Wexford County Council

Killurin Landfill
W0016-02

Annual Environmental Report 2015

Quality Control Sheet

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EXECUTIVE SUMMARY

This *Annual Environmental Report* has been prepared for Killurin Landfill, Waste Licence 16-2, for the reporting period from **1 January 2015 to 31 December 2015 inclusive**. The report includes the information specified in Schedule G of the Waste Licence, Content of the Annual Environmental Report, in accordance with Waste Licensing - *Draft Guidance on Environmental Management Systems (EMS) and Reporting to the Agency, 1999'.* The main topics discussed with this report are as follows:

- General Site Information
- Management and Staffing
- Reported Incidents and Complaints
- Development Works
- Waste Acceptance and Handling
- Emissions Management
- Environmental Nuisances
- Resource and Energy Consumption
- Environmental Monitoring and Emissions

Killurin Landfill was closed to accepting waste on the 07 June 2008. No waste was accepted to landfill in 2015.

Wexford County Council continued to carry out a comprehensive environmental monitoring programme during 2014, in compliance with the waste licence conditions (Schedule D), to assess the significance of emissions. The monitoring programme included Landfill Gas, Leachate Level & Quality, Surface Water Quality, Groundwater Level & Quality, Odour monitoring and Meteorological monitoring.

1 INTRODUCTION

1.1 General Information

The Annual Environmental Report (AER) for Killurin Landfill includes the information specified in Schedule G of the Waste Licence W0016-2, *Content of Annual Environmental Report* and has been prepared in accordance with the Environmental Protection Agency (EPA) publication *'Waste Licensing – Draft Guidance on Environmental Management Systems (EMS) and Reporting to the Agency, 1999'.*

The reporting period for this AER is **1st January 2015 to 31st December 2015 inclusive**.

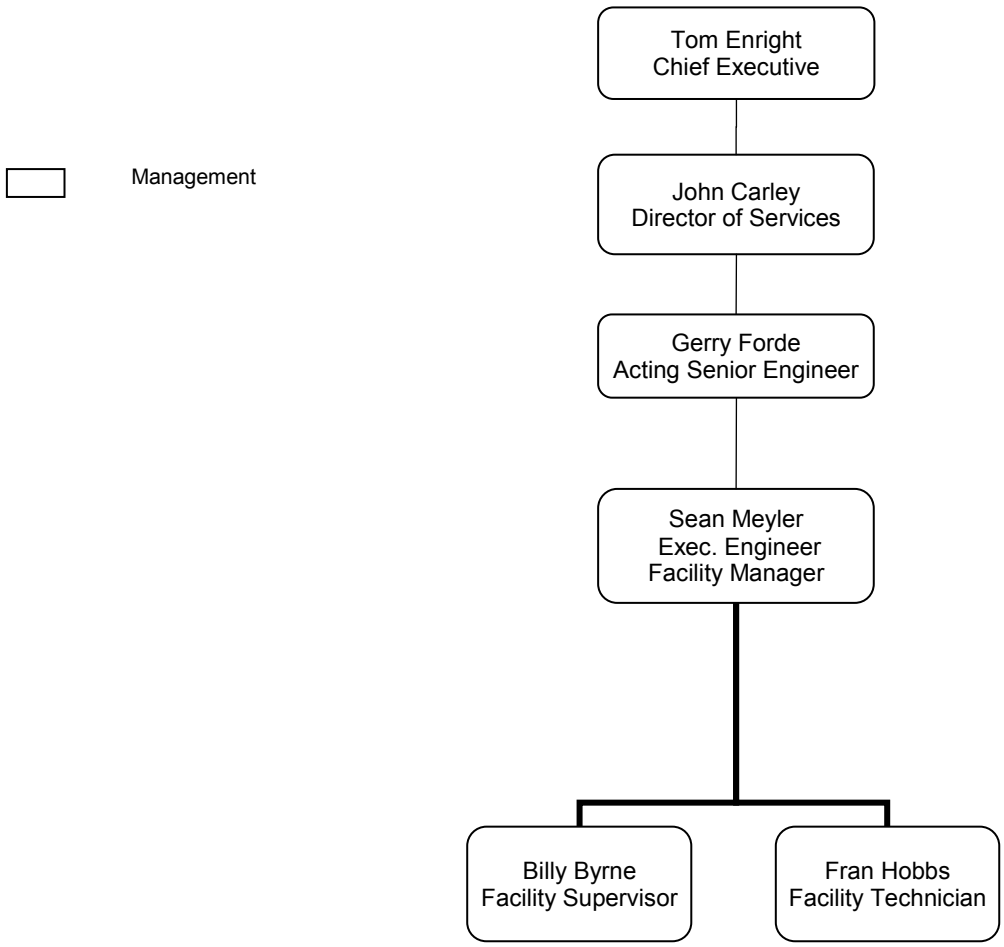
1.2 Site information

Table 1 Site information for Killurin Landfill

KILLURIN LANDFILL	
Waste licence register no:	W0016-2
Name and address of operator:	Wexford County Council County Hall Spawell Road County Wexford
Name and address of facility:	Killurin Landfill Killurin County Wexford
Site Description:	Killurin Landfill site is located in the town land of Newtown lower, Killurin, close to Deeps Bridge on a meander of the eastern bank of the River Slaney. The site is approximately 11km from Wexford town and covers an area of 10.7 hectares, of which 4.9 hectares are landfill and the remainder is CA site, buildings, car parking and buffer zones/screening. The facility is located in what once was a sand and gravel quarry. The area surrounding the site is rural with a mixed pattern of highly productive pasture and arable land use, with the River Slaney being the prominent landscape feature. Landfilling and CA site operations ceased in June 2008.

2 MANAGEMENT & STAFFING STRUCTURE

2.1 Management and staffing structure for Killurin Landfill on 31st December 2015



Killurin Landfill was operated by Wexford County Council during 2015 with support provided by Irish Biotech Services.

2.2 Financial provisions

In accordance with Condition 12.1 Wexford County Council paid a sum of €15,699 to the Environmental Protection Agency for the management and monitoring of the waste licence.

2.2.1 *Provision for the Closure, Restoration and Aftercare*

Wexford County Council (WCC), as a Local Authority, has made the necessary provisions, for the development, management, restoration and aftercare of Killurin Landfill. WCC has assigned engineering and technical staff to manage the facility. Wexford County Council is committed to the ongoing provision of funding for all site development works, environmental monitoring costs and restoration and aftercare works at Killurin Landfill for the duration of the Waste Licence.

2.3 Environmental Management System

2.3.1 *Environmental Management Programme*

The site has an operational environmental management system (EMS) in accordance with the Waste Licence condition 2.3.2.1. Implementation of the EMS continued during this reporting period (January 2015 - December 2015). The Objectives and Targets of the EMS were reviewed and revised for the reporting period 2015.

2.3.2 *Environmental objectives and targets.*

Table 2 below provides the Objectives and Targets for 2015 and details progress made regarding each objective. Table 3 provides the Objectives and Targets for 2016 and the methods by which they will be achieved.

An environmental management plan (EMP) was prepared as part of the EMS for the facility. The EMP comprises information on the following topics:

- Site description
- Site infrastructure
- Leachate Collection and treatment Leachate Management System
- Landfill Gas Abatement Methods
- Surface water Control Measures
- Environmental Monitoring
- Site Security and Site Offices
- Operational Matters
- Vermin control
- Fires
- Restoration and Aftercare

Table 2 **Achievements of Objectives and Targets for 2015**

Achievement of Objectives and Targets for 2015			
	Comments	Date	Responsibility
Objective No 1:			
1.1 Resolve landfill gas flare issues	Pumping trials ongoing to evaluate current gas yield.	Dec 2015	Facility Manager / Facility Technician
Objective No 2:			
2.1 Compile enhanced data set in accordance with the leachate management plan	Ongoing. Data discussed in GW Technical Assessment Report, submitted in June 2015	Dec 2015	Facility Manager / Facility Technician
Objective No 3:			
3.1 Complete the Groundwater Technical Assessment and Implement any recommendations	The GWTA report was submitted in June 2015. RFI response report was submitted in December 2015.	June/Dec 2015	Facility Manager / Facility Technician

Table 3 **Objectives and Targets for 2016**

Objectives and Targets for 2016			
	Comments	Target	Responsibility
Objective No 1:			
1.1 Resolve landfill gas flare issues	Submit proposals for revised LFG flaring infrastructure, and procure infrastructure as appropriate	December 2016	Facility Manager / Facility Technician
Objective No 2:			
2.1 Continued monitoring of groundwater data	Interrogate environmental monitoring data and abstracted leachate data to evaluate effectiveness of the perimeter road capping works and enhanced leachate abstraction system	December 2016	Facility Manager / Facility Technician
Objective No 3:			
3.1 Analysis of leachate volumes	Examine leachate volumes extracted, with a view to better aligning predicted volumes with	December 2016	Facility Manager / Facility

Objectives and Targets for 2016			
	Comments	Target	Responsibility
	extracted volumes		Technician

2.3.3 *Corrective action Procedure*

Procedures are in place in accordance with Condition 2.3.2.3 of the licence to monitor, measure, audit and record the environmental performance of the environmental management system. These procedures establish how non-conformance within the system is dealt with and how any corrective and preventive action is carried out. A corrective action procedure was prepared in October 2008 (reviewed in 2010) and is included in the overall EMS report.

2.3.4 *Awareness and Training Programme*

In accordance with Condition 2.3.2.4 of the licence, an awareness and training programme has been developed to increase environmental awareness among staff and identify training needs of all personnel working at Killurin Landfill. The facility manager has overall responsibility for reviewing training needs on an annual basis to ensure that all staff have the necessary skills and level of awareness to carry out their duties to the highest environmental and safety standards. Training records are kept on file at Holmestown Waste Management Facility.

2.3.5 *Full title of any procedures developed by the licensee in the year which relates to the facility operation*

No additional procedures were developed or submitted during the reporting period.

2.3.6 *Report on communication programme*

The site's EMS includes a procedure for communication. In addition Wexford County Council provides the following documentation for public viewing at Holmestown Waste Management Facility:

Table 4 List of records available for public access in relation to the landfill

List of records available for public viewing
Waste Licence W0016-2
Waste Licence application
Correspondence with the EPA
Incident / complaints records

Audit records
Waste acceptance records
Material acceptance dockets
All monitoring records
Leachate removal records
Vermin control reports

3 REPORTED INCIDENTS & COMPLAINTS SUMMARIES

3.1 Incidents

No incidents were reported during this reporting period. However ongoing elevated levels of ammonia (which are decreasing over time) are still being recorded in downstream groundwater boreholes. Refer to quarterly monitoring reports and the Leachate Management Plan for further details.

3.2 Complaints

No complaints were received during this reporting period.

4 DEVELOPMENT WORKS UNDERTAKEN DURING THE REPORTING PERIOD & THOSE PROPOSED FOR THE COMING YEAR

4.1 Landfill Engineering Works

4.1.1 *Completed Engineering Works 2015*

Engineering works for 2015 as detailed in the Leachate Management Plan were progressed as follows:

- Continue the leachate extraction infrastructure maintenance works programme

Also, we commenced a landfill gas pumping trial on 4th December 2015, with a view to ascertaining the actual gas yield from the waste mass. This trial is due for completion in Q1 2016.

4.1.2 *Proposed Engineering Works 2016*

Proposed engineering works for 2016 as follows:

- Continue the leachate extraction infrastructure maintenance works programme
- Complete landfill gas pumping trial and formulate, seek approval of and implement proposals to improve flaring infrastructure.

4.2 Restoration and Aftercare

A revised restoration and aftercare plan was submitted to the EPA for approval in July 2013.

Restoration works are now complete at the facility.

5 WASTE ACCEPTANCE & HANDLING

5.1 Waste Activities carried out at the Facility

No waste disposal operations took place on site at Killurin Landfill during the reporting period 1st January 2015 to 31st December 2015.

5.2 Total Quantity of Waste Consigned Off Site

A summary of the total quantity of waste consigned off site at Killurin Landfill for the period 1st January 2015 to 31st December 2015 is presented below in Table 5.

The total volume of leachate transported off site for treatment at Wexford Wastewater Treatment Works was 5,322 Tonnes.

5.3 Remaining capacity of the site

Killurin Landfill closed at the end of June 2008. There is no remaining landfill capacity.

Table 5 **Waste consigned off-site from Killurin Landfill from 1st January to 31st December 2015 (tonnes)**

Waste Out	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly totals
LEACHATE	465	264	387	279	833	93	622	208	300	370	815	682	5318
Total													5318

6 ENVIRONMENTAL NUISANCES

6.1 Review of environmental nuisance control at the facility for the reporting period

Nuisances at Killurin Landfill are logged in a monthly tick-box report and action is taken immediately to address any identified issues. Table 7 below summarises the measures implemented on site to combat environmental nuisances during 2015.

Table 6 Environmental Nuisance Control during 2015

Nuisance	Mitigation Measures in Place
Vermin	Permanent bait points set up on site (internal and external). Inspections carried out on a monthly basis. If infection found then weekly inspections until rodent free. Monthly reports produced and kept at Holmestown site office.
Litter	Killurin landfill is litter free.
Flies	No flies present.
Odour	No odour emissions

7 RESOURCE & ENERGY CONSUMPTION

7.1 Electricity and Energy Usage

Electricity usage for the reporting period was estimated at 88,499 kWh.

7.2 Water

Domestic water usage data was not recorded.

7.3 Diesel

Total diesel fuel consumption (for operations) is estimated to be 0 litres from 1st January to 31st December 2015.

8 ENVIRONMENTAL MONITORING & EMISSIONS SUMMARY

8.1 Summary report on emissions

A summary of emissions monitoring at Killurin Landfill carried out during this reporting period (January 2015 – December 2015) is contained in Table 8 below. The E-PRTR Regulation (EC) No. 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register came into force in February 2006 and was brought into Irish law through SI No 123 of 2007. As a result all industries have to annually report environmental emissions and waste transfer data through a web-based form as part of their AER. The PRTR 2015 document is included in Appendix A1.

Table 7 A summary of Emissions monitoring as specified in Waste Licence W0016-2

Emission Monitoring	Frequency
Landfill Gas	Continuously (Dwellings adjacent to Landfill, Flare) Weekly (Site Accommodation) Monthly (Landfill Gas & Leachate extraction Wells) Annual (Flare emissions)
Leachate	Monthly (Analysis Note 2) Quarterly (Level & Analysis) Annually (Analysis)
Surface water	Weekly (Visual) Quarterly (Analysis) Annually (Analysis)
Groundwater Levels	Quarterly (Borehole Level)
Groundwater	Quarterly (Analysis) (Note 2) Annually (Analysis)
Noise	As required (Note 1)
Dust	As required (Note 1)
River Water	Quarterly (Analysis)

Note 1: When specific engineering works are being carried out

Note 2: As detailed in the Leachate Management Plan additional monitoring of groundwater and leachate around and within the Landfill footprint took place during 2015

8.2 Environmental Monitoring

Wexford County Council carries out a comprehensive environmental monitoring programme, in compliance with the waste licence conditions, to assess the significance of emissions. The monitoring programme includes Landfill Gas, Leachate Level & Quality, Surface Water Quality, Groundwater Level & Quality, Noise and Dust monitoring (as required), Odour monitoring and Meteorological monitoring, as well as Flare emission and Topographical.

Monitoring during this reporting period was carried out according to Schedule D of Waste Licence W0016-2, Quarters 1, 2, 3 and 4 results for 2015 are summarised in this chapter. Additional monitoring was also carried out as detailed in the Leachate Management Plan. A monitoring point location plan is provided see Appendix A2.

8.2.1 *Landfill gas*

In accordance with Schedule D.1 of the Waste Licence W0016-2, the following monitoring has been carried out and reported to the Agency.

- Monitoring boreholes boundary locations GW1, GW9, GW10, GW11, GBH1 and GBH2
- Perimeter boreholes T1, T2, T3, T5, T6, T7, T9, T10, T11, T12, T13, T14, T15, T16, T17, T18 and T19 were monitored on a monthly basis by Wexford County Council site staff.
- In waste landfill gas extraction wells series W, A and LE wells.

The majority of boreholes have varying levels of gas quality over the reporting period and no particular trend could be identified. Gas monitoring details are provided in Table 8 below.

Table 8 **Gas Monitoring Points**

Off site and on site gas boreholes		
CO2 and CH4 levels (monthly)	20 boundary locations 77 in waste locations	Boundary gas monitoring wells T1 –T3, T5- T7, T9- T19 GW1, GW9- GW11. In waste landfill gas extraction wells series W, A & LE wells
		Resident gas boreholes: GB1 and GB2
Residential Dwelling gas alarms		
CO2 and CH4 levels (continuously)	2 points	Two closest residences
CO2 and CH4 levels (As required)	8 points	All site buildings

Perimeter boreholes

No exceedences of licence limits were recorded at T17, T18, T19, GBH1 or GBH2 which would indicate that landfill gas migration off site has not taken place.

Carbon Dioxide levels inT2, T3, T5, T6, T9, T11, T12 and T13 are slightly elevated. The most likely cause of the slightly elevated readings is their location in a mature wooded area. The exceedences are low (max 6.8% in T9).

No exceedences of licence limits were recorded at any of the remaining peripheral gas monitoring wells. This indicates that landfill gas migration off site has not taken place.

Methane (CH_4)

Resident's boreholes

The following was recorded at resident's boreholes during this reporting period:

- **GB1 at Carley's:** Methane levels at this monitoring location were seen to be below the 1.0% volume per volume (v/v) trigger-level throughout the reporting period.

- **GB2 at Kelly's:** Methane levels at this monitoring location were seen to be below the 1.0% volume per volume (v/v) trigger-level throughout the reporting period.

The CH_4 trigger level at the gas monitoring wells is 1.0% volume by volume (v/v).

Carbon Dioxide (CO_2)

Resident's boreholes

The following was recorded at resident's boreholes during this reporting period:

- **GB1 at Carley's:** All results were below the 1.5% volume per volume (v/v) trigger-level.

- **GB2 at Kelly's:** All results were below the 1.5% volume per volume (v/v) trigger-level.

The CO_2 trigger level at the gas monitoring wells is 1.5% volume by volume ` (v/v).

Monitoring boreholes GBH1 and GBH2 are located on the resident's side of the gas migration cut off trench. The cut off trench consists of an excavated trench along the landfill boundary adjacent to Carley's and Kelly's residents. Installed in this trench is an impermeable geotextile membrane with a series of gas extraction wells installed on the landfill side. The results indicate that the gas migration cut off trench combined with the gas abstraction system is operating as designed. Continuous monitoring for the detection of landfill gas was carried out at Carley's and Kelly's residents. Landfill gas was not detected at either residence in 2015.

Methane and Carbon Dioxide levels (as expected) remain elevated in the dual leachate/Gas extraction wells which are located in the waste body (Series W, A & LE). This gas is being continuously extracted and flared off. The monthly results are available for inspection at the Holmestown waste Management Facility site office.

8.2.2 *Flare Emissions*

An air emission test of the landfill flare was carried out by Fitz scientific on the 8th August 2015. NO_x, HCL, HF were found to be in compliance with the emission limit values contained in Waste Licence W0016-2 – Schedule C5, the CO emission was found to be not representative at the monitoring location and not reported on. The report is in included in Appendix A4.

8.2.3 *Leachate levels and monitoring*

Leachate monitoring points

Leachate Monitoring			
Level	16 points	LE12-1 to LE12-16	Quarterly
Analysis	1 point 48 points	Leachate storage tanks Series W, A & LE wells	Monthly / Annually Quarterly

Leachate levels

Leachate levels were taken at 16 leachate boreholes during 2015. Samples for analysis were obtained from the leachate storage tanks in 2015 in compliance with Schedule D.5. The levels were recorded using a dip meter on a quarterly basis by Wexford County Council staff at the landfill. The annual analysis results of the leachate removed from the tanks in 2015 is detailed in Table 10. The quantity exported off-site in 2015 was 5,319 tonnes compared to 5,322 tonnes in 2014.

Leachate is collected from 40 extraction wells located around the site within the waste boundary. This leachate is directed to the three holding tanks located in the northwest of the landfill. It is then removed by road tanker on a routine basis and transported to Wexford Wastewater Treatment Plant (and, since August 2015, to Holmestown leachate treatment plant) for treatment in accordance with Waste Licence Condition 6.6.

Leachate monitoring

Annual monitoring was undertaken on 27th April 2015. A leachate sample was collected from the leachate storage tanks. The sample was analysed for a range of parameters as defined in Table D.5.1 of the Waste Licence 16-2.

The typical characteristics of leachate generated on site are presented in Table 10. The results are similar to those obtained for the last reporting period and are in general indicative of a landfill in the methanogenic stage of decomposition of organic compounds i.e. conversion of organic compounds to landfill gas.

Table 9 **Leachate analysis results 2015**

Sampling Points		**Tanks**
Sampling Date		27/04/2015
Parameters	**Units**	Annual
Temperature	^{o}C	11.5
Ammonia	mg/l N	340
Biochemical Oxygen Demand	mg/l 02	<50
Chemical Oxygen Demand	mg/l 02	828
Chloride	mg/l Cl	678
Conductivity	µS/cm	7510
Fluoride	mg/l F	<1.6
Mercury	µg/l	<0.5
Nitrite	mg/l N	0.421
Ortho-Phosphate	mg/l P	1.1
pH	pH	8.2
Sulphate	mg/l SO4	<16
Total Oxidised Nitrogen	mg/l N	0.68
Aluminum	µg/l	250
Antimony	µg/l	3.8
Arsenic	µg/l	34
Barium	µg/l	240
Cadmium	µg/l	<0.020
Calcium	mg/l	120
Chromium	µg/l	nm
Cobalt	µg/l	15
Copper	µg/l	99
Iron	µg/l	3800
Lead	µg/l	<1.0
Magnesium	mg/l	59
Manganese	µg/l	570
Molybdenum	µg/l	2
Nickel	µg/l	74
Potassium	mg/l	320
Selenium	µg/l	1.1
Sodium	mg/l	580
Thallium	µg/l	<1.0
Uranium	µg/l	<1.0
Vanadium	µg/l	11
Zinc	µg/l	250

Additional leachate analysis was undertaken during 2015 from 48 number leachate wells located within the waste body, the results of this analysis is to be submitted as part of the Leachate Management Plan review reports.

Inspection and testing of leachate storage tanks

The leachate tanks were tested in 2014; the tanks passed the integrity test and were assessed as being fit for the storage of leachate. The tanks are due to be re-tested in October 2017.

8.2.4 *Surface Water*

Under Schedule D.5 of the Waste Licence 16-2, surface water monitoring was required in the locations listed below. SW1 is located upstream of the site, SW2 is situated downstream of the site SW3 is located on the eastern side of the site adjacent to the landfill flare compound and SW4 is located at the southern tip of the facility (see monitoring point location drawing in Appendix A2). The site streams / drains regularly run dry during the drier months of the year and consequently surface water samples cannot be obtained. These are discussed in subsequent sections.

Table 10 **Surface water monitoring locations and frequency**

Surface water monitoring locations and frequency			
Parameter	**Location**	**Name**	**Frequency**
Visual Inspection/ Odour	Off site (River Slaney)	S1, S2, S3	Quarterly
Chemical analysis	Off site (River Slaney)	S1, S2, S3	Quarterly
Visual inspection	On site	SW1, SW2, SW3 and SW4	Weekly
Chemical analysis	On site	SW1, SW2, SW3 and SW4,	Quarterly and Annual

Visual inspection of surface water

Surface water on site consists of a series of open and piped drains. Weekly visual inspections of surface water were conducted for monitoring points SW1, SW2, SW3 (SW 3 is a surface water manhole that collects surface water from the upper cap subsurface drainage layer and is adjacent to the flare compound, monitoring commenced in Q4, 2012) and SW4, and quarterly at off-site locations (River Slaney) S1, S2 and S3. All surface water details are included in previously submitted monitoring reports for the landfill. No visual abnormalities were recorded for any of the surface water inspection points during the reporting period.

Surface water quality analysis

Results for all surface water monitoring carried out in 2015 will be submitted to the Agency in the annual monitoring report. Due to dry periods it was not always possible to retrieve samples from all of the monitoring points. No sample was obtainable from SW1, SW2, SW3 and SW4 in Q1. No sample was obtainable from SW3 in Q3 or Q4.

All sampling and analysis was carried out in accordance with recognised quality assurance and control procedures. The detailed monitoring results are presented in the annual monitoring report. The range of analysis is as specified in Schedule D.5 of the Waste Licence 16-2 and includes parameters such as ammoniacal nitrogen, BOD, COD, dissolved oxygen, pH, electrical conductivity, suspended solids and temperature. No atypical results were recorded during the quarterly monitoring in 2015.

River water

The river water monitoring results for the river Slaney are presented in the annual monitoring report. Monitoring location S1 is located upstream of the landfill,

monitoring location S2 in the river adjacent to the landfill and monitoring location S3 is located downstream of the landfill and all are located within the tidal zone of the river estuary.

Ammonia results were relatively low. There is no evidence from the upstream and downstream river results that the landfill is impacting negatively on the Slaney.

8.2.5 *Groundwater*

Table 11 **Groundwater monitoring locations**

Groundwater Monitoring Locations		
Downgradient	1 point	GW1
Downgradient (border of reed beds)	1 point	GW9
Downgradient (border of reed beds)	1 point	GW10
Upgradient	1 point	GW11
Upgradient	1 point	GBH1
Upgradient	1 point	GBH2

Groundwater levels

Groundwater levels were measured on a quarterly basis using a dip meter. The groundwater dip levels are included in the annual monitoring report. Groundwater levels remained relatively constant throughout the monitoring period, with only minor variations in groundwater levels in accordance with prevailing weather conditions. During the drier months the groundwater levels were seen to gradually decrease while during wetter periods where prolonged rain was evident.

Groundwater quality boreholes

No significant variation from historical result trends was noted in 2015. The highest levels of contaminants have been recorded in the boreholes located along the south east side of the landfill. These BH's are on the maximum hydraulic groundwater gradient that falls from the landfill towards the river. Samples were taken from both soil and underlying rock layers. In both cases the distribution of contamination was not even, with certain boreholes recording higher results than others. This may be due to preferential flow paths caused by gravel/sand lenses in the soils and increased permeability due to higher levels of fracturing or faults in the underlying rock. The result trends show that leachate management on site has had a beneficial effect on these wells and Ammonal, Chloride and Conductivity levels have been decreasing since 2006. Boreholes with low contaminant readings have exhibited little change since 2006. This may be due to the lower permeability and recharge in these zones. Further information on the above can be found in the annual monitoring report and the Leachate Management Plan review report.

Private Well water analysis

Table 12 **Private well monitoring locations**

Drinking water

Private residence	UV treated	Kitchen tap

Quarterly and annually monitoring was carried out on drinking water samples from our neighbour's private well.

Additional private well / groundwater analysis was undertaken during 2015 from 3 number private wells located above the western bank of the river Slaney opposite the landfill, the results of this analysis is to be submitted as part of the Leachate Management Plan review report.

8.2.6 *Noise*

No noise monitoring was undertaken during 2015.

8.2.7 *Meteorological monitoring*

All 2015 meteorological monitoring information was obtained from the Met Éireann weather station located at Johnstown Castle, Wexford; this station is within 10km of the Killurin Landfill site. The monitoring data is contained in Appendix A3.

8.2.8 *Topographical Survey*

The latest topographical survey of the site was carried out by Capital Surveys Ltd in November 2014. The topographical survey drawing is contained in Appendix A2.

Given that the landfill has not accepted waste since 2008, and that the site has been fully capped the enclosed topographical survey was carried out for the purpose of checking settlement in the waste body. There appears to have been very little settlement since the 2013 AER topographical survey was carried out. The maximum observed level for the 2013 AER survey was 30.2 mOD, as compared to a level of 30.5 mOD for the 2014 AER survey. The rise in level appears to be due to local temporary works associated with the recent leachate abstraction wells installation.

There has been some minor changes to levels along the route of the perimeter road due to capping works, but these are inconsequential in relation to settlement or stability.

We propose to carry out the next topographical survey during 2016.

8.2.9 *Slope Stability Assessment*

Walkover slope stability assessments were conducted weekly in 2015 to check for any visible signs of slippage or instability on the flanks of the waste body. None were noted. It was concluded that the waste body remained stable during 2015.

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9 Water Balance Calculations

The objective of the assessment of water balance calculations is to understand and predict the liquid inputs and outputs of the facility. Water balance calculations have been calculated for the period 1st January 2015 to 31st December 2015 to estimate the approximate volume of leachate generated on site. This volume can then be compared to the volume of leachate leaving site, by tanker over the weighbridge.

The water balance addressed the volume of leachate generated at the site including the estimated annual infiltration of rainfall. The water balance methodology is described below and the calculation is shown in Appendix A5.

The water balance calculations are based on the methodology specified in the EPA's Landfill Site Design Manual. The calculation used is as follows: -

Lo = [ER(A) + LW + IRCA +ER(l)] – [aw]

Lo = leachate produced (m^3)

ER = effective rainfall (m) (Use actual rainfall (R) for active cells)

A = area of cell (m^2)

LW = liquid waste (m^3)

IRCA = infiltration through restored and capped areas (m)

l = surface area of lagoon (m^2)

a = absorptive capacity of new waste (m^3/t)

w = weight of waste deposited (t/a)

An absorptive capacity of 0.025 m^3 per tonne was assumed.

The meteorological data used was obtained from the nearby Met Eireann meteorological station at Johnstown Castle. The total rainfall from 1st January 2015 to the 31st December 2015 was approximately 1063 mm. Meteorological data is presented in Appendix A3.

The water balance calculation considers the infiltration types influencing leachate generation:

- Infiltration directly through the permanently capped areas, estimated at 5%
- Infiltration due to run-off from the upper capped areas onto the capped perimeter access road, and infiltration through that capped road. This is treated separately to overall cap filtration as it is a relatively flat surface.

The estimated volume of leachate generated for the period 1st January 2015 to the 31st December 2015 is 2,835 m^3 (a calculation summary is included in Appendix A5). During the same period 5,318 m^3 of leachate was removed from the site for treatment in the waste water treatment plant at Wexford Town WWTP (January to July) and the leachate treatment plant at Holmestown WMF(August to December). A monthly breakdown of leachate volumes removed is presented in Table 5 above. It is expected that the additional volume of leachate removed over that generated is due to the additional deeper leachate extraction boreholes installed during 2014. While the process of reducing the elevation of the leachate water table is ongoing, a surplus of leachate extracted each year (over that generated) can be expected.

The fact that more leachate was removed off-site than was estimated to be generated in 2015 is a positive development.

APPENDICES

A1 PRTR 2015

| PRTR# : W0016 | Facility Name : Killurin Landfill Site | Filename : Killurin W0016_2015.xls | Return Year : 2015 | 29/04/2016 09:45

Guidance to completing the PRTR workbook

PRTR Returns Workbook

Version 1.1.19

REFERENCE YEAR	2015

1. FACILITY IDENTIFICATION

Parent Company Name	Wexford County Council
Facility Name	Killurin Landfill Site
PRTR Identification Number	W0016
Licence Number	W0016-02

Classes of Activity

No.	class_name
-	Refer to PRTR class activities below

Address 1	Newtown Lower
Address 2	Killurin
Address 3	
Address 4	
	Wexford
Country	Ireland
Coordinates of Location	-6.56116 52.3816
River Basin District	IESE
NACE Code	3821
Main Economic Activity	Treatment and disposal of non-hazardous waste
AER Returns Contact Name	Sean Meyler
AER Returns Contact Email Address	sean.meyler@wexfordcoco.ie
AER Returns Contact Position	Waste Operations Manager
AER Returns Contact Telephone Number	053 9120922
AER Returns Contact Mobile Phone Number	087 6846089
AER Returns Contact Fax Number	
Production Volume	0.0
Production Volume Units	
Number of Installations	0
Number of Operating Hours in Year	0
Number of Employees	3
User Feedback/Comments	Closed landfill no permanent staff presence on site. Leachate collection and landfill gas infrastructure maintenance ongoing, leachate tankered off site ongoing, general site maintenance ongoing.
Web Address	

2. PRTR CLASS ACTIVITIES

Activity Number	Activity Name
5(d)	Landfills
5(c)	Installations for the disposal of non-hazardous waste
50.1	General

3. SOLVENTS REGULATIONS (S.I. No. 543 of 2002)

Is it applicable?	
Have you been granted an exemption ?	
If applicable which activity class applies (as per Schedule 2 of the regulations) ?	
Is the reduction scheme compliance route being used ?	

4. WASTE IMPORTED/ACCEPTED ONTO SITE Guidance on waste imported/accepted onto site

Do you import/accept waste onto your site for on-site treatment (either recovery or disposal activities) ?	

This question is only applicable if you are an IPPC or Quarry site

4.1 RELEASES TO AIR

Link to previous years emissions data

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD				QUANTITY		
			Method Used		Flare 1			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
08	Nitrogen oxides (NOx/NO2)	M	EN 14792:2005		81.4	81.4	0.0	0.0
11	Sulphur oxides (SOx/SO2)	M	EN 14791:2005		2.6	2.6	0.0	0.0
01	Methane (CH4)	C	ALT		225353.0	225353.0	0.0	0.0
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD				QUANTITY		
			Method Used		Flare 1			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
84	Fluorine and inorganic compounds (as HF)	M	ISO/DIS 15713:2004		1.4	1.4	0.0	0.0
80	Chlorine and inorganic compounds (as HCl)	M	EN 1911-1 to 3:2003		0.6	0.6	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (As required in your Licence)

RELEASES TO AIR					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD				QUANTITY		
			Method Used		Flare 1			
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
351	**Total Organic Carbon (as C)**	M	ALT		19.8	19.8	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

Additional Data Requested from Landfill operators

For the purposes of the National Inventory on Greenhouse Gases, landfill operators are requested to provide summary data on landfill gas (Methane) flared or utilised on their facilities to accompany the figures for total methane generated. Operators should only report their Net methane (CH4) emission to the environment under T(total) KG/yr for Section A: Sector specific PRTR pollutants above. Please complete the table below:

Landfill: Killurin Landfill Site

Please enter summary data on the quantities of methane flared and / or utilised	**T (Total) kg/Year**	**M/C/E**	**Method Used**		**Facility Total Capacity m3 per hour**	
			Method Code	**Designation or Description**		
Total estimated methane generation (as per site model)	0.0				N/A	
Methane flared	0.0				0.0	(Total Flaring Capacity)
Methane utilised in engine/s	0.0				0.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	0.0				N/A	

5. ONSITE TREATMENT & OFFSITE TRANSFERS OF WASTE

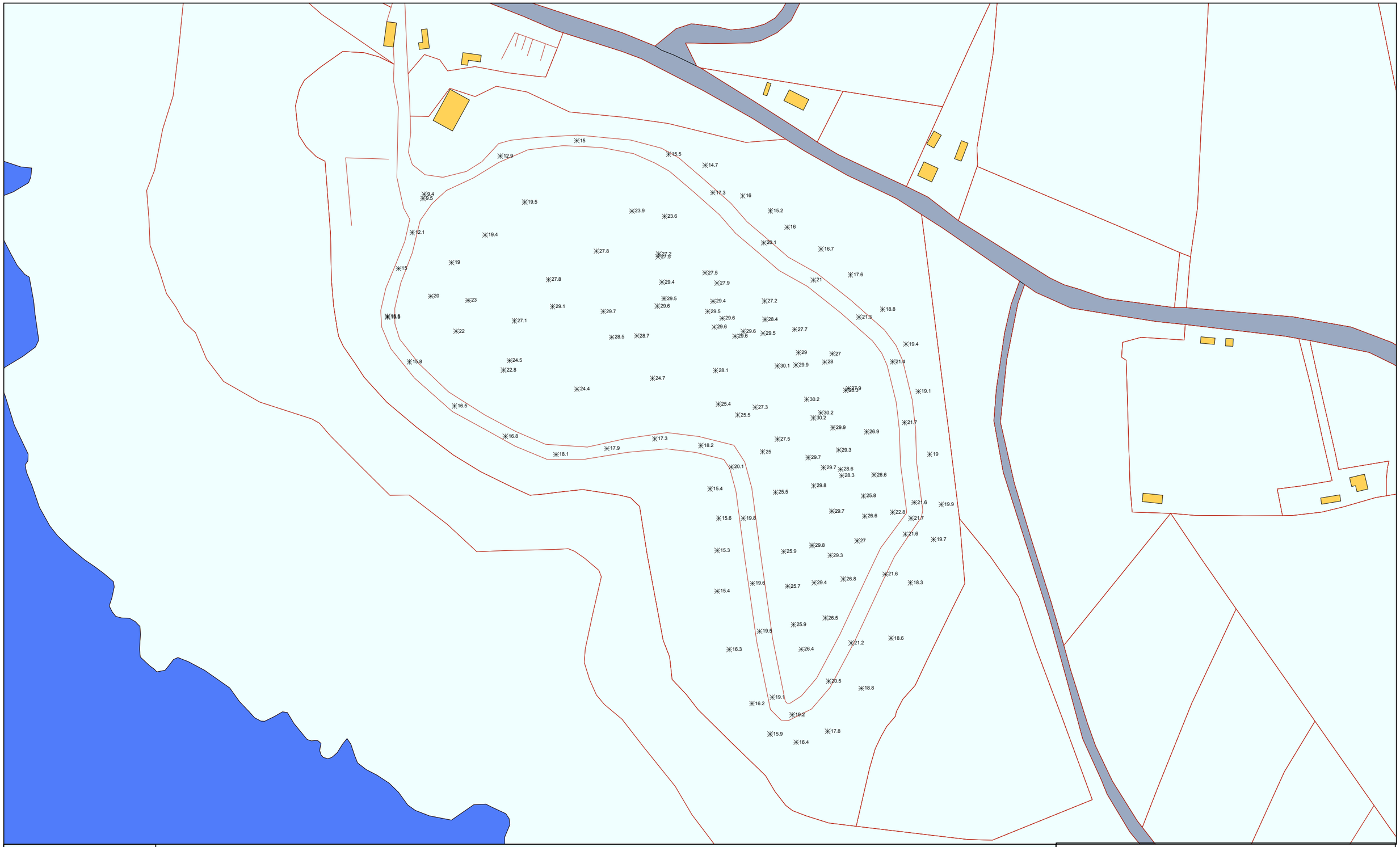
Please enter all quantities on this sheet in Tonnes

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
Within the Country	02 02 02	No	0.0	animal-tissue waste	D10	M	Weighed	Offsite in Ireland	Waterford Proteins Ltd. ,Dept of Agriculture R919	Ferrybank,.,Waterford ,.,Ireland		
Within the Country	19 07 03	No	2944.0	landfill leachate other than those mentioned in 19 07 02	D9	M	Volume Calculation	Offsite in Ireland	Wexford WWTP Wexford County Council,"."	Pumping Station.,Trinity Street ,Wexford,.,Ireland		
Within the Country	20 01 40	No	0.0	metals	R4	M	Weighed	Offsite in Ireland	Mulligan Dismantling and Salvage Ltd,WP/05/20	Mulligan Dismantling and Salvage Ltd,Lower Inch,Gorey,County Wexford.,Ireland		
Within the Country	**19 07 03**	**No**	2375.0	landfill leachate other than those mentioned in 19 07 02	D9	M	Volume Calculation	Offsite in Ireland	Holmestown Waste Management Facility,W0191-02	Wexford County Council,Holmestown,Barntown,Co. Wexford,Ireland		

* Select a row by double-clicking the Description of Waste then click the delete button

Link to previous years waste data
Link to previous years waste summary data & percentage change
Link to Waste Guidance

A2 Topographical and Monitoring location drawings



Killurin Landfill Mar 2014 Elevation surevy

Title: DESCRIPTION OF CONTENT	
Drawn by: EL	Checked by:SM
Date: 26 Mar 2014	Map No: 1

KILLURIN BRIDGE APPROX 150m

SITE ENTRANCE

LEACHATE STORAGE TANKS

REED BEDS

River Slaney Mud

CR

GW11: 115m to the south east
PW1: 370m to the south east

Map Legend

- Site Boundary
- W02 Gas extraction wells
- A10 Gas extraction wells (New Wells (2010))
- T1 Perimeter Gas migration wells
- W05 Leachate and Gas extraction wells
- LB 5 Leachate dipping wells
- BRO 1 Bored rock wells
- GW12 Ground water wells

Drawn by:	F. Ryan
Checked by:	FH
Date	21-11-11
Scale	1:6000
	Drawing No.

Drawing

Borehole Locations

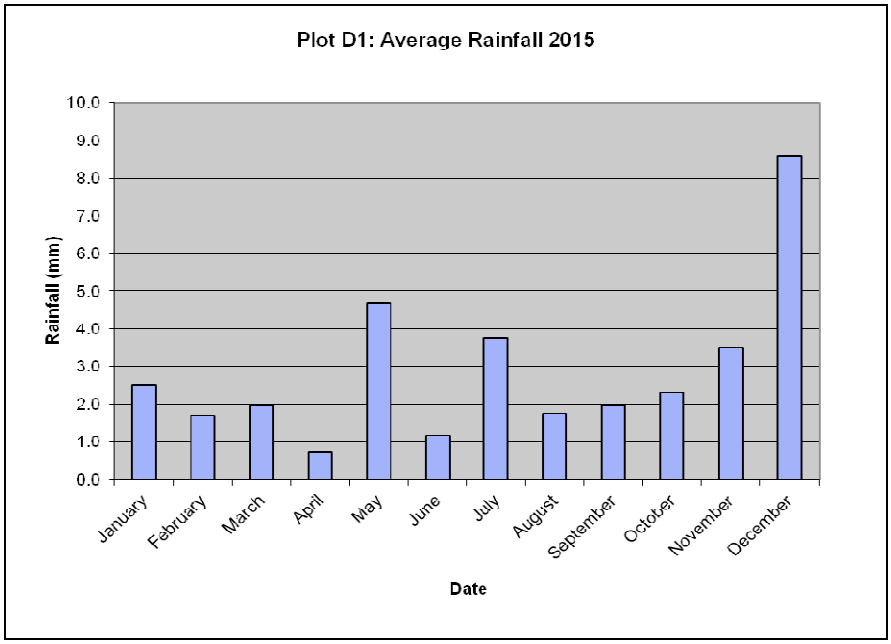
Killurin Landfill

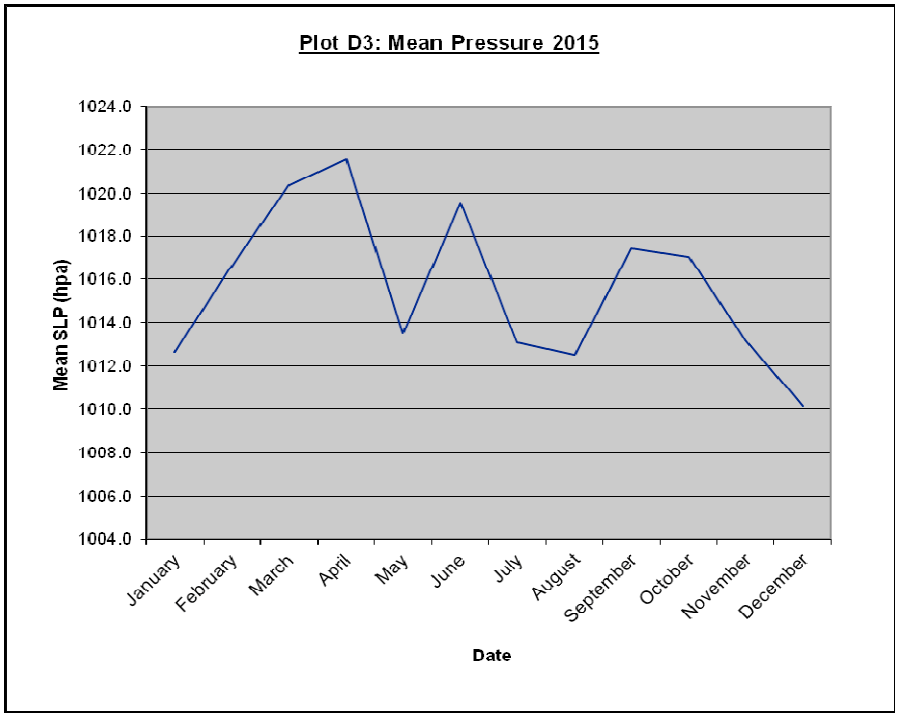
Wexford County Council,
Wexford
Tel: 053-9120922

Wexford County Council

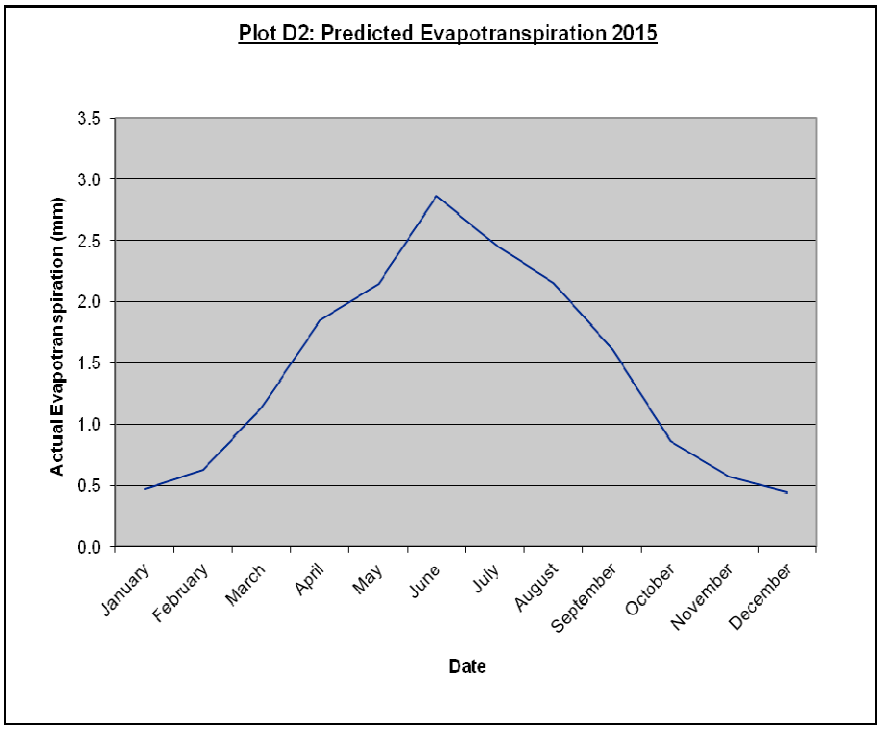
A3 Meteorological Data

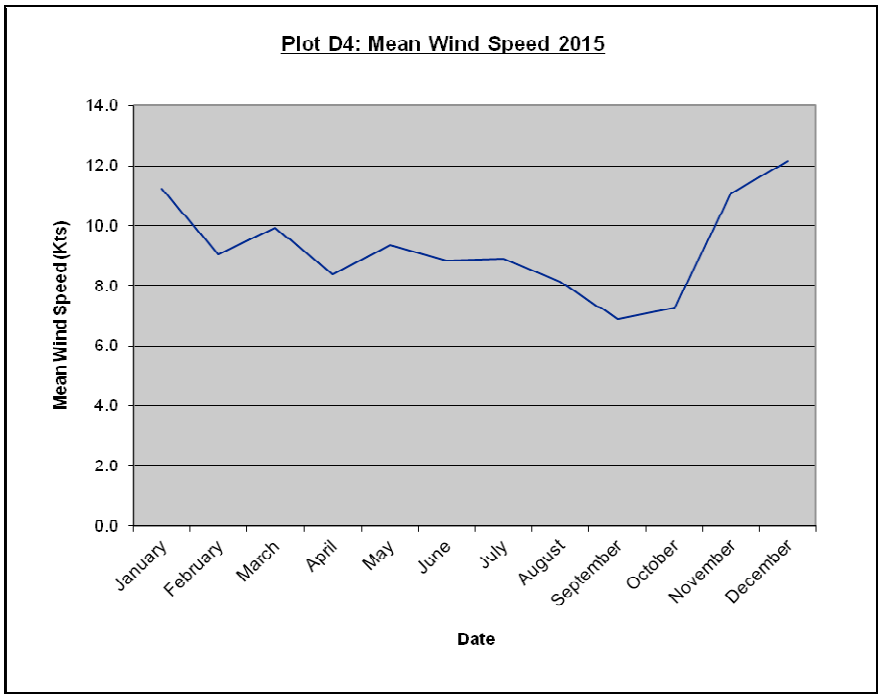
Appendix D – Meteorological Graphs



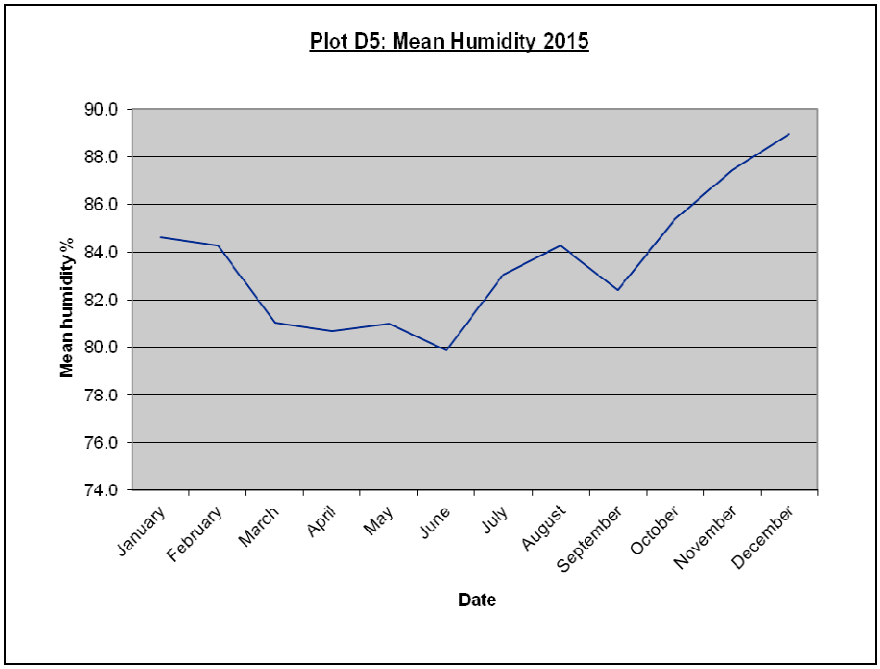


Appendix D – Meteorological Graphs





Appendix D – Meteorological Graphs



A4 Air emission report

Wexford County Council

Holmestown Landfill, Castlebridge, Killurin, Co. Wexford.

Emissions to Atmosphere Report No: 2140/M02

Industrial Emissions W0016-02 Licence

Report Date:

14/08/2015

Fitz Scientific

Unit 35, Boyne Business Park, Drogheda, Co Louth

Phone: +353 41 98 45440

Report for the Periodic Monitoring of Emissions to Air

Executive Summary

Licence / Permit Number:	W0016-02
Job Quote Number:	Y15Q16039
Operator Name:	Wexford County Council
Installation:	Holmestown Landfill, Castlebridge, Killurin, Co. Wexford.
Contact Name:	Fran Hobbs
Phone:	087 9141105

Monitoring Dates: 06/08/2015

Monitoring Organisation: Fitz Scientific
Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland
Phone: +353 41 98 45440 / Fax: +353 41 98 46171
email: air@fitzsci.ie

UKAS Registration number 2802

Report Date: 14/08/2015

Report created using QRSys version 3.1 May 2015

Written By:	Victor Olmos	**Approved By:**	Geoff Fitzpatrick
MCERTS Reg:	MM08 919	**MCERTS Reg:**	MM07 801
Competency:	Level 2	**Competency:**	Level 2
Function:	Field Services Manager	**Function:**	Manager
Endorsements:	TE1, TE2, TE3, TE4	**Endorsements:**	TE1, TE2, TE3, TE4

Signed: _____ **Signed:** _____

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING 2802 Accredited to ISO/IEC 17025:2005

Contents

1.- Part 1

1.1.- Monitoring Objectives

The monitoring was carried out as requested by the management of the company above mentioned. The customer has chosen to sample to the requirements of BS EN 15259:2007 for the substances monitored at the emission points listed below.

Flare Killurin	
Parameter	**Result**
Hydrogen Chloride	<1.1 mg/m3
Hydrogen Fluoride	1.23 mg/m3
NOx	75.6 mg/m3
O2	15.75 %
SO2	2.4 mg/m3
TVOC	18.37 mg/m3

1.2.- Special Monitoring Remarks

Due to close proximity to the exhaust an alternative samplng port was used. This port is not suitable for velocity, temperature or pressure measurements. CO emissions are not representative at this location and are not reported

NOx conversion efficiency: 97.1% tested on 20/04/2015

Opinions and interpretations expressed in this report are outside the scope of any claimed UKAS accreditation. EPA requirements AG1 (Safety) and AG2 (Monitoring Guidance Note) were applied during the monitoring.

All the sampling points were obtainable Yes

All parameters were sampled No

Additional information

1.3.- Monitoring Results

Emission Point Reference	Substance to be Monitored	ELV	Result	Uncert (+/-)	LOD	Units	Flow rate (m/s)	Date of sampling	Start - End Times	Reference Method	Accr.
Flare Killurin	Hydrogen Chloride	50 mg/m3	<1.1	0.1	0.9	mg/m3		06/08/2015	11:30-12:00	BS EN 1911:2010	MCERTS
Flare Killurin	Hydrogen Fluoride	5 mg/m3	1.23	0.106	0.04	mg/m3	n/a	06/08/2015	13:23-13:53	BS EN 15713:2006	MCERTS
Flare Killurin	NOx	150 mg/m3	75.6	127.2	0.04	mg/m3	n/a	06/08/2015	11:20-11:50	BS EN 14792:2005	MCERTS
Flare Killurin	O2	n/a	15.75	2.79	0.01	%		06/08/2015	11:20-11:50	BS EN 14789:2005	MCERTS
Flare Killurin	SO2	0 mg/m3	2.4	0.2	0.2	mg/m3		06/08/2015	12:24-12:54	BS EN 14791:2005	MCERTS
Flare Killurin	TVOC	10 mg/m3	18.37	11.67	0.27	mg/m3		06/08/2015	13:02-13:32	BS EN 12619:2013	MCERTS
Flare Killurin	Hydrogen Chloride-blank		<0.7	0.1	0.9	mg/m3		06/08/2015	11:07-11:09	BS EN 1911:2010	MCERTS
Flare Killurin	Hydrogen Fluoride-blank		<0.05	0.004	0.04	mg/m3		06/08/2015	12:55-12:57	BS EN 15713:2006	MCERTS
Flare Killurin	SO2-blank		1.4	0.1	0.2	mg/m3		06/08/2015	12:05-12:07	BS EN 14791:2005	MCERTS

No*: Sampling stage carried out as per MCERTS requirements

Analysis information

Hydrogen Chloride	Fitz Scientific
Hydrogen Fluoride	Fitz Scientific
NOx	Fitz Scientific
O2	Fitz Scientific
SO2	Fitz Scientific
TVOC	Fitz Scientific

Additional information

* The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%

** Results reported at following Reference Conditions

Reference Conditions

Emission Point Reference	Monitoring Result Reference Conditions			
	Temperature (K)	Pressure (KPa)	Moisture (%)	Oxygen (%)
Flare Killurin	273	101.3	0	5

Abatement system and process load

Location	Abatement system	In Operation	Fuel type and Load	
Flare Killurin	None	n/a	Landfill gas	As normal

1.4.- Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Substance	CEMS	PR	Units
Flare Killurin	06/08/2015	Combustion	Continuous	Hydrogen Chloride	n/a	<1.1	mg/m3
Flare Killurin	06/08/2015	Combustion	Continuous	Hydrogen Fluoride	n/a	1.23	mg/m3
Flare Killurin	06/08/2015	Combustion	Continuous	NOx	n/a	75.6	mg/m3
Flare Killurin	06/08/2015	Combustion	Continuous	O2	n/a	15.75	%
Flare Killurin	06/08/2015	Combustion	Continuous	SO2	n/a	2.4	mg/m3
Flare Killurin	06/08/2015	Combustion	Continuous	TVOC	n/a	18.37	mg/m3

* CEMS: Continuous Emission Monitoring System Results

* PR: Periodic Monitoring Results

1.5.- Monitoring Deviations

Emission Point **Flare Killurin** Parameter **Hydrogen Chloride**

- ☐ Emission monitoring point does not have required number of ports as per AG1 section 2.1/2.2 (per M1 Figure A2.5).
- ☐ Sampling port size is too small for velocity, temperature and pressure measurements to be carried out as per AG1 section 2.1/2.2 (M1 Annex 1).
- ☐ Emission point does not meet the requirements of BS EN 15259:2007 Section 6.2.1 NOTE 4 and AG1 section 2.1/2.2 (per M1 Annex 1) - The measurement plane is not in a section of duct that is at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downtream (5 hydraulic diameters from the top of the stack)
- ☐ Negative flow was found (BS EN 13284-1 section 5.2 b).
- ☐ The stack flow direction doesn't meet the minimum requirement of 15 degrees with regard the axis of the stack. (BS EN 13284-1 section 5.2 a).
- ☐ The ratio of highest to lowest local gas velocity is outside (higher than 3:1) of BS EN 13284-1 section 5.2 d) requirements.
- ☐ Differential pressure lower than 5Pa measured with pitot tube (BS EN 13284-1 section 5.2 c).
- ☐ Isokinetic conditions were outside the requirements of BS EN 13282-1 section 10.4.
- ☐ Due to the high velocity in the duct a smaller nozzle size was used than required by BS EN 13282-1 section 5.2.4 (6mm) to carry out isokinetic sampling.
- ☐ The blank reading does not meet the required target of <10% of the daily limit value (for ELV >10 mg/m3) (BS EN 12384-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >10% ELV to be achieved (for ELV >5 mg/m3) (MID 13248-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >20% ELV to be achieved (for ELV <5 mg/m3) (MID 13248-1 section 10.6)
- ☐ NOx overall uncertainty calculated is outside requirement of <10% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.1 BS EN 14789:2005
- ☐ CO overall uncertainty calculated is outside requirement of <6% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.3 BS EN 15058:2006.
- ☐ O2 overall uncertainty calculated is outside requirement of <6% of the value expressed on dry basis as per 7.3 BS EN 14789:2005
- ☐ NOx calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ CO calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ O2 calibration drift is higher than 2% of the span value. Results are corrected to drift. (EN 14789:2005 Section 8.4.2.3)
- ☐ TVOC calibration drift is higher than 2% of the span value. Results are corrected to drift. (BS EN 12619:2013 Section 6.2.3)
- ☐ SO2 Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 14791:2005 section 6.6.1)
- ☑ HCl Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2)
- ☐ HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).
- ☐ Homogeneity test is required for this stack as per BS EN 15259:2007 but customer did not require it in the Confirmation Form

Low HCl levels detected. Impinger efficiency NOT relevent.
Due to small port no externally heated probe was used

Emission Point **Flare Killurin** Parameter **Hydrogen Fluoride**

- ☐ Emission monitoring point does not have required number of ports as per AG1 section 2.1/2.2 (per M1 Figure A2.5).
- ☐ Sampling port size is too small for velocity, temperature and pressure measurements to be carried out as per AG1 section 2.1/2.2 (M1 Annex 1).
- ☐ Emission point does not meet the requirements of BS EN 15259:2007 Section 6.2.1 NOTE 4 and AG1 section 2.1/2.2 (per M1 Annex 1) - The measurement plane is not in a section of duct that is at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downtream (5 hydraulic diameters from the top of the stack)
- ☐ Negative flow was found (BS EN 13284-1 section 5.2 b).
- ☐ The stack flow direction doesn't meet the minimum requirement of 15 degrees with regard the axis of the stack. (BS EN 13284-1 section 5.2 a).
- ☐ The ratio of highest to lowest local gas velocity is outside (higher than 3:1) of BS EN 13284-1 section 5.2 d) requirements.
- ☐ Differential pressure lower than 5Pa measured with pitot tube (BS EN 13284-1 section 5.2 c).
- ☐ Isokinetic conditions were outside the requirements of BS EN 13282-1 section 10.4.
- ☐ Due to the high velocity in the duct a smaller nozzle size was used than required by BS EN 13282-1 section 5.2.4 (6mm) to carry out isokinetic sampling.
- ☐ The blank reading does not meet the required target of <10% of the daily limit value (for ELV >10 mg/m3) (BS EN 12384-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >10% ELV to be achieved (for ELV >5 mg/m3) (MID 13248-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >20% ELV to be achieved (for ELV <5 mg/m3) (MID 13248-1 section 10.6)
- ☐ NOx overall uncertainty calculated is outside requirement of <10% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.1 BS EN 14789:2005
- ☐ CO overall uncertainty calculated is outside requirement of <6% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.3 BS EN 15058:2006.
- ☐ O2 overall uncertainty calculated is outside requirement of <6% of the value expressed on dry basis as per 7.3 BS EN 14789:2005
- ☐ NOx calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ CO calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ O2 calibration drift is higher than 2% of the span value. Results are corrected to drift. (EN 14789:2005 Section 8.4.2.3)
- ☐ TVOC calibration drift is higher than 2% of the span value. Results are corrected to drift. (BS EN 12619:2013 Section 6.2.3)
- ☐ SO2 Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 14791:2005 section 6.6.1)
- ☐ HCl Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2)
- ☐ HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).
- ☐ Homogeneity test is required for this stack as per BS EN 15259:2007 but customer did not require it in the Confirmation Form

Due to small port no externally heated probe was used

Emission Point **Flare Killurin** Parameter **NOx**

- ☐ Emission monitoring point does not have required number of ports as per AG1 section 2.1/2.2 (per M1 Figure A2.5).
- ☐ Sampling port size is too small for velocity, temperature and pressure measurements to be carried out as per AG1 section 2.1/2.2 (M1 Annex 1).
- ☐ Emission point does not meet the requirements of BS EN 15259:2007 Section 6.2.1 NOTE 4 and AG1 section 2.1/2.2 (per M1 Annex 1) - The measurement plane is not in a section of duct that is at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downtream (5 hydraulic diameters from the top of the stack)
- ☐ Negative flow was found (BS EN 13284-1 section 5.2 b).
- ☐ The stack flow direction doesn't meet the minimum requirement of 15 degrees with regard the axis of the stack. (BS EN 13284-1 section 5.2 a).
- ☐ The ratio of highest to lowest local gas velocity is outside (higher than 3:1) of BS EN 13284-1 section 5.2 d) requirements.
- ☐ Differential pressure lower than 5Pa measured with pitot tube (BS EN 13284-1 section 5.2 c).
- ☐ Isokinetic conditions were outside the requirements of BS EN 13282-1 section 10.4.
- ☐ Due to the high velocity in the duct a smaller nozzle size was used than required by BS EN 13282-1 section 5.2.4 (6mm) to carry out isokinetic sampling.
- ☐ The blank reading does not meet the required target of <10% of the daily limit value (for ELV >10 mg/m3) (BS EN 12384-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >10% ELV to be achieved (for ELV >5 mg/m3) (MID 13248-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >20% ELV to be achieved (for ELV <5 mg/m3) (MID 13248-1 section 10.6)
- ☑ NOx overall uncertainty calculated is outside requirement of <10% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.1 BS EN 14789:2005
- ☐ CO overall uncertainty calculated is outside requirement of <6% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.3 BS EN 15058:2006.
- ☐ O2 overall uncertainty calculated is outside requirement of <6% of the value expressed on dry basis as per 7.3 BS EN 14789:2005
- ☐ NOx calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ CO calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ O2 calibration drift is higher than 2% of the span value. Results are corrected to drift. (EN 14789:2005 Section 8.4.2.3)
- ☐ TVOC calibration drift is higher than 2% of the span value. Results are corrected to drift. (BS EN 12619:2013 Section 6.2.3)
- ☐ SO2 Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 14791:2005 section 6.6.1)
- ☐ HCl Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2)
- ☐ HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).
- ☐ Homogeneity test is required for this stack as per BS EN 15259:2007 but customer did not require it in the Confirmation Form

Emission Point **Flare Killurin** Parameter **O2**

- ☐ Emission monitoring point does not have required number of ports as per AG1 section 2.1/2.2 (per M1 Figure A2.5).
- ☐ Sampling port size is too small for velocity, temperature and pressure measurements to be carried out as per AG1 section 2.1/2.2 (M1 Annex 1).
- ☐ Emission point does not meet the requirements of BS EN 15259:2007 Section 6.2.1 NOTE 4 and AG1 section 2.1/2.2 (per M1 Annex 1) - The measurement plane is not in a section of duct that is at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downtream (5 hydraulic diameters from the top of the stack)
- ☐ Negative flow was found (BS EN 13284-1 section 5.2 b).
- ☐ The stack flow direction doesn't meet the minimum requirement of 15 degrees with regard the axis of the stack. (BS EN 13284-1 section 5.2 a).
- ☐ The ratio of highest to lowest local gas velocity is outside (higher than 3:1) of BS EN 13284-1 section 5.2 d) requirements.
- ☐ Differential pressure lower than 5Pa measured with pitot tube (BS EN 13284-1 section 5.2 c).
- ☐ Isokinetic conditions were outside the requirements of BS EN 13282-1 section 10.4.
- ☐ Due to the high velocity in the duct a smaller nozzle size was used than required by BS EN 13282-1 section 5.2.4 (6mm) to carry out isokinetic sampling.
- ☐ The blank reading does not meet the required target of <10% of the daily limit value (for ELV >10 mg/m3) (BS EN 12384-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >10% ELV to be achieved (for ELV >5 mg/m3) (MID 13248-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >20% ELV to be achieved (for ELV <5 mg/m3) (MID 13248-1 section 10.6)
- ☐ NOx overall uncertainty calculated is outside requirement of <10% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.1 BS EN 14789:2005
- ☐ CO overall uncertainty calculated is outside requirement of <6% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.3 BS EN 15058:2006.
- ☐ O2 overall uncertainty calculated is outside requirement of <6% of the value expressed on dry basis as per 7.3 BS EN 14789:2005
- ☐ NOx calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ CO calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ O2 calibration drift is higher than 2% of the span value. Results are corrected to drift. (EN 14789:2005 Section 8.4.2.3)
- ☐ TVOC calibration drift is higher than 2% of the span value. Results are corrected to drift. (BS EN 12619:2013 Section 6.2.3)
- ☐ SO2 Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 14791:2005 section 6.6.1)
- ☐ HCl Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2)
- ☐ HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).
- ☐ Homogeneity test is required for this stack as per BS EN 15259:2007 but customer did not require it in the Confirmation Form

Monitoring carried out as per Standard Methods. No deviations were recorded

Emission Point **Flare Killurin** Parameter **SO2**

- ☐ Emission monitoring point does not have required number of ports as per AG1 section 2.1/2.2 (per M1 Figure A2.5).
- ☐ Sampling port size is too small for velocity, temperature and pressure measurements to be carried out as per AG1 section 2.1/2.2 (M1 Annex 1).
- ☐ Emission point does not meet the requirements of BS EN 15259:2007 Section 6.2.1 NOTE 4 and AG1 section 2.1/2.2 (per M1 Annex 1) - The measurement plane is not in a section of duct that is at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downtream (5 hydraulic diameters from the top of the stack)
- ☐ Negative flow was found (BS EN 13284-1 section 5.2 b).
- ☐ The stack flow direction doesn't meet the minimum requirement of 15 degrees with regard the axis of the stack. (BS EN 13284-1 section 5.2 a).
- ☐ The ratio of highest to lowest local gas velocity is outside (higher than 3:1) of BS EN 13284-1 section 5.2 d) requirements.
- ☐ Differential pressure lower than 5Pa measured with pitot tube (BS EN 13284-1 section 5.2 c).
- ☐ Isokinetic conditions were outside the requirements of BS EN 13282-1 section 10.4.
- ☐ Due to the high velocity in the duct a smaller nozzle size was used than required by BS EN 13282-1 section 5.2.4 (6mm) to carry out isokinetic sampling.
- ☐ The blank reading does not meet the required target of <10% of the daily limit value (for ELV >10 mg/m3) (BS EN 12384-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >10% ELV to be achieved (for ELV >5 mg/m3) (MID 13248-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >20% ELV to be achieved (for ELV <5 mg/m3) (MID 13248-1 section 10.6)
- ☐ NOx overall uncertainty calculated is outside requirement of <10% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.1 BS EN 14789:2005
- ☐ CO overall uncertainty calculated is outside requirement of <6% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.3 BS EN 15058:2006.
- ☐ O2 overall uncertainty calculated is outside requirement of <6% of the value expressed on dry basis as per 7.3 BS EN 14789:2005
- ☐ NOx calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ CO calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ O2 calibration drift is higher than 2% of the span value. Results are corrected to drift. (EN 14789:2005 Section 8.4.2.3)
- ☐ TVOC calibration drift is higher than 2% of the span value. Results are corrected to drift. (BS EN 12619:2013 Section 6.2.3)
- ☑ SO2 Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 14791:2005 section 6.6.1)
- ☐ HCl Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2)
- ☐ HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).
- ☐ Homogeneity test is required for this stack as per BS EN 15259:2007 but customer did not require it in the Confirmation Form

Low SO2 levels detected. Impinger efficiency NOT relevent.
Due to small port no externally heated probe was used

Emission Point **Flare Killurin** Parameter **TVOC**

- ☐ Emission monitoring point does not have required number of ports as per AG1 section 2.1/2.2 (per M1 Figure A2.5).
- ☐ Sampling port size is too small for velocity, temperature and pressure measurements to be carried out as per AG1 section 2.1/2.2 (M1 Annex 1).
- ☐ Emission point does not meet the requirements of BS EN 15259:2007 Section 6.2.1 NOTE 4 and AG1 section 2.1/2.2 (per M1 Annex 1) - The measurement plane is not in a section of duct that is at least 5 hydraulic diameters of straight duct upstream of the sampling plane and 2 hydraulic diameters downtream (5 hydraulic diameters from the top of the stack)
- ☐ Negative flow was found (BS EN 13284-1 section 5.2 b).
- ☐ The stack flow direction doesn't meet the minimum requirement of 15 degrees with regard the axis of the stack. (BS EN 13284-1 section 5.2 a).
- ☐ The ratio of highest to lowest local gas velocity is outside (higher than 3:1) of BS EN 13284-1 section 5.2 d) requirements.
- ☐ Differential pressure lower than 5Pa measured with pitot tube (BS EN 13284-1 section 5.2 c).
- ☐ Isokinetic conditions were outside the requirements of BS EN 13282-1 section 10.4.
- ☐ Due to the high velocity in the duct a smaller nozzle size was used than required by BS EN 13282-1 section 5.2.4 (6mm) to carry out isokinetic sampling.
- ☐ The blank reading does not meet the required target of <10% of the daily limit value (for ELV >10 mg/m3) (BS EN 12384-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >10% ELV to be achieved (for ELV >5 mg/m3) (MID 13248-1 section 10.6)
- ☐ The ELV is such that the LOD for the analysis does not allow for the requirement of >20% ELV to be achieved (for ELV <5 mg/m3) (MID 13248-1 section 10.6)
- ☐ NOx overall uncertainty calculated is outside requirement of <10% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.1 BS EN 14789:2005
- ☐ CO overall uncertainty calculated is outside requirement of <6% at the daily ELV expressed on dry basis before correction to O2 reference concentration as per 7.3 BS EN 15058:2006.
- ☐ O2 overall uncertainty calculated is outside requirement of <6% of the value expressed on dry basis as per 7.3 BS EN 14789:2005
- ☐ NOx calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ CO calibration drift is higher than 2% of the span value. Results are corrected to drift. (TGN M22 Section 6)
- ☐ O2 calibration drift is higher than 2% of the span value. Results are corrected to drift. (EN 14789:2005 Section 8.4.2.3)
- ☐ TVOC calibration drift is higher than 2% of the span value. Results are corrected to drift. (BS EN 12619:2013 Section 6.2.3)
- ☐ SO2 Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 14791:2005 section 6.6.1)
- ☐ HCl Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2)
- ☐ HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).
- ☐ Homogeneity test is required for this stack as per BS EN 15259:2007 but customer did not require it in the Confirmation Form

Monitoring carried out as per Standard Methods. No deviations were recorded

2.- Part 2

Supporting information

Licence / Permit Number:	W0016-02
Job Quote Number:	Y15Q16039
Operator Name:	Wexford County Council
Installation:	Holmestown Landfill, Castlebridge, Killurin, Co. Wexford.
Contact Name:	Fran Hobbs
Phone:	087 9141105

Monitoring Dates: 06/08/2015

Monitoring Organisation: Fitz Scientific
Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland
Phone: +353 41 98 45440 / Fax: +353 41 98 46171
email: air@fitzsci.ie

Laboratory details

Hydrogen Chloride

	Address	Contact	email	Phone	Acc. Number
Fitz Scientific	Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland	Geoff Fitzpatrick	info@fitzsci.ie	+353 41 98 45440 - ext 2	UKAS 2802

Hydrogen Fluoride

	Address	Contact	email	Phone	Acc. Number
Fitz Scientific	Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland	Geoff Fitzpatrick	info@fitzsci.ie	+353 41 98 45440 - ext 2	UKAS 2802

NOx

	Address	Contact	email	Phone	Acc. Number
Fitz Scientific	Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland	Geoff Fitzpatrick	info@fitzsci.ie	+353 41 98 45440 - ext 2	UKAS 2802

O2

	Address	Contact	email	Phone	Acc. Number

Fitz Scientific	Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland	Geoff Fitzpatrick	info@fitzsci.ie	+353 41 98 45440 - ext 2	UKAS 2802

SO2

	Address	Contact	email	Phone	Acc. Number
Fitz Scientific	Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland	Geoff Fitzpatrick	info@fitzsci.ie	+353 41 98 45440 - ext 2	UKAS 2802

TVOC

	Address	Contact	email	Phone	Acc. Number
Fitz Scientific	Unit 35, Boyne Business Park, Drogheda, Co. Louth, Ireland	Geoff Fitzpatrick	info@fitzsci.ie	+353 41 98 45440 - ext 2	UKAS 2802

Appendix 1:

Sampling personnel used

06/08/2015	Technician Name	Position	Qualification	TEs	MCERTS nc
	Victor Olmos	Team Leader	Level 2	TE1, TE2, TE3, TE4	MM08 919
	Jason McGuirk	Technician	Level 1	-	MM14 1320

Substances Monitored

Substance	Method used for Monitoring	Fitz SOP
Hydrogen Fluoride	BS EN 15713:2006	129
NOx	BS EN 14792:2005	161
O2	BS EN 14789:2005	161
SO2	BS EN 14791:2005	167
TVOC	BS EN 12619:2013	155

As an accredited organisation Fitz scientific have implemented procedures to ensure that the requirements of TPS 63 (UKAS Policy on Deviating Samples) are met with regard to samples taken and tested for chemical analysis. As such all samples, when applicable, have been transported in containers, and in an environment, that meet the relevant standard requirements where applicable

Equipment Checklist References

Stack:	Flare Killurin				
Parameter:	TVOC				
TCR	n/a	**Weights**	n/a	**FTIR**	n/a
Nozzles	n/a	**Caliper**	n/a	**Filters**	n/a
Impingers	n/a	**Testo**	n/a	**Gases**	53145
Probe	n/a	**Horiba**	n/a	**Handheld pumps**	n/a
Pitot tube	n/a	**FID**	EM211	**Tubes**	n/a
Parameter:	SO2				
TCR	EM333	**Weights**	EM200	**FTIR**	n/a
Nozzles	n/a	**Caliper**	n/a	**Filters**	n/a
Impingers	Set D	**Testo**	n/a	**Gases**	n/a
Probe	n/a	**Horiba**	n/a	**Handheld pumps**	n/a
Pitot tube	n/a	**FID**	n/a	**Tubes**	n/a
Parameter:	O2				
TCR	n/a	**Weights**	n/a	**FTIR**	n/a
Nozzles	n/a	**Caliper**	n/a	**Filters**	n/a
Impingers	n/a	**Testo**	n/a	**Gases**	n/a
Probe	n/a	**Horiba**	EM365	**Handheld pumps**	n/a
Pitot tube	n/a	**FID**	n/a	**Tubes**	n/a

Parameter:	NOx				
TCR	n/a	**Weights**	n/a	**FTIR**	n/a
Nozzles	n/a	**Caliper**	n/a	**Filters**	n/a
Impingers	n/a	**Testo**	n/a	**Gases**	2035794
Probe	n/a	**Horiba**	EM365	**Handheld pumps**	n/a
Pitot tube	n/a	**FID**	n/a	**Tubes**	n/a
Parameter:	Hydrogen Fluoride				
TCR	EM333	**Weights**	EM200	**FTIR**	n/a
Nozzles	n/a	**Caliper**	n/a	**Filters**	n/a
Impingers	EM088	**Testo**	n/a	**Gases**	n/a
Probe	n/a	**Horiba**	n/a	**Handheld pumps**	n/a
Pitot tube	n/a	**FID**	n/a	**Tubes**	n/a
Parameter:	Hydrogen Chloride				
TCR	EM333	**Weights**	EM200	**FTIR**	n/a
Nozzles	n/a	**Caliper**	n/a	**Filters**	n/a
Impingers	Set D	**Testo**	n/a	**Gases**	n/a
Probe	n/a	**Horiba**	n/a	**Handheld pumps**	n/a
Pitot tube	n/a	**FID**	n/a	**Tubes**	n/a

Appendix 2:

Monitoring Information

Stack Flare Killurin **Parameter:** NOx, O2, SO2, HCl, HF

Number of Ports	1	**Dry Flow rate at STP, Ref O2 (m3/h)**	n/a
Number of Points	1	**Max Flow Rate in Licence (m3/h):**	3000
Average Velocity v'a (m/s)	n/a	**T reference (Deg K)**	273
Average Pressure (KPa)	n/a	**P reference (KPa)**	101.3
Average Temperature (ºC)	n/a	**Isokinetic condition (%)**	n/a
Stack Diameter (m)	n/a	**Oxygen measured (%)**	15.75
Actual Moisture Flow rate (m3/h)	n/a	**Water vapor (%)**	2.10
Moisture Flow rate at STP (m3/h)	n/a	**Wet Stack (yes/no)**	No
Size of Nozzle	n/a	**Probe Temperature (°C)**	n/a
		Impinger efficiency (%)	HCL58.8%) SO2(77.5%) HF(97.1%)

Monitoring result calculations and uncertainty calculations

Moisture Content				BS EN 14790:2005
Company	Wexford County Council		Date of Test	06/08/2015
Site	Holmestown Landfill, Castlebridge, Killurin, Cl		Reference No	M02
Plant Identification	Flare Killurin		Operator Id	MM08 919
Test carried out by	Victor Olmos		TE's	TE1, TE2, TE3, TE4
Report Number :	2140/M02			

Dry at Gas Meter: (Vg)	0.0864	m3	
Gas Meter Temperature: (tg)	21.27	294.27	K
Ambient Pressure Measured:(Pa)	100.78	kPa	
Gas Volume STP (Vgn)	0.079743503	m3	
Gas Volume Factor Correction:	0.9898	taken from this table -->	
Corrected Volume STP	0.078930119	m3	

Correction Factors for Volume:			
TCR EM No.	Volume:	rrection Fact	Calibration Date:
EM036	0.5	1.0028	18/11/2014
	1	1.0055	
	1.5	1.0104	
	2	1.0141	
	2.5	1.018	
EM003	0.5	0.9993	03/12/2014
	1	1.0035	
	1.5	1.0086	
	2	1.0156	
	2.5	1.0288	
EM207	0.5	1.0049	11/05/2015
	1	0.9946	
	1.5	0.9955	
	2	0.9974	
	2.5	1.006	
EM333	0.5	0.9898	15/04/2015
	1	0.9908	
	1.5	0.9931	
	2	0.9951	
	2.5	1.0013	

Readings:	Before Line	Impinger 1	Impinger 2	Impinger 3	Impinger 4	Sum:
1	472.0	491.6	510.5	361.6	535.8	2371.5
2	472.0	491.6	510.6	361.8	535.8	2371.8
3	472.0	491.7	510.6	361.7	535.8	2371.8
4	472.2	491.7	510.6	361.7	535.9	2372.1
5	472.1	491.9	510.6	361.7	535.9	2372.2
6	472.1	491.8	510.6	361.7	535.9	2372.1
7	472.1	491.8	510.6	361.7	535.9	2372.1
8	472.1	491.8	510.6	361.7	535.9	2372.1
9	472.1	491.8	510.6	361.7	535.9	2372.1
10	472.1	491.8	510.6	361.7	535.9	2372.1
Standard Deviation:	0.1	0.1	0.0	0.0	0.0	0.2
Average:	472.1	491.8	510.6	361.7	535.9	2372.0

Readings:	After: Line	Impinger 1	Impinger 2	Impinger 3	Impinger 4	Sum:
1	472.2	492.6	510.5	362.1	535.7	2373.1
2	472.2	492.6	510.5	362.2	535.7	2373.2
3	472.3	492.6	510.5	362.2	535.7	2373.3
4	472.3	492.6	510.5	362.2	535.7	2373.3
5	472.3	492.7	510.5	362.2	535.7	2373.4
6	472.3	492.7	510.6	362.2	535.6	2373.4
7	472.3	492.7	510.6	362.2	535.6	2373.4
8	472.3	492.7	510.6	362.2	535.6	2373.4
9	472.3	492.7	510.6	362.3	535.6	2373.5
10	472.3	492.7	510.6	362.3	535.6	2373.5
Standard Deviation:	0.0	0.1	0.1	0.1	0.1	0.1
Average:	472.3	492.7	510.6	362.2	535.7	2373.4

Difference in weigh of impingers after and before measurements: 1.4 g

Water vapour content on STP basis:	17.23	g/m3
Referenced oxygen:	3.00	%
Meas oxygen:	15.75	%
Water vapour content in % on wet basis:	2.1	%
Corrected to O2ref:	7.3	%

Weights:	Before Sampling:	After Sampling:	Difference:	
Silca trap:	535.9	535.7	-0.22	g
		Efficiency:	100.0	%

Moisture Uncertainty Calculations

Measured concentration	2.1	% (at STP)

Measured Quantities	Symbol		Value	Standard uncertainty		Units
Sampled Volume	Vm		0.078930119	uVm	0.001	m3
Sampled gas Temperature	Tm		273	uTm	2	k
Sampled gas Pressure	ρm		101.3	uρm	1	kPa
Efficiency	Ɛ		100.04			%
Oxygen content	O2,m		15.75	uO2,m	0.1	% by volume
Water collected in condensation stage			535.90			
Water collected in adsorption stage			-0.22			
Wate collected in addidional unit			-0.22			
Water collected in trapping	m		535.68	um	0.00	g

Intermediate calculations

Vwc	107.893012			^2		
	0.0			0.0		Efficiency uncertain 0.00
	-0.1			0.0		support 0.00
	-1.3			1.8		calculations -0.19
				√		
			water in trapping unit	23.1		
			water in adsorption stage	#NUM!		
Uncertainty Efficiency^2				#NUM!		
Volume ^2				0.3		
Sensityvity coefficiency				#NUM!		

Uncertainty efficiency		#NUM!
	Repatability standard dev	
Weight in the field st	0.2	0.1
Sampled Volume	0.002	0.0
Sampled gas Temperature	0.02	0.0
Sampled gas Pressure	0.3	0.2

Combined measurement uncertainty	#NUM!	%

Expanded uncertainty as percentage of measured value #NUM! **% measured of value** **expressed with a level of confidence of 95%**
(Using a coverage factor k=2)

Expanded uncertainty in units of measuremen #NUM! **% of water vapour**

Overall uncertainty should be less than +/-20% of the measured concentration.

Flue gases		O2 BS EN 14789:2005, NOx BS EN 14792:2005, CO BS EN 15058:2006, CO2 ISO 12039:2001	
Company	Wexford County Council	Date of Test	06/08/2015
Site	Holmestown Landfill, Castlebridge, Kill	Reference No	M02
Plant Identification	Flare Killurin	Operator Id	MM08 919
Test carried out by	Victor Olmos	TE's	TE1, TE2, TE3, TE4
Report Number :	2140/M02		

Fitz scientific
Monitoring and Testing Services

No.	O2 %	CO2 %	CO ppm	NOx ppm	SO2 ppm
1	15.75			10.61	

Flue Gas parameter		Concentration	Unit
Ref O2 Value		3.00	%
Meas O2 Value	O2	15.75	%
Uncertainty		2.79	%
NOx		10.61	ppm
Convert to NO2 mg/Nm3		21.7	Nmg/m3
Corrected to ref. O2 %	NOx	75.6	Nmg/m3
Uncertainty		127.2	Nmg/m3
Mass concentration STP, dry, Ref O2		0.0	kg/hr

If no correction for oxygen use the same value as for measured oxygen.

Flow Rate STP,dry,RefO2 **0.00** m3/hr

	Calibration Cylinder No:	Concentration ppm	Concentration mg/m3
NO	2035794	90.87	186.2835
		Concentration%	
O2	Ambient Air	20.9	

Drift Calculations

	NO ppm	CO ppm	SO2 ppm	O2 %	CO2
Sampling time	30			30	
Span expected Value	90.87			20.9	
Zero expected result	0			0	
Zero reading before 1	0			0	
Span reading before measurement	91			20.9	
Zero reading before 2	0			0	
Zero reading after	0			-0.02	
Span reading after measurement	91.5			20.79	

If the span or zero are higher than 2% of the spar value, it is necessary to correct result for zero and span drifts. The results shal be rejected if the drift in zero or span gas is higher than 5%

Span adjustment	0.999			1.000	
Span Check	0.993			1.004	
Deviation	-0.005			0.004	
Drift/Min	-0.000181889			0.00014416	
Zero adjustment 1	0			0	
Zero Adjustment 2	0			0	
Zero check 1	0			0.0200865	
Zero Check 2	0			0.0200865	
Deviation 1	0			-0.0200865	
Deviation 2	0			-0.0200865	
Drift/min 1	0			-0.0006695	
Drift/min 2	0			-0.0006695	
Drift	-0.545667447			0.33637674	
Actual measured Concentration	10.61			15.75	
Corrected concentration for drift	10.61			15.75	

Uncertainty calculation for Gaseous Measurement Oxygen EN14789
V2.2 Jul-08

Limit value	n/a	%vol	**Calibration gas**	**20.9**	%vol
Measured concentration	15.75	%vol	**Full Scale**	**25**	%vol

Performance characteristic	Value				specification
Response time		60	seconds		< 200 s
Logger sampling interval		60	seconds		
Measurement period		30	minutes		
Number of readings in measurement		30	Assuming 1 minute collected over 1 hour		
Repeatability at zero		0	% by volume	stdev	<0.2 % range
Repeatability at span level		0.1	% by volume	stdev	<0.4 % range
Deviation from linearity		0.13	% vol	+/-	<0.3 % volume
Zero drift (during measurement period)		0.000144161	% vol at zero level	+/-	<2% of volume / 24hr
Span drift (during measurement period)		0.000144161	% vol at span level	+/-	<2% volume/24hr
volume or pressure flow dependence		0	% of fs / 10l/h	+- 5 l/h	<1% range
atmospheric pressure dependence		0.3	% of fs/kPa	+- 2kPa	< 1.5 % range
ambient temperature dependence		-0.07	% by volume /10K	+- 15K	<0.3% volume 10 K
CO2 (% vol)	15	0.07	% by volume per	15	
NO (mg/m3)	300	0.02	% by volume per	300	
NO2 (mg/m3)	30	0	% by volume per	30	
Combined interference		0.56	% range		<2% range
Dependence on voltage		0.1	% by volume /10V	+- 5%	< 0.1%vol /10 volt
Losses in the line (leak)		2	% of value		< 2% of value
Uncertainty of calibration gas		0.5	% of value		

Effect of drift	
0.00	% vol
0.00	% value

	range of variation from conditions at calibration			
	min	max	value at calib	
flow	5	15	10	l/h
pressure	99.00	101	100	kPa
temp	280	285	285	K
CO2 range	8	15	0	% vol
NO range	100	150	0	mg/m3
NO2 range	5	7.5	0	mg/m3
Voltage	105	115	110	V

Performance characteristic			Uncertainty		Value of uncertainty quantity		% vol
Standard deviation of repeatability at zero			ur0		for mean		Only use rep at span
Standard deviation of repeatability at span level			urs		for mean		0.02
Lack of fit			ufit				0.08
Drift			u0dr				0.00
volume or pressure flow dependence			uspres				0.00
atmospheric pressure dependence			uapres				0.04
ambient temperature dependence			utemp				-0.02
CO2							0.05
NO							0.01
NO2							0.00
Combined interference (from mcerts)							0.08
dependence on voltage			uvolt				0.03
losses in the line (leak)			uleak				0.18
Uncertainty of calibration gas			ucalib				0.05

Use largest of sum of all positive or all negative influences

0.06	all +ves	Criteria
0	all -ves	sum <2% value
0.06	largest	0.315044

Value to use for intereference uncertainty
uint 0.06

Measurement uncertainty			15.75	%vol
Combined uncertainty			0.22	%vol
% of value			1.39	%
Coverage factor k =	2			
Expanded uncertainty	**expressed with a level of confidence of 95%**		**2.79**	**% of value**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**0.44**	**% vol**

Requirement for SRM is that Uncertaitny should be < 6% of value, on a dry gas basis

Uncertainty calculation for Gaseous Measurement NOx

V2 Jul-08

Limit value	150	**mg/m3 (corrected) SC**	**Cal gas conc**	186.2835	**mg.m-3**
Measured concentration	21.74	**mg/m3**	**Full Scale**		**mg/m3**
Measured concentration	75.6	**mg/m3 (Corrected)**			

Correction for reference conditions					
		O2, %	**Moisture,**	**Pressure,**	**Temperature, K**
	ref	3.00	0.00	101.30	**273.00**
	measured	15.75	2.10	101.30	**273.00**
	Uncert	0.35	1.00	0.00	**1.00**
Factors		3.48	1.02	1.00	1.00
Uncertainty in factor		0.24	0.01	0.00	0.00
Correction Factor		**3.55**	uf	**0.24**	

Performance characteristic	**Value**				**specification**
Response time		160	seconds		180.000
Logger sampling interval		60	seconds		
Measurement period		30	minutes		
Number of readings in measurement		30			
Repeatability at zero		0.25	% full scale		<1 % range
Repeatability at span level		0.15	% full scale		<2 % range
Deviation from linearity		0.7	% of value		<2 % range
Zero drift		0	% full scale		<2% range / 24hr
Span drift		-0.000181889	% full scale		<2% range/24hr
volume or pressure flow dependence		0.02	% of full scale/3 kPa		<2 % / 3 kPa
atmospheric pressure dependence		0.8	% of full scale/2 kPa		<3% / 2 kPa
ambient temperature dependence		0.01	% full scale/10K		<3% range / 10 K
N2O (mg/m3)	40	9.0	mg/m3		
CO2 (% vol)	15	9.0	mg/m3		
CH4 (mg/m3)	57	9.0	mg/m3		
H2O (% vol)	30	9.0	mg/m3		
dependence on voltage		0.1	% full scale/10V		<2% range
losses in the line (leak)		1	% of value		< 0.1%vol /10 volt
Uncertainty of calibration gas		1.07	% of value		< 2% of value

Effect of drift	
0.00	mg/m3
0.00	% value

	ranges min	max	value at calib	
flow	0.3	0.5	0.4	l/hr
pressure	100.76	100.92	100.88	kPa
temp	287	288.5	287.5	K
N2O range	0	0	0	mg/m3
CO2 range	0	40	0	%vol
CH4 range	0	57	0	mg/m3
H2O range	0	1	0	%vol
Voltage	93	121	110	V

Performance characteristic			**Uncertainty**		**Value of uncertainty quantity**		
Standard deviation of repeatability at zero			ur0		for mean		use rep at span
Standard deviation of repeatability at span level			urs		for mean		0.03
Lack of fit			ufit				0.00
Drift			u0dr				0.00
volume or pressure flow dependence			uspres				0.00
atmopsheric pressure dependence			uapres				0.00
ambient temperature dependence			utemp				0.00
N2O (mg/m3)			uinterf				0.00
CO2 (% vol)			uinterf				13.86
CH4 (mg/m3)			uinterf				5.20
H2O (% vol)			uinterf				0.17
Dependence on voltage			uvolt				0.00
losses in the line (leak)			uleak				0.44
Uncertainty of calibration gas			ucalib				0.47
Uncertiany in factor			uf				17.90

Use largest of sum of all positive or all negative influences		
19.23	all +ves	Criteria
0	all -ves	sum <4% range
19.23	largest	0.434896
Value to use for intereference uncertainty		
uint	19.23	

Measurement uncertainty			75.61	mg/m3
Combined uncertainty			17.91	mg/m3
Expanded uncertainty	k =	2	35.82	mg/m3
Uncertainty corrected to std conds			127.21	mg/m3
Expanded uncertainty	**expressed with a level of confidence of 95%**		**84.81**	**% ELV**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**127.21**	**mg.m-3**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**168.2**	**% value**

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Date / Time	NOx (ppm)	O2 (%)
06/08/2015 11:20	9.97	16.11
06/08/2015 11:20	10.57	15.97
06/08/2015 11:20	10.83	15.66
06/08/2015 11:20	12.00	15.33
06/08/2015 11:21	10.10	15.78
06/08/2015 11:21	9.40	16.46
06/08/2015 11:21	12.07	15.08
06/08/2015 11:21	10.00	16.01
06/08/2015 11:22	10.50	15.79
06/08/2015 11:22	9.70	16.18
06/08/2015 11:22	11.40	15.58
06/08/2015 11:22	10.60	15.81
06/08/2015 11:23	8.83	16.31
06/08/2015 11:23	9.83	16.13
06/08/2015 11:23	10.67	15.78
06/08/2015 11:23	11.13	15.48
06/08/2015 11:24	11.07	15.40
06/08/2015 11:24	10.57	15.82
06/08/2015 11:24	9.67	16.02
06/08/2015 11:24	10.60	15.83
06/08/2015 11:25	10.37	15.74
06/08/2015 11:25	9.83	15.98
06/08/2015 11:25	7.63	16.77
06/08/2015 11:25	10.13	16.08
06/08/2015 11:26	10.07	16.01
06/08/2015 11:26	9.90	15.93
06/08/2015 11:26	10.43	16.05
06/08/2015 11:26	9.73	16.11
06/08/2015 11:27	8.80	16.44
06/08/2015 11:27	10.13	16.17
06/08/2015 11:27	11.03	15.65
06/08/2015 11:27	10.43	15.84
06/08/2015 11:28	10.77	15.78
06/08/2015 11:28	9.43	16.24
06/08/2015 11:28	10.27	16.05
06/08/2015 11:28	9.73	16.12
06/08/2015 11:29	9.97	16.17
06/08/2015 11:29	10.47	15.88
06/08/2015 11:29	10.47	15.95
06/08/2015 11:29	11.13	15.63
06/08/2015 11:30	10.67	15.73
06/08/2015 11:30	10.57	16.08
06/08/2015 11:30	13.87	14.60
06/08/2015 11:30	13.30	14.58
06/08/2015 11:31	10.87	15.69
06/08/2015 11:31	12.47	15.12
06/08/2015 11:31	13.27	14.71
06/08/2015 11:31	11.60	15.36
06/08/2015 11:32	13.93	14.56
06/08/2015 11:32	13.77	14.69
06/08/2015 11:32	12.37	15.06
06/08/2015 11:32	11.63	15.49
06/08/2015 11:33	10.60	15.79
06/08/2015 11:33	10.97	15.73
06/08/2015 11:33	10.33	15.99
06/08/2015 11:33	11.33	15.56
06/08/2015 11:34	11.33	15.35
06/08/2015 11:34	10.57	15.92
06/08/2015 11:34	11.20	15.65
06/08/2015 11:34	10.10	16.09
06/08/2015 11:35	11.43	15.34
06/08/2015 11:35	9.83	16.15
06/08/2015 11:35	10.67	15.97
06/08/2015 11:35	11.50	15.36
06/08/2015 11:36	10.37	15.91

Date / Time	NOx (ppm)	O2 (%)
06/08/2015 11:36	13.50	14.83
06/08/2015 11:36	15.07	13.95
06/08/2015 11:36	14.30	14.03
06/08/2015 11:37	11.67	15.13
06/08/2015 11:37	9.80	15.95
06/08/2015 11:37	12.00	15.36
06/08/2015 11:37	11.10	15.42
06/08/2015 11:38	11.17	15.65
06/08/2015 11:38	11.70	15.28
06/08/2015 11:38	11.93	15.02
06/08/2015 11:38	11.00	15.59
06/08/2015 11:39	12.00	15.35
06/08/2015 11:39	11.80	15.06
06/08/2015 11:39	9.40	16.21
06/08/2015 11:39	10.03	15.94
06/08/2015 11:40	9.20	16.28
06/08/2015 11:40	9.80	16.13
06/08/2015 11:40	9.57	16.38
06/08/2015 11:40	12.00	15.35
06/08/2015 11:41	12.17	15.04
06/08/2015 11:41	10.03	15.84
06/08/2015 11:41	9.57	15.97
06/08/2015 11:41	9.40	16.07
06/08/2015 11:42	9.60	16.22
06/08/2015 11:42	10.00	15.91
06/08/2015 11:42	11.30	15.35
06/08/2015 11:42	10.33	15.64
06/08/2015 11:43	10.20	15.84
06/08/2015 11:43	11.27	15.40
06/08/2015 11:43	8.40	16.19
06/08/2015 11:43	7.07	17.27
06/08/2015 11:44	10.23	16.00
06/08/2015 11:44	10.77	15.67
06/08/2015 11:44	9.17	16.23
06/08/2015 11:44	8.47	16.61
06/08/2015 11:45	10.33	15.99
06/08/2015 11:45	10.10	15.82
06/08/2015 11:45	9.50	16.14
06/08/2015 11:45	8.60	16.50
06/08/2015 11:46	9.17	16.40
06/08/2015 11:46	9.73	16.07
06/08/2015 11:46	10.37	15.80
06/08/2015 11:46	9.90	16.12
06/08/2015 11:47	9.50	16.05
06/08/2015 11:47	11.87	15.24
06/08/2015 11:47	11.27	15.21
06/08/2015 11:47	10.47	15.54
06/08/2015 11:48	11.07	15.45
06/08/2015 11:48	8.93	16.11
06/08/2015 11:48	10.50	15.88
06/08/2015 11:48	8.67	16.50
06/08/2015 11:49	10.77	15.60
06/08/2015 11:49	10.20	15.56
06/08/2015 11:49	8.83	16.39
06/08/2015 11:49	9.33	16.08
Average	**10.61**	**15.75**

TVOC by FID Calculations (Concentration mg/m3)			BS EN 12619:2013
Company	Wexford County Council	**Date of Test**	06/08/2015
Site	Holmestown Landfill, Castlebridge, Killurin, Co. Wexford.	**Reference No**	M02
Plant Identification	Flare Killurin	**Operator Id**	MM08 919
Test carried out by	Victor Olmos	**TE's**	TE1, TE2, TE3, TE4
Report Number:	2140/M02		

Fitz scientific
Monitoring and Testing Services

Zero Gas Concentration:	0	ppm
Span Gas Concentration:	90.01	ppm

Calibration records:			
Zero Gas Results:	Zero Gas Results:	Span Gas Result:	
Before	After	Before	After
-0.04	-0.34	87.9	87.9

Readings:	**Concentration ppm**
1	3.22

Sample Time	30
Average Conc	3.22

TVOC Results	TVOC	
TVOC @ STP,	5.17	mgC/M3
TVOC @ STP, Dry	5.28	mgC/M3
TVOC @ STP, Ref Oxygen, Dry	18.37	mgC/M3
Uncertainty	11.67	mgC/M3
Mass Emission (STP,dry, refO2)	0.00	mg/hr
Mass Emission (STP,dry, refO2)	0.00	Kg/hr

	Reference	**Measured**
Oxygen (%)	3.00	15.8
Moisture (%)	0	2.1

Volumetric Flow rate	0.0	m3/hr

Span expected Value	90.01	ppm
Span reading before measurement	87.9	ppm
Span reading after measurement	87.9	ppm
Sampling time	30	mins
Zero expected result	0.00	ppm
Zero reading before	-0.04	ppm
Zero reading after	-0.34	ppm
Span adjustment	1.024	
Span Check	1.020	
Deviation	-0.003	
Drift/Min	-0.000115995	
Zero adjustment	-0.040941551	
Zero check	-0.346820036	
Deviation	0.305878485	
Drift/min	0.01019595	
Drift	-0.01	%
Actual measured Concentration	3.22	ppm
Corrected concentration for drift	3.22	

Uncertainty calculation TVOC

Limit value	10	mg/m3 (corrected)	Cal gas conc	144.6589	mg.m-3
Measured concentration	3.22	ppm	Full Scale		mg/m3
Measured concentration	18.4	mg/m3 (Corrected)			

Correction for reference conditions					
		O2, %	**Moisture, %**	**Pressure, KPa**	**Temperature, K**
	ref	3.00	0.00	101.30	**273.00**
	measured	15.75	2.10	101.30	**273.00**
	Uncert	0.13	1.00	0.00	**1.00**
Factors		3.48	1.02	1.00	1.00
Uncertainty in factor		0.09	0.01	0.00	0.00
Correction Factor		**3.55**	uf	**0.09**	

Effect of drift
0.01 mg/m3
0.06 % value

Performance characteristics	**Value**				**specification**		ranges min	max	value at calib	
Response time		160	seconds		180.000					
Logger sampling interval		60	seconds							
Measurement period		30	minutes							
Number of readings in measurement		30								
Repeatability at zero		0.25	% full scale		<1 % range					
Repeatability at span level		0.15	% full scale		<2 % range					
Deviation from linearity		0.7	% of value		<2 % range					
Zero drift		0.01019595	% full scale		<2% range / 24hr					
Span drift		-0.000115995	% full scale		<2% range/24hr					
volume or pressure flow dependence		0	% of full scale/3 kPa		<2 % / 3 kPa	flow	0.3	0.5	0.4	l/hr
atmospheric pressure dependence		0	% of full scale/2 kPa		<3% / 2 kPa	pressure	100.76	100.92	100.88	kPa
ambient temperature dependence		0	% full scale/10K		<3% range / 10	temp	287	288.5	287.5	K
N2O (mg/m3)	40	9.0	mg/m3			N2O range	0	0	0	mg/m3
CO2 (% vol)	15	9.0	mg/m3			CO2 range	0	40	0	%vol
CH4 (mg/m3)	57	9.0	mg/m3			CH4 range	0	57	0	mg/m3
H2O (% vol)	30	9.0	mg/m3			H2O range	0	1	0	%vol
dependence on voltage		0.1	% full scale/10V		<2% range	Voltage	93	121	110	V
losses in the line (leak)		1	% of value		< 0.1%vol /10 volt					
Uncertainty of calibration gas		1.07	% of value		< 2% of value					

Performance characteristic			**Uncertainty**		**Value of uncertainty quantity**		
Standard deviation of repeatability at zero			ur0		for mean		use rep at span
Standard deviation of repeatability at span level			urs		for mean		0.03
Lack of fit			ufit				0.00
Drift			u0dr				0.01
volume or pressure flow dependence			uspres				0.00
atmopsheric pressure dependence			uapres				0.00
ambient temperature dependence			utemp				0.00
N2O (mg/m3)			uinterf				0.00
CO2 (% vol)			uinterf				13.86
CH4 (mg/m3)			uinterf				5.20
H2O (% vol)			uinterf				0.17
Dependence on voltage			uvolt				0.00
losses in the line (leak)			uleak				0.11
Uncertainty of calibration gas			ucalib				0.11
Uncertianty in factor			uf				1.63
Measurement uncertainty			18.37	mg/m3			
Combined uncertainty			1.64	mg/m3			
Expanded uncertainty	k =	2	3.29	mg/m3			
Uncertainty corrected to std conds			11.67	mg/m3			
Expanded uncertainty	**expressed with a level of confidence of 95%**		**116.68 % ELV**				
Expanded uncertainty	**expressed with a level of confidence of 95%**		**11.67 mg.m-3**				
Expanded uncertainty	**expressed with a level of confidence of 95%**		**63.5 % value**				

Use largest of sum of all positive or all negative influences

19.23 all +ves		Criteria
0 all -ves		sum <4% range
19.23 largest		0.06436

Value to use for intereference uncertainty
uint 19.23

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Date	Time	TVOC (ppm)
06/08/2015	13:02:13	5.00
06/08/2015	13:02:27	3.21
06/08/2015	13:02:42	1.35
06/08/2015	13:02:57	1.14
06/08/2015	13:03:12	4.55
06/08/2015	13:03:27	1.35
06/08/2015	13:03:42	0.97
06/08/2015	13:03:57	0.85
06/08/2015	13:04:12	0.81
06/08/2015	13:04:27	0.88
06/08/2015	13:04:42	1.07
06/08/2015	13:04:57	1.06
06/08/2015	13:05:13	0.80
06/08/2015	13:05:27	0.69
06/08/2015	13:05:42	0.65
06/08/2015	13:05:57	0.77
06/08/2015	13:06:12	0.44
06/08/2015	13:06:28	0.44
06/08/2015	13:06:42	0.73
06/08/2015	13:06:58	1.03
06/08/2015	13:07:12	0.80
06/08/2015	13:07:27	0.98
06/08/2015	13:07:43	0.76
06/08/2015	13:07:58	1.63
06/08/2015	13:08:13	1.93
06/08/2015	13:08:28	0.44
06/08/2015	13:08:43	0.63
06/08/2015	13:08:58	0.47
06/08/2015	13:09:13	0.53
06/08/2015	13:09:28	0.55
06/08/2015	13:09:43	0.74
06/08/2015	13:09:58	0.52
06/08/2015	13:10:13	0.55
06/08/2015	13:10:28	0.75
06/08/2015	13:10:43	0.76
06/08/2015	13:10:58	0.62
06/08/2015	13:11:13	0.64
06/08/2015	13:11:28	0.91
06/08/2015	13:11:43	0.63
06/08/2015	13:11:58	0.70
06/08/2015	13:12:13	0.69
06/08/2015	13:12:28	0.72
06/08/2015	13:12:43	0.63
06/08/2015	13:12:58	0.55
06/08/2015	13:13:13	0.61
06/08/2015	13:13:28	0.58
06/08/2015	13:13:43	0.60
06/08/2015	13:13:58	0.59
06/08/2015	13:14:13	56.50
06/08/2015	13:14:28	0.93
06/08/2015	13:14:43	4.36
06/08/2015	13:14:58	0.69
06/08/2015	13:15:13	0.56
06/08/2015	13:15:28	0.35
06/08/2015	13:15:43	0.69
06/08/2015	13:15:58	0.86
06/08/2015	13:16:13	0.77
06/08/2015	13:16:28	206.00
06/08/2015	13:16:43	0.82
06/08/2015	13:16:58	0.63
06/08/2015	13:17:13	0.38
06/08/2015	13:17:28	0.31
06/08/2015	13:17:43	0.80
06/08/2015	13:17:58	0.32
06/08/2015	13:18:13	0.57

Date	Time	TVOC (ppm)
06/08/2015	13:18:28	0.56
06/08/2015	13:18:43	0.57
06/08/2015	13:18:58	0.51
06/08/2015	13:19:13	9.13
06/08/2015	13:19:28	0.38
06/08/2015	13:19:43	0.49
06/08/2015	13:19:58	0.38
06/08/2015	13:20:13	0.47
06/08/2015	13:20:28	0.56
06/08/2015	13:20:43	0.73
06/08/2015	13:20:58	0.58
06/08/2015	13:21:13	0.45
06/08/2015	13:21:28	0.44
06/08/2015	13:21:43	0.50
06/08/2015	13:21:58	0.60
06/08/2015	13:22:13	0.47
06/08/2015	13:22:28	0.57
06/08/2015	13:22:43	0.52
06/08/2015	13:22:58	0.79
06/08/2015	13:23:13	2.62
06/08/2015	13:23:28	1.01
06/08/2015	13:23:43	0.80
06/08/2015	13:23:58	0.68
06/08/2015	13:24:13	1.14
06/08/2015	13:24:28	0.57
06/08/2015	13:24:43	3.58
06/08/2015	13:24:58	23.45
06/08/2015	13:25:13	0.29
06/08/2015	13:25:28	0.46
06/08/2015	13:25:43	0.52
06/08/2015	13:25:58	0.23
06/08/2015	13:26:13	0.24
06/08/2015	13:26:28	0.12
06/08/2015	13:26:43	0.63
06/08/2015	13:26:58	0.46
06/08/2015	13:27:13	0.31
06/08/2015	13:27:28	0.40
06/08/2015	13:27:43	0.62
06/08/2015	13:27:58	0.27
06/08/2015	13:28:13	0.23
06/08/2015	13:28:28	0.17
06/08/2015	13:28:43	0.31
06/08/2015	13:28:58	0.06
06/08/2015	13:29:13	0.06
06/08/2015	13:29:28	0.30
06/08/2015	13:29:43	0.17
06/08/2015	13:29:58	0.37
06/08/2015	13:30:13	0.42
06/08/2015	13:30:28	0.44
06/08/2015	13:30:43	0.31
06/08/2015	13:30:58	0.57
06/08/2015	13:31:13	0.41
06/08/2015	13:31:28	0.38
06/08/2015	13:31:43	0.74
06/08/2015	13:31:58	0.28
	average	**3.22**

SO2				BS EN 14791:2005
Company:	Wexford County Council		**Date of test:**	06/08/2015
Site:	Holmestown Landfill, Castlebridge, Kil		**Reference No:**	M02
Plant Identification	Flare Killurin		**Operator Id**	MM08 919
Test Carried out by:	Victor Olmos		**TE's**	TE1, TE2, TE3, TE4
Report Number:	2140/M02			

	Run					
Laboratory Results:	mgSO4/L	Cert Number:	Laboratory	Accredtation	Analytical Meth	Date of Analysis
LOD	0.029		Fitz Scientific	MCERTS	IC	14/08/2015
Impinger 1	0.521	4450/030/01	Fitz Scientific	MCERTS		
Impinger 2	0.174	4450/030/02	Fitz Scientific	MCERTS		
Line Wash			Fitz Scientific	MCERTS		
	Blank					
Impinger 1	0.196	4450/030/03	Fitz Scientific	MCERTS		
Impinger 2	0.184	4450/030/04	Fitz Scientific	MCERTS		
Line Wash			Fitz Scientific	MCERTS		

Run		Blank	
Sample Volumes			
ml	L	ml	L
115.2	0.1152	122.3	0.1223
132.2	0.1322	127.4	0.1274
	0		0

Dry at Gas Meter: (Vg)	0.0872	m3	
Gas Meter Temperature: (tg)	27	300	K
Ambient Pressure Measured:(Pa)	100.78	0.512	
Gas Volume STP (Vgn)	0.078944665	Nm3	
Gas Volume Factor Correction:	0.9898		
Corrected Volume STP	0.078930119	Nm3	

	SO4 mg	mgSO2/m3 at STP,Dry	mgSO2/m3 at Reference Conditions	Uncertainty mgSO2/m3	kg/hr
LOD	0.01	0.1	0.2	n/a	3.31924E-06
Run	0.08	0.7	2.4	0.2	3.84091E-05
Blank	0.05	0.4	1.4	0.1	2.19348E-05

Reference oxygen:	3.0	%
Measured oxygen:	15.8	%
Flow Rate at reference conditions	0.00	m3/hr

Absorption efficiency(Impinger 1 should absorb 95% of total sulphate): 77.5 %
or result in second absorber should be <LOD

Low SO2 levels detected. Impinger efficiency NOT relevent

Calculation spreadsheet v.37

Uncertainty calculation for EN 14791 Determination of mass concentration of sulphur dioxide, Reference method

Run

Limit value (ELV)	0	**mg.m-3**	**Reference oxygen**	3	**% by volume**
Measured concer	2.4	**mg.m-3**	**(at reference conditions)**		

$$c = \frac{m}{V} f_c$$

Measured Quantit	Symbol	Value	Standard uncertainty		Units	Uncertainty as per	Uncertainty at lv	Requirement of std
Sampled Volume	Vm	0.078930119	uVm	0.001	**m3**	1.27		<=2%
Sampled gas Ten	Tm	273	uTm	2	k	2.00		<2.5 k
Sampled gas Pres	ρm	101.3	uρm	1	**kPa**	0.99		<=1%
Sampled gas Hur	Hm	2.099219336	uHm	1	**% by volume**	47.64		<=1%
Oxygen content	O2,m	0	uO2,m	0.1	**% by volume**	#DIV/0!		<=5%
Concentration in	C	0.7	uC	0.02085	**mg/l**	3.00		<5%
Impinger solutio	VS	247.4	uVS	0.001	**l**	0.00		<1%
Mass SO2	m	0.1	um	0.00	**mg**	3.00	#DIV/0!	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas meter								
Leak	L	2			**%**	2.00		<=2%

Intermediate calculations

Factor for std cor	fs	0.98				
uncertainty comp	symbol	**ensitivity coeff**		**u (in units of fs)**		
	ρm	0.010		0.010		
	Hm	0.010		0.010	$f_s = \frac{(100 - H_m)}{100} \frac{273}{T_m} \frac{\rho_m}{101.3}$	
	Tm	0.004		0.007		
	ufs			0.016		1.60
Corrected volum	V	0.08	uV	0.002 **m3**	$V = V_m f_s$	2.06
Factor for O2 cor	fc	0.86				
uncertainty comp	symbol	**ensitivity coeff**		**u**	$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$	
	O2,m	0.04		0.004		
Factor for O2 Co	ufc	0.86		0.004		0.48

Parameter		Value	Units	Sensitivity coeff	Uncertainty contribution		Uncertainty as %	
Corrected Volume	V	0.08	m3	31.55	0.05	mg.m-3	#VALUE!	%
Mass	m	0.08	mg	29.37	0.07	mg.m-3	#VALUE!	%
Factor for O2 Corr	fc	0.86		2.85	0.01	mg.m-3	#VALUE!	%
Leak	L	0.03	mg.m-3	1.00	0.03	mg.m-3	#VALUE!	%
Combined uncertainty					**0.09**	mg.m-3		

Expanded uncertainty as percentage of measured value	**7.69**	**% measured of value**	**expressed with a level of confidence of 95%**
			(Using a coverage factor k=2)
Expanded uncertainty in units of measurement	**0.19**	**mg.m-3**	
Expanded uncertainty as percentqge of limit value	**#DIV/0!**	**% ELV**	

Uncertainty calculation for EN 14791 Determination of mass concentration of sulphur dioxide, Reference method
Blank

Limit value (ELV)	0	**mg.m-3**	**Reference oxygen**	3	**% by volume**
Measured concer	1.4	**mg.m-3**	**(at reference conditions)**		

$$c = \frac{m}{V} f_c$$

Measured Quantit	Symbol	Value	Standard uncertainty		Units	Uncertainty as per	Uncertainty at lv	Requirement of std
Sampled Volume	Vm	0.1	uVm	0.001	**m3**	1.27		<=2%
Sampled gas Ten	Tm	273	uTm	2	k	2.00		<2.5 k
Sampled gas Pres	ρm	101.3	uρm	1	**kPa**	0.99		<=1%
Sampled gas Hur	Hm	2.099219336	uHm	1	**% by volume**	47.64		<=1%
Oxygen content	O2,m	15.75	uO2,m	0.1	**% by volume**	0.63		<=5%
Concentration in	C	0.4	uC	0.0114	**mg/l**	3.00		<5%
Impinger solutio	VS	249.7	uVS	0.001	**l**	0.00		<1%
Mass SO2	m	0.0	um	0.00	**mg**	3.00	#DIV/0!	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas meter								
Leak	L	2			**%**	2.00		<=2%

Intermediate calculations							
Factor for std cor	fs	0.98					
uncertainty comp	symbol	**ensitivity coeff**		**u (in units of fs)**			
	ρm	0.010		0.010			
	Hm	0.010		0.010	$f_s = \frac{(100 - H_m)}{100} \frac{273}{T_m} \frac{\rho_m}{101.3}$		
	Tm	0.004		0.007			
	ufs			0.016		1.60	
Corrected volum	V	0.08	uV	0.002	**m3**	$V = V_m f_s$	2.06
Factor for O2 cor	fc	3.48					
uncertainty comp	symbol	**ensitivity coeff**		**u**			
	O2,m	0.68		0.068	$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$		
Factor for O2 Co	ufc	3.48		0.068		1.94	

Parameter		Value	Units	Sensitivity coeff	Uncertainty contribution		Uncertainty as %	
Corrected Volume	V	0.08	m3	18.02	0.03	mg.m-3	#VALUE!	%
Mass	m	0.05	mg	29.37	0.04	mg.m-3	#VALUE!	%
Factor for O2 Corr	fc	3.48		0.40	0.03	mg.m-3	#VALUE!	%
Leak	L	0.02	mg.m-3	1.00	0.02	mg.m-3	#VALUE!	%
Combined uncertainty					**0.06**	mg.m-3		

Expanded uncertainty as percentage of measured value	**8.56**	**% measured of value**	**expressed with a level of confidence of 95%**
			(Using a coverage factor k=2)
Expanded uncertainty in units of measurement	**0.12**	**mg.m-3**	
Expanded uncertainty as percentqge of limit value	**#DIV/0!**	**% ELV**	

HCl				BS EN 1911:2010
Company	Wexford County Council		Date of Test	06/08/2015
Site	Holmestown Landfill, Castlebridge, I		Reference No	M02
Plant Identification	Flare Killurin		Operator Id	MM08 919
Test carried out by	Victor Olmos		TE's	TE1, TE2, TE3, TE4
Report Number :	2140/M02			

	Run					
Laboratory Results	mgHCl/L	Cert Number:	Laboratory	Accredtation	Analytical Method	Date of Analysis
LOD	0.069		Fitz Scientific	MCERTS	IC	14/08/2015
Impinger 1	0.096	4450/030/05	Fitz Scientific	MCERTS		
Impinger 2	**0.069**	4450/030/06	Fitz Scientific	MCERTS		
Line Wash			Fitz Scientific	MCERTS		
	Blank					
Impinger 1	**0.069**	4450/030/07	Fitz Scientific	MCERTS		
Impinger 2	**0.069**	4450/030/08	Fitz Scientific	MCERTS		
Line Wash			Fitz Scientific	MCERTS		

Run		Blank	
Sample Volumes			
ml	L	ml	L
151.5	0.1515	125.0	0.125
155.3	0.1553	105.6	0.1056
	0		0

Sampled Volume corrected to reference conditions STP, Dry: 0.078930119 Nm3

	HCl mg	mgHCl/m3 at STP,Dry	mgCl/m3 at STP	mgHCl/m3 at Refernce Conditions	Uncertainty mgHCl/mg	HCl kg/hr	Uncertainty HCl kg/hr
LOD	0.02	0.3	0.3	0.9	n/a	0	n/a
Run	0.03	0.3	0.3	1.1	0.1	0	1.50557E-06
Blank	0.02	0.2	0.2	0.7	0.1	0	9.50477E-07

Reference oxygen: 3.0 %
Measured oxygen: 15.8 %

Flow Rate at reference conditions 0.00 m3/hr

Absorption efficiency(Impinger 1 should absorb 95% of total HCl): **58.8** %
or result in second absorber should be <LOD

Low HCl levels detected. Impinger efficiency NOT relevent

Uncertainty calculation for Determination of mass concentration of HCl, Reference method (taken from SO2 uncertainty STA website)

v2

Run Measurement Equation

Limit value (ELV)	50	**mg.m-3**	**Reference oxygen**	3.0	**% by volume**
Measured concen	1.1	**mg.m-3 (at reference conditions)**			

Measured Quantit	Symbol	Value	Standard uncertainty		Units	Uncertainty as pe	Uncertainty at lv	Requirement of std
Sampled Volume	Vm	0.078930119	uVm	0.001	**m3**	1.27		<=2%
Sampled gas Ten	Tm	273	uTm	2	k	2.00		<2.5 k
Sampled gas Pres	ρm	101.3	uρm	1	**kPa**	0.99		<=1%
Sampled gas Hur	Hm	2.099219336	uHm	1	**% by volume**	47.64		<=1%
Oxygen content	O2,m	15.8	uO2,m	0.1	**% by volume**	0.63		<=5%
Concentration in	C	0.1650	uC	0.00495	**mg/l**	3.00		<5%
Impinger solution	VS	0.3068	uVS	0.001	**l**	0.33		<1%
Mass HCl	m	0.0	um	0.00	**mg**	3.02	0.07	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas mete								
Leak	L	2			**%**	2.00		<=2%

Intermediate calculations							
Factor for std con	fs	0.98					
uncertainty comp	symbol	**sensitivity coeff**		**u (in units of fs)**			
	ρm	0.010		0.010			
	Hm	0.010		0.010			
	Tm	0.004		0.007			
	ufs			0.016			1.60
Corrected volume	V	0.08	uV	0.002	**m3**		2.06
Factor for O2 cor	fc	3.48					
uncertainty comp	symbol	**sensitivity coeff**		**u**			
	O2,m	0.68		0.068			
Factor for O2 Co	ufc	3.48		0.068			1.94

Parameter		Value	Units	Sensitivity coe	Uncertainty contribution		Uncertainty as %	
Corrected Volume	V	0.08	m3	14.40	0.02	mg.m-3	#DIV/0!	%
Mass	m	0.03	mg	44.05	0.03	mg.m-3	#DIV/0!	%
Factor for O2 Corre	fc	3.48		0.32	0.02	mg.m-3	#DIV/0!	%
Leak	L	0.01	mg.m-3	1.00	0.01	mg.m-3	#DIV/0!	%
Combined uncertainty					**0.05**	mg.m-3		

Expanded uncertainty as percentage of measured val	**8.59**	**% measured of value**	**expressed with a level of confidence of 95% (Using a coverage factor k=2)**
Expanded uncertainty in units of measurement	**0.10**	**mg.m-3**	
Expanded uncertainty as percentqge of limit value	**0.2**	**% ELV**	

Requirement in standard is for uncertainty to be < 20% at ELV at standard conditions

Uncertainty calculation for Determination of mass concentration of HCl, Reference method (taken from SO2 uncertainty STA website)
Blank

Limit value (ELV)	5	**mg.m-3**	**Reference oxygen**	3.0	**% by volume**
Measured concen	0.7	**mg.m-3 (at reference conditions)**			

Measured Quantit	Symbol	Value	Standard uncertainty		Units	Uncertainty as pe	Uncertainty at lv	Requirement of std
Sampled Volume	Vm	0.078930119	uVm	0.001	**m3**	1.27		<=2%
Sampled gas Ten	Tm	273	uTm	2	k	2.00		<2.5 k
Sampled gas Pres	ρm	101.3	uρm	1	**kPa**	0.99		<=1%
Sampled gas Hur	Hm	2.099219336	uHm	1	**% by volume**	47.64		<=1%
Oxygen content	O2,m	15.75222219	uO2,m	0.1	**% by volume**	0.63		<=5%
Concentration in	C	0.1380	uC	0.00414	**mg/l**	3.00		<5%
Impinger solution	VS	0.2	uVS	0.001	**l**	0.43		<1%
Mass NH3	m	0.0	um	0.00	**mg**	3.03	0.42	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas mete								
Leak	L	2			**%**	2.00		<=2%

Intermediate calculations						
Factor for std con	fs	0.98				
uncertainty comp	symbol	**sensitivity coeff**		**u (in units of fs)**		
	ρm	0.010		0.010		
	Hm	0.010		0.010		
	Tm	0.004		0.007		
	ufs			0.016		1.60
Corrected volume	V	0.08	uV	0.002	**m3**	2.06
Factor for O2 cor	fc	3.48				
uncertainty comp	symbol	**sensitivity coeff**		**u**		
	O2,m	0.68		0.068		
Factor for O2 Co	ufc	3.48		0.068		1.94

Parameter		Value	Units	Sensitivity coe	Uncertainty contribution	Uncertainty as %	
Corrected Volume	V	0.08	m3	9.07	0.01 mg.m-3	#DIV/0!	%
Mass	m	0.02	mg	44.05	0.02 mg.m-3	#DIV/0!	%
Factor for O2 Corre	fc	3.48		0.20	0.01 mg.m-3	#DIV/0!	%
Leak	L	0.01	mg.m-3	1.00	0.01 mg.m-3	#DIV/0!	%
Combined uncertainty					**0.03** mg.m-3		

Expanded uncertainty as percentage of measured val	**8.61**	**% measured of value**	**expressed with a level of confidence of 95%**
			(Using a coverage factor k=2)
Expanded uncertainty in units of measurement	**0.06**	**mg.m-3**	
Expanded uncertainty as percentqge of limit value	**1.2**	**% ELV**	

HF				BS ISO 15713:2006
Company	Wexford County Council		Date of Test	06/08/2015
Site	Holmestown Landfill, Castlebridge, I	Fitz scientific Monitoring and Testing Services	Reference No	M02
Plant Identification	Flare Killurin		Operator Id	MM08 919
Test carried out by	Victor Olmos		TE's	TE1, TE2, TE3, TE4
Report Number :	2140/M02			

	Run					
Laboratory Results	mgHF/L	Cert Number:	Laboratory	Accredtation	Analytical Method	Date of Analysis
LOD	0.004		Fitz Scientific	MCERTS	IC	14/08/2015
Impinger 1	0.2540	4450/030/09	Fitz Scientific	MCERTS		
Impinger 2	0.0070	4450/030/10	Fitz Scientific	MCERTS		
Line Wash			Fitz Scientific	MCERTS		
	Blank					
Impinger 1	0.0050	4450/030/11	Fitz Scientific	MCERTS		
Impinger 2	**0.0040**	4450/030/12	Fitz Scientific	MCERTS		
Line Wash			Fitz Scientific	MCERTS		

Run		Blank	
Sample Volumes			
ml	L	ml	L
107.2	0.1072	130.5	0.1305
99.3	0.0993	106.4	0.1064
	0		0

Dry at Gas Meter: (Vg)	0.0868	m3	
Gas Meter Temperature: (tg)	27.83	300.83	K
Ambient Pressure Measured:(Pa)	100.78	0.512	
Gas Volume STP (Vgn)	0.078365722	Nm3	
Gas Volume Factor Correction:	0.9898		
Corrected Volume STP	0.078930119	Nm3	

	HF mg	mgHF/m3 at STP,Dry	mgF/m3 at STP	mgHF/m3 at Refernce Conditions	Uncertainty mgHF/mg	HF kg/hr	Uncertainty HF kg/hr
LOD	0.0	0.01	0.01	0.04	n/a	5.73208E-07	n/a
Run	0.0	0.35	0.34	1.23	0.106	1.9378E-05	1.67014E-06
Blank	0.0	0.01	0.01	0.05	0.004	7.48155E-07	6.43838E-08

Reference oxygen: 3.0 %
Measured oxygen: 15.8 %

Flow Rate at reference conditions 0.00 m3/hr

Absorption efficiency(Impinger 1 should absorb 95% of total HF): 97.1 %
or result in second absorber should be <LOD

Uncertainty calculation for Determination of mass concentration of HF, Reference method (taken from SO2 uncertainty STA website)

v2

Run Measurement Equation

Limit value (ELV)	5	**mg.m-3**	**Reference oxygen**	3.0	**% by volume**
Measured concen	1.2	**mg.m-3**	**(at reference conditions)**		

Measured Quantit	Symbol	Value	Standard uncertainty		Units	Uncertainty as pe	Uncertainty at lv	Requirement of std
Sampled Volume	Vm	0.078930119	uVm	0.001	**m3**	1.27		<=2%
Sampled gas Tem	Tm	273	uTm	2	k	2.00		<2.5 k
Sampled gas Pres	ρm	101.3	uρm	1	**kPa**	0.99		<=1%
Sampled gas Hun	Hm	2.099219336	uHm	1	**% by volume**	47.64		<=1%
Oxygen content	O2,m	15.8	uO2,m	0.1	**% by volume**	0.63		<=5%
Concentration in	C	0.2610	uC	0.00783	**mg/l**	3.00		<5%
Impinger solution	VS	0.2065	uVS	0.001	**l**	0.48		<1%
Mass HCl	m	0.0	um	0.00	**mg**	3.04	0.75	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas mete								
Leak	L	2			**%**	2.00		<=2%

Intermediate calculations							
Factor for std con	fs	0.98					
uncertainty compo	symbol	**sensitivity coeff**		**u (in units of fs)**			
	ρm	0.010		0.010			
	Hm	0.010		0.010			
	Tm	0.004		0.007			
	ufs			0.016			1.60
Corrected volume	V	0.08	uV	0.002	**m3**		2.06
Factor for O2 con	fc	3.48					
uncertainty compo	symbol	**sensitivity coeff**		**u**			
	O2,m	0.68		0.068			
Factor for O2 Cor	ufc	3.48		0.068			1.94

Parameter		Value	Units	Sensitivity coe	Uncertainty contribution	Uncertainty as %	
Corrected Volume	V	0.08	m3	15.92	0.03 mg.m-3	#DIV/0!	%
Mass	m	0.03	mg	44.05	0.04 mg.m-3	#DIV/0!	%
Factor for O2 Corre	fc	3.48		0.35	0.02 mg.m-3	#DIV/0!	%
Leak	L	0.01	mg.m-3	1.00	0.01 mg.m-3	#DIV/0!	%
Combined uncertainty					**0.05** mg.m-3		

Expanded uncertainty as percentage of measured val	**8.62**	**% measured of value**	**expressed with a level of confidence of 95% (Using a coverage factor k=2)**
Expanded uncertainty in units of measurement	**0.11**	**mg.m-3**	
Expanded uncertainty as percentqge of limit value	**2.1**	**% ELV**	

Requirement in standard is for uncertainty to be < 20% at ELV at standard conditions

Uncertainty calculation for Determination of mass concentration of HF, Reference method (taken from SO2 uncertainty STA website)
Blank

Limit value (ELV)	0.5	**mg.m-3**	**Reference oxygen**	3.0	**% by volume**
Measured concen	0.0	**mg.m-3**	**(at reference conditions)**		

Measured Quantit	Symbol	Value	Standard uncertainty		Units	Uncertainty as pe	Uncertainty at lv	Requirement of std
Sampled Volume	Vm	0.078930119	uVm	0.001	**m3**	1.27		<=2%
Sampled gas Tem	Tm	273	uTm	2	k	2.00		<2.5 k
Sampled gas Pres	ρm	101.3	uρm	1	**kPa**	0.99		<=1%
Sampled gas Hun	Hm	2.099219336	uHm	1	**% by volume**	47.64		<=1%
Oxygen content	O2,m	15.75222219	uO2,m	0.1	**% by volume**	0.63		<=5%
Concentration in	C	0.0040	uC	0.00012	**mg/l**	3.00		<5%
Impinger solution	VS	0.2	uVS	0.001	**l**	0.42		<1%
Mass NH3	m	0.0	um	0.00	**mg**	3.03	0.29	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas mete								
Leak	L	2			**%**	2.00		<=2%

Intermediate calculations						
Factor for std con	fs	0.98				
uncertainty compo	symbol	**sensitivity coeff**		**u (in units of fs)**		
	ρm	0.010		0.010		
	Hm	0.010		0.010		
	Tm	0.004		0.007		
	ufs			0.016		1.60
Corrected volume	V	0.08	uV	0.002	**m3**	2.06
Factor for O2 con	fc	3.48				
uncertainty compo	symbol	**sensitivity coeff**		**u**		
	O2,m	0.68		0.068		
Factor for O2 Cor	ufc	3.48		0.068		1.94

Parameter		Value	Units	Sensitivity coe	Uncertainty contribution		Uncertainty as %	
Corrected Volume	V	0.08	m3	0.61	0.00	mg.m-3	#DIV/0!	%
Mass	m	0.00	mg	44.05	0.00	mg.m-3	#DIV/0!	%
Factor for O2 Corre	fc	3.48		0.01	0.00	mg.m-3	#DIV/0!	%
Leak	L	0.00	mg.m-3	1.00	0.00	mg.m-3	#DIV/0!	%
Combined uncertainty					**0.00**	mg.m-3		

Expanded uncertainty as percentage of measured val	**8.61**	**% measured of value**	**expressed with a level of confidence of 95%**
			(Using a coverage factor k=2)
Expanded uncertainty in units of measurement	**0.00**	**mg.m-3**	
Expanded uncertainty as percentqge of limit value	**0.8**	**% ELV**	

A5 Water Balance Calculation

Appendix A5

Water Balance Calculation for Killurin Landfill 2015

Month	Rainfall	Evaporation	Effective Rainfall	Capped Area (above road)	Capped Area (Below road)	Capped Area (Haul Road)	Additional runoff to haul road (effective area)	Capped Infiltration	Infiltration through incident rain on haul road	Infiltration from runoff to haul road	Total Leachate Production	Cumulative Leachate Production	Leachate Tankered Offsite
	(mm)	(mm)	(mm)	(m^2)	(m^2)	(m^2)	(m^2)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)
Jan-15	77.7	14.5	63.2	39,282	15,340	6,600	39,282	172.6	41.7	74.5	288.8	288.8	465.0
Feb-15	47.2	17.6	29.6	39,282	15,340	6,600	39,282	80.8	19.5	34.9	135.3	424.1	263.5
Mar-15	61.8	35.4	26.4	39,282	15,340	6,600	39,282	72.1	17.4	31.1	120.6	544.7	387.0
Apr-15	21.9	55.3	0	39,282	15,340	6,600	39,282	-	-	-	-	544.7	279.0
May-15	145	66.7	78.3	39,282	15,340	6,600	39,282	213.8	51.7	92.3	357.8	902.5	833.5
Jun-15	35	86	0	39,282	15,340	6,600	39,282	-	-	-	-	902.5	93.0
Jul-15	116.6	76.4	40.2	39,282	15,340	6,600	39,282	109.8	26.5	47.4	183.7	1,086.2	622.0
Aug-15	54.2	66.8	0	39,282	15,340	6,600	39,282	-	-	-	-	1,086.2	207.8
Sep-15	59.8	48.6	11.2	39,282	15,340	6,600	39,282	30.6	7.4	13.2	51.2	1,137.4	299.9
Oct-15	72	27	45	39,282	15,340	6,600	39,282	122.9	29.7	53.0	205.6	1,343.0	369.6
Nov-15	105.2	17.2	88	39,282	15,340	6,600	39,282	240.3	58.1	103.7	402.1	1,745.1	815.2
Dec-15	266.9	13.8	253.1	39,282	15,340	3,960	39,282	691.2	100.2	298.3	1,089.7	2,834.9	682.0
Total	**1,063**	**525**	**635**					**1,734**	**352**	**748**	**2,835**		**5,318**

Notes:
The calculation was carried out using MS Excel following the method from the EPA Landfill Manual on Landfill Site Design, as shown:

Lo = [ER(A) + LW + IRCA + ER(I)] - a(W);

where:	Lo =	leachate produced(m^3)
	ER =	effective rainfall, [(ER) is defined as Total Rainfall (R) minus Actual Evapotranspiration (AE) i.e. ER=R-AE]
	A =	area of cell (m^2)
	LW =	liquid waste (m^3)
	IRCA =	infiltration through restored and capped areas (m^2)
	I =	surface area of lagoons (m^2)
	a =	absorptive capacity of waste (m^3/t)
	W =	weight of waste deposited (t/a)

* Infiltration Rates (%) Look to Design Criteria for exact figures (Ranges from 5% to 100%)