PARRY'S QUARRY LANDFILL
ALLTAMI, FLINTSHIRE

Environmental Permit Application

Landfill Gas Risk Assessment
Prepared for: Mold Investments Limited
Client Ref: 416.07238.00001

SLR Ref: 416.00492.00019/ESID
Version No:1
August 2019

SLR

BASIS OF REPORT

This document has been prepared by SLR Consulting Limited with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with Mold Investments Limited (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

SLR shall not be liable for the use of or reliance on any information, advice, recommendations and opinions in this document for any purpose by any person other than the Client. Reliance may be granted to a third party only in the event that SLR and the third party have executed a reliance agreement or collateral warranty.

Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

The copyright and intellectual property in all drawings, reports, specifications, bills of quantities, calculations and other information set out in this report remain vested in SLR unless the terms of appointment state otherwise.

This document may contain information of a specialised and/or highly technical nature and the Client is advised to seek clarification on any elements which may be unclear to it.

Information, advice, recommendations and opinions in this document should only be relied upon in the context of the whole document and any documents referenced explicitly herein and should then only be used within the context of the appointment.

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1.0 Introduction

SLR Consulting Limited (SLR) has been instructed by Mold Investments Limited (Mold) to prepare an application for an Environmental Permit for Parry's Quarry Landfill and Waste Transfer Station (WTS) in Mold, Flintshire under the Environmental Permitting (EP) (England and Wales) Regulations 2016 (as amended).

This report sets out the Landfill Gas Risk Assessment (LFGRA) that has been prepared in support of this application. The proposed installation design and the site's setting (including geological and engineering information, site monitoring data and development proposals) are detailed within the Supporting Statement which is included with this application and should be read in conjunction with this document.

This document has been prepared to demonstrate that the proposed landfill is compliant with the requirements of the Environmental Permitting (England and Wales) Regulations 2016. These regulations implement the Landfill Directive and require that:

- Landfill gas must be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and, to the extent possible used;
- Appropriate measures must be taken in order to control the accumulation and migration of landfill gas;
- The collection, treatment and use of landfill gas must be carried out in a manner which minimises damage to or deterioration of the environment and risk to human health; and
- Landfill gas which cannot be used to produce energy must be flared.

This document has been prepared with due regard to Natural Resources Wales (NRW) EPR Guidance framework[1], and Landfill Technical Guidance Notes LFTGN03 - 08 on the management and monitoring of landfill gas.

Further, reference has been made to a previous EP application for a landfill at the site (refused) and the NRW Decision Document[2] as necessary throughout the report.

[1] https://naturalresources.wales/permits-and-permissions/environmental-permits/epr-guidance
[2] Natural Resources Wales permitting decisions, Parry's Quarry Non-Hazardous Waste Landfill Refusal Decision Document (Refused 20th December 2016)

2.0 Conceptual Model

The conceptual model for the assessment is presented in Figure 2-1 and a description of the site setting, sources, exposure pathways and receptors is provided in the following sections.

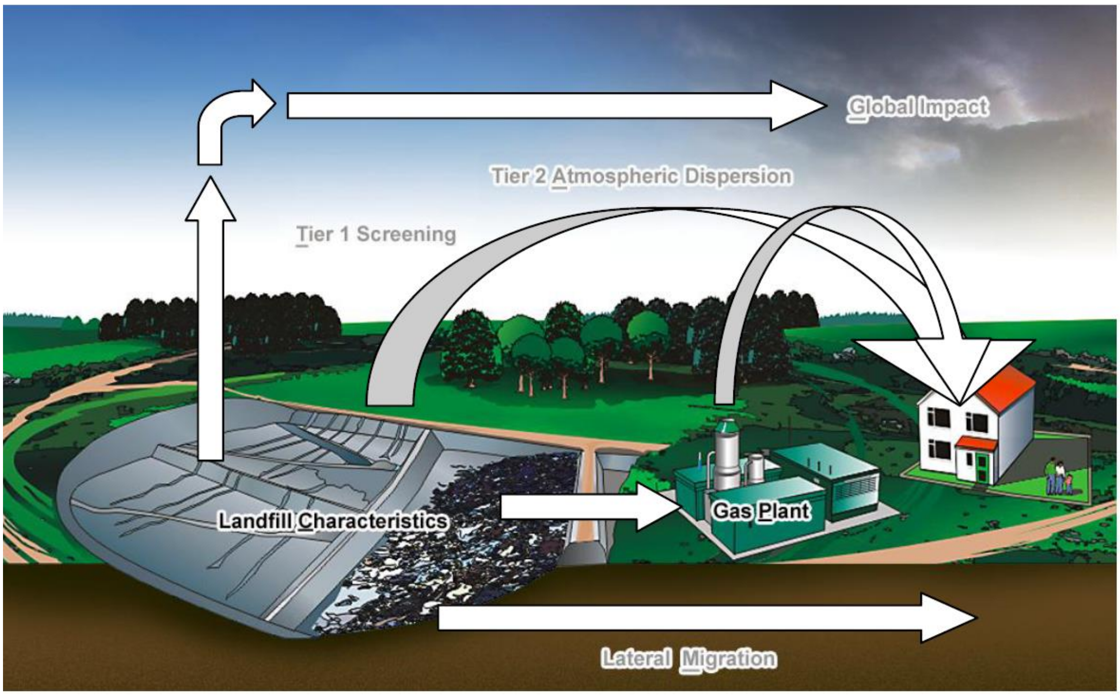


Figure 2-1
GasSim Landfill Gas Risk Assessment Conceptual Model

2.1 Site Setting

The site is situated within the existing Parry's Quarry in Alltami, Flintshire and bounded by the A494 to the south, A55 to the north and Pinfold Road to the west. The National Grid Reference (NGR) for the entrance to the site is SJ 27478 66278. The site location is presented on Drawing ESID1.

The land use immediately surrounding the proposed site is predominately agricultural land, with scattered residential and commercial / industrial premises. Access to the site will be via Pinfold lane. The site's environmental site setting is illustrated on Drawing ESID3 and ESID4.

2.2 Installation Details

The Site is currently operated as a brick clay quarry which covers an area of approximately 17 hectares. An area of the wider Site holds an EP (NRW Ref: EPR/TB3590HJ) for the transfer and reprocessing of inert waste. This EP application seeks to consolidate this activity within the overall landfill EP for the Site.

2.2.1 Sources

The proposed landfill operations comprise restoring the quarry void using non-hazardous and inert wastes within fully engineered containment cells. The site will be restored by importing approximately 2,050,133m^3 (2,460,161 tonnes[3]) of non-hazardous and inert waste material over an estimated 8-year period to enable satisfactory restoration. This will equate to 320,000 tonnes per annum (tpa).

Drawing ESID5 illustrates the design of the landfill and the location of each Phase. There are to be eight landfilled cells at the proposed Parry's Quarry landfill site; Cells 1, 2, 3, 4, 5, 6, 7 and 8. These cells will ultimately occupy a surface area of 9.8ha.

One of these cells, Cell 6, is designated as the cell that will accept biodegradable wastes. All other cells will be limited to commercial and industrial wastes that meet the <10% Loss on Ignition (LoI test), i.e. the waste will have less than 10% biodegradable material.

The landfill waste streams, can be split into the 3 following categories:

- Inert Waste (as defined in the Landfill Directive) – which will be deposited into Phases 1, 2, 3, 4, 5, 7, 8.
- Non-Hazardous Non-Biodegradable Waste (meeting <10% LOI test) – which will be deposited into Phases 1, 2, 3, 4, 5, 7, 8.
- Non-Hazardous Biodegradable Waste – only deposited into Phase 6.

2.2.2 Containment

The side slope lining system will provide full containment engineering comprising (see Drawing ESID9):

- Geological barrier a minimum of 0.5m thick constructed of clay with a permeability of $5x10^{-10}$m/s;
- Geosynthetic Clay Liner (GCL);
- Artificial sealing liner (2mm HDPE);
- Protective geotextile (non-woven); and,
- Leachate drainage layer.

The site will be capped following placement of waste. Capping will comprise a minimum of 1m of restoration soils overlying an artificial sealing liner (1mm LLDPE) and underlying regulation layer.

The installation of all elements of the permanent capping and lining system will be subject to Construction Quality Assurance (CQA).

2.2.3 Gas Extraction and Combustion

An active gas management system will be constructed at the landfill comprising a network of vertical and side slope gas extraction wells, including temporary and sacrificial wells on temporary capped areas as required, connected to a system of gas mains and spurs. The gas collection system will direct the collected gas to the Landfill Gas Utilisation Plant. The gas extraction system will be progressively expanded as the landfill develops and the completed phases are permanently capped. This will ensure that the quantity of landfill gas collected at any one time is optimised.

The installation of all elements of the gas extraction system will be subject to Construction Quality Assurance (CQA).

LFG will be utilised where possible to generate electricity in a suitable sized Generator set (gen-set) with a back-up LFG flare sized to flare the total predicted LFG volumes and suitable turn-down ratio. It is anticipated that gas plant would comprise:

- Gas engine gen-set 500kW_e output model (capacity 260m^3/hour at 50% methane); and

---

[3] Based on a conversion rate of 1.2$tonnes/m^3$

- Enclosed flare 500m^3/hour capacity with 10:1 turndown ratio.

2.3 Pathways

There are a number of pathways whereby landfill gas has the potential to affect on-site and off-site receptors. These include:

- Fugitive emissions of landfill gas from the surface of the landfill (active landfill, partially restored and fully restored surfaces) into the atmosphere where they will be diluted and dispersed;
- Lateral migration of landfill gas through the landfill liner and subsurface; and
- Emissions of landfill gas combustion products from landfill gas utilisation plants such as gas engines and flares. Emissions will be from stacks associated with engines and flares and as with fugitive releases will be diluted and dispersed in the atmosphere depending on meteorological conditions.

Human exposure to landfill gas emissions in the atmosphere may arise via a number of pathways as follows:

- Direct inhalation of airborne contaminants and particles, including airborne contaminants that may arise from lateral migration of landfill gas;
- Deposition of contaminants on to soils, vegetation and surfaces and subsequent ingestion of soils, vegetation and deposited dust;
- Dermal contact with contaminated soils and dust; and
- Contamination of vegetation via deposition and uptake through leaves and roots.

The atmospheric dispersion of landfill gas and landfill gas combustion products from the site is assessed, using the GasSim model, to determine the concentration of selected pollutants at sensitive receptor locations (i.e. exposure via direct inhalation).

2.4 Receptors

Receptors included within the assessment according to the conceptual model include those as a result of emissions to air and those as a result of lateral sub-surface migration. In addition the global impact is considered.

2.4.1 Exposure location for direct inhalation (including odour)

The site setting is presented on Drawing ESID3. The land immediately to the north of the site is occupied by a variety of commercial premises including a track dealer and a self-storage facility. To the east lies a number of recreational facilities including Costa Coffee and the Holiday Inn. The site is partly bordered to the south by Buckley Clay Pits and Commons Site of Special Scientific Interest (SSSI). A disused quarry is located off Pinfold Lane to the west of the site.

The closest residential property is Parry Houses, which lie 22m from the boundary at the southeast corner. Ewloe Wood House lies 120m northeast of the site, whilst Pottery Cottages are located 200 metres to the east of the site. Further residential properties are located approximately 280 metres northwest and on Smithy Lane, which is located 420 m east of the site.

The A55 Northop Services lie 20m from the sites eastern boundary and include a petrol station, 3 dining venues and a Holiday Inn (with residential use).

To the north, south and west of the site there are a number of industrial estates. The nearest industrial site is 20m west of the permit boundary and comprises a disused quarry. Immediately south of the site at 25m from the site boundary, is a mixed use commercial and industrial estate which consists of several building material suppliers and a manufacturing facility. A number of commercial units are situated adjacent to the northern edge of the site including Deeside Truck Services, a Fire Door manufacturer and a self-storage facility.

For the purposes of this assessment, a range of receptor locations have been selected as summarised in Table 2-1. Defra technical guidance for use in Local Air Quality Management[4] (LAQM.TG(16)) states that air quality standards should only apply to locations where *'members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. Authorities should not consider exceedences of the objectives at any location where relevant public exposure would not be realistic'*. This is emphasised in the EA Specified Generator modelling guidance that states the 1-hour mean should apply (but may not be limited to) '*residential properties, schools, hospitals, care homes, hotels, gardens, busy shopping streets, bus stations and railway stations that are not fully enclosed, and car parks where the public are reasonably expected to spend an hour or more'*. Longer term standards such as annual means, should apply at houses or other locations which the public can be expected to occupy on a continuous basis. These standards do not apply to exposure at the workplace.

Table 2-1
Sensitive Receptors

ID	Receptor	Type	X-coordinate	Y-coordinate
R_1	Parry's Cottage	Residential	327787	366321
R_2	Holiday Inn	Leisure	327897	366607
R_3	Service Station	Commercial	327799	366746
R_4	The Box	Residential	327606	366919
R_5	Alltami House	Residential	327443	366807
R_6	Pinfold Cottage	Residential	327439	366837
R_7	Ewloe Wood House	Residential	327455	366919
R_8	Services (Subway/Costa)	Commercial	327838	366600
R_9	Ewloe Barns Industrial Estate	Industrial	327744	366232
R_10	SCANIA units	Industrial	327567	366762
R_11	AH Plant Hire	Industrial	327467	366357
R_12	Services (Diner)	Commercial	327826	366664
R_13	Services (future development)	Commercial	327861	366533
R_14	RAP Pumps	Commercial	327451	366273
R_15	FCC Depot	Commercial	327444	366233
R_16	Pottery Cottages	Residential	328046	366320
R_17	Unnamed House	Residential	327889	366499

[4] Department for Environment, Food and Rural Affairs (DEFRA): Local Air Quality Management Review and Assessment Technical Guidance LAQM.TG(16), 2016

Figure 2-2
Receptor Locations for Emissions to Air

Ecological receptors may be sensitive to emissions of nitrogen oxide and sulphur dioxide from the landfill gas engine (generator). Given the size of the plant, the EA/NRW specified generator screening approach is considered appropriate, on this basis protected national and international sites within 3.5km have been identified (see Table 2-2). Ecological receptors are presented on Drawing ESID4.

Table 2-2
Designated Sites Requiring Assessment

ID	Site (Designation)	Location relative to site
ER1	Buckley Claypit and Commons (SSSI)*	To immediate S; 350m S
ER2	Connah's Quay Ponds and Woodland (SSSI)*	720m NE
ER3	Maes Y Grug (SSSI)*	1.1km W
ER1-3	The Deeside and Buckley Newt Site (SAC)	To immediate S; 350m S, 720m NE,

Table note:* the SSSI's are part of The Deeside and Buckley Newt Site (SAC)

3.0 LANDFILL GAS RISK ASSESSMENT INPUTS

3.1 The Nature of the Landfill Gas Risk Assessment

The site's conceptual landfill gas model, which includes the estimations of potential landfill gas generation, indicates that potential gas volumes cannot be considered to be negligible. Consequently, given the site's environmental setting there is a requirement for a greater level of assessment complexity than risk screening[5]. It was considered appropriate to carry out the risk assessment modelling in a "complex"[6] fashion using GasSim (Version 2 (2.05.0008)) to provide an indication of the potential risks associated with the Parry's Quarry Landfill site posed by fugitive (surface) and point sources (combustion plant) emissions.

3.1.1 Lifecycle Phases / Assessment Scenarios

GasSim 2 allows determination of emissions from the landfill and impacts at receptor locations throughout the life of the landfill. On this basis, all years are assessed at the Tier 1 stage. Emissions (whether fugitive surface emissions, or point source combustion emissions) that are identified as 'not insignificant' and require further assessment are assessed for the required years.

3.1.2 Generated Gases to be Modelled

The GasSim 2 model contains default information for a wide range of gases that have been shown to be generated and / or emitted from a typical landfill site. As a new landfill it is not possible to supplement this default information with actual site data in this case.

With respect to emissions to air there are three main potential issues associated with landfill sites, as follows:

- Odorous emissions which may be the result of a single contaminant (e.g. hydrogen sulphide) but more generally for landfill sites occur as a result of a complex mixture of contaminants;
- The emission of contaminants that may be, under certain circumstances, harmful to health. These contaminants may be contained within the waste itself, generated during decomposition processes within the waste and/or they may be combustion products generated during the treatment of landfill gas in gas engines or flares; and
- Emissions of greenhouse and associated gasses (such as CO_2 and CH_4) which have been linked with potential ozone depletion and global warming.

GasSim 2 assesses a suite of pollutants that may be emitted from the landfill surface or from a landfill gas utilisation plant.

3.2 Quantitative Assessment

A multi-stage assessment has been undertaken comprising screening to determine whether emissions from the landfill gas engines and flare or surface of the landfill are significant, followed by more detailed assessment as necessary, as described in the sections below.

---

[5] In the context of this risk assessment, risk screening involves the consideration of whether the site poses, or could potentially pose, a hazard owing to the generation of landfill gas.

[6] As defined by the Environment Agency, September 2004, Guidance on the Management of Landfill Gas. Complex assessments should be carried out in a quantitative manner using stochastic techniques. They should be carried out when the site setting is sufficiently sensitive to warrant detailed assessment and a high level of confidence needs to be provided.

3.2.1 Tier 1

This was undertaken using the Tier 1 screening tool incorporated into GasSim Version 2. This application allows assessment of emissions from the surface, engines and flares for each year of operation. Emissions to air are considered to warrant further assessment (Tier 2) if:

- [Maximum Process Contribution (long term) + background concentration] ≥ 70% of the Environmental Assessment Level; or
- [Maximum Process Contribution (short term) + 0.2 * background concentration] ≥ 20% Environmental Assessment Level.

The results of the Tier 1 screening are presented in Section 4.3.

3.2.2 Tier 2

Further assessment has been undertaken using the GasSim 2 Tier 2 assessment module. GasSim 2 calculates the atmospheric dispersion on-site and off-site from the surface of the landfill (or individual phases), engine and flare emissions using the AERMOD model atmospheric dispersion algorithms.

The results of the Tier 2 assessment are presented in Section 4.4.

3.2.3 Tier 3

The assessment of impact of any pollutant may need to progress to a third tier where uncertainties concerning the level of impact exist. If required, Tier 3 assessments would be undertaken using an advanced dispersion model approved by the NRW (such as AERMOD or ADMS).

An Odour Constraints Assessment was completed using Tier 3 techniques to inform the design of the landfill which resulted in the decision to receive biodegradable wastes in Cell 6 only. There has been no requirement for further Tier 3 assessment on the basis of the LFGRA.

3.3 Numerical Modelling

A total of 250 iterations were run in GasSim. This is above the theoretical minimum required to achieve statistical confidence for both a 50th percentile (minimum 20 iterations) and 95th Percentile (minimum 201 iterations) and is considered to represent a statistically robust approach.

For the GasSim assessment, the 95% percentile (%ile) confidence level has been used unless otherwise stated. The 95%ile presents a low probability of occurrence and is typically chosen in these circumstances. Furthermore, NRW commonly considers a 95%ile to be a reasonable and conservative assessment level in a GasSim assessment. GasSim 2 Tier 1 screening calculations always consider the 100%ile impact[7] using the 95%ile emissions from the process.

3.4 Model Parameterisation

The site specific input parameters used for the GasSim model have been input on the basis of design and environmental data. Where there is no site specific information, the GasSim default values, or other published information has been used to develop parameters that would be appropriate for the Parry's Quarry Landfill site and the activities and design details for the site. Where there is uncertainty concerning the parameter to be used, probability density functions (PDFs) have been used to provide an appropriate range for the parameter. These are detailed in the model reports in Appendix D. Details relating to the parameters used are discussed below.

[7] GasSim 2 Manual. p100.

3.4.1 Landfill Phasing / Waste Inputs

It is proposed to receive a fill tonnage not exceeding 320,000 t/annum.

The Parry's Quarry site will be divided into 8 cells which will be progressively filled. The phasing (phased waste filling, temporary capping and permanent capping) is represented in Drawing ESID5. As is evident the filling does not precisely follow the basal cell layout, therefore the phasing has been input in GasSim2 to represent the capping (temporary and permanent) progression as shown in Appendix A - Table A-1. The tonnage input to each cell/phase has been calculated from the void space applying a density of 1.2t/m^3.

GasSim 2 allows determination of emissions from the landfill and impacts at receptor locations throughout the life of the landfill. On this basis, all years and phases are assessed at the Tier 1 stage and progressed to Tier 2 as appropriate.

3.4.2 Waste Breakdown

Future waste breakdowns for the site have been estimated based on information provided by Mold Investments Limited. The waste breakdown that has been applied for the modelling exercise are presented in Table 3-1.

Table 3-1
Waste Breakdown for Parry's Quarry Landfill

Waste Type	Cell 6 - Breakdown (%)	All other Cells - Breakdown (%)
Domestic	Uniform(15,20)	Single(0)
Civic Amenity	Uniform(5,10)	Single(0)
Commercial	Uniform(15,20)	Single(0)
Industrial	Uniform(30,50)	Single(0)
Inert	Uniform(15,20)	Uniform(15,20)
Waste meeting <10% LOI test	Single (0)	Uniform(80,85)

3.4.3 Waste Composition

For Cell 6 receiving biodegradable waste the default waste composition files for Wales were applied for Domestic and Civic Amenity Streams with modification for the low carbon Commercial and Industrial waste streams. This was as previously agreed to by NRW in the recent decision document where it stated it '*agreed with the low Carbon C&I approach as detailed in Table 11 of the applicants Landfill Gas Risk Assessment (LFGRA)*', reproduced in Table 3-2.

For cells 1, 2, 3, 4, 5, 7, 8 receiving Non-Hazardous Non-Biodegradable Waste meeting <10% LOI test, a user derived waste stream has been entered with 10% as 'other miscellaneous combustibles' and 90% inert.

Table 3-2
Waste Composition

Waste Type	Commercial (%)	Industrial (%)
Other paper	5	5
Wood	3.3	5

Waste Type	Commercial (%)	Industrial (%)
Textiles	1.1	0.3
Other misc.	5	5
Garden waste	0	0
Other putrescible	5	5
10mm fines	1.9	0.5
Incinerator Ash	0.2	25.5
Non-degradable	78.5	53.7

3.4.4 Landfill Characteristics

Lining and capping systems to be used at Parry's Quarry Landfill site are provided in Table 3-3 with the permeability and thickness PDF's applied in the model.

Table 3-3
Input Values for the Landfill Characteristics

Characteristic	Material	Thickness (m)	Hydraulic Permeability (m s^{-1}) PDF
Landfill cap (temporary)	Mineral	0.5	Single($5x10^{-9}$)
Landfill cap (permanent)	LLDPE	0.001	Single($1x10^{-11}$)
Sidewall Liner	Mineral	0.5	Single($5x10^{-10}$)
	HDPE	0.002	Single($1x10^{-12}$)

3.4.5 Infiltration Coefficient and Cellulose Decay Rates

The Met Office *Rainfall Amount Annual Average 1980-2010* map indicates the average total rainfall in the area to be between 800 to 1000mm/year. The value used in GasSim to represent the effective rainfall is 900mm 'uncapped infiltration' (i.e. therefore excluding evaporation). The GasSim 2 suggested default value of Normal (50.0, 5.0) mm/a has been used for 'capped infiltration'.

The GasSim default cellulose decay rates that correspond to 'wet' moisture conditions whilst temporarily capped have been applied with a change to 'average' moisture conditions once permanently capped.

3.4.6 Geosphere

The data input values for the Geosphere have been derived from typical Landsim values for sandstone.

- Moisture content: Uniform (5, 20); and
- Porosity: Uniform (24, 53).

3.4.7 Collection Efficiency Estimates

The default GasSim collection efficiencies have been applied in the model. GasSim uses this information to determine the overall collection at the site alongside the phasing of the landfill with regard to the timing of temporary/permanent capping and installation of gas extraction systems as presented in Appendix A.

Table 3-4
Default Landfill Gas Collection Efficiency Estimates

Collection System	No Cap	Temporary Cap	Permanent Cap
Sacrificial	Triangular(30.0, 40.0, 50.0)	Triangular(40.0, 50.0, 60.0)	Triangular(55.0, 65.0, 75.0)
Permanent	Triangular(50.0, 60.0, 70.0)	Triangular(75.0, 85.0, 95.0)	Triangular(90.0, 95.0, 97.5)

GasSim v2 automatically assumes that temporary capping is removed for the period of filling:

> *'If a temporary cap has been installed, GasSim 2 assumes the cap is removed and then reinstated once filling is complete'* GasSim 2 User Manual, p36.

Since the filling at Parry's Quarry will be coordinated with a progressive capping programme, the model will assume that temporary capping is removed during a filling period, and only sacrificial extraction (no cap) values applied.

3.4.8 Methane and Carbon Dioxide Concentrations

The concentration of methane and carbon dioxide present within the landfill gas has been based upon the GasSim defaults. Given the low biodegradability of the wastes, the use of the defaults is considered to present a precautionary assessment of potential gas combustion impacts. The default values entered into GasSim for the proportions of methane and carbon dioxide are detailed below:

- Carbon dioxide (%) Single(50); and
- Methane (%) Single(50).

3.4.9 Trace Gases

As a conservative, worst case assumption, the GasSim default values for trace gas concentrations in raw landfill gas have been used in all cases with the exception of hydrogen sulphide.

Following information provided by NRW in their decision document in which it is stated '*we are now finding much higher H2S levels in the raw inlet gas on some sites. Accordingly, NRW has re-run the model using a suggested Log triangular of 10, 200 and 750 mg/m^3 H_2S*'. As such this PDF has been applied.

3.4.10 Gas Plant

Landfill gas generated at the site will be collected and treated at the landfill gas utilisation plant.

Based on the predicted gas generation rates the plant detailed in Table 3-5 has been applied in the model. The engine capacity is sufficient to utilise all available gas and the flare to treat all generated gas (above the turn-down ratio) in the event of engine failure. Standard parameters for the size of plant have been applied.

In the case of low-calorie gas yield (which is a possibility given the low degradable content of the waste inputs) then a low-calorie gas flare would be utilised.

Table 3-5
Landfill Gas Utilisation Plant

Flare/Engine	Operational Period	Capacity (Nm^3 h^{-1})	Downtime
Engine 1	2023- 2045	160 -260	UNIFORM(3.0, 5.0)
Flare 1	2021- 2060	50 – 500	UNIFORM(3.0, 5.0)

Table Note: The commissioning dates are restricted by the model to when gas is available. Gas plant to treat gas would be available from initiation of waste imports. Decommissioning dates have been selected based upon the gas generation curve for the site and would be kept under review.

For the trace gas emissions of carbon monoxide and nitrogen oxides from the landfill combustion plant, the compliant levels have been modelled as a Single Value PDF, i.e. at worst case. Emissions of sulphur dioxide have been set to be calculated by the model on the basis of parent species (e.g. H_2S).

Table 3-6
Emission Limit Concentrations (CO NO_X) from Engines and Flares

Gas Plant	Carbon Monoxide (mg/Nm^3)	Nitrogen Oxides (mg/Nm^3)
Agency guidance for engines [(a)]	1400	500
Agency guidance for flares [(b)]	50	150

Table notes:

a) Emission Limits specified in Guidance for Monitoring Landfill Gas Engine Emissions (September 2004) for engines installed after 31 December 2005.

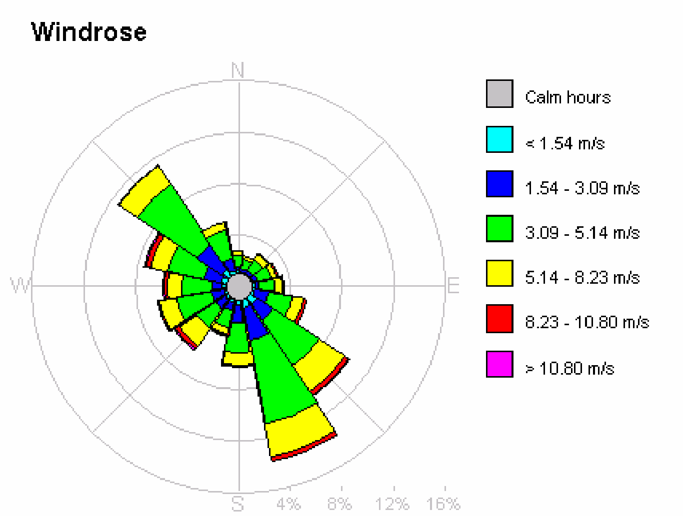
b) Emission Limits specified in Guidance for Monitoring of Enclosed Landfill Gas Flares (September 2004) for flares installed after 31 December 2003.

3.4.11 Atmospheric Dispersion

For Tier 2 atmospheric dispersion modelling, the default meteorological data set for North East Wales has been used. The windrose providing the frequency of wind speed and direction, is presented in Figure 3-1.

The Tier 2 dispersion module in GasSim 2 allows a simulation of a 5 year data set from 1 year of AERMOD data in order to provide a simulation of inter-annual variability by applying a factor of 1.3. This has been used for Tier 2 assessment.

Figure 3-1
Wales North East Windrose



3.4.12 Lateral Migration

The lateral migration module has been run assuming confined migration pathways. GasSim (v2) allows the user to simulate the effects of soil breathing; soil breathing is considered to be mainly controlled by the variations of atmospheric pressure over the year. When atmospheric pressure increases, air is effectively pushed into the soil through the ground surface. The air that is forced into the soil will be mixed with the migrating gases. In contrast, as the pressure decreases a proportion of the air-gas mixture will escape into the atmosphere. The processes will continue throughout the year to dilute the initial concentration of the migrating gases. Therefore, confined migration pathways represents worst case for migration associated with services, for example.

4.0 RISKS TO THE ENVIRONMENT AND HUMAN HEALTH

The landfill gas risk assessment has focussed on the potential risks associated with the following hazards:

- Sub-surface migration;
- The impact of the emissions to air on human health; and
- Global warming and ozone depletion potential of landfill gas emissions.

4.1 Landfill Gas Emissions

Predicted landfill gas generation and emissions for the site are presented graphically in Appendix B. The modelling indicates that gas generation is at its highest in 2027 and then declines, a selection of future maximum predicted values are presented in Table 4-1 below.

Table 4-1
GasSim Results

Parameter	Year	Percentile	Value (m^3/hr)
Landfill gas generation (maximum year)	2027	50	288
		95	293
Landfill gas to engines and flare (maximum year)	2028	50	230
		95	237
Surface emissions of bulk LFG (maximum year)	2027	50	79
		95	88

4.2 Sub-Surface Migration

GasSim 2 allows lateral migration predictions to be made from each individual cell, taking into account the gas emission rate and geosphere characteristics. The lateral emissions module indicates that lateral migration for all cells adjacent to the installation boundary that methane concentrations fall to less that 1% v/v within approximately 20m of the cell liner. There are no receptors within 20m of the cell liner as such the potential risk to receptors is not considered significant. Graphs presenting lateral migration for Cell 8 (the cell with highest lateral emission rates) are presented in Appendix B.

4.3 Emissions to Atmosphere - Tier 1 Screening

The GasSim Tier 1 screening assessment has been undertaken for all years. The background pollutant concentrations and results are presented below.

4.3.1 Background Concentrations

Background pollutant concentration data on a 1km x 1km spatial resolution is provided by Defra through the UK AIR website and is routinely used to support air quality assessments where site specific monitoring has not been undertaken.

Background pollutant concentrations of NOx, NO_2, and PM_{10} are based upon a 2017 base year[8] and background pollutant concentrations of SO_2, CO and Benzene are based upon a 2001 base year. Projection factors for SO_2

[8] Background mapping data for local authorities – http://uk-air.defra.gov.uk/data/laqm-background-home.

are not provided in LAQM.TG(16) since 2001 therefore values are likely to be an over prediction. The estimated annual mean background concentrations that have been applied in the Tier 1 screening are presented in Table 4-2.

Table 4-2
Estimated Background Air Quality (annual average)

Pollutant	2020 (µg/m^3)
Nitrogen Dioxide (NO_2)	9.7
Nitrogen oxides (NOx)	12.9
Particulate Matter (PM_{10})	11.1
Sulphur Dioxide (SO_2)	3.53
Carbon Monoxide (CO)	119.6
Benzene	0.287
1,3 Butadiene	0.067

4.3.2 Tier 1 - Results

The outputs from Tier 1 screening are presented in Appendix C. The results indicate that all emissions screen out with the exception of short-term impacts from surface emissions of hydrogen sulphide in the years 2022, 2026 and 2027. Therefore H_2S has been subject to further Tier 2 assessment.

Tier 1 does not directly screen for impacts on ecological sites therefore combustion emissions and potential impacts on ecological receptors have also been subject to Tier 2 assessment.

4.4 Emissions to Atmosphere - Tier 2 Dispersion Modelling

4.4.1 Impacts at Human Receptors

GasSim Tier 2 results for hydrogen sulphide are presented in Table 4-3. These results have been presented based on the 95th percentile of emissions. The results show that EALs are not exceeded at any receptor or at the boundary of the site. In addition to the hydrogen sulphide impacts, given its relation to odour, the total odour impacts as a 98th percentile of hourly emissions have also been presented in Table 4-4. The odour impacts show that the odour criterion of $C_{98,1hour}$ 1.5ou_E/m^3 for the 'most offensive odours' (defined in H4 guidance) is not exceeded at any modelled receptor location.

Table 4-3
Hydrogen Sulphide Impacts – short-term

ID	Type	2022 (µg/m^3)	2026 (µg/m^3)	2027 (µg/m^3)	Maximum of all Years (µg/m^3)	Max. as % of EAL
R_1	Residential	22.5	47.7	54.6	54.6	36%
R_2	Leisure	21.5	29.0	31.8	31.8	21%

ID	Type	2022 (µg/m³)	2026 (µg/m³)	2027 (µg/m³)	Maximum of all Years (µg/m³)	Max. as % of EAL
R_3	Commercial	37.9	28.2	28.5	37.9	25%
R_4	Residential	22.0	18.7	17.4	22.0	15%
R_5	Residential	21.9	21.5	20.6	21.9	15%
R_6	Residential	20.4	19.8	18.9	20.4	14%
R_7	Residential	17.1	17.1	16.7	17.1	11%
R_8	Commercial	30.1	34.2	32.3	34.2	23%
R_9	Industrial	21.6	40.5	42.4	42.4	28%
R_10	Industrial	32.3	31.7	30.2	32.3	22%
R_11	Industrial	12.6	50.0	45.3	50.0	33%
R_12	Commercial	25.1	26.5	28.9	28.9	19%
R_13	Commercial	30.4	34.4	37.5	37.5	25%
R_14	Commercial	10.6	34.6	39.9	39.9	27%
R_15	Commercial	9.9	20.7	24.2	24.2	16%
R_16	Residential	11.9	23.5	24.7	24.7	16%
R_17	Residential	25.6	25.9	30.3	30.3	20%
Max at Boundary		42.9	73.4	85.7	85.7	57%

Table 4-4
Odour Impacts – 98th %ile of hourly means

ID	Type	2022 ($C_{98,1\text{-hour}}$ ou_E/m^3)	2026 ($C_{98,1\text{-hour}}$ ou_E/m^3)	2027 ($C_{98,1\text{-hour}}$ ou_E/m^3)	Max of all Years ($C_{98,1\text{-hour}}$ ou_E/m^3)
R_1	Residential	0.4	1.1	1.1	1.1
R_2	Leisure	0.4	0.3	0.3	0.4
R_3	Commercial	0.6	0.2	0.2	0.6
R_4	Residential	0.5	0.2	0.2	0.5
R_5	Residential	0.5	0.5	0.4	0.5
R_6	Residential	0.4	0.4	0.4	0.4
R_7	Residential	0.4	0.3	0.3	0.4
R_8	Commercial	0.8	0.4	0.3	0.8
R_9	Industrial	0.1	0.8	0.8	0.8

ID	Type	2022 ($C_{98,1\text{-hour}}$ ou_E/m^3)	2026 ($C_{98,1\text{-hour}}$ ou_E/m^3)	2027 ($C_{98,1\text{-hour}}$ ou_E/m^3)	Max of all Years ($C_{98,1\text{-hour}}$ ou_E/m^3)
R_10	Industrial	1.3	0.6	0.5	1.3
R_11	Industrial	0.1	0.5	0.5	0.5
R_12	Commercial	0.7	0.3	0.2	0.7
R_13	Commercial	0.7	0.5	0.4	0.7
R_14	Commercial	0.1	0.2	0.2	0.2
R_15	Commercial	<0.1	0.2	0.2	0.2
R_16	Residential	0.3	0.2	0.2	0.3
R_17	Residential	0.5	0.4	0.4	0.5

4.4.2 Impacts at Ecological Receptors

Background Critical Levels and Loads

The APIS support tool for assessment of potential effects of air pollutants on habitats and species developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology has been used to provide information on:

- identification of whether the habitats present are sensitive and the most sensitive habitat present;
- critical levels and current baseline levels (Table 4-5); and
- critical loads and current loads (Table 4-6 and Table 4-7).

Table 4-5
Baseline Concentrations

Site	Site	NO_x (µg/m^3)	SO_2 (µg/m^3)
ER1a	Buckley Claypit and Commons (SSSI)* Adjacent	15.81	1.62
ER1b	Buckley Claypit and Commons (SSSI)* South	13.46	1.69
ER2	Connah's Quay Ponds and Woodland (SSSI)*	15.81	1.62
ER3	Maes Y Grug (SSSI)*	14.49	1.61

Table note:* the SSSI's are part of The Deeside and Buckley Newt Site (SAC)

APIS was used to obtain location specific C_{Lo} of nitrogen and acid deposition and current loads (3-year average 2015 - 2017) as summarised in Table 4-6 and Table 4-7 below. The most sensitive habitat type listed on APIS has been used for the assessment according to APIS guidance[9].

[9] 'Indicative values within nutrient nitrogen critical load ranges for use in air pollution impact assessments' (http://www.apis.ac.uk/indicative-critical-load-values)

Table 4-6
Relevant N Critical Loads (kgN/ha/yr)

Site	APIS Habitat (most sensitive to N deposition)	C_{Lo} for Assessment (kgN/ha/yr)	Current N Load (kgN/ha/yr)
ER1a	Adjacent to site: Old sessile oak woods w/ Ilex and Blechnum	10	35.7
ER1b	South of site: Wet Heath	10	22.0
ER2	Old sessile oak woods w/ Ilex and Blechnum	10	35.7
ER3	Old sessile oak woods w/ Ilex and Blechnum	10	35.7

Table 4-7
Relevant Acid Critical Loads and Baseline Deposition

Site	Habitat (most sensitive to acid deposition)	Critical Level (k_{eq}/ha/yr)			Current Load (k_{eq}/ha/yr)	
		CLmaxS	CLminN	CLmaxN	N	S
ER1a	Adjacent to site: Old sessile oak woods	1.471	0.357	1.828	2.55	0.39
ER1b	South of site: Wet Heath	0.870	0.714	1.584	1.57	0.35
ER2	Old sessile oak woods w/ Ilex and Blechnum	1.448	0.142	1.72	2.55	0.39
ER3	Old sessile oak woods w/ Ilex and Blechnum	1.477	0.357	1.837	2.55	0.39

Impacts on Critical Levels

The predicted impacts on C_{Le} at the identified ecological sites are presented in Table 4-8 and Table 4-9. The findings are that the PC's are insignificant at ER2 and ER3 and less than 100% of the C_{Le} at ER1 and therefore the impact is considered 'not likely to damage' the SSSIs and to cause 'no likely significant effect' on the SAC.

Table 4-8
Predicted Impacts on Long-term NOx Critical Levels

Site	PC NO_x (µg/m^3)	PC as % C_{Le}	PEC NO_x (µg/m^3)	PEC as % C_{Le}
ER1a	3.1	10.2%	18.9	62.9%
ER1b	1.0	3.2%	14.4	48.1%
ER2	<0.1	0.3%	n/c	n/c
ER3	<0.1	0.3%	n/c	n/c

Table note: n/c = PEC not calculated as PC does not exceed 1% of C_{Le}

Table 4-9
Predicted Impacts on Long-term SO_2 Critical Levels

Site	PC SO_2 (µg/m^3)	PC as % C_{Le}	PEC SO_2 (µg/m^3)	PEC as % C_{Le}
ER1a	1.39	6.9%	3.0	15.0%
ER1b	0.44	2.2%	2.1	10.6%

ER2	0.04	0.2%	n/c	n/c
ER3	0.04	0.2%	n/c	n/c

Table note: n/c = PEC not calculated as PC does not exceed 1% of C_{Le}

Impacts on Critical Loads

Deposition rates of nitrogen and sulphur were calculated using empirical methods recommended by the EA AQTAG06[10].

The predicted impact on C_{Lo}'s at the identified ecological sites for nitrogen and acid deposition are presented in Table 4-10 and Table 4-11 respectively. The findings are that:

- the N PC's are not insignificant at part of Buckley Claypit and Commons adjacent to the site, and the baseline deposition already exceeds the C_{Lo} as such there is the potential for a significant effect. However at the next closest unit of the SSSI the PC is not significant. This indicates that the potential for an effect is localised only to the part of the SSSI adjacent to the site;
- the acid PC's are not insignificant at the Buckley Claypit and Commons adjacent to the site, and the baseline deposition already exceeds the C_{Lo} as such there is the potential for a significant effect. The acid PC at the next closest unit of the SSSI the PC is not insignificant however is much reduced; and
- the PC to N and acid C_{Lo}'s is insignificant at ER2 and ER3 and therefore is considered 'not likely to damage' the SSSIs and to cause 'no likely significant effect' on the SAC.

Table 4-10
Predicted Impacts on Nitrogen Critical Loads

Site	PC N (kg/ha/yr)	Applied C_{Lo}	PC as % C_{Lo}	PEC N (kg/ha/yr)	PEC as % C_{Lo}
ER1a	0.617	10	6.2%	36.3	242%
ER1b	0.097	10	1.0%	n/c	n/c
ER2	0.019	10	0.2%	n/c	n/c
ER3	0.018	10	0.2%	n/c	n/c

Table 4-11
Predicted Impacts on Acid Critical Loads

Site	PC N (kg/ha/yr)	PC S (kg/ha/yr)	Applied C_{Lo} CLmaxN (kg/ha/yr)	PC as % C_{Lo} (PC S + N as % CLmaxN)	PEC S + N (kg/ha/yr)	PEC as % C_{Lo} (PC S + N as % CLmaxN)
ER1a	0.044	0.328	1.828	20.3%	3.312	181.2%
ER1b	0.007	0.052	1.584	3.7%	1.979	124.9%
ER2	0.001	0.010	1.720	0.7%	n/c	n/c
ER3	0.001	0.009	1.837	0.6%	n/c	n/c

[10] AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. Environment Agency, March 2014 version.

4.5 Accidents and Consequences

An assessment of accident risk is presented in Table 4-12 based on the approach and scoring advised by the Agency[11]. The accident scenarios have been selected to represent the worst case. They are general and broad in their definition such that other potential scenarios envisaged would be less severe and are covered within the definition. For example, vehicular damage to a gas well might be a valid accident scenario to consider in isolation. However the severity of the consequence will be less than the score and hence risk associated with that arising from overall loss of collection. Similarly the severity of a surface grass fire on a restored area would be less than for a shallow waste fire. Whilst each individual scenario is not itemised, Mold will have has procedures in place at the site to deal with the broad accident scenarios should they arise.

Given that the magnitude of risk in all cases is within acceptable levels it is considered that a more detailed assessment of accidents and their consequences is not required at this time.

Table 4-12
Accident Risk

Accident Scenario	Likelihood	Severity	Magnitude of Risk
Loss of containment- (i.e. penetration of liner)	Fairly Probable (5)	Noticeable (2)	Acceptable (10)
Loss of collection (for > 24hrs)	Fairly Probable (5)	Noticeable (2)	Acceptable (10)
Explosion/fire in LFG plant	Unlikely (3)	Significant (3)	Acceptable (9)
Fire in shallow waste	Fairly Probable (5)	Noticeable (2)	Acceptable (10)
Deep seated fire in waste	Somewhat Unlikely (4)	Significant (3)	Acceptable (12)

4.6 Global Atmospheric Impact

The potential global atmospheric impact of the installation has been predicted using the GasSim model. The Global Warming Potential (GWP) and Ozone Depletion Potential (ODP) have been assessed using the default data provided by GasSim 2. The results of the assessment are provided in Appendix D. Predictions are presented for the 50%ile.

4.7 Landfill Gas Completion Criteria

Landfill completion with respect to landfill gas is the point where there is insufficient gas generated to require active management and flaring on the basis that the resultant passive fluxes would no longer pose a risk to human health, the local environment or amenity in the short or long-term. Typically this point in time will occur when gas generation rates have been reduced so that a $50m^3$/hr flare cannot be supported and will be related to collection effectiveness over the site area.

Parry's quarry landfill would be fully restored following installation of the permanent cap to the final phase, anticipated in 2027. Gas generation predictions indicate that peak gas production will occur in 2027 and thereafter, gas generation rates are predicted to decrease such that until 2034 predicted gas generation is above

[11] Environment Agency (2004): LFTGN 03, Section 2.5 (pp31-33).

approximately 160m^3/hr. If all of this generated gas is collected this would be sufficient to operate the on-site gas engine. If the engine is not replaced with a lower capacity engine after this time then the gas would be flared. Beyond 2050, landfill gas generation rates are predicted to be less than 50m^3/hr which falls below the capacity of current flares on the market. It is likely that it will not be possible to collect all of the generated gas and it may be necessary to consider the operation of the flare on a non-continuous basis, or a low calorific flare, in order to optimise gas collection and flaring and minimise release into the environment at this time.

A re-evaluation of this time scale to completion would be undertaken closer to the time and the treatment options engine/flare re-evaluated based on the best available techniques at the time.

5.0 GAS MANAGEMENT

Details of the landfill gas control measures in place or proposed for Parry's Quarry Landfill are provided in the Operating Techniques and Management Plan (OTMP). The sections below provide an overview of the control measures, monitoring and sampling, and compliance limits.

5.1 Control Measures

The control of landfill gas relies on containment, extractions and treatment, as follows:

- containment is provided by engineered cell sidewalls and caps as described in Section 2.2.2. The installation these measures progresses with the filling of the landfill.
- extraction is provided by a system of gas collection wells linked to gas mains that provide suction to the landfill via blowers located in the GUP. The gas infrastructure is installed progressively with the filling and capping of cells. Gas well locations are presented in Drawing ESID13.
- treatment of the gas is provided by gas engines to utilise the gas to create electricity and by a flare to burn any surplus gas.

5.2 Monitoring and Sampling

The efficacy of the gas control system is assessed by monitoring of the in-waste gas wells and perimeter boreholes. The former are monitored to allow the system to be balanced for optimum performance and to characterise the source in terms of identifying potential risks. The boreholes, which are positioned around the perimeter of the site, are monitored to detect any lateral gas migration beyond the sidewall liner.

Monitoring of combustion emissions from GUP is undertaken annually in order to check compliance with emission limits designed to protect the health of humans and ecosystems.

Further details are provided in the sections below.

5.2.1 In-waste Landfill Gas Monitoring Control and Trigger Levels

In-waste monitoring of the following parameters will be routinely undertaken at the landfill site:

- methane;
- carbon dioxide;
- oxygen;
- temperature;
- atmospheric and differential pressure; and
- gas flow rate / suction (on collection wells).

Temperature and carbon monoxide are only measured as and when required. Annual trace analysis is also required of the Gas Line to the gas utilisation compound.

5.2.2 Perimeter Landfill Gas Monitoring – Sub Surface

The locations of existing and proposed perimeter borehole locations are presented in Drawing No. ESID 8. This borehole spacing is considered adequate on the basis of EA guidance (LFTGN03).

Monitoring is typically carried out monthly, but weekly when required by an Action Plan. Perimeter borehole monitoring of the following parameters will be routinely undertaken at the landfill site:

- methane;
- carbon dioxide;
- oxygen;

- temperature; and
- atmospheric and differential pressure.

Other gases, for example hydrogen sulphide, carbon monoxide, may be monitored within perimeter boreholes if considered necessary at any given time, as will gas pressures.

5.2.3 Surface Emissions Monitoring

Landfill Technical Guidance Note LFTGN07v2[12] provides a methodology to determine the emission of methane from the surface of a landfill. This guidance sets out a two stage approach (Stage 1 walkover and Stage 2 flux survey) for the monitoring of emissions through a landfill cap, and hence determining the effectiveness of the cap. Monitoring (and frequency of monitoring) would be carried out as required by this guidance on the basis of the development of the temporary and permanent cap.

5.2.4 Landfill Gas Engine and Flare Emissions Monitoring

Emissions from the combustion plant, i.e. gas utilization engines and flare (if operated for more than 10% of the hours in a year) will be monitored annually using methodologies compliant with the EA and Health and Safety Executive guidance at the time.

5.2.5 Perimeter / Receptor Landfill Gas Monitoring – Aerial Emissions

Off-site monitoring of landfill gas and / or trace gasses will only be undertaken in response to persistent odour complaints or as part of the Action Plan relating to exceedences of other compliance limits. In this event, monitoring would be undertaken in accordance with EA Technical Guidance notes M9 and M13.

5.3 Compliance Limits

5.3.1 Surface Emissions

The emission standards for capped zones provided in LFTGN07 are given in Table 5-1 below.

Table 5-1
Emission Standards for different types of landfill zones

Type of zone	Surface emission standard
Any zone with permanent cap	Methane flux of 0.001 mg/m^2/second
Any zone with temporary or interim cap	Methane flux of 0.1 mg/m^2/second

5.3.2 Perimeter Gas Monitoring Boreholes

The NRW/EA position on perimeter soil gas compliance limits is set out in the Position Statement (dated August 2011) which states:

> *'We will require operators to set action levels as part of their gas management plan and to monitor perimeter boreholes and assess carbon dioxide concentrations against the action level to prompt investigatory action and inform regular reviews of the conceptual model. ....*

[12] Environment Agency, Guidance on Monitoring Landfill Gas Surface Emissions V2 (LFTGN07_v2) 2010.

We will continue to set compliance limits in the permit for methane. These will generally be set at background levels (established in accordance with the ICOP) + 1% v/v to ensure that the migration of landfill gas is minimised in accordance with the Landfill Directive'.

The approach to establishing background methane and carbon dioxide concentrations is set out within the Industry Code of Practice (ICoP) '*Perimeter soil gas emissions criteria and associated management'*. The NRW/EA Position Statement states:

'The ICOP presents "best available" approaches to establishing background methane and carbon dioxide concentrations at sites ahead of, and even following, the placement of waste in an engineered cell. Statistical techniques are proposed to define background concentrations for stable and unstable data sets and derive compliance limits and action levels based on these concentrations.

The ICOP proposes that no compliance limits should be set for carbon dioxide in the permit, unless there is a sensitive receptor where there is a risk to human health. We accept this is a reasonable approach"

The approach to setting of Compliance Limits (for methane) and Action Levels (for methane and carbon dioxide) is summarised in Table 5-2 and Table 5-3 below. Background data collected prior to the commencement of filling will be analysed to establish the Compliance Limits (for methane) and Action Levels (for methane and carbon dioxide) and is likely to be agreed as a pre-operational condition.

Table 5-2
Carbon Dioxide Action Levels

Background	T_{max} Range	Action Level
Stable gas Concentrations		
T_{max}	T_{max} carbon dioxide concentrations in range 0 - 5%	T_{max} +1%
T_{max}	T_{max} carbon dioxide concentrations in range 5 – 10%	T_{max} +2%
T_{max}	T_{max} carbon dioxide concentrations in range 10 – 20%	T_{max} +3%
T_{max}	T_{max} carbon dioxide concentrations in range 20 – 25%	T_{max} +4%
T_{max}	T_{max} carbon dioxide concentrations in range >25%	None
Unstable gas Concentrations		
T_{max}	Not applicable	T_{max}

Table 5-3
Methane Action Levels and Compliance Limits

Background	Action Level	Compliance Limit
Stable gas Concentrations		
T_{max}	T_{max} +0.5%	T_{max} +1%
Unstable gas Concentrations		
T_{max}	T_{max}	T_{max} +1%

5.3.3 Landfill Gas Engine and Flare Emissions

Details of emissions monitoring frequency and emission levels for the gas engines and flares are provided in Table 5-4 and Table 5-5 as per LFTGN08 and LFTGN05 respectively.

Table 5-4
Emissions Monitoring of Landfill Gas Utilisation Plant

Engine & Substance	Frequency of Monitoring	Emission Level
NOx	Annually	500 mg/Nm^3
CO	Annually	1400 mg/Nm^3
Total VOC's	Annually	1000 mg/Nm^3

Table Note: Reference conditions: 273 K; 101.3 kPa and 5% v/v oxygen (dry gas).

Table 5-5
Emissions Monitoring of the Landfill Gas Flares

Flare & Substance	Frequency of Monitoring	Emission Level
NOx	Annually	150 mg/Nm^3
CO	Annually	50 mg/Nm^3
Total VOC's	Annually	10 mg/Nm^3

Table Note: Reference conditions: 273 K; 101.3 kPa and 3% v/v oxygen (dry gas).

5.4 Health and Safety - DSEAR

The primary legislation applying to the control of substances that can cause fires and explosions in the workplace is the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (SI 2002 No.2776).

The Health and Safety Executive (HSE) is the regulator for DSEAR. The Waste Industry Safety and Health (WISH) Forum, comprising the HSE, industry trade bodies (e.g. Environmental Services Association) and professional associations (e.g. CIWM), has identified the need for guidance on the implications of DSEAR for landfill sites. A series of Industry Codes of Practice (ICoP) have been released (available at the ESAUK website[13]). Mold will operate the landfill with due regard to the published ICoP's, 1 (2005), 2 (2005), 3 (2006), 5 (2007).

[13] http://www.esauk.org

6.0 Conclusion

The landfill gas risk assessment undertaken for the Parry's Quarry Landfill has demonstrated that, given the design, control and management and monitoring for the site, the landfill will be operated in compliance with the requirements of the Environmental Permitting (England and Wales) Regulations 2016. In particular:

- Appropriate measures will continue to be taken in order to control the accumulation and migration of landfill gas;
- The landfill will receive biodegradable wastes and landfill gas generated will continue to be collected, treated and, to the extent possible, used. The landfill gas will be used to generate electricity using gas engines employed at the landfill as long as sufficient gas is generated;
- The collection, treatment and use of landfill gas will continue to be carried out in a manner that minimises damage to, or deterioration of, the environment and risk to human health; and
- Odour nuisance will be minimised by the management and monitoring of landfill gas.

APPENDIX A

Landfill Phasing Input

Table A-1
Landfill Phasing and Waste Inputs (t)

Year	Cell 1a	Cell 1b	Cell 2a	Cell 2b	Cell 3a	Cell 3b	Cell 4a	Cell 4b	Cell 5a	Cell 5b	Cell 6a	Cell 6b	Cell 7a	Cell 7b	Cell 8
2020	50299	58682	59948	69939	64583	16549									
2021						58798	47280	55160	63444	74018	21300				
2022								55160		74019	137530	53291			
2023				69939		75347						105539	69175		
2024													155440	164560	
2025														60055	259945
2026		58681													261319
2027															220160
Total	167662		199826		215278		157600		211481		317660		449230		741424

Table Key:

	Temporary Cap and gas infrastructure
	Permanent Cap and gas infrastructure

Table note: The tonnes of waste value in the table represents the 'likely' value in a Triangular PDF with the 'minimum' at -10% and 'maximum' at +10%.

APPENDIX B

GasSim Results Graphs

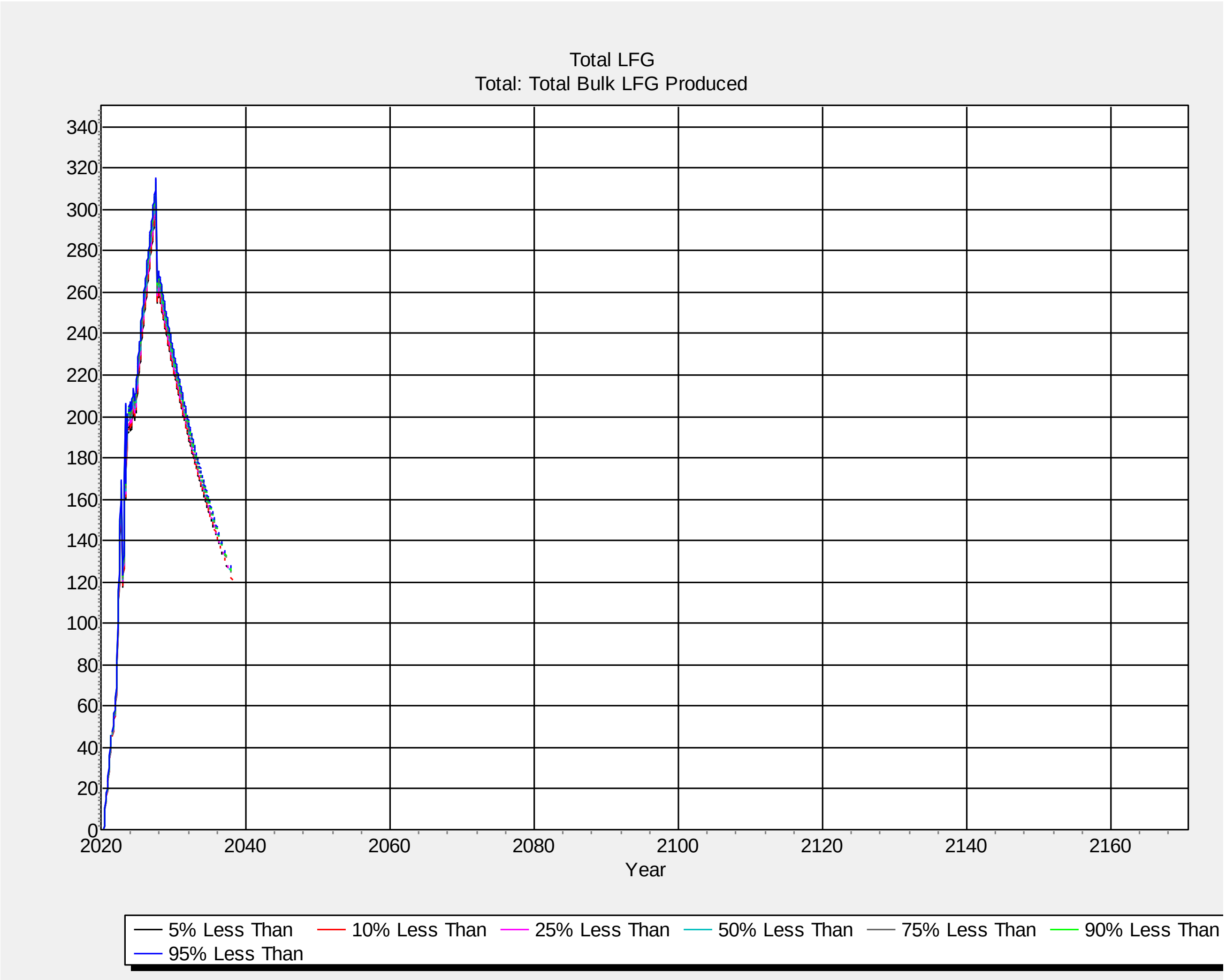


Figure B-1
Landfill Gas Generation Rate

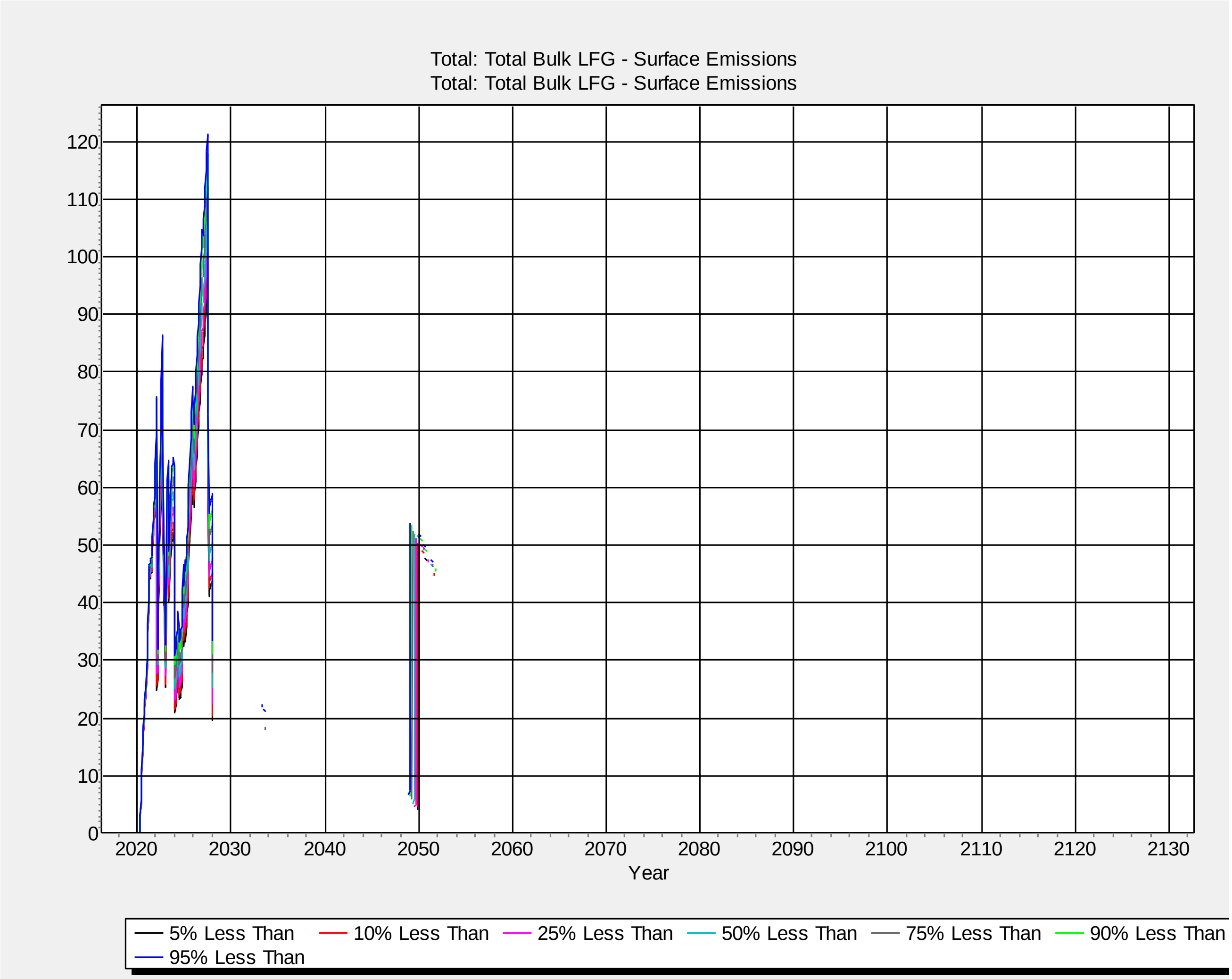


Figure B-2
Landfill Gas Surface Emissions

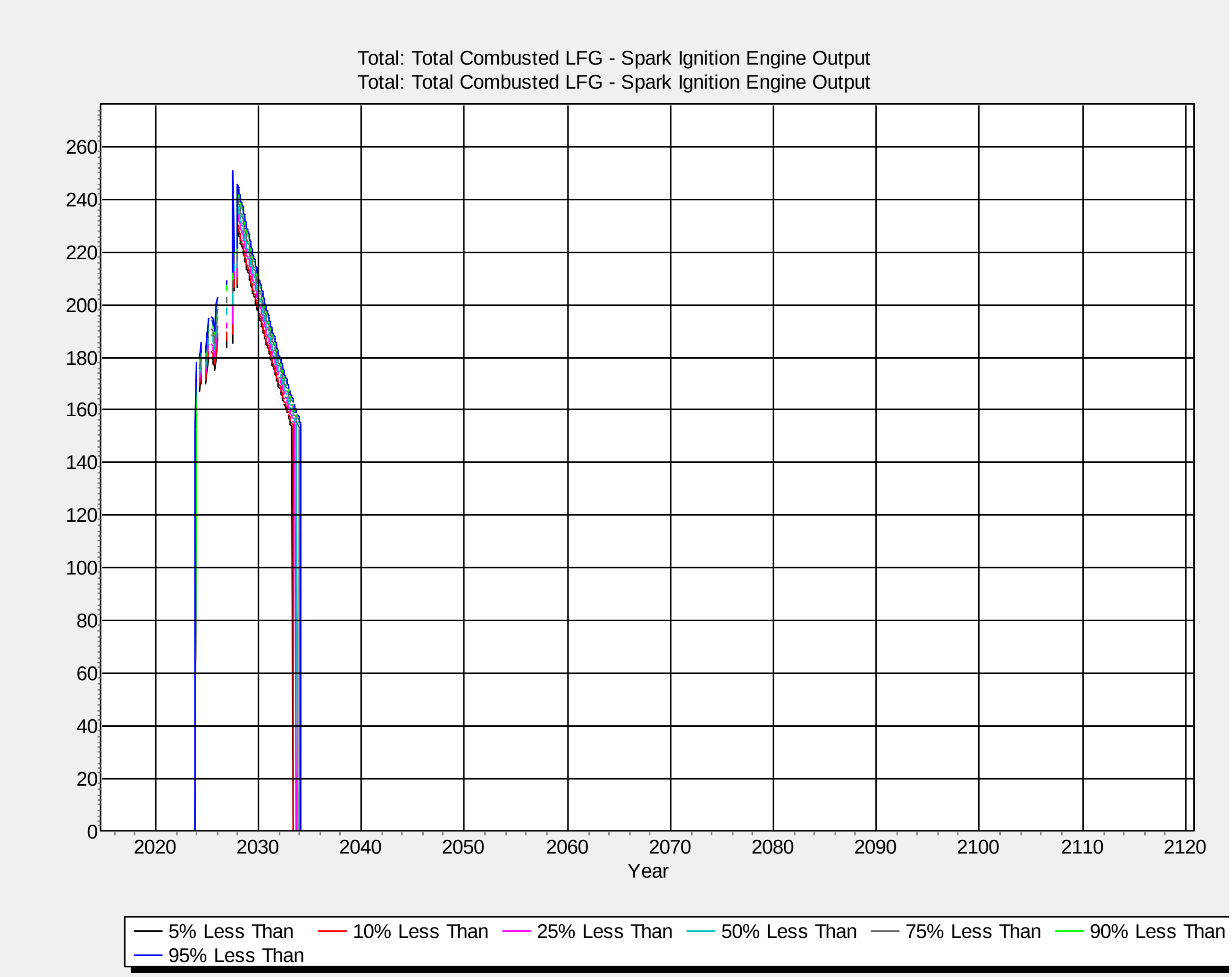


Figure B-3
Landfill Gas to Engines

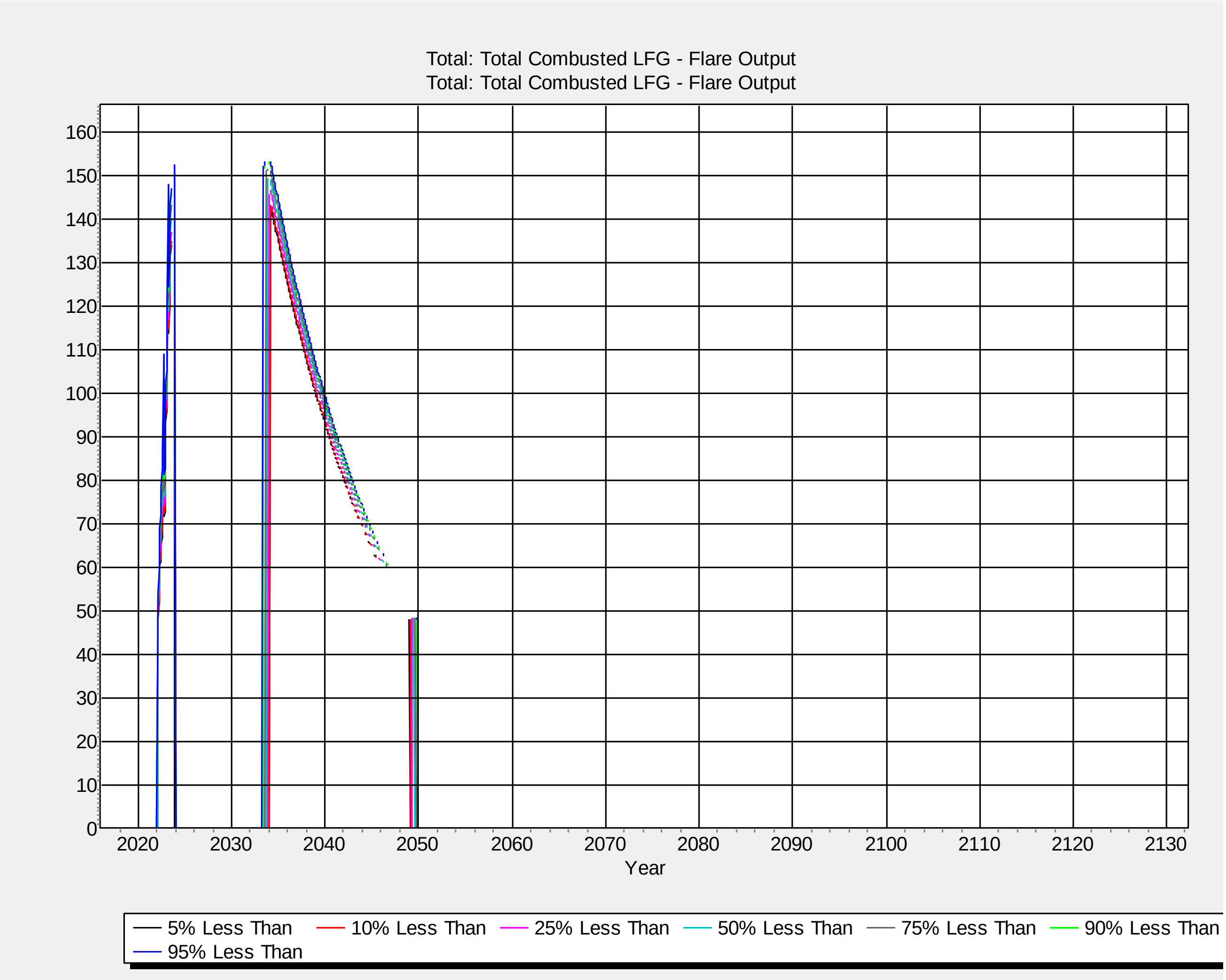


Figure B-4
Landfill Gas to Flares

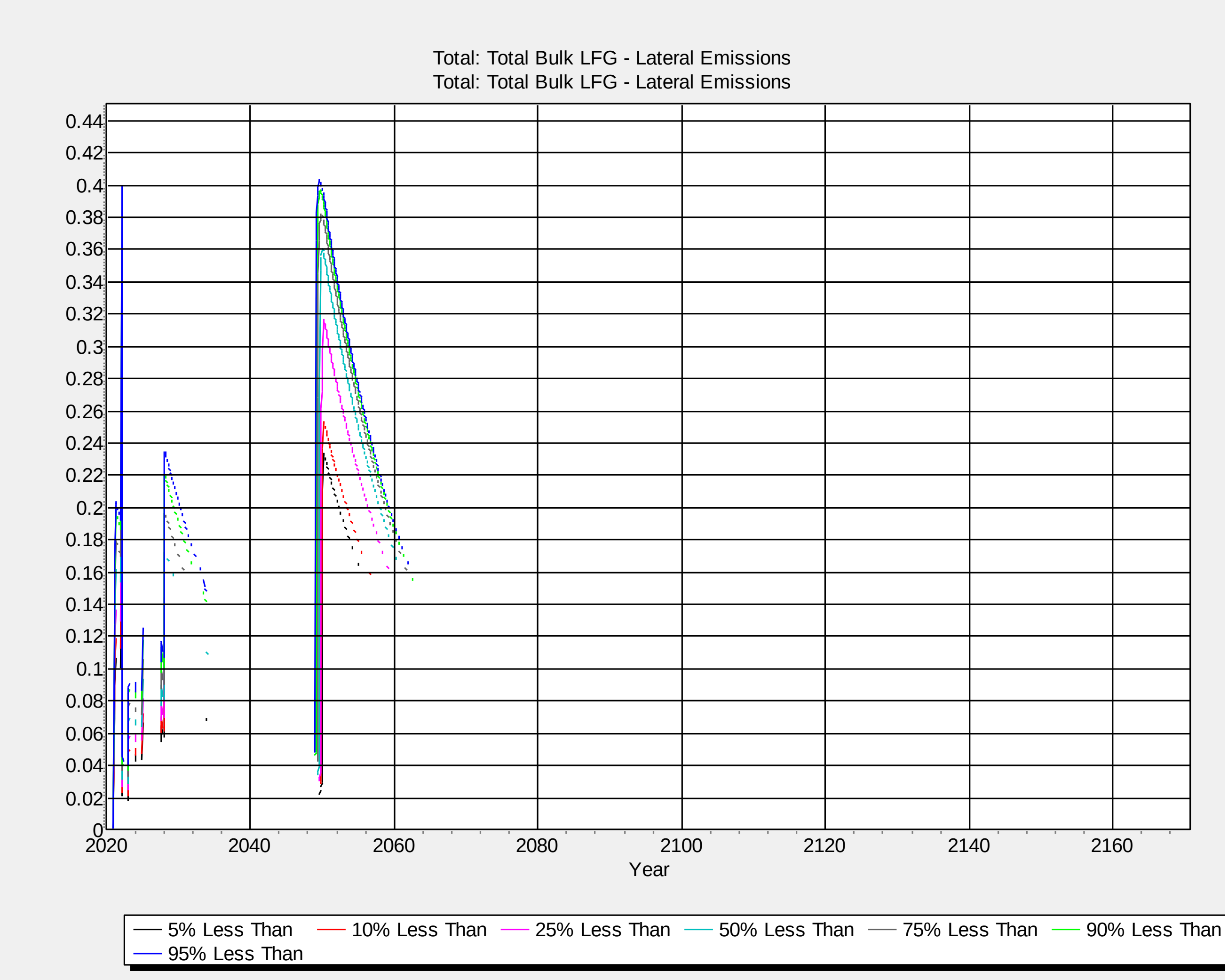


Figure B-5
Landfill Gas Lateral Emissions

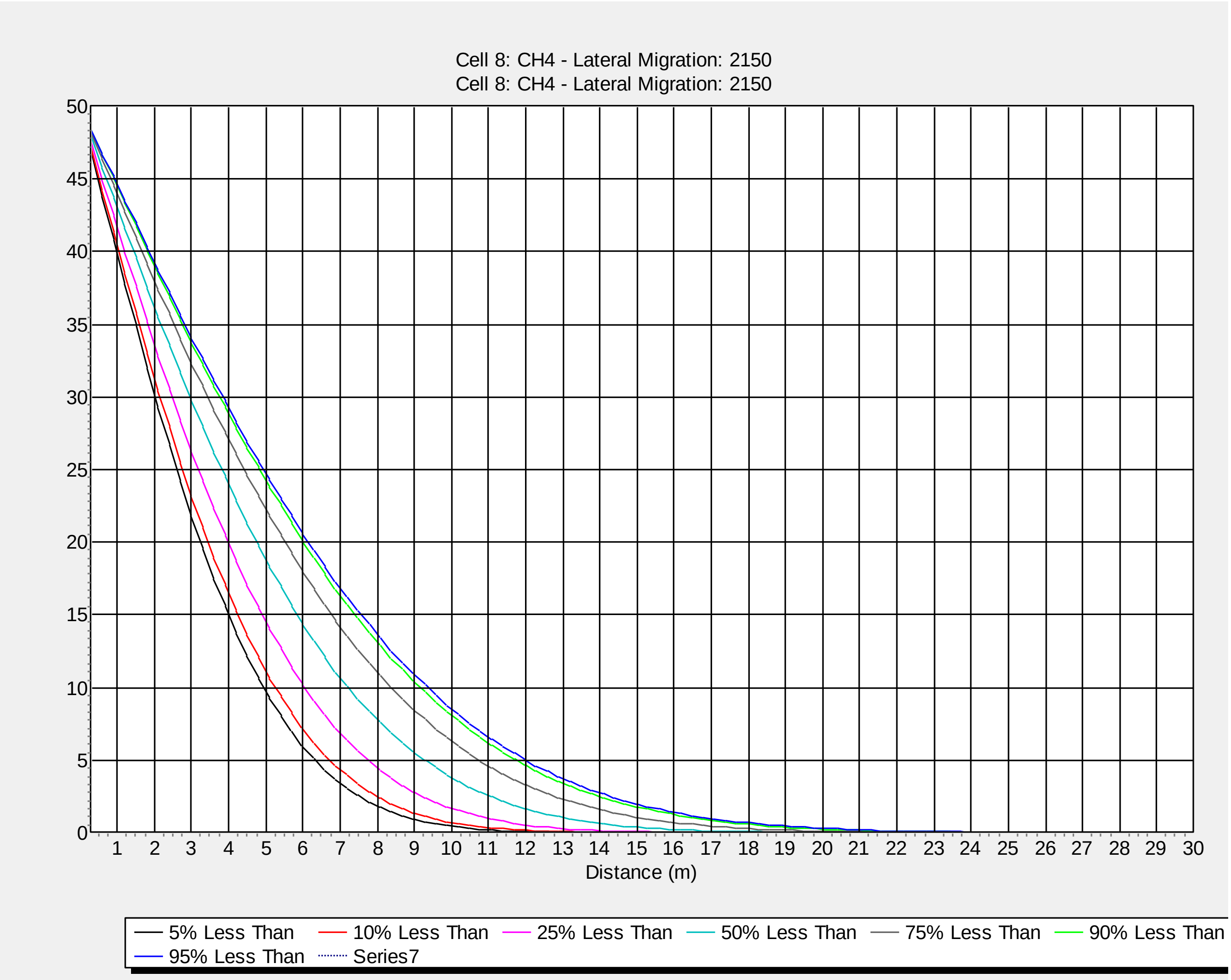


Figure B-6
Cell 8 Methane Lateral Migration

EUROPEAN OFFICES

United Kingdom

AYLESBURY
T: +44 (0)1844 337380

BELFAST
T: +44 (0)28 9073 2493

BRADFORD-ON-AVON
T: +44 (0)1225 309400

BRISTOL
T: +44 (0)117 906 4280

CAMBRIDGE
T: + 44 (0)1223 813805

CARDIFF
T: +44 (0)29 2049 1010

CHELMSFORD
T: +44 (0)1245 392170

EDINBURGH
T: +44 (0)131 335 6830

EXETER
T: + 44 (0)1392 490152

GLASGOW
T: +44 (0)141 353 5037

GUILDFORD
T: +44 (0)1483 889800

LEEDS
T: +44 (0)113 258 0650

LONDON
T: +44 (0)203 691 5810

MAIDSTONE
T: +44 (0)1622 609242

MANCHESTER
T: +44 (0)161 872 7564

NEWCASTLE UPON TYNE
T: +44 (0)191 261 1966

NOTTINGHAM
T: +44 (0)115 964 7280

SHEFFIELD
T: +44 (0)114 245 5153

SHREWSBURY
T: +44 (0)1743 23 9250

STAFFORD
T: +44 (0)1785 241755

STIRLING
T: +44 (0)1786 239900

WORCESTER
T: +44 (0)1905 751310

Ireland

DUBLIN
T: + 353 (0)1 296 4667

France

GRENOBLE
T: +33 (0)4 76 70 93 41