 73039Kwh in 2020. This could be attributed to a reduction in staff during 2020 due to Covid-19 and the ongoing training of employees in energy management.

In order to maintain the current levels of energy efficiency the site will continue to work to best practice for waste handling techniques, machine maintenance and consider the reduction of energy users on site or upgrading to more energy efficient users.

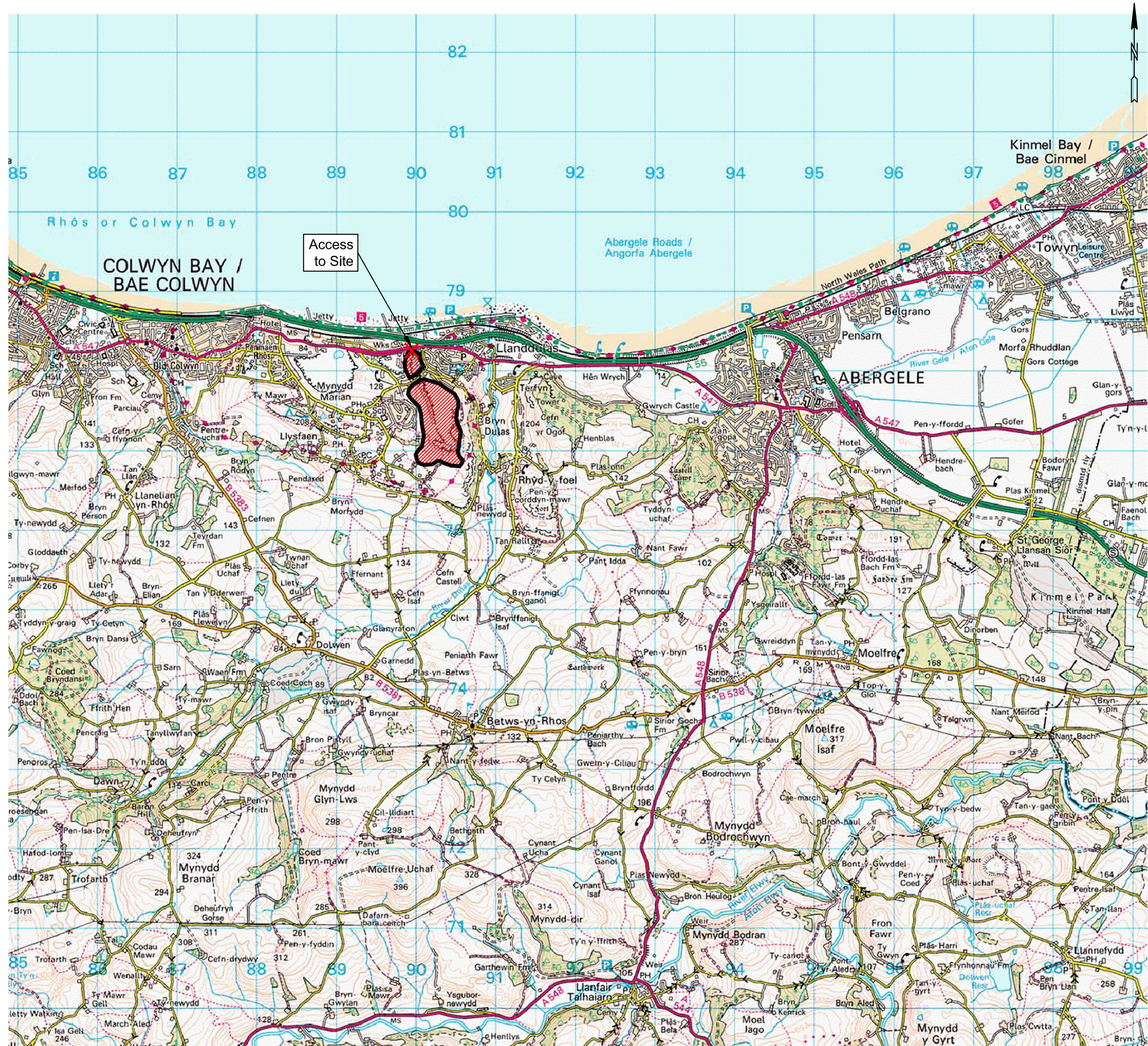
The corporate energy reduction target is set at a 1% reduction target year on year. Each site has a year which is used as a baseline from which the 1% reduction target is measured against.

The baseline year for Llanddulas was set at 2015 but this was amended to 2019 during 2020. It was apparent that 2015 was no longer suitable as a baseline and didn't reflect current operations in terms of energy usage and tonnages.

Tonnages are likely to have peaked in 2018 and will likely decrease moving forwards due to declining void space and the waste companies moving away from Landfill for a greener option. Therefore 2019 appears to be a good option to set as a revised baseline.

2020 has been a difficult year to accurately monitor the sites energy efficiency due to the pandemic which has caused large swings in the incoming waste. When the site has been quiet Plant Operators have been carrying out site works which has used fuel with little tonnages coming in effecting the Kwh/Tonne figures. Hopefully things will settle down in 2021 and we will be able to monitor this more accurately.

DRAWING 1



Llanddulas Landfill Site
Abergele
Clwyd
LL22 8PH
Tel: 01492 518248

5km east of Colwyn Bay, North Wales
Site centred N.G.R. SH903776

REVISIONS				
No	Description	By	Chk'd	Date
A	Titlebox updated.	CMD	CJM	07.07.04

Project: **LLANDDULAS LANDFILL SITE**

Title: **Site Location Plan**

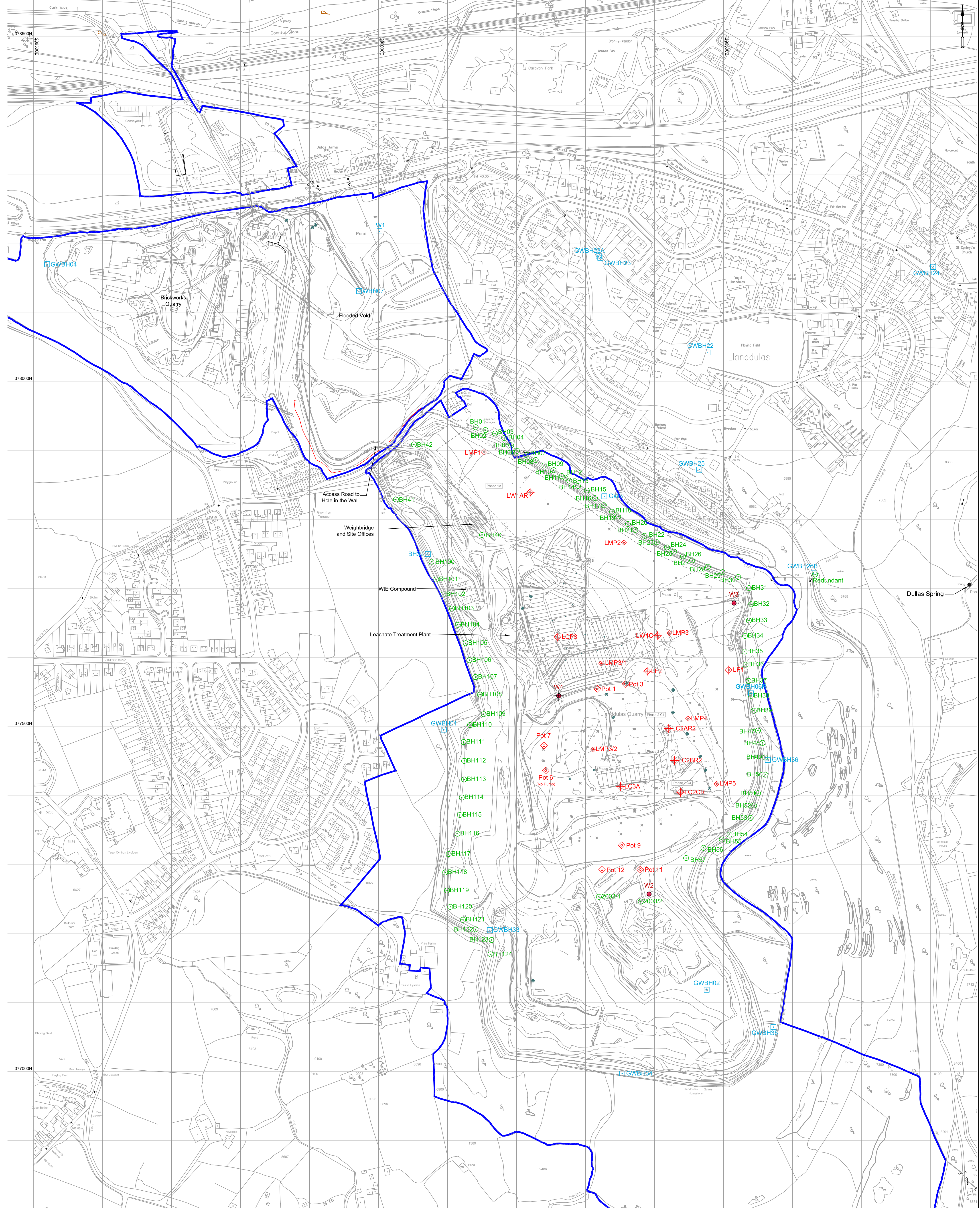
Drawn By	JRP	Date	21.06.01
Chk'd By	CJM	Date	21.06.01
Scale 1:	50,000	Sheet Size	A3

Waste Recycling Group
3 Sidings Court
White Rose Way
Doncaster
DN4 5NU



Drawing No
122T020A

DRAWING 2



LEGEND

Ownership Boundary

Landfill Gas Monitoring Borehole

Landfill Gas Surface Monitoring Point

Combined Gas/ Groundwater Monitoring Point

Gas Flare Stack

Landfill Gas Extraction/ Leachate Monitoring Point

Condensate Unit (Knock-out Pot)

Gas Manifold

Groundwater Monitoring Borehole

Groundwater Pumping Point

Surface Water Monitoring Point

Leachate Collection Point

Leachate Monitoring Point

Leachate Recirculation Point

Leachate Collection Sump

Leachate Discharge Sampling Point

Leachate Detection Point

Underdrainage Monitoring Point

Site Investigation Borehole

Soakaway

Drain/ Dewatering Tank

Valve

As-built Cell Footprint

Files Used:

Site Survey: 122E1400

Monitoring Plan: 122M1126

Cell Footprints: 122B014

REVISIONS

No	Description	By	Chk'd	Date
A	Well Detail Updated	LH	GF	12.05.14

Project:

**LLANDDULAS
LANDFILL SITE**

Title:

Environmental Monitoring Plan

Drawn By: LH

Date: 28.05.14

Chk'd By: GF

Date: 28.05.14

Scale 1: 2500

Sheet Size A1

FCC Environment (UK Limited)
3 Skidings Court
White Rose Way
Doncaster
DN4 5NU

FCC Environment (UK Limited)
3 Skidings Court, White Rose Way, Doncaster, DN4 5NU

Drawing No:
122M264

Plan A4

Left Hand By: Llanddulas Quarry Site 12-2-2014-14

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APPENDIX 1

Site: Llanddulas

Permit: BP 3734 XX

Reporting period: 6th February 2020 - 6th February 2021

Test date: 09-Dec-20

Engine Emission Data

Engine 1 (A2)	Species	Method description		Measurement uncertainty (+ or - mg/Nm3)	Average measured emission concentration (mg/Nm3)	LFTGN08 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence	BS EN 14792	11	562	30	731	393	650
	CO	IR	BS EN 15058	19	1492	20	1790	1194	1,500
	TVOC	FID	BS EN 12619	37	917	40	1284	550	1,750

Engine 2 (A3)	Species	Method description		Measurement uncertainty (+ or - mg/Nm3)	Average measured emission concentration (mg/Nm3)	LFTGN08 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence	BS EN 14792	na	see note 4	30	na	na	650
	CO	IR	BS EN 15058	na	see note 4	20	na	na	1,500
	TVOC	FID	BS EN 12619	na	see note 4	40	na	na	1,750

Engine 3 (A4)	Species	Method description		Measurement uncertainty (+ or - mg/Nm3)	Average measured emission concentration (mg/Nm3)	LFTGN08 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence	BS EN 14792	na	see note 4	30	na	na	650
	CO	IR	BS EN 15058	na	see note 4	20	na	na	1,500
	TVOC	FID	BS EN 12619	na	see note 4	40	na	na	1,750

Note 1 All data is expressed as mg/Nm3 at 273K, 101.3kPa, dry gas, corrected to an oxygen content of 5%. Average measured emissions concentration is calculated from data collected over a one hour period.

Note 2 The monitoring and reporting were carried out by Socotec, an MCERTS accredited contractor.

Note 3 Measurement uncertainty is shown. Overall site uncertainty could not be deduced from available data - maximum uncertainty values set out in LFTGN08 have therefore been applied.

Note 4 Engine 3 (A4) was removed from site in January 2016. Available landfill gas is normally controlled by the two remaining engines. Engine 2 (A3) has been taken out of service. If the engine becomes available again emissions testing will be carried out.

Note 5 All measured parameters on engine #1 engine met permit requirements.

Note 6 Over the past 12 months, flare #2 (which is the lead flare) has run for more than 10% of the time - emissions testing was therefore required (see separate tab)

INFINIS ENERGY SERVICES LIMITED

Periodic monitoring of raw landfill gas

LLanddulas Landfill Site

Report LNO16097-TG

Date 19 January 2021

Issue 1



PERIODIC MONITORING OF RAW LANDFILL GAS

LLANDDULAS LANDFILL SITE

Report prepared for

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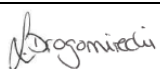
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Issue history

Issue	Date	Approved
LN016097-TG, 1	19 January 2021	L Drogomirecki 
First issue		

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1 Introduction

Infinis Energy Services Limited (Infinis) contracted SOCOTEC UK Limited (SOCOTEC) to undertake monitoring of the landfill gas supply to its combustion operations at the Llanddulas Landfill site.

2 Test methodology

Infinis requested that duplicate samples of landfill gas be collected and analysed for the priority trace components (LFGTGN04, Table 1.1) specified in Environment Agency guidance (Guidance for monitoring trace components in landfill gas – LFGTGN04 v3.0, 2010). The test methodology should be in accordance with that specified within LFGTGN04.

Based on LFGTGN04 the priority trace gas components are sampled using a combination of four sampling media as shown in Table 1.

Table 1 Sampling media and analytical methods

Trace component	CAS number	Sampling method	Analytical method
1,1-dichloroethane	75-34-3	Dual solid sorbent	ATD-GC-MS
1,2-dichloroethane	107-06-2	Dual solid sorbent	ATD-GC-MS
1,1-dichloroethene	75-35-4	Dual solid sorbent	ATD-GC-MS
1,2-dichloroethene	540-59-0	Dual solid sorbent	ATD-GC-MS
1,3-butadiene	106-99-0	Dual solid sorbent	ATD-GC-MS
1-butanethiol	109-79-5	Dual solid sorbent	ATD-GC-MS
1-pentene	109-67-1	Dual solid sorbent	ATD-GC-MS
1-propanethiol	107-03-9	Dual solid sorbent	ATD-GC-MS
2-butoxyethanol	111-76-2	Dual solid sorbent	ATD-GC-MS
Arsenic (as As)	7440-38-2	Charcoal	ICP-MS
Benzene	71-43-2	Dual solid sorbent	ATD-GC-MS
Butyric acid	107-92-6	Dual solid sorbent	ATD-GC-MS
Carbon disulphide	75-15-0	Dual solid sorbent	ATD-GC-MS
Chloroethane	75-00-3	Dual solid sorbent	ATD-GC-MS
Chloroethene (vinyl chloride)	75-01-4	Dual solid sorbent	ATD-GC-MS
Dichloromethane	75-09-2	Dual solid sorbent	ATD-GC-MS
Dimethyl disulphide	624-92-0	Dual solid sorbent	ATD-GC-MS
Dimethyl sulphide	75-18-3	Dual solid sorbent	ATD-GC-MS
Ethanal (acetaldehyde)	75-07-0	Silica gel/2,4 DNPH	HPLC-DAD
Ethanethiol	75-08-1	Dual solid sorbent	ATD-GC-MS
Ethyl butyrate	105-54-4	Dual solid sorbent	ATD-GC-MS
Furan (1,4-epoxy-1,3-butadiene)	110-00-9	Dual solid sorbent	ATD-GC-MS
Hydrogen sulphide	7783-06-4	Charcoal	IC
Methanal (formaldehyde)	50-00-0	Silica gel/2,4 DNPH	HPLC-DAD
Methanethiol	74-93-1	Dual solid sorbent	ATD-GC-MS
Styrene	100-42-5	Dual solid sorbent	ATD-GC-MS
Tetrachloromethane	56-23-5	Dual solid sorbent	ATD-GC-MS
Toluene	108-88-3	Dual solid sorbent	ATD-GC-MS
Trichloroethene	79-01-6	Dual solid sorbent	ATD-GC-MS

ATD – automated thermal desorption

GC-MS – gas chromatography and mass spectrometry

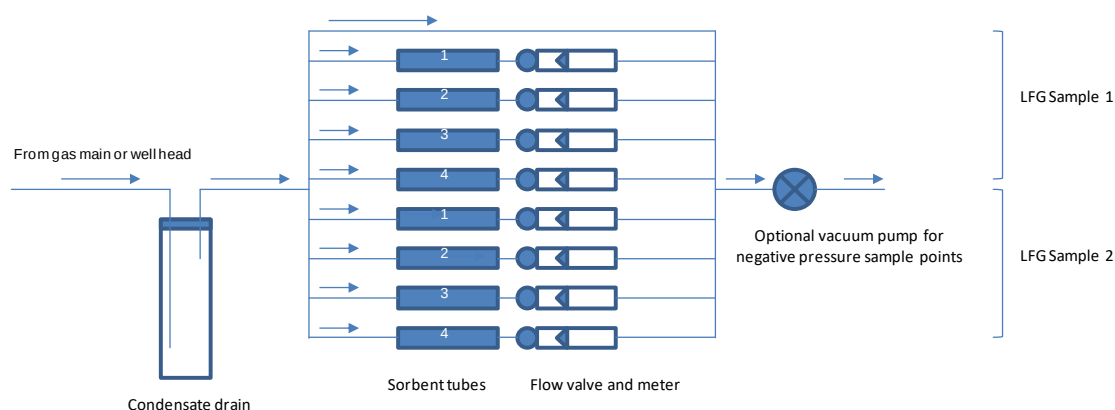
ICP-MS – inductively couple plasma/mass spectrometry

HPLC-DAD – high performance liquid chromatography and diode array detection

IC – ion chromatography

Sampling for all components is undertaken simultaneously using a multiple stream sampler as shown in Figure 1.

Figure 1 Landfill gas sampling arrangement



A sample is taken from either the gas main or well head and passed through a condensate drain to remove excess moisture. The sample gas is then split to pass through a series of eight regulated rotameters arranged in two banks of four. There is also a bypass stream for excess sample. This allows the duplicate simultaneous sampling at regulated flow rates onto four sampling media. The flow rates and sampling duration are set in accordance with LFGTGN04 requirements as summarised in Table 2.

Table 2 Sampling media and analytical methods

Media	Target species	Sampling rate (ml/min)	Sampling duration (min)	Sample volume (l)
Dual solid sorbent (Tenax/Sulficarb)	VOCs	20	10	0.2
Silica gel and 2,4 DNPH (SKC 226-119)	Aldehydes	20	50	1.0
Activated carbon 1 (SKC 226-09)	Arsenic	100	50	5.0
Activated carbon 2 (SKC 226-09)	Hydrogen sulphide	100	50	5.0

In the case of negative pressure sources it is necessary to employ a vacuum pump at the sampler's common outlet. This is not normally required with positive pressure systems

This results in two duplicate samples of landfill gas with each sample comprising the four sub-samples above covering all of the priority trace components within Table 1.

The samples are subject to the analytical procedures described in Table 1 to provide a mass on the collected sample which can then be related to the volume of gas sampled to provide a component concentration in the sampled landfill gas.

The sampling followed internal procedure GAS14 and is accredited under test certificate 1015.

3 Site information

Sample point details			
Date	09 December 2020	Site	Llanddulas landfill site
Ambient temperature	12 °C	Atmospheric pressure	99.6 kPa
Monitoring organisation	SOCOTEC UKAS 1015	Analytical laboratory	SOCOTEC UKAS 1252
Location of sampling point	Gas main to compound After blower	Area of influence of collection system sampled	All
Type of sample point	¼" Tefen	Temperature of gas	16 °C
Pressure at sample point	150 mb	Type of waste	Not recorded
Status of gas system	Active	Age of waste	Not recorded

4 Preliminary checks and field measurements

Parameter		Concentration
Methane	%	40.6
Carbon dioxide	%	37.4
Oxygen	%	1.6
Nitrogen	%	20.4
Hydrogen sulphide	ppmv	85.2
Carbon monoxide	ppmv	2.1

*carbon monoxide is measured with a hydrogen sulphide filter in the sampling line.

Preliminary bulk gas measurements were undertaken using a Gasdata LMSxi electrochemical cell analyser (no 5167). Reported measurements are spot readings following gas sampling for a period of 5 minutes.

5 Results of landfill gas analysis

The results of the sampling and analysis are summarised in Table 3 below.

Table 3 Priority trace component measurement results

Parameter		Concentration ($\mu\text{g}/\text{m}^3$,STP)
1 Pentene		<106
1,1-Dichloroethane		<32
1,1-Dichloroethylene		<48
1,2-Dichloroethane		159
1,2-Dichloroethylene		585
1,3-Butadiene		<37
1,4 epoxy 1,3 butadiene		1063
1-Propanethiol		<106
2-butoxyethanol		<106
Benzene		7442
Butyric acid		<213
Carbon disulphide		10100
Carbon tetrachloride		<53
Chloroethane		<53
Dichloromethane		744
Dimethyl disulphide		372
Dimethyl sulphide		10100
Ethyl butyrate		159
Ethyl mercaptan		<159
Methyl mercaptan		<532
N-Butyl mercaptan		<159
Styrene		532
Toluene		21262
Trichloroethene		<53
Vinyl chloride monomer		1063
Arsenic		447
Hydrogen sulphide		90031
Acetaldehyde	*	213
Formaldehyde	*	213

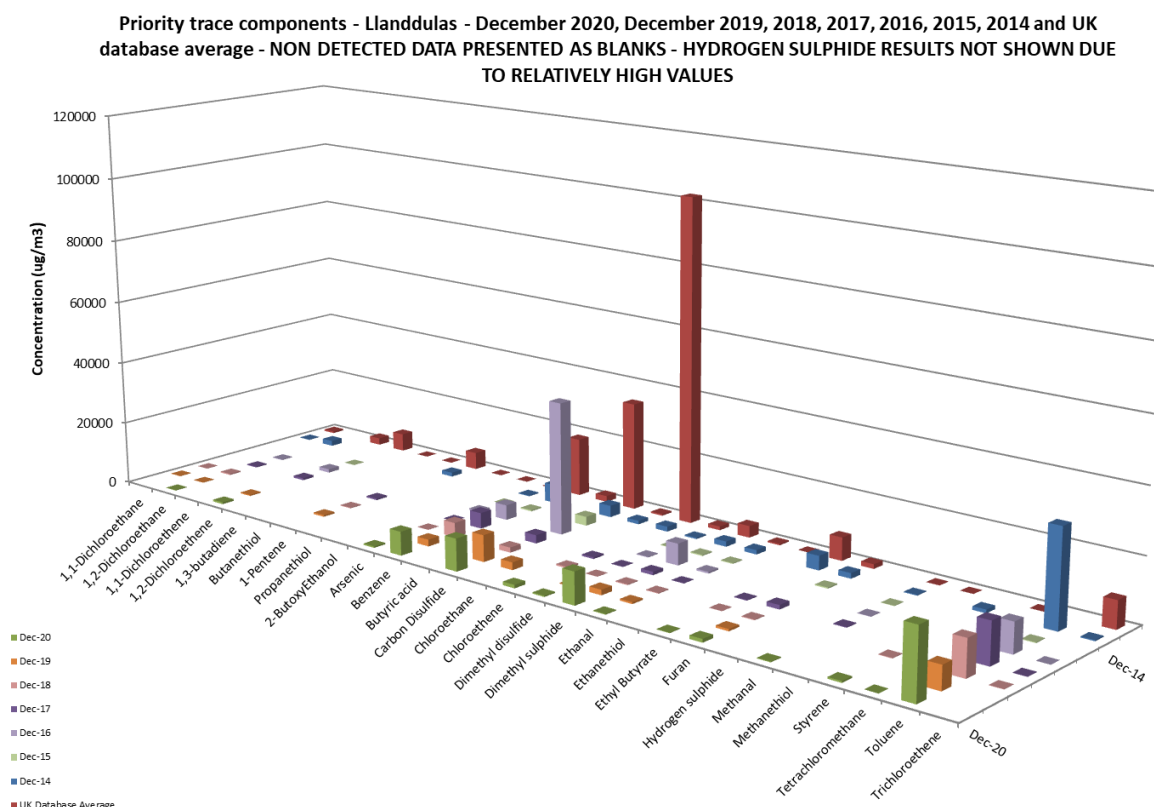
* indicates result is UKAS accredited

< indicates result is below the method limit of detection

The above reported results are the maximum concentrations measured for each parameter in two samples.

The maximum results of the current analyses are compared with historical data and the UK database average in Figure 2.

Figure 2 Historical priority trace component analysis results at Llanddulas



6 Notes

Sampling of landfill gas was undertaken in accordance with SOCOTEC procedure GAS14 and is UKAS accredited under certificate 1015.

Analysis of collected samples was undertaken by SOCOTEC's Bretby laboratory. The analytical results which fall within SOCOTEC's scope of accreditation under certificate 1252 are identified in Table 3.

The priority component measurements which can be considered to be within the scope of UKAS accreditation are identified in Table 3.

Any interpretations and opinions expressed are outside of the scope of UKAS accreditation.

END OF REPORT

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