REPORT

Air quality modelling assessment for Knockharley Landfill

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Executive Summary

Olfasense UK Ltd were commissioned by Beauparc to undertake an update to the air quality dispersion modelling which was undertaken for Knockharley Landfill site in 2018.

The objective of the study was to assess the risk of impact from the emissions from the gas utilisation plant under the future normal operational conditions.

The modelling was undertaken using meteorological data from Dunsany and using updated emission estimates for flares and engines based on recent monitoring data.

The scope of the study was as follows:

- To update the air quality models for the gas utilisation plant to reflect the future normal operational conditions and an engine failure situation, using recent monitoring data.
- To run the models using meteorological data from Dunsany and assess the operational impact of the landfill gas utilisation plant upon residential and ecological receptors.

The assessment involved a dispersion modelling study which was undertaken in accordance with EPA guidance AG4[1]. The results of the modelling study were compared to the target values in EU Ambient Air Quality Directive (EU 2008/50/EC) and the Environment Agency's Air emissions risk assessment guidance[2] (for HCl and HF). An assessment was also made against the Annual critical level for the protection of vegetation and natural ecosystems as required by EPA guidance AG4

The key findings of the study are as follows:

- For scenario 1 (future normal operational conditions) the modelling results indicate that predicted concentrations fall below all of the short term and long term limit values set out in EPA guidance AG4 at all nearby sensitive receptors for all of the pollutants assessed. The predicted concentrations are also below AG4's Maximum Allowable Process Contribution for all pollutants assessed.
- For scenario 2 (engine failure scenario) the results indicate that predicted concentrations fall below all of the short term term limit values at all nearby sensitive receptors for all of the pollutants assessed. The predicted concentrations are also below AG4's Maximum Allowable Process Contribution for all pollutants assessed.
- For both scenarios, the results of the ecological receptors assessment indicates that for predicted annual concentrations of NOx as a result of the emissions from the facility are below 1 $\mu g/m^3$ at all of the designated European sites, which is substantially below the annual critical level for the protection of vegetation & natural ecosystems (30 $\mu g/m^3$).
- On this basis, the risk of impact of the emissions from the landfill gas utilisation plant at Knockharley Landfill is considered to be low.

[1] EPA Air Dispersion Modelling Guidance Note (AG4) 2020
[2] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

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1 Introduction and Scope

1.1 Introduction

Olfasense UK Ltd were commissioned by Beauparc to undertake an update to the air quality dispersion modelling which was undertaken for Knockharley Landfill site in 2018.

The objective of the study was to assess the risk of impact from the emissions from the gas utilisation plant under the future normal operational conditions.

The modelling was undertaken using meteorological data from Dunsany and using updated emission estimates for flares and engines based on recent monitoring data.

1.2 Scope

The scope of the study was as follows:

- To update the air quality models for the gas utilisation plant to reflect the future normal operational conditions and an engine failure situation, using recent monitoring data.
- To run the models using meteorological data from Dunsany and assess the operational impact of the landfill gas utilisation plant upon residential and ecological receptors.

This report presents the findings of the assessment.

1.3 Structure of report

The report is structured as follows:

- Section 2 presents a description of the approach.
- Section 3 outlines the relevant Air Quality Standards.
- Section 4 presents a summary of emission assumptions.
- Section 5 outlines the dispersion modelling assumptions.
- Section 6 outlines the results of the dispersion modelling.
- Section 7 summaries the key findings of the study.

Supporting information is presented within the Annex

1.4 Quality Control and Assurance

All activities are conducted by trained and experienced specialist staff in accordance with quality management procedures that are certified to ISO 9001 (Certificate No. A13725).

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2 Description of approach

2.1 Overview

To assess the impact of the landfill gas utilisation plant upon residential and ecological receptors consideration was given to the following pollutants:

- Nitrogen dioxide (NO_2);
- Sulphur dioxide (SO_2);
- Total dust (as PM_{10});
- Carbon monoxide (CO);
- Hydrogen chloride (HCl);
- Hydrogen fluoride (HF);
- Total non-methane volatile organic compounds (TNMVOC);
- Nitrous oxides (NOx)

To assess the potential impact of the emissions a dispersion modelling study was undertaken in accordance with EPA guidance AG4[3]. The results of the modelling study were compared to the target values in EU Ambient Air Quality Directive (EU 2008/50/EC) and the Environment Agency's Air emissions risk assessment guidance[4] (for HCl and HF). Further detail is presented in section 3 below.

An assessment was also made against the Annual critical level for the protection of vegetation and natural ecosystems as required by EPA guidance AG4. There are no specific screening distances stated by AG4, so a screening distance of 15 km (which exceeds the Environment Agency's Air emissions risk assessment guidance[4] screening distance of 10 km) for all designated European sites (special protection areas, candidate special areas of conservation or Ramsar sites) was used.

2.2 Dispersion modelling

2.2.1 Model selection

Air quality dispersion modelling techniques were applied in accordance with EPA guidance AG4. The US EPA AERMOD dispersion model was used, and based on AG4 it is considered that AERMOD is appropriate for the assessment of impacts of pollutant emissions from this facility.

The model took into consideration the effects of meteorology, local topography and site buildings on dispersion. The study focussed on assessing the long-term and short-term exposure levels which are predicted to occur at a number of residential and ecological receptors in the areas surrounding the site.

[3] EPA Air Dispersion Modelling Guidance Note (AG4) 2020
[4] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

2.2.2 Scenarios modelled

Under the future normal operational conditions the site will operate 2 gas engines (engines 3 and 4) continuously. There are also 2 spare engines that are available in the event of breakdown in the duty engines. In addition enclosed flare 2 (site bad gas flare) will also run continuously. The combined capacity of the 2 engines is 1350 m^3/hr, and the capacity of flare 2 is 1500 m^3/hr.

In the event of all of the engines failing, enclosed flare 1 (capacity 1500 m^3/hr) will run in addition to enclosed flare 2. The site operator has indicated that a failure event of this nature could realistically be anticipated to only occur for a small number of hours per year.

The following operational scenarios were modelled:

- Scenario 1 'Future normal operational conditions': Engines 3 & 4 and flare 2 in operation.
- Scenario 2 'Engine failure': Flares 1 and 2 in operation.

2.2.3 Emissions data

Emissions estimates for engines 3 and 4 were defined on the basis of emission limit values within the site permit, typical emissions defined in AG7[5] and the most recent emissions monitoring data (collected in 2019[6]). These engines have recently been replaced but no new monitoring data is available.

Emissions estimates for flares 1 and 2 were defined on the basis of emission limit values within the site permit, typical emissions defined in AG7 on the most recent emissions monitoring data (collected in 2021[7]).

2.2.4 Background concentrations

The modelled facility contribution was added to maximum EPA monitored rural background concentrations and compared to the relevant ambient air quality guidelines, in accordance with EPA guidance AG4. The nearest EPA air quality monitoring station within a comparably rural location (Zone D) is located at Monaghan (Kilkitt) and this measures a range of air quality parameters, but not CO or Benzene. CO data was obtained from Birr (a Zone D station) and Benzene data was obtained from Kilkenny (a Zone C station).

Table 1: Relavant background data

Location	Pollutant	Hourly average pollutant concentration (µg/m^3 unless stated)			
		2019	2020	2021	Average
Monaghan_Kilkitt	NO_2 (ug/m^3)	5	2	2.4	3.1
Monaghan_Kilkitt	SO_2 (ug/m^3)	0.7	1.4	1.7	1.3
Monaghan_Kilkitt	PM_{10} (ug/m^3)	7	8	7.8	7.6
Birr	CO (mg/m^3)	-	0.4	0.3	0.4
Kilkenny	Benzene (ug/m^3)	0.12	0.04	0.18	0.11

[5] EPA Guidance Note on Landfill Flare and Engine Management and Monitoring (AG7), 2013
[6] Air Scientific "Air Emissions Compliance Monitoring Emissions Report" KH03 and KH04. 15/08/2019
[7] Air Scientific "Air Emissions Compliance Monitoring Emissions Report" F1 and F2. 19/11/2021

Background concentrations for HCl or HF are not routinely monitored in Ireland or in the UK and are unlikely to be high in rural locations such as Kentstown near Knockharley landfill. For this assessment their background concentrations have been assumed to be zero.

The above background levels were doubled when assessing against short term emission standards with the exception of PM_{10} where under standard practice this is not undertaken due to the small ratio between the annual and 24-hourly standard.

2.2.5 Assessment of impact

The long and short term Process Contribution (PC) for each pollutant have been added to the local background concentration (2x background concentration for short term) in order to calculate the Predicted Environmental Concentration (PEC).

The PEC's have been compared against the air quality standards to establish if there are likely to be any exceedances and establish to what extent the operation of the facility will have an impact on ambient air concentrations.

In addition, the Process Contribution (PC) for each pollutant (short term and long term) has been compared to AG4's Maximum Allowable Process Contribution:

- Maximum Allowable PC = 0.75 * Air quality standard
  (where there is no significant background concentration)

  Or

- Maximum Allowable PC = 0.75 * (Air quality standard – background concentration)
  (where there is a significant background concentration)

For ecological receptors, predicted concentrations were compared directly to the NOx air quality standard.

In all cases each individual year in the 5 No. year set was modelled, with the highest predicted process contribution (PC) of any of the years for each compound for each averaging period used as the basis for the assessment in accordance with AG4.

3 Relevant standards

3.1 Standards for residential receptors

Human health air quality objectives are set by the European Union (EU) as part of the ambient air quality and cleaner air for Europe Directive (2008/50/EC), and these are presented Table 2. In the absence of EU ambient air quality limit values for hydrogen chloride (HCl) and hydrogen fluoride (HF), Environmental Assessment Levels (EALs) from the UK[8] were examined for limit values for these parameters and are shown in Table 3.

Table 2: European Union Limit and target values as outlined in Directive 2008/50/EC

Pollutant	Obligation	Time Period	Legal Nature	Allowable Exceedances
Nitrogen Dioxide	200 µg/m³	1 hour	Limit Value	18 (99.79 %ile)
	40 µg/m³	Annual	Limit Value	n/a
Sulphur Dioxide	350 µg/m³	1 hour	Limit Value	24 (99.73 %ile)
	125 µg/m³	24 hours	Limit Value	3 (99.18 %ile)
PM_{10}	50 µg/m³	24 hours	Limit Value	35 (90.41 %ile)
	40 µg/m³	Annual	Limit Value	n/a
Carbon Monoxide	10 mg/m³	Maximum daily 8 hour mean	Limit Value	n/a
Benzene	5 ug/m³	Annual	Limit Value	n/a

In order to ensure a robust and conservative assessment, as a precaution, all TNMVOC was assumed to be benzene and compared against the European limit value of 5 µg/m³.

Table 3: Hydrogen Chloride and Hydrogen Fluoride EALs as per Environment Agency air emissions risk assessment[2]

Pollutant	Obligation	Time Period	Allowable Exceedances
Hydrogen chloride	750 µg/m³	1 hour	None (100th percentile)
Hydrogen fluoride	160 µg/m³	1 hour	None (100th percentile)
	16 µg/m³	Monthly mean	n/a

3.2 Standards for ecological receptors

Predicted concentrations at the ecological receptors were compared against the NOx Annual critical level of 30 µg/m³ presented in Directive 2008/50/EC.

[8] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

4 Estimation of emissions

4.1 Scenario 1

The physical parameters applied for the sources in the model for scenario 1 are detailed in Table 4 below. The location of each source is shown in Annex A.

Table 4: Summary of source physical parameters (scenario 1)

Source	Stack height (m)	Stack diameter (m)	Exhaust temperature (K)	Actual flow rate (Am^3/s^A)	Normalised flow rate (Nm^3/s^B)
Engine 3	10.2	0.4	698	1.99	0.67
Engine 4	10.2	0.4	693	1.90	0.65
Flare 2	10	1.6	1288	22.11	2.63

^{A} Flow rate at stack conditions (details in Annex A).

^{B} Engine flow rates normalised to 273K, 101.3 kPa, 5% O_2, dry. Flare flow rate normalised to 273K, 101.3 kPa, 3% O_2, dry.

The concentration and emission rate of each pollutant applied in the model for scenario 1 are detailed in Table 5 below.

Table 5: Emission concentrations and emission rates (scenario 1)

Pollutant	Emission concentration (mg/m^3) and emission rate (g/s)		
	Engine 3	Engine 4	Flare 2
NOx (as NO_2)^A	500 [0.33]	500 [0.32]	150 [0.39]
Sulphur dioxide^B	2040.8 [1.36]	1937.8 [1.26]	4357.9 [11.47]
Carbon monoxide^C	1400 [0.93]	1400 [0.91]	50 [0.13]
PM_{10}^{A}	130 [0.09]	130 [0.08]	-
Total non-methane VOCs (expressed as Benzene)^D	75 [0.05]	75 [0.05]	-
Hydrogen chloride^A	50 [0.03]	50 [0.03]	50 [0.13]
Hydrogen fluoride^A	5 [0.003]	5 [0.003]	5 [0.01]

^{A} ELV defined within site permit

^{B} Most recent (2019 engines and 2021 flare) SO_2 monitoring results

^{C} ELV for CO presented in AG7

^{D} Typical emission for NMVOC presented in AG7

4.2 Scenario 2

The physical parameters applied for the sources in the model for scenario 2 are detailed in Table 6 below.

Table 6: Summary of source physical parameters (scenario 2)

Source	Stack height (m)	Stack diameter (m)	Exhaust temperature (K)	Actual flow rate (Am^3/s[A])	Normalised flow rate (Nm^3/s[B])
Flare 1	8.75	1.6	1283	18.64	2.63
Flare 2	10	1.6	1288	22.11	2.63

[A] Flow rate at stack conditions (details in Annex A).

[B] Flare flow rates normalised to 273K, 101.3 kPa, 3% O_2, dry

The concentration and emission rate of each pollutant applied in the model for scenario 2 are detailed in Table 7 below.

Table 7: Emission concentrations and emission rates (scenario 2)

Pollutant	Emission concentration (mg/m^3) and emission rate (g/s)	
	Flare 1	Flare 2
NOx (as NO_2)[A]	150 [0.39]	150 [0.39]
Sulphur dioxide[B]	2526.8 [6.65]	4357.9 [11.47]
Carbon monoxide[C]	50 [0.13]	50 [0.13]
Hydrogen chloride[A]	50 [0.13]	50 [0.13]
Hydrogen fluoride[A]	5 [0.01]	5 [0.01]

[A] ELV defined within site permit

[B] Most recent (2021) flare monitoring SO_2 results

[C] ELV for CO presented in AG7

5 Model assumptions

5.1 Model settings

AERMOD version 11, executable 22112 was used for the modelling. The US EPA and AERMOD BREEZE regulatory options were used in this assessment.

The study area was defined as rural, in line with land use classification techniques described in the AERMOD User Guide issued by the US EPA.

5.2 Meteorological data

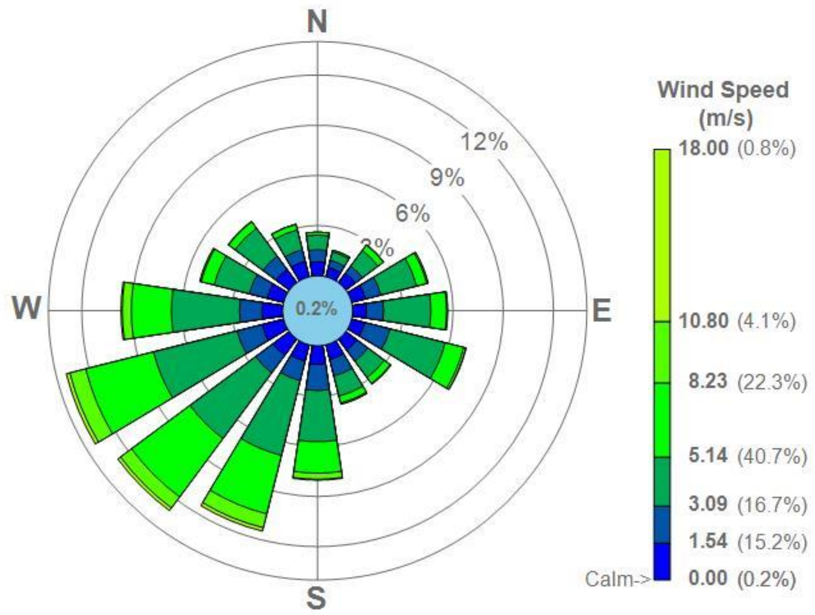
To comply with the EPA request the updated modelling has been conducted using meteorological data from Dunsany[9]. Five years of data was obtained (2012 to 2016) and adjusted to reflect the surface characteristics of the meteorological site in accordance with the guidelines in the Implementation Guide[10].

Table 8: Land use roughness values applied during meteorological processing.

Sector [degrees]	Surface roughness [m]	Albedo / Bowen ratio
335-80	0.12	0.278 / 0.761
80-165	0.10	
165-280	0.07	
280-335	0.08	

The windrose for the data is presented below:

Figure 1: A wind-rose for Dunsany 2012- 2016



[9] Missing cloud data was substituted from the Dublin Airport dataset.
[10] AERMOD Implementation Guide, Published by the US EPA: Last Revised: June 2022.

5.3 Topography

Data describing the topography of the area surrounding the works was obtained from Ordnance Survey Ireland for the area surrounding the proposed facility.

5.4 Building downwash

The AERMOD Building Profile Input Parameters (BPIPPRM) subprogram was run to calculate the potential for building downwash on each emission source in each of the 36 wind direction sectors (10° width/sector). This data is used in AERMOD to calculate plume downwash (i.e. adjusted plume centreline due to building wake affects). The following buildings were included in the model:

Table 9: Buildings included within the model

Building	Height (m)
Engine containers	4
Electrical sub station	4.5
Other structures in gas compound	3-3.5

5.5 Nitric Oxide to Nitrogen dioxide conversion

In line with EPA guidance AG4, the PVMRM NO_2/NO_X conversion method was used in AERMOD to take into account the portion of NOx converted to NO_2 in the atmosphere. This conversion assumes that 90% of the released emissions are nitric oxide and that there is an ambient ozone concentration of 72.4 $\mu g/m^3$. This is based on data collected by the EPA[11] at Macehead Galway in 2021. Macehead Galway is considered to be in Zone D (a town with a population less than 15,000). Therefore, based on the guidance outlined in AG4 Galway is considered to be representative of ozone concentration at Kentstown, near Knockharley landfill.

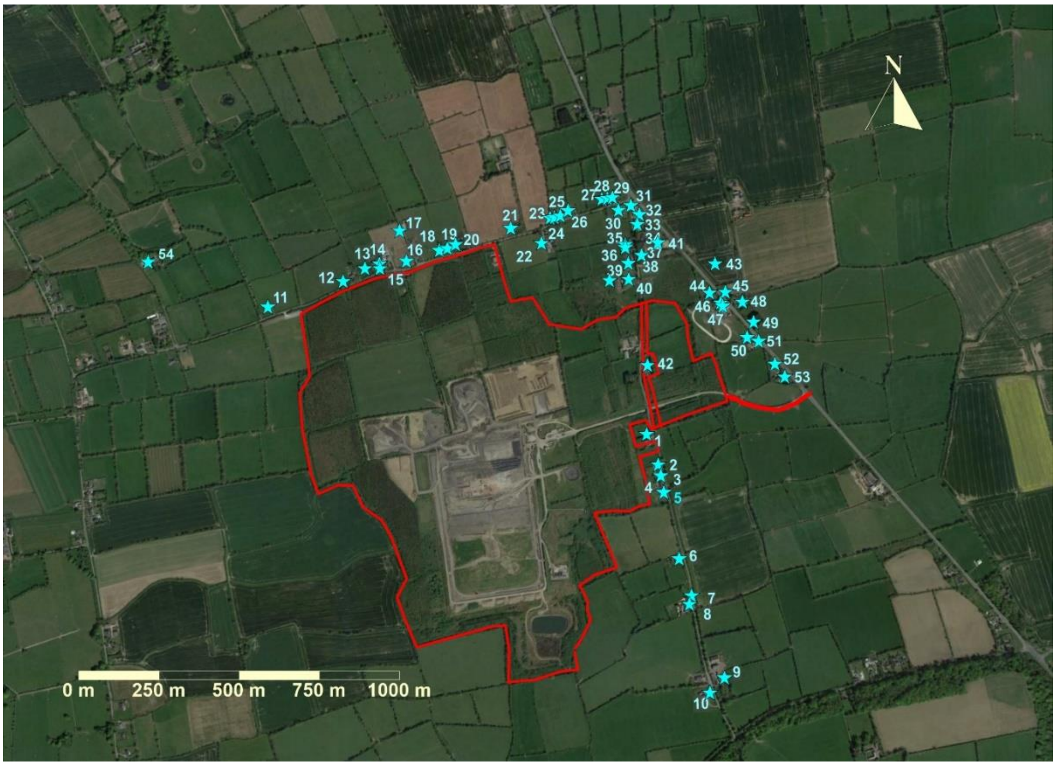
5.6 Receptors

5.6.1 Residential receptors

The model was set up to assess the impact of emissions on discrete receptors which were placed on 54 of the sensitive residential receptors in the vicinity of the site. The following receptors were included within the dispersion model:

[11] https://www.epa.ie/publications/monitoring--assessment/air/air-quality-in-ireland-2021.php

Figure 2: Discrete receptors included within dispersion model



Map imagery: Google Earth. The red line indicates the planning boundary of the facility. Discrete receptors considered within the dispersion model are presented as blue stars.

Table 10: Receptors included within the model

Receptor number	Coordinate (UTM)	
	X	Y
1	663887.5	5947144.5
2	663927.8	5947038
3	663938.7	5946975.5
4	663936.8	5946998.7
5	663946.7	5946940.3
6	664001.2	5946708.6
7	664043.8	5946578.6
8	664036.9	5946548.4
9	664157.9	5946290.5
10	664108.3	5946238.1
11	662569.7	5947590.4
12	662832.1	5947679.7
13	662908.5	5947724.1
14	662958.1	5947741.2
15	662960	5947724.1
16	663051.5	5947750
17	663028.5	5947856
18	663166.3	5947787.5

19	663194.1	5947795.6
20	663222.8	5947808.7
21	663414.2	5947866.1
22	663521.3	5947812.7
23	663552	5947901.4
24	663565.9	5947903.4
25	663587.7	5947909.4
26	663614.5	5947927.6
27	663731.5	5947966.9
28	663750.3	5947970.9
29	663768.2	5947973.9
30	663789	5947928.6
31	663832.6	5947944.7
32	663862.4	5947913.5
33	663854.5	5947879.2
34	663856.4	5947836.9
35	663812.8	5947808.7
36	663813.8	5947797.6
37	663869.3	5947771.4
38	663823.7	5947742.2
39	663758.7	5947683.4
40	663825.7	5947687
41	663925.8	5947814.7
42	663890.2	5947385.6
43	664125	5947741
44	664106.3	5947639.4
45	664161.8	5947642.5
46	664145	5947604.2
47	664151.9	5947593.1
48	664221.3	5947607.2
49	664260	5947536.7
50	664237.2	5947483.3
51	664276.9	5947469.2
52	664333.4	5947390.6
53	664367.1	5947345.3
54	662153.9	5947747.6

5.6.2 Ecological receptors

Using the screening distance of 15 km, an assessment of the potential air quality impacts arising on the following ecological receptors was made:

- River Boyne and River Blackwater cSAC (site code 002299)

- Boyne Estuary SPA (site code 004080)
- River Boyne and River Blackwater SPA (site code 004232)

6 Results of the assessment

6.1 Scenario 1

6.1.1 Summary of PEC to limit value

Table 11 below presents the highest predicted process contribution (PC) at any receptor for any of the years modelled for each compound. The PCs have then been added to the background concentration (2x background concentration for short term limits) in order to calculate the Predicted Environmental Concentration (PEC) which is then compared to the limit value.

Table 11: Summary of PEC to limit value

Parameter	Period	PC: Modelled ground level concentration (μg/m^3)	PEC: Modelled ground level concentration plus background (μg/m^3)	PEC as a % of limit value (μg/m^3)	Limit value (μg/m^3)
NOx as NO_2	1 hour (99.79%)	18.9	25.1	12.6%	200 μg/m^3
	Annual	1.6	4.7	11.6%	40 μg/m^3
Sulphur Dioxide	1 hour (99.73%)	162.2	164.8	47.1%	350 μg/m^3
	24 hours (99.18%)	73.0	74.3	59.4%	125 μg/m^3
PM_{10}	24 hours (90.41%)	1.2	8.8	17.6%	50 μg/m^3
	Annual	0.4	8.0	20.0%	40 μg/m^3
CO	Maximum daily 8 hour mean	51.9	851.9	8.5%	10,000 μg/m^3
Benzene	Annual	0.2	0.4	7.1%	5 ug/m^3
Hydrogen chloride	1 hour	2.7	2.7	0.4%	750 μg/m^3
Hydrogen fluoride	1 hour	0.24	0.2	0.1%	160 μg/m^3
	Monthly mean	0.04	0.04	0.2%	16 μg/m^3

6.1.2 Summary of PC to Maximum Allowable Process Contribution

Table 12 below compares the process contributions (PC) to AG4's Maximum Allowable Process Contribution.

Table 12: Summary of PC to Maximum Allowable Process Contribution

Parameter	Period	PC: Modelled ground level concentration (μg/m^3)	Maximum allowable process contribution (μg/m^3)	PC as a % of maximum allowable process contribution (μg/m^3)
NOx as NO_2	1 hour (99.79%)	18.9	150	12.6%
	Annual	1.6	30	5.2%
Sulphur Dioxide	1 hour (99.73%)	162.2	262.5	61.8%
	24 hours (99.18%)	73.0	93.8	77.9%
PM_{10}	24 hours (90.41%)	1.2	37.5	3.3%
	Annual	0.4	30	1.4%
CO	Maximum daily 8 hour mean	51.9	7500	0.7%

Parameter	Period	PC: Modelled ground level concentration (µg/m³)	Maximum allowable process contribution (µg/m³)	PC as a % of maximum allowable process contribution (µg/m³)
Benzene	Annual	0.2	3.8	6.5%
Hydrogen chloride	1 hour	2.7	562.5	0.5%
Hydrogen fluoride	1 hour	0.2	120	0.2%
	Monthly mean	0.04	12	0.3%

6.1.3 Ecological receptors

The results of the ecological receptors assessment indicates that for scenario 1 predicted annual concentrations of NOx as a result of the emissions from the facility are below 1 µg/m³ at all of the designated European sites.

This is substantially below the annual critical level for the protection of vegetation & natural ecosystems (30 µg/m³).

6.2 Scenario 2

6.2.1 Summary of PEC to limit value

Table 13: Summary of PEC to limit value

Parameter	Period	PC: Modelled ground level concentration (µg/m³)	PEC: Modelled ground level concentration plus background (µg/m³)	PEC as a % of limit value (µg/m³)	Limit value (µg/m³)
NOx as NO_2	1 hour (99.79%)	8.2	14.4	7.2%	200 µg/m³
Sulphur Dioxide	1 hour (99.73%)	191.4	194.0	55.4%	350 µg/m³
CO	Maximum daily 8 hour mean	2.7	802.7	8.0%	10,000 µg/m³
Hydrogen chloride	1 hour	3.5	3.5	0.5%	750 µg/m³
Hydrogen fluoride	1 hour	0.3	0.3	0.2%	160 µg/m³

6.2.2 Summary of PC to Maximum Allowable Process Contribution

Table 14: Summary of PC to Maximum Allowable Process Contribution

Parameter	Period	PC: Modelled ground level concentration (µg/m³)	Maximum allowable process contribution (µg/m³)	PC as a % of maximum allowable process contribution (µg/m³)
NOx as NO_2	1 hour (99.79%)	8.2	150	5.5%
Sulphur Dioxide	1 hour (99.73%)	191.4	262.5	72.9%
CO	Maximum daily 8 hour mean	2.7	7500	<0.1%

Parameter	Period	PC: Modelled ground level concentration (μg/m³)	Maximum allowable process contribution (μg/m³)	PC as a % of maximum allowable process contribution (μg/m³)
Hydrogen chloride	1 hour	3.5	562.5	0.6%
Hydrogen fluoride	1 hour	0.3	120	0.2%

6.2.3 Ecological receptors

The results of the ecological receptors assessment indicates that for scenario 2 predicted annual concentrations of NOx as a result of the emissions from the facility are below 1 $\mu g/m^3$ at all of the designated European sites.

This is substantially below the annual critical level for the protection of vegetation & natural ecosystems (30 $\mu g/m^3$).

6.3 Discussion

For scenario 1 (future normal operational conditions) the modelling results indicate that predicted concentrations fall below all of the short term and long term limit values set out in EPA guidance AG4 at all nearby sensitive receptors for all of the pollutants assessed. The predicted concentrations are also below AG4's Maximum Allowable Process Contribution for all pollutants assessed.

For scenario 2 (engine failure scenario) the results indicate that predicted concentrations fall below all of the short term term limit values at all nearby sensitive receptors for all of the pollutants assessed. The predicted concentrations are also below AG4's Maximum Allowable Process Contribution for all pollutants assessed.

On this basis, the risk of impact of the emissions from the landfill gas utilisation plant at Knockharley Landfill is considered to be low.

6.4 Uncertainty

As stated in EPA guidance AG4, dispersion modelling assessments include an inherent level of uncertainty. The assessment detailed within this report includes a number of precautious elements which are designed to account for this uncertainty:

a. ELVs from the site permit are used to define emissions of NOx as NO2, PM10, HCl and HF. Monitoring data from the last 4 years indicate that the emissions from the plant are consistently below these ELVs.

b. The emissions of SO_2 from engines 3 and 4 were defined on the basis of the 2019 monitoring data. However sulphur scrubbing plant has now been installed prior to these engines so the sulphur concentration of the emissions is likely to be lower.

c. As per EPA guidance AG4, an appropriate “window” has been reserved between the predicted environmental concentration (PEC) and the ambient air quality standard (AQS) to take account of model accuracy.

7 Summary of findings

The key findings of the study are as follows:

- For scenario 1 (future normal operational conditions) the modelling results indicate that predicted concentrations fall below all of the short term and long term limit values set out in EPA guidance AG4 at all nearby sensitive receptors for all of the pollutants assessed. The predicted concentrations are also below AG4's Maximum Allowable Process Contribution for all pollutants assessed.
- For scenario 2 (engine failure scenario) the results indicate that predicted concentrations fall below all of the short term limit values at all nearby sensitive receptors for all of the pollutants assessed. The predicted concentrations are also below AG4's Maximum Allowable Process Contribution for all pollutants assessed.
- For both scenarios, the results of the ecological receptors assessment indicates that for predicted annual concentrations of NOx as a result of the emissions from the facility are below 1 $\mu g/m^3$ at all of the designated European sites, which is substantially below the annual critical level for the protection of vegetation & natural ecosystems (30 $\mu g/m^3$).
- On this basis, the risk of impact of the emissions from the landfill gas utilisation plant at Knockharley Landfill is considered to be low.

Annex A Modelling parameters

A.1 Model sources and buildings

Figure 3: Location of sources and buildings included in model

Table 15: Sources included within the model

Ref	Source	Elevation (m)	Coordinates (UTM)
S1	Flare 1 stack	55.75	663583,5946640
S2	Flare 2 stack	55.85	663577,5946654
S3	Engine 3 stack	55.58	663604,5946651
S4	Engine 4 stack	55.47	663610,5946652

Table 16: Buildings included within the model

Ref	Building	Height (m)	Elevation (m)	X length (m)	Y length (m)	Coordinates (UTM)
B1	Engine container 1	4	55.48	12	2.5	663609, 5946652
B2	Engine container	4	55.83	12	2.5	663591, 5946650
B3	Engine container	4	55.71	12	2.5	663597, 5946651
B4	Engine container	4	55.59	12	2.5	663603, 5946651
B5	Electrical sub station	4.5	55.13	4.6	11	663617, 5946639
B6	Container adj to flare	3	55.98	12	1.7	663583, 5946648
B7	Structure	3	55.79	2.5	6.3	663575, 5946657
B8	Structure	3.5	55.89	4	4	663580, 5946654
B9	Structure	3.5	55.85	5	2.5	663581, 5946659

A.2 Stack parameters

Table 17: Actual stack conditions

Source	Temperature (K)	Oxygen concentration (%)	Moisture content (%)	Exit velocity (m/s)
Flare 1	1283	7.34	8.1	9.3
Flare 2	1288	9.16	8.1	11.0
Engine 3	698	6.0	8.5	15.8
Engine 4	693	5.9	8.5	15.1