March 2011

ANNUAL ENVIRONMENTAL REPORT 2010

KTK Landfill, Brownstown, Kilcullen, W0081-03

Submitted to:
Mr Tomás Fingleton
General Manager
KTK Landfill
Brownstown
Kilculllen
Co. Kildare

REPORT

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1.0 INTRODUCTION

This Annual Environmental Report (AER) has been prepared in accordance with Condition 11.8 of Waste Licence Register No. W0081-03 and contains the information listed in Schedule F of the Licence for the reporting period 1 January 2010 to 31 December 2010.

2.0 SITE HISTORY

KTK Landfill Ltd. (KTK), a wholly owned subsidiary company of Greenstar Ltd., is currently developing and operating the KTK Landfill under Waste Licence Register Number W0081-03. KTK Landfill was granted a Waste Licence (W0081-01) by the Environmental Protection Agency (EPA) in April 1999. In July 2001, KTK Landfill submitted an application for a Review of Waste Licence W0081-01. An amended licence (Register No. W0081-02) was granted by the Agency on 8 April 2002. In November 2004 an application for revision of Waste Licence W0081-02 was submitted. An amended Licence (Register No. W0081-03) was granted on 16 February 2006. Acceptance of construction material containing asbestos ceased in October 2008. The site is currently undergoing an operational, closure and restoration phase with final filling, profiling and placement of a capping liner system and restoration soils being undertaken. A detailed site map showing all monitoring locations at the site is presented in Appendix A.

3.0 REPORTING PERIOD

The reporting period for the Annual Environmental Report (AER) is from 1 January 2010 to 31 December 2010. During this reporting period Waste Licence Register No. W0081-03 was in effect.

4.0 WASTE ACTIVITIES CARRIED OUT AT THE SITE DURING THIS PERIOD

KTK Landfill is a fully engineered facility with a composite lining system on the base and side walls of a large excavation. The licensed waste activities are as follows:

Licensed Waste Disposal Activities in Accordance with the Third Schedule of the Waste Management Act, 1996 to 2003:

Class 1	Deposit on, in or under land (including landfill).
Class 5	Specially engineered landfill, including placement into lined discrete cells, which are capped and isolated from one another and the environment.
Class 11	Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.
Class 13	Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.

The licensed waste recovery activities for the site in Accordance with the Fourth Schedule of the Waste Management Act, 1996 to 2003 were as follows:

Class 3	Recycling or reclamation of metals and metal compounds.
Class 4	Recycling or reclamation of other inorganic materials
Class 13	Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.

5.0 QUANTITIY AND COMPOSITION OF WASTE RECEIVED, DISPOSED OF AND RECOVERED DURING THE REPORTING PERIOD AND EACH PREVIOUS YEAR.

Table 1: Wastes Received for the Purpose of Recovery and Disposal during 2010

Waste Type	Description	Total Accepted 2010 (tonnes)	Licence Limit (tonnes)
Commercial and Industrial	Mixed Commercial and Industrial	0	222,750
Industrial	Misc. Non-Hazardous Industrial solid wastes	23,226	24,750
Industrial	Industrial Non-Hazardous sludges and filtercakes	5	13,750
Asbestos	Construction materials containing Asbestos.	0	3,000
Construction and Demolition	Mixed Construction and Demolition Waste.	77	10,750
Total Waste Intake		**23,308**	**275,000**

Table 2: Materials received for engineering and restoration purposes 2010

Description	Quantity (Tonnes)
Shredded Timber – Reused on site.	1,831
Compost – Reused on site.	1,720
Filter cakes from the clarification of water intended for human consumption.	12,454
Soil and Fines material – Reused on site for daily cover, intermediate cover and profiling site for final capping.	44,084.7
Soils received for use Final Capping layer including Subsoil & Topsoil	236,657.1
Combined Total of Received and Recovered	**296,746.8**

6.0 METHODS OF DEPOSITION OF WASTE

The site significantly reduced acceptance of commercial and industrial wastes and ceased acceptance of asbestos wastes on the 21st of October 2008. The process for waste deposition is described below:

Waste was delivered to the site in heavy goods vehicles (HGV) with the appropriate covers to prevent loss of load. Each HGV passed through the weighbridge prior to proceeding to the active waste disposal/recovery areas. The weighbridge operator and/or the facility manager could at their own discretion request the load to be tipped in the Waste Inspection Area. Waste vehicles would then proceed to the active waste disposal/recovery areas where waste was deposited under the direction of waste inspection personnel.

Waste was deposited directly on a surface of waste close to and above the advancing tipping face. In accordance with Condition 6.19.2, the active working face was confined to a height of 3.5 metres after compaction and a width of 35 metres. Deposited waste was spread in shallow layers on the inclined surface and compacted. Steel-wheeled compactors operated on the gradient of the more shallow face, pushing thin layers of wastes and applying compaction pressure to them. Wastes were covered with heavier materials or covered with permeable soil drawn from stockpiles of heavy inert waste or fine sand/silt located on the site. Alternative fabric cover systems were also utilised where appropriate.

7.0 SUMMARY REPORT ON EMISSIONS

This summary report has been compiled in accordance with Emission Limit Values (ELV's) for the following media as detailed in Condition 6 and Schedule B of the current licence:

- Dust;
- Noise;
- Landfill Gas; and
- Leachate.

Environmental media for which no ELV's have been set under Waste Licence Register No. W0081-03 are discussed in Section 8.0.

7.1 Dust Deposition

Dust deposition emission limit values as established in Schedule B.1 of Waste Licence Register No. W0081-03 are detailed in Table 3 below.

Table 3: Depositional Dust Emission Limit Value

Level ($mg/m^2/day$) Note 1
350

Note 1: 30 day composite sample

Dust monitoring was conducted at six locations on three occasions during the 2010 reporting period as specified in Schedule C.3 of the waste licence. Geotesting Ltd. conducted the analysis of dust deposition results from the KTK facility. Dust reports were included in the subsequent 2nd, 3rd and 4th Quarterly monitoring reports of 2010.

7.2 Noise Emissions

Noise ELVs as established in Waste Licence Register No. W0081-03 are detailed in Table 4 below:

Table 4: Environmental Noise Emission Limit Values

Day dB(A)L_{Aeq}(30 minutes)	Night dB(A)L_{Aeq}(30 minutes)
55	45

Noise monitoring was conducted by Golder Associates Ireland Ltd. at six on-site locations and four sensitive receptors in May 2010. The complete noise monitoring report was included in Quarter 2 2010 submission to the Agency.

The survey revealed a number of sources on site and off site. Levels were detected that were above the specified licence limit of 55 dB(A). However, the levels detected by the sound level metre were a record of the ambient noise levels at the monitoring locations. This means that the levels were a combination of all the noise sources at the monitoring locations and were not as a direct result of operations at the facility. The dominant source of on-site noise during the survey was intermittent operational noise from trucks entering and leaving the site, and traffic movements on the P1318 and the main Kilcullen to Naas road. The off-site noise locations were found to be effected by traffic on the P1321 and P1318 roads far more than from on-site operational activities.

7.3 Landfill Gas Emissions

Landfill Gas ELV's as established in Waste Licence Register No. W0081-03 are detailed in Table 5 below:

Table 5: Landfill Gas Concentration ELV's (measured in any building on or adjacent to the facility)

Methane	Carbon Dioxide
20% LEL (1% v/v)	1.5% v/v

Landfill Gas Monitoring was conducted at 14 monitoring well locations on a monthly basis during the 2010 reporting period. Golder Associates conducted the sampling on one occasion (December 2010) during this period. KTK Landfill staff conducted the remaining 11 months of landfill gas analysis and reporting of landfill gas emissions. Collated landfill gas emission summary reports were included in the subsequent quarterly monitoring reports for 2010. Category 3 non-urgent incident reports were also forwarded to the Agency not later than 24 hours after a landfill gas emission level value was breeched.

Landfill Gas monitoring was carried out at the facility offices and buildings by an on-site continuous monitoring system and on a weekly basis by trained facility staff. There were two measured landfill gas levels above limits in facility buildings during 2010 both of which incidents were reported as Category 3 non-urgent incident reports to the agency.

7.4 Fugitive Gas Emission Report 2010

7.4.1 Locations and methods

Waste Licence Register No. W0081-03 stipulates that Monitoring of any emissions to air is carried out at the enclosed gas Flare No. 1 (HAASE 2500) and No. 2 (HAASE 1500) and at the gas Utilisation Plant Engines GE01, GE02 and GE03 at KTK Landfill. Odour Monitoring Ireland Ltd undertook this monitoring on two occasions, on 2 June 2010 and 11 January 2011 which was rescheduled from 7 December 2010 due to heavy snow fall at that time. These reports are presented in Appendix B.

7.4.2 Results

Table 6: Emission value results from landfill gas flare No. 1 (2,500 HAASE) monitored at KTK Landfill.

Parameter	02 June 2010	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ N/m^3$)
Nitrogen oxides (NO_X)	57	150
Sulphur Dioxide (SO_2)	1,414	-

Table 7: Emission value results from landfill gas flare No. 2 (1,500 HAASE) monitored at KTK Landfill.

Parameter	02 June 2010	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
Nitrogen oxides ($NO_{X)}$	86	150
Sulphur Dioxide ($SO_{2)}$	1,418	-

Table 8: Emission value results from gas utilisation engine GE01 monitored at KTK Landfill.

Parameter	02 June 2010	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
NO_X	473	500
CO	694	1,400
TNMVOCs	44	75
SO_2	1,073	-
Particulates	92	-

Table 9: Emission value results from gas utilisation engine GE02 monitored at KTK Landfill.

Parameter	02June 2010	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
NO_X	279	500
CO	1,050	1,400
TNMVOCs	61	75
SO_2	1,006	-
Particulates	58	-

Table 10: Emission value results from gas utilisation engine GE03 monitored at KTK Landfill.

Parameter	02 June 2010	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
NO_X	494	500
CO	859	1,400
TNMVOCs	38	75
SO_2	978	-
Particulates	63	-

Table 11: Emission value results from landfill gas flare No. 1 (2,500 HAASE) monitored at KTK Landfill.

Parameter	11 January 2011	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
Nitrogen oxides (NO_X)	87.60	150
Sulphur Dioxide (SO_2)	531	-

Table 12: Emission value results from landfill gas flare No. 2 (1,500 HAASE) monitored at KTK Landfill.

Parameter	11 January 2011	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
Nitrogen oxides (NO_X)	91.31	150
Sulphur Dioxide (SO_2)	611.64	-

Table 13: Emission value results from gas utilisation engine GE01 monitored at KTK Landfill.

Parameter	11 January 2011	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
NO_X	229.91	500
CO	865	1,400
TNMVOCs	22.39	75
SO_2	227.60	-
Particulates	-	-

Table 14: Emission value results from gas utilisation engine GE02 monitored at KTK Landfill.

Parameter	11 January 2011	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
NO_X	269.38	500
CO	1014	1,400
TNMVOCs	31.14	75
SO_2	395.39	-
Particulates	-	-

Table 15: Emission value results from gas utilisation engine GE03 monitored at KTK Landfill.

Parameter	11 January 2011	
	Normalised Emission Conc. (mgN/m^3)	Emission Limit Value ($mg\ Nm^{-3}$)
NO_X	248	500
CO	572	1,400
TNMVOCs	21.69	75
SO_2	508	-
Particulates	-	-

8.0 SUMMARY OF ALL REMAINING ENVIRONMENTAL MONITORING DATA

8.1 Introduction

Monitoring was conducted at the KTK Landfill in accordance with Schedule D of Waste Licence Register No. W0081-03. However, in some cases additional monitoring was carried out at the discretion of KTK, e.g. leachate quality etc. Details of monitoring and reporting frequencies of environmental data are presented in Table 16 below.

The locations of all environmental monitoring points as well as current topographic conditions are illustrated on Drawing KTK/602, Rev B1 (Appendix A).

Table 16: Environmental Monitoring and Reporting Frequency

Environmental Monitoring Data	Monitoring Frequency	Reporting Frequency
Groundwater Quality	Quarterly	Quarterly
Groundwater Levels	Monthly	Quarterly
Surface Water Quality	Quarterly	Quarterly
Surface Water Visual Inspection	Weekly	Quarterly
Leachate Quality	Monthly*	Quarterly
Leachate Quality – RO plants	Quarterly	Quarterly
Leachate Levels	Weekly	Quarterly
Landfill Gas (Boreholes)	Monthly	Quarterly
Landfill Gas (Site Offices)	Weekly	Quarterly
Dust	Three times per year	Subsequent Quarterly
Noise	Annually	Annually
Meteorological Data	Daily	Annually
Asbestos Fibre Monitoring	Annually	Annually

*Schedule C 2.1 of the licence (W0081-03) specifies annual monitoring of leachate quality for all parameters with the exception of BOD and COD which are monitored on a quarterly basis.

8.2 Depositional Dust Monitoring

Dust Monitoring was conducted on three occasions at six monitoring locations in 2010: 28 April 2010 to 27 May 2010, 27 August 2010 to 28 September 2010 and 16 November to 16 December 2010 in accordance with Table C.3 of Schedule C of the Licence.

Co-ordinates for all monitoring locations are detailed in Table 17 below with locations illustrated on KTK/602 Rev. B1.

Table 17: Depositional Dust Monitoring Locations

Monitoring Element	Location	Eastings	Northings
Dust Monitoring	D1A	285663	211440
	D2A	285883	211396
	D3A	286122	211102
	D4A	286032	210960
	D5A	285612	211021
	D6A	285550	211230

8.2.1 Dust monitoring methods

Total dust deposition was measured at the site using Bergerhoff gauges as specified in the Standard Method VDI 2119 (German Engineering Institute). The dust gauges were set up such that the glass containers were approximately 2 m above the ground surface. In order to inhibit the growth of algae in the dust jars 20 ml of 5% 2-methoxyethanol was added to each jar during warm months. The glass jars containing the dust were submitted to GeoTesting Ltd for analysis.

8.2.2 Dust monitoring results

The results of dust monitoring conducted at KTK landfill during 2010 are presented in Table 18 below. Dust concentrations and ELV's as detailed in Schedule B.1 of Waste Licence W0081-03 are discussed below.

The Dust ELV of 350 mg/m^2/day was exceeded at locations D4A and D6A during the measurement period 28 April to 27 May 2010, and location D1A during the measurement period 27 August to 28 September 2010. However, both samples D1A and D4A were contaminated with organic matter and are not representative of actual conditions at the site. Sample D6A was contaminated with windblown dust from the main haul route to the site adjacent to the stage 1 capping area. This area was subsequently seeded with grass as part of the capping works preventing high dust levels from occurring again. In subsequent monitoring in 2010, the dust results from this location were well below the Dust ELV of 350mg/m^2/day.

Table 18: Dust monitoring results 2010

Location	28/04//10 – 27/05/10	27/08/10 – 28/09/10	16/11/10 – 16/12/10
	mg/m^2/day		
D1A	288.3	1763.6*	132.1
D2A	171.9	77.9	45.9
D3A	116.4	268.0*	97.6
D4A	637.5	24.4	80.4
D5A	299.4	87.7	23.0
D6A	360.4	39.0	11.5
Average	**312.32**	**376.8**	**65.08**

* - Jar contaminated with organic matter.

8.3 Groundwater Monitoring

8.3.1 Groundwater monitoring locations

Groundwater monitoring was conducted at twelve locations during 2010 in accordance with Schedule C.3 of the current licence. Co-ordinates for all monitoring locations are detailed in Table 19 with locations illustrated on Drawing KTK/602, Rev B1, Appendix A.

Table 19: Groundwater Monitoring Locations

Media	Location	Eastings	Northings
Groundwater	BH11d	286157	211305
	97-4d	285441	211146
	97-5d	285534	211075
	97-6d	285612	211019
	97-7d	285916	210979
	KTK-10	285787	211045
	KTK-11	285518	211116
	KTK-15d	285884	211394
	KTK-16	285728	211444
	KTK-19	285819	210997
	KTK-20	285665	211078
	KTK-21	286065	210999

8.3.2 Groundwater levels

Groundwater levels were monitored on a monthly basis in accordance with Schedule C of Waste Licence Register No. W0081-03. The results of water level monitoring were furnished to the Agency in the subsequent quarterly reports (Quarter 1 to Quarter 4, 2010).

8.3.2.1 Groundwater level measurement methodology

Groundwater levels were measured using a standard dip-meter probe, which upon contact with water emits an audible signal. Measurements were made to the nearest centimetre relative to the top of the steel casing that protects each monitoring pipe.

8.3.2.2 Groundwater level measurements 2010

Figure 1, Figure 2 and Figure 3 illustrate the annual water level data recorded from groundwater monitoring wells up-gradient and down-gradient of the facility during 2010. The groundwater flows in a south-westerly direction. The readings for July 2010 are estimated because the groundwater levels were mislaid by Golder Associates as stated in the Quarter 3 2010 report. During Quarter 3, no groundwater levels were recorded at boreholes KTK-20 in August or at borehole KTK-15d in September as both wells were found to be dry on the days in question. During Quarter 4, an unusually high reading was recorded at KTK-20 in November. This reading may be an error as it is unlikely that the water levels in this well would rise and fall to such an extent when water levels in surrounding well did not show a similar change.

Figure 1: Static Groundwater Levels at KTK Landfill January - December 2010

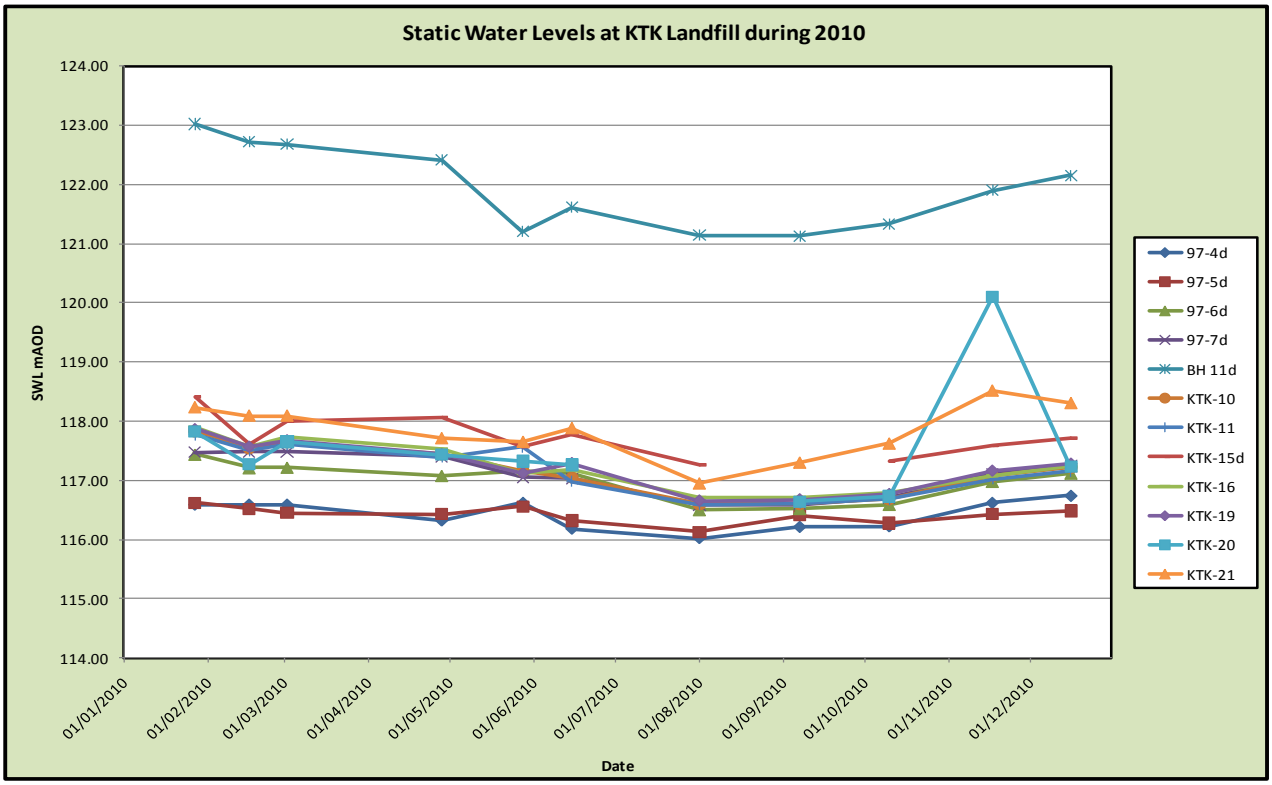


Figure 2: Static Groundwater Levels in Up-Gradient monitoring wells at KTK Landfill during 2010

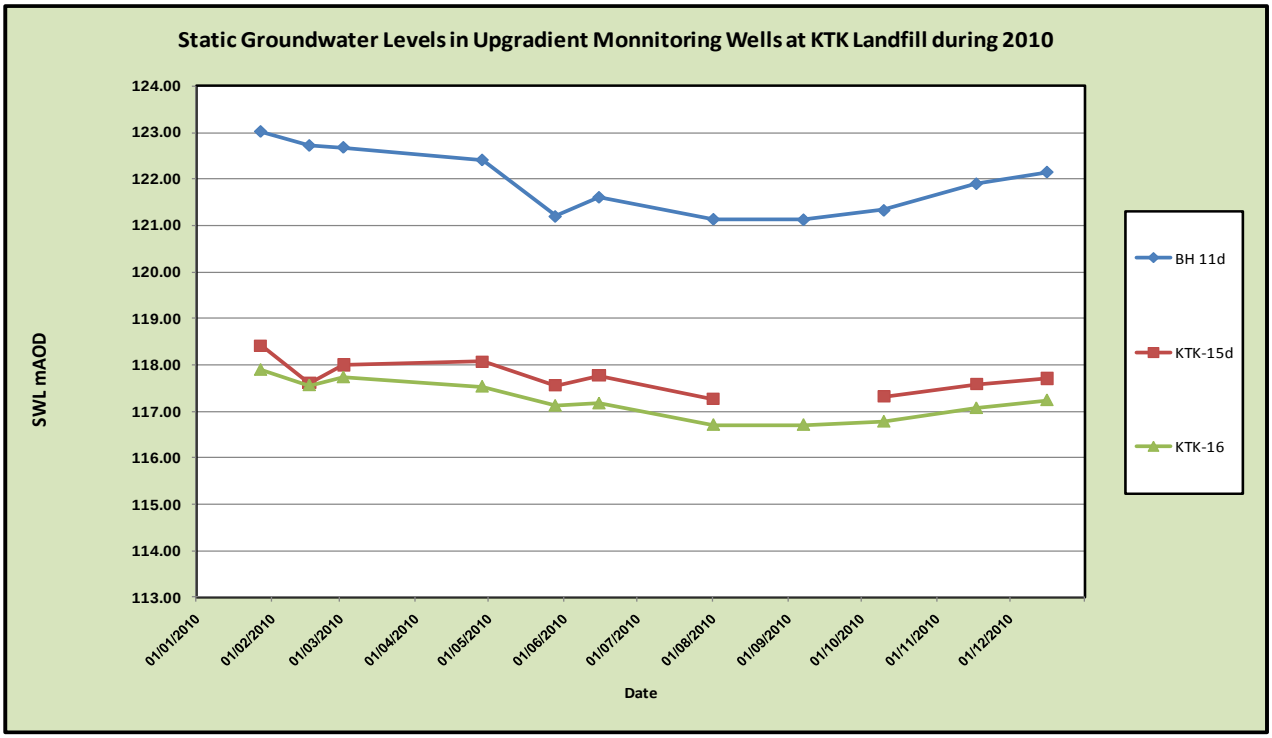
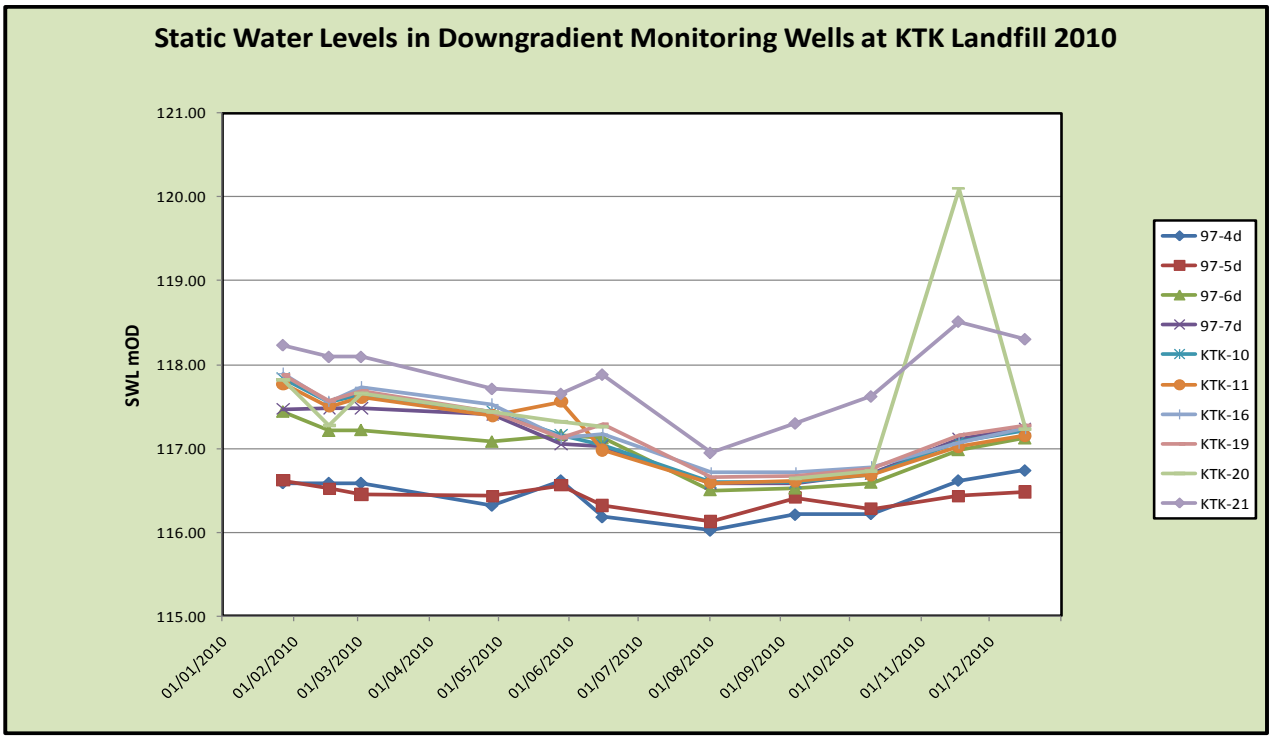


Figure 3: Static Groundwater Level in Down-Gradient monitoring wells at KTK Landfill during 2010



8.3.2.3 Methods for determining groundwater quality

Groundwater samples were collected by purging a minimum 3 borehole volumes prior to sample collection. This allowed stagnant water to be removed and representative groundwater to be drawn into the hole. Dedicated sampling equipment was used to prevent cross contamination between sampling locations. Field measurements of temperature, pH and conductivity were recorded. Samples were decanted into laboratory designated containers and stored in cooler boxes to maintain sample temperature at approximately 4°C. All samples were submitted to the laboratory within 24 hours of sampling.

8.3.2.4 Groundwater quality results 2010

Groundwater quality monitoring is carried out at KTK Landfill on a quarterly basis with annual parameters analysed during one of these quarters. Groundwater quality has been monitored at twelve locations during 2010 in accordance with Schedule C.3 of the current licence. The results of all quarterly monitoring have been presented to the Agency in reports Quarter 1 to Quarter 4 of 2010.

A summary of concentrations from a number of indicator parameters up-gradient and down-gradient of the facility recorded during the reporting period are presented in Figure 4 to Figure 11. Monitoring well KTK-15d has no results from Quarter 1 as the well was blocked, and again in Quarter 3 as the well was dry.

It can be seen that up-gradient monitoring locations KTK-16 and BH11d continue to be impacted from the groundwater contamination plume from the adjacent, partially lined, Silliot Hill landfill. Both KTK-16 and BH11d are deep wells (30 m and 44 m bgl respectively) with screens located in medium to coarse sand.

Elevated levels have also been detected at monitoring location KTK-11, which is down gradient of both KTK landfill, KTK-16 and Silliot Hill. This is also a deep well screened in coarse sands and gravels at a depth of 5m below that of KTK-16. These levels for KTK-11 and KTK-16 can be seen in Figures 4 to 11.

Figure 4: pH levels detected in up-gradient groundwater monitoring wells at KTK Landfill during 2010

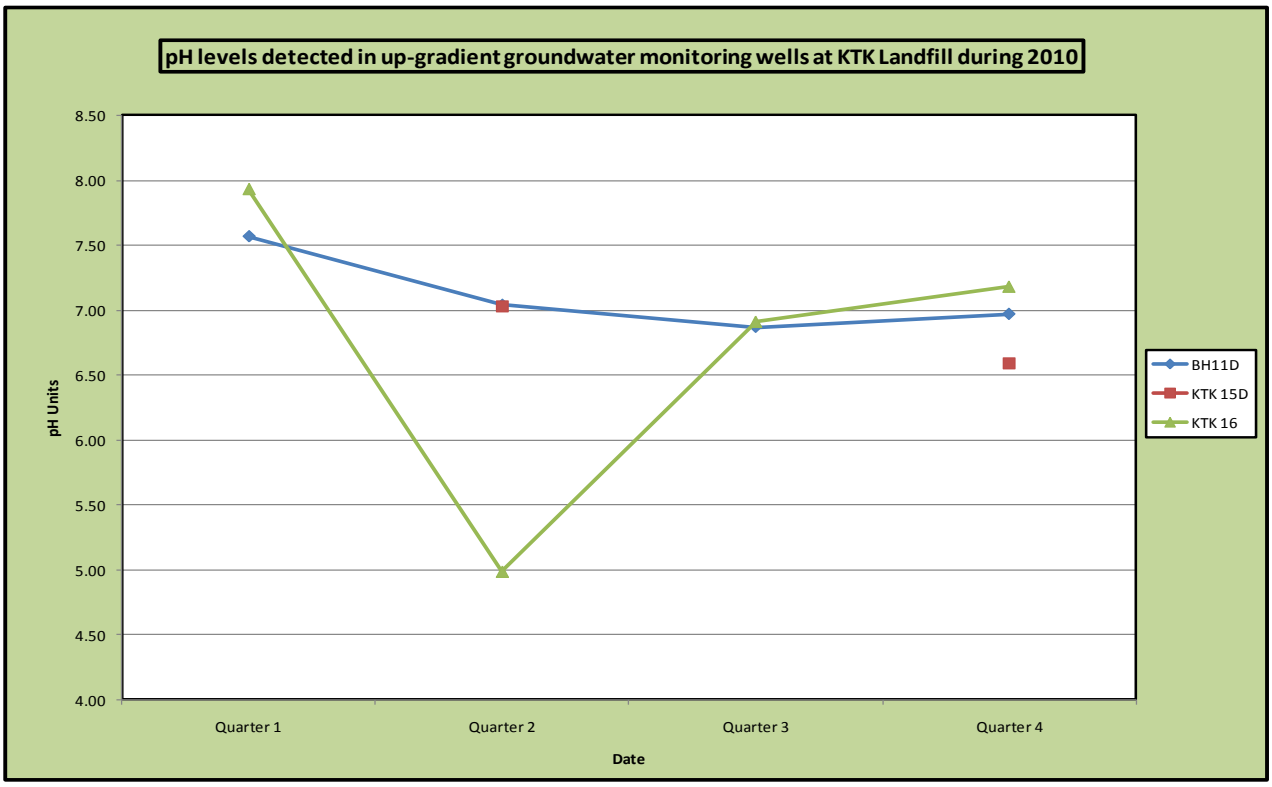


Figure 5: Electrical Conductivity levels detected in up-gradient groundwater monitoring wells KTK Landfill during 2010

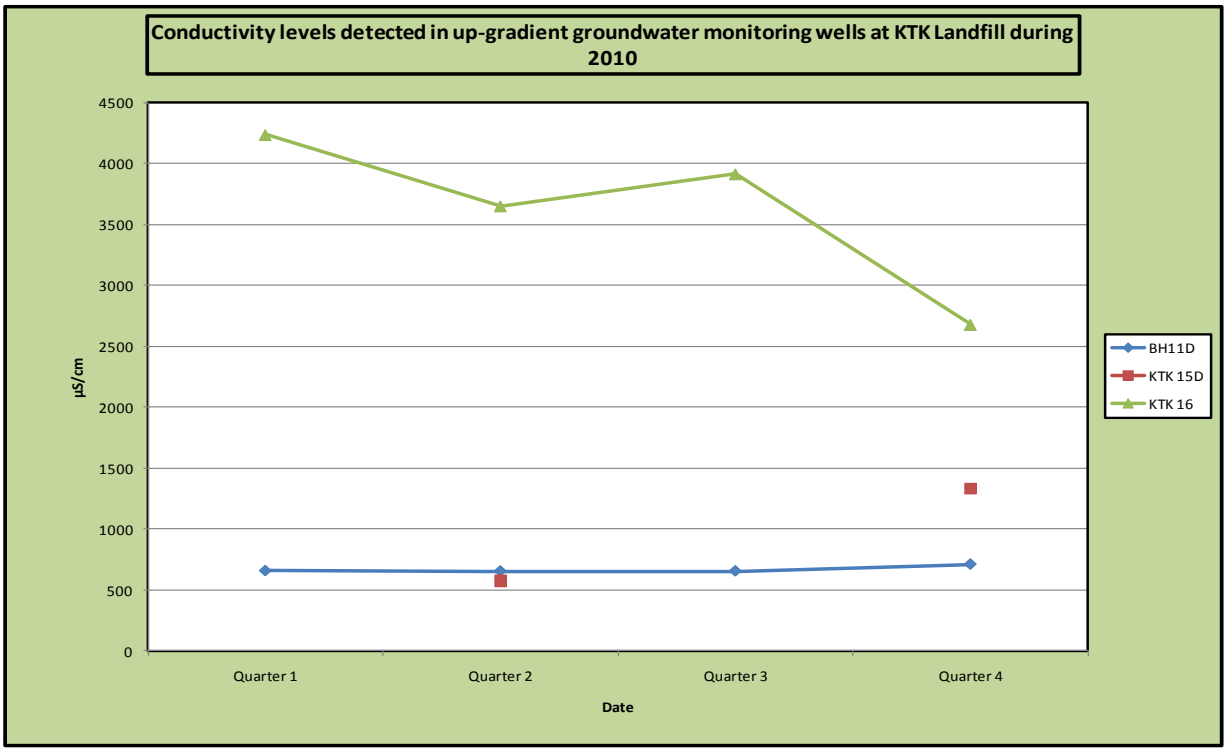


Figure 6: pH levels detected in down-gradient groundwater monitoring wells at KTK Landfill during 2010

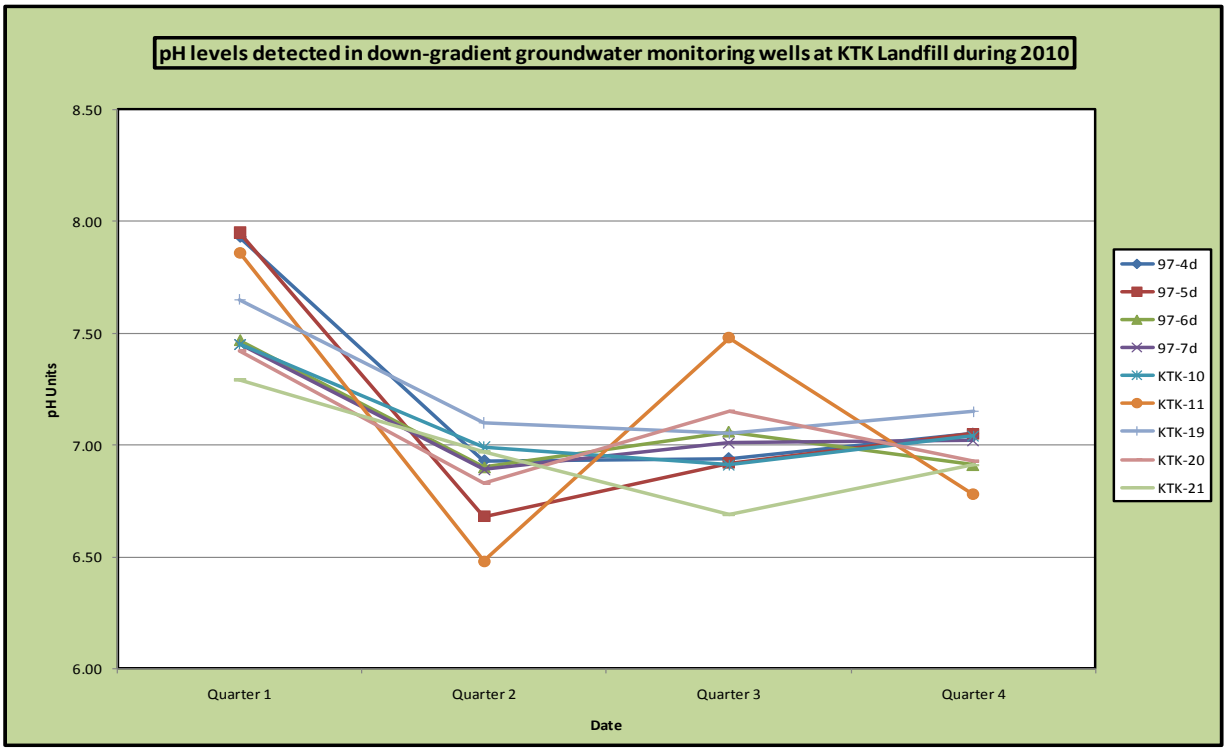


Figure 7: Electrical Conductivity levels detected in down-gradient groundwater monitoring wells at KTK Landfill during 2010.

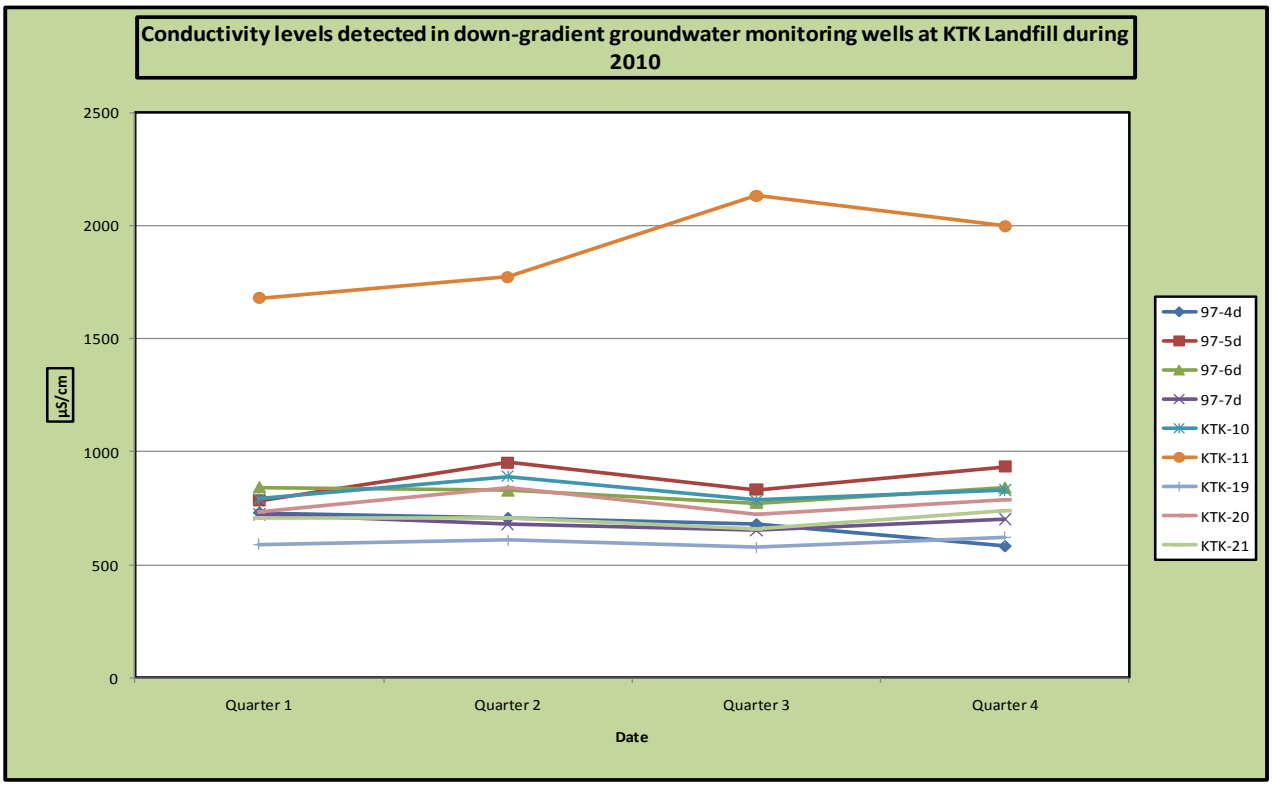


Figure 8: Chloride Levels detected in up-gradient groundwater monitoring wells at KTK Landfill during 2010

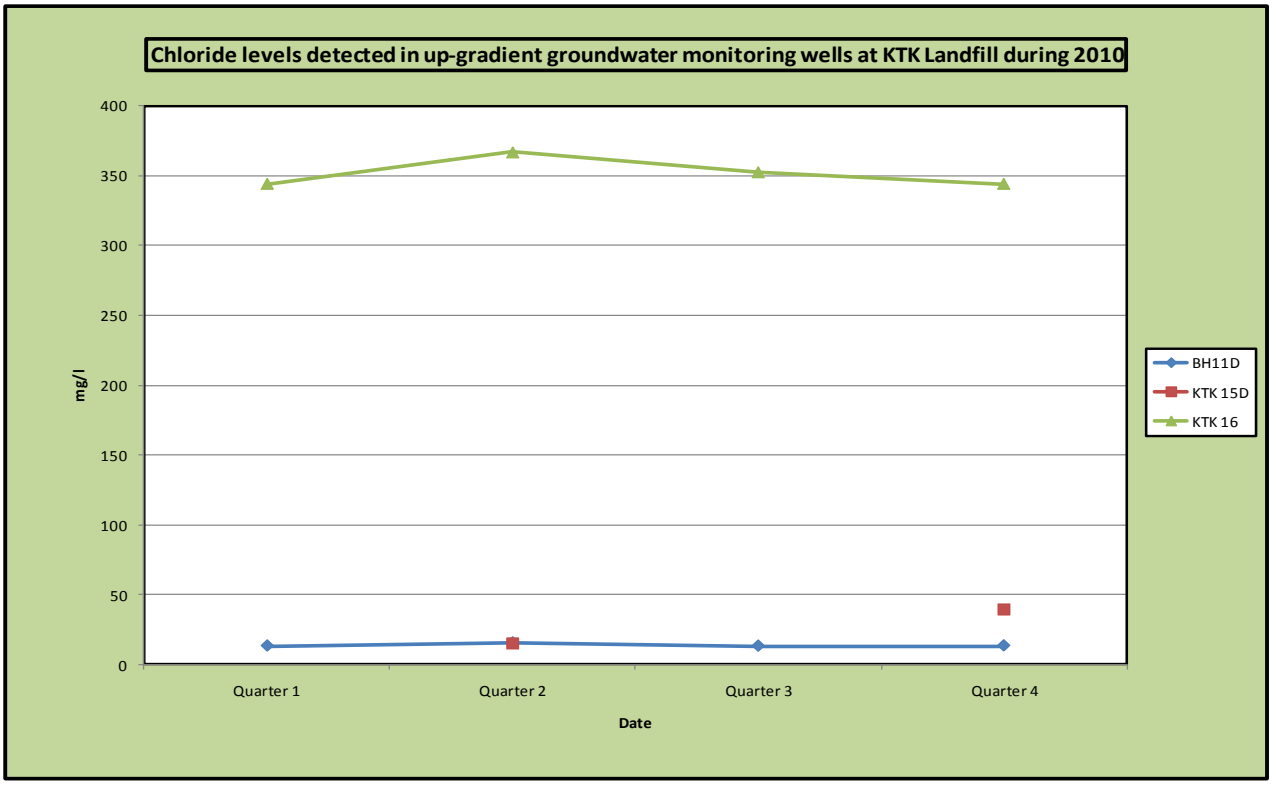


Figure 9: Chloride levels detected in down-gradient groundwater monitoring wells at KTK Landfill during2010

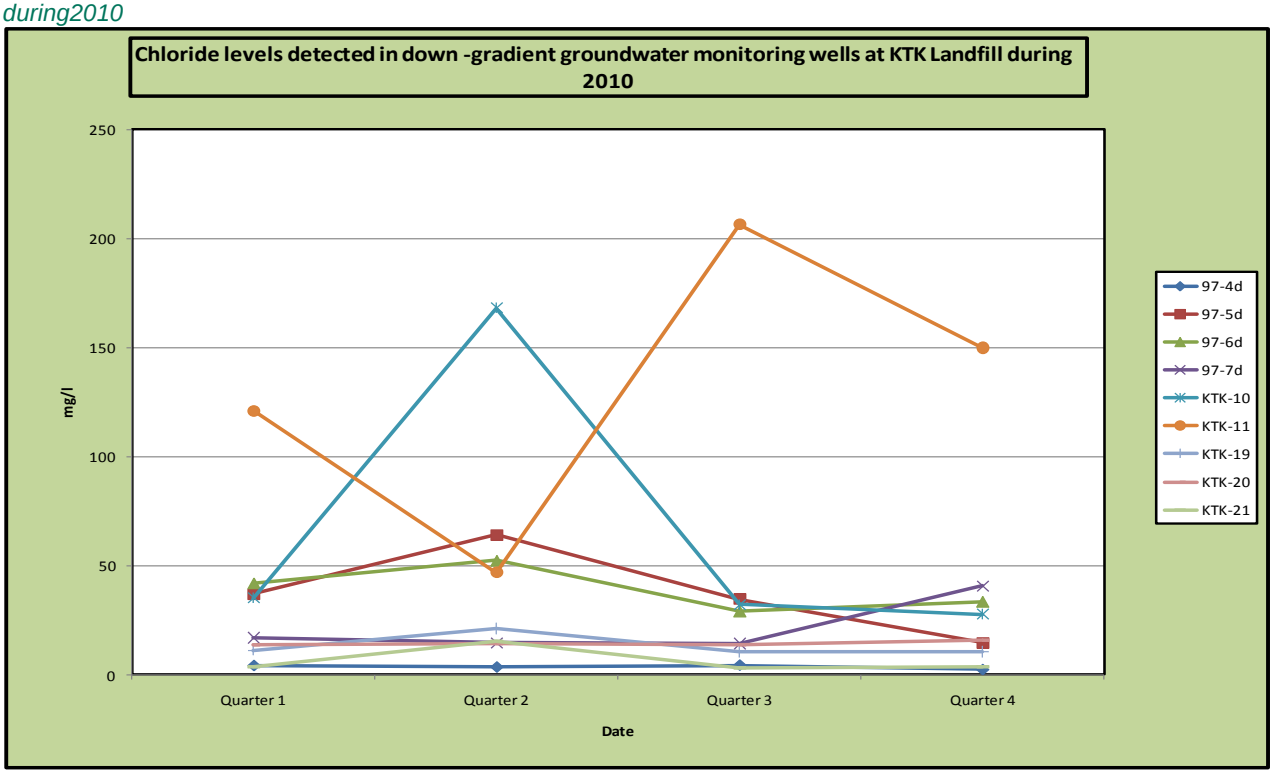


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Figure 10: Sulphate levels detected in up-gradient groundwater monitoring wells at KTK Landfill during 2010

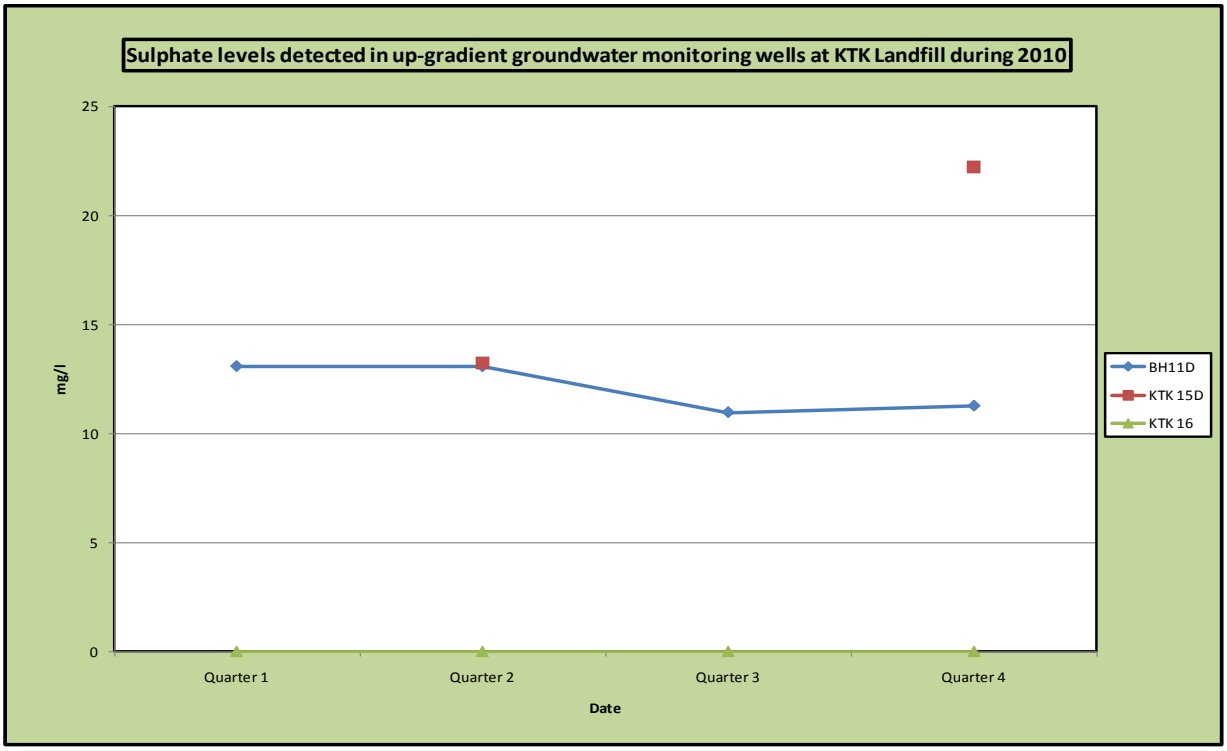
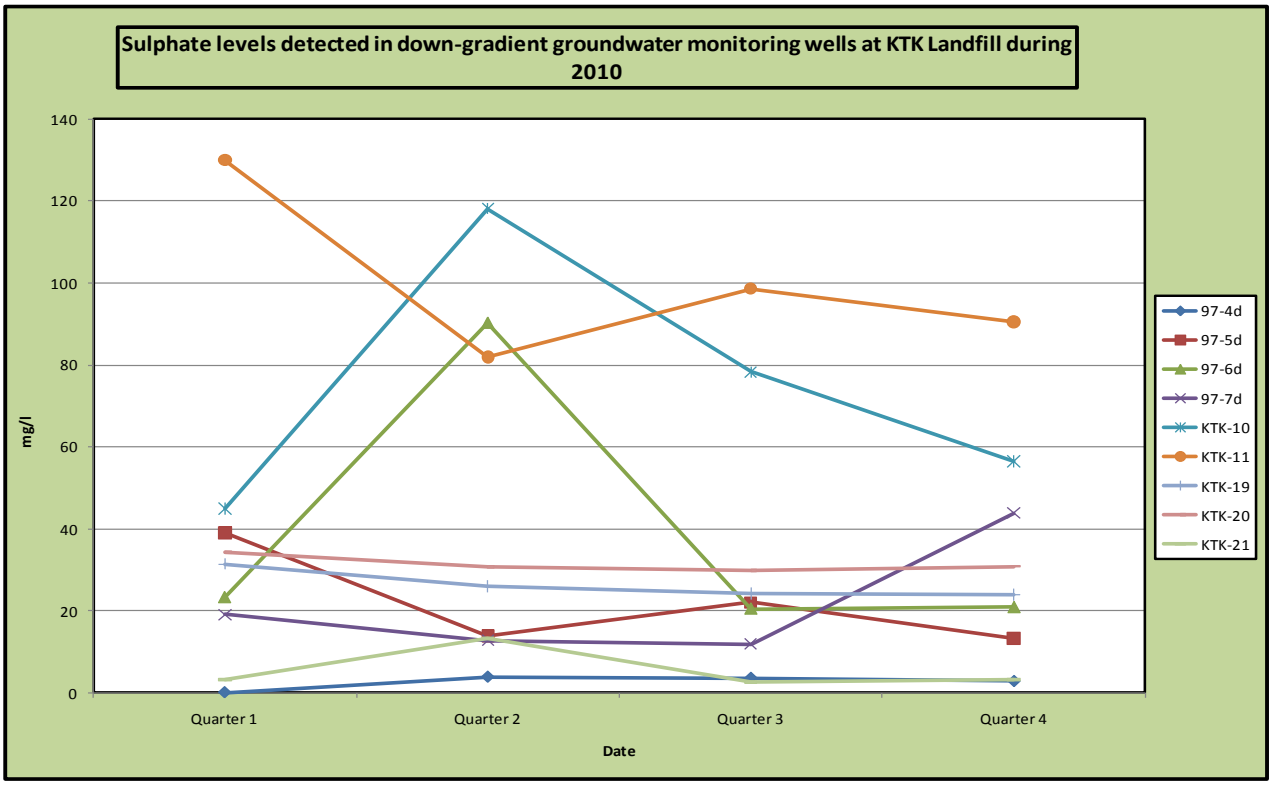


Figure 11: Sulphate levels detected in down-gradient groundwater monitoring wells at KTK Landfill during 2010.



8.4 Private Wells Monitoring

In accordance with Condition 6.10 the current licence, Private Well monitoring was conducted at two locations (DW8 and DW10) on 9 February 2010. The locations of these private wells are illustrated on Drawing KTK/602, Rev B1, Appendix A. The results were issued by letter to the private well landowners, and the results are presented in Appendix C.

8.5 Landfill Gas Monitoring

Gas Monitoring was conducted at the facility in accordance with Table C.1.3 of Schedule C of the current waste licence (W0081-03). Co-ordinates for all monitoring locations are detailed in Table 20 with locations illustrated on Drawing KTK/602, Rev B1 (Appendix A).

8.5.1 Landfill gas monitoring locations

Monthly gas monitoring was conducted at 15 no. gas monitoring wells. The general site offices are monitoring on a continuous basis via a fixed monitoring system. Details of gas monitoring from the mobile monthly monitoring and continuous fixed systems are discussed below.

Table 20: Landfill Gas Monitoring Locations at KTK Landfill

Media		Location	Eastings	Northings
Landfill Gas	Landfill Gas Monitoring Boreholes	G1	285726	211444
		G2	285695	211452
		G3	285653	211437
		G4	285623	211382
		G5	285591	211330
		G6	285565	211279
		G7	285537	211214
		G8	286116	211093
		G9	286135	211239
		G10	285894	211395
		G11	286160	211305
		G14	285513	211146
		G15	285600	211093
		G16	285720	211060
	Catch Pits	CP1	285623	211158
		CP2	285662	211133
		CP3	285729	211103

8.5.2 Landfill gas monitoring methodologies

Landfill gas measurements were undertaken using a GA2000 Landfill Gas Analyser. The gas is analysed for its content by % volume of the following constituents:

- Methane CH_4
- Carbon Dioxide CO_2
- Oxygen O_2

The LEL (lower explosive limit of methane), atmospheric pressure (millibars) and temperature (°C) were also recorded by the GA2000 Landfill Gas Analyser. Each gas monitoring location was sampled for 1 minute and the results were then recorded.

8.5.3 Site buildings

The main site offices are monitored on a continuous basis by two fixed monitoring systems (GMI Landsurveyor II and Monicon MC4000). Gas monitoring results from the fixed systems have been submitted to the Agency in Quarterly Reports 1 to 4 of 2010.

8.5.4 Landfill gas monitoring results

Gas monitoring results were forwarded to the Agency on a quarterly basis during 2010. A summary of carbon dioxide (CO_2) and methane (CH_4) monitoring results for 2010 is presented in Figure 12 and 13 respectively. The trigger level breaches were reported to the Agency as category 3 non-urgent incidents as they occurred.

Moreover, in response to a recommendation by the inspector following an Agency audit on 23 November 2004, a full report on the assessment of landfill gas migration in the vicinity of KTK Landfill and Silliot Hill Landfill was submitted to the Agency on 7 April 2005.

This assessment concluded that the most likely source of elevated landfill gas levels in monitoring wells located outside the body of waste at KTK Landfill are attributable to the historical uncontained landfilling operations at the adjacent Silliot Hill facility and are therefore not in any way connected with KTK Landfill. Full details of landfill gas trigger level breaches can be found in Table 39: Reported Incidents – 2010.

Historical monitoring at KTK Landfill has identified elevated gas levels at monitoring locations on the western and southern boundaries of the site, particularly at G2, G3, G4, G5 and G7. Significant works at Silliot Hill were carried out during 2009 which included the capping of that facility and the installation of large diameter gas extraction wells. Despite these works, elevated levels of CH_4 persisted into 2010 in the first quarter, reducing during the second and third quarters before spiking again in December 2010. The CO_2 levels followed a similar but more erratic pattern.

Figure 12: Graph showing Methane concentrations detected in boundary landfill gas monitoring wells at KTK Landfill during
2010

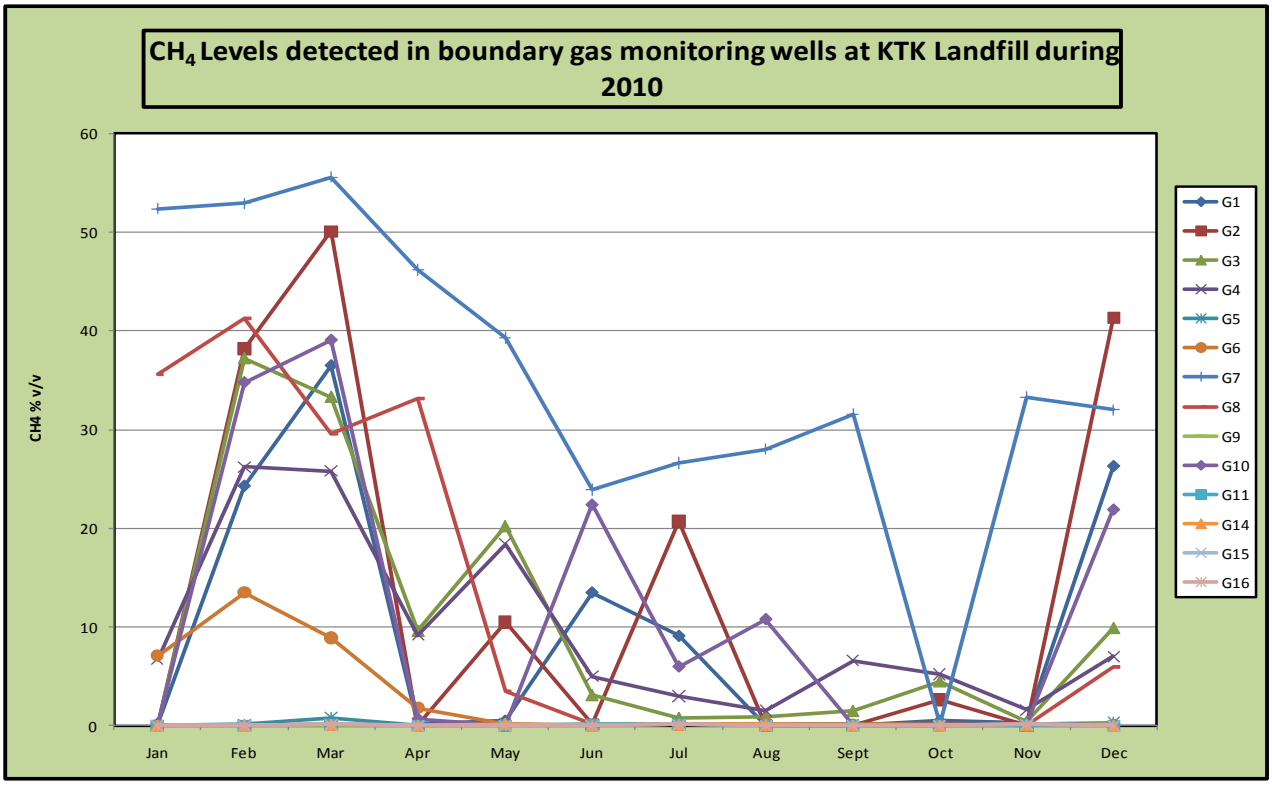


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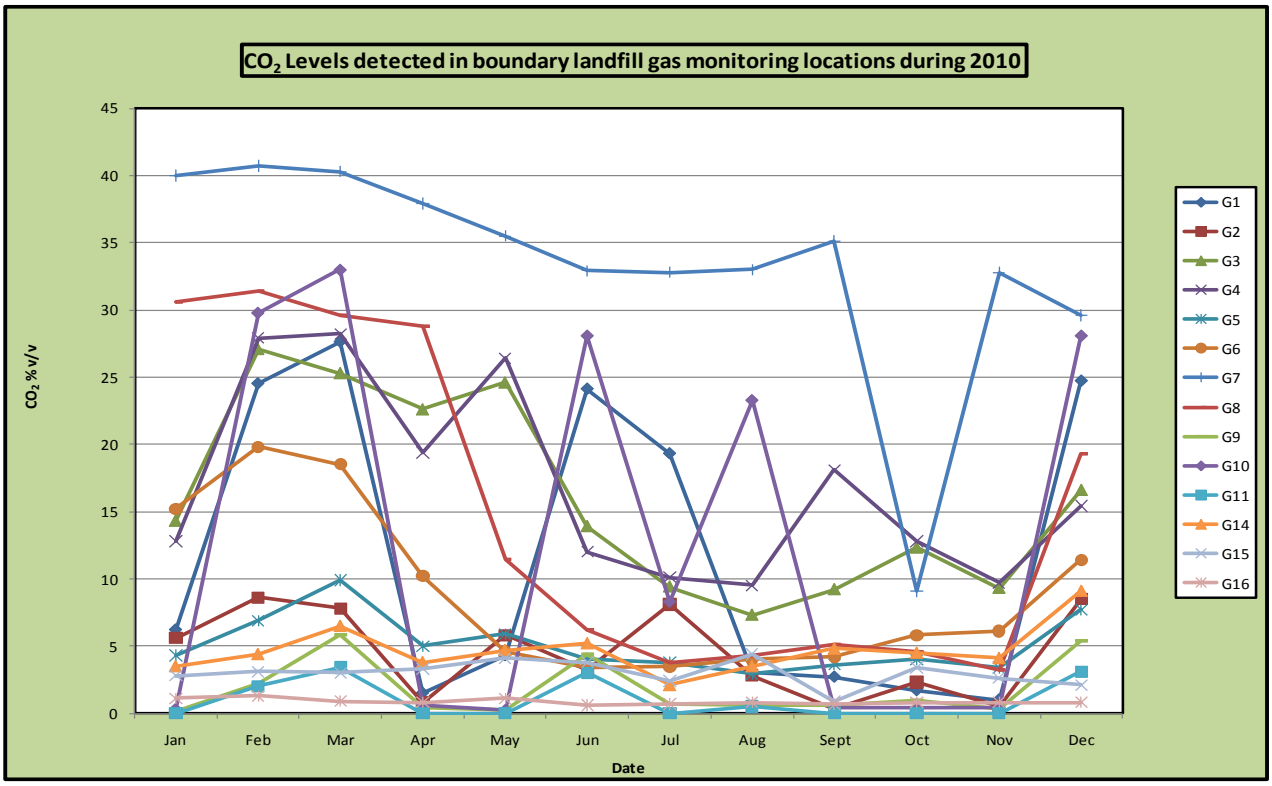
Figure 13: Carbon Dioxide concentrations detected in boundary landfill gas monitoring locations during 2010



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8.6 Leachate Monitoring

8.6.1 Leachate monitoring locations

In accordance with Condition 6.13.1, Condition 6.13.2 and as outlined in Table C2.1 of Schedule C of the Waste Licence Register No. W0081-03, leachate composition and level monitoring are conducted at locations detailed in Table 21 below.

Table 21: Leachate Level and Sampling locations at KTK Landfill

Media	Location	Eastings	Northings
Leachate Sampling Locations	LP1	285761	211123
	LP3	285783	211092
	LP6	285805	211086
	LP7	285881	211163
Leachate Levels	VWP1	285724	211113
	VWP2	285767	211144
	VWP3	285751	211149
	VWP4	285746	211195
	VWP5	285760	211244
	VWP6	285799	211140
	VWP7	285881	211163
	VWP8	285990	211081

8.6.2 Leachate levels

8.6.2.1 Methods for measuring leachate levels

Leachate levels have been recorded using the data collection method known as DataTaker. The leachate data acquisition system employs one data logger and three pressure sensors. The pressure sensors measure the pressure of the leachate in three locations, Sump 1 (Phase 1 & 2), Sump 3 (Phase 3, 4 & 5) and Sump 6 (Phase 6). The DataTaker is a data logger, which takes measurements of a number of fundamental parameters from the pressure sensors, such as voltage, current, resistance and frequency; readings are taken every 20 minutes. It then converts the pressure readings into meaningful quantities such as metres depth of leachate. Data recorded from the data logger is downloaded to a USB stick.

8.6.2.2 Leachate level results during 2010

Leachate levels have been reported to the Agency in each of the monitoring reports from Quarter 1 to Quarter 4 of 2010. A summary of sump 1, sump 3 and sump 6 leachate levels recorded during 2010 is presented in Table 22 below. It is noted that the data presented in Table 22 represents the leachate head over the base of the landfill. Results from leachate monitoring conducted at the facility during the reporting period have been reported to the Agency in the quarterly reports for Quarter 1 to Quarter 4 2010.

Table 22: Average Leachate Levels recorded at KTK Landfill during 2010

Date	Sump 1 (LP1) Average Level for Month (metres above liner)	Sump 3 (LP3) Average Level for Month (metres above liner)	Sump 6 (LP6) Average Level for Month (metres above liner)
January 2010	7.4	5.19	2.68
February 2010	2.03	2.23	0.79
March 2010	1.81	1.92	0.84
April 2010*	2.36	1.67	0.80
May 2010*	1.14	1.45	2.92
June 2010*	1.01	1.07	0.34
July 2010*	0.91	1.19	0.19
August 2010*	1.02	1.27	0.16
September 2010*	0.88	1.00	0.16
October 2010*	0.90	0.96	0.15
November 2010*	1.13	1.56#	0.65
December 2010*	1.48	0.32$	0.38

*** = These are monthly averages taken from weekly readings.**

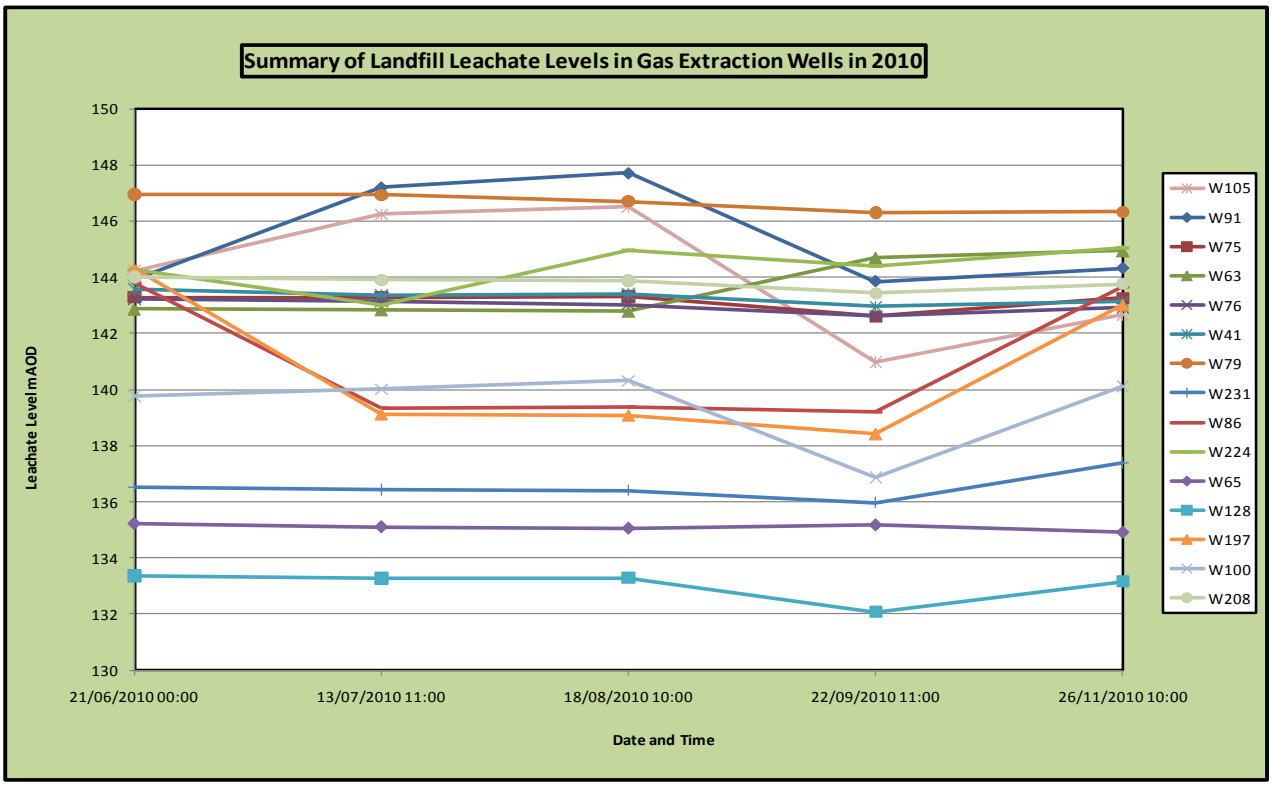
\# **= Error readings suspected at LP3 in November 2010**

$ **= Wire broken message at LP3 headworks 4/12/2010**

8.6.2.3 Leachate levels from gas extraction wells results during 2010

Leachate levels in gas extraction wells have been reported to the Agency in each of the monitoring reports from Quarter 2 to Quarter 4 of 2010. A summary of the results is shown below in Figure 14.

Figure 14: Summary of Landfill Leachate Levels in Gas Extraction Wells during 2010



8.6.3 Leachate composition and analysis

Monthly leachate monitoring includes sampling to be taken from three sumps (LP1, LP3, LP6) and leachate holding tank (LP7). Monthly monitoring of leachate quality in 2010 was conducted at LP1, LP3, LP6 and LP7. Leachate samples are analysed for parameters as stipulated in Table C 2.1 of Schedule C of Waste Licence Register No. W0081-03. All samples were filled directly into laboratory designated containers and transported to the laboratory. KTK staff also carried out analysis of selected parameters at the Reverse Osmosis Plants each quarter. KTK staff also monitored the leachate levels each week. These results were included in the Quarterly reports.

8.6.3.1 Leachate analysis results

Results from leachate monitoring conducted at the facility during the reporting period have been presented to the Agency in each of the quarterly reports. Summary tables for selected parameters are presented below in **Table 23**- Table 25.

Table 23: Summary Table of Parameters recorded at Leachate Location LP1 during 2010

Parameter	Feb	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
BOD	364	543	241	296	279	287	317	288	175	284
COD	4120	4560	4520	4700	4610	4350	4470	4740	5110	4540
Chloride	1896	1879	1498	1845	1859	1580	1260	1944	2294	84
NH_4-N	1419	1785	1686	1111	1590	1411	1095	1948	1882	1956

Table 24: Summary Table of Parameters recorded at Leachate Location LP3 during 2010

Parameter	Feb	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
BOD	259	238	297	209	165	262	283	165	182	162
COD	3290	3820	3610	3990	4130	4790	4130	4060	4750	3100
Chloride	1580	1577	1039	1465	1585	1430	1333	1618	1965	75
NH_4-N	1250	1598	1246	895	1516	1340	1219	1784	1824	1977

Table 25: Summary Table of Parameters recorded at Leachate Location LP6 during 2010

Parameter	Feb	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
BOD	338	453	293	378	296	451	286	293	114	194
COD	4020	3710	4660	7660	4420	4520	4410	3740	1119	4240
Chloride	1926	1575	1784	2190	1704	1646	1620	1580	617	70
NH_4-N	1415	1376	1872	2135	1458	1264	1367	1701	692	1593

Table 26: Summary Table of Parameters recorded at Leachate Location LP7 during 2010

Parameter	Feb	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
BOD	375	310	232	310	226	374	258	264	157	203
COD	3650	4150	4350	4880	4290	4640	4230	4100	3145	3300
Chloride	1312	1316	1912	1026	1360	1336	1064	1798	1174	1611
NH_4-N	1721	1404	1723	1632	1573	1585	1199	1685	1450	1508

8.7 Environmental Noise Monitoring

8.7.1 Environmental noise monitoring locations

Annual noise monitoring was conducted at the facility on 21 May 2010 in accordance with Condition 6.11.1 and Schedule B.4 of Waste Licence Register No. W0081-03. Monitoring was conducted at six locations on the site; N1, N2, N3, N4, N5 and N6 and at four Noise Sensitive Locations; N8, N12, N14 and N16 as detailed in Table 27 The locations of all noise monitoring stations are detailed on Drawing KTK/602, Rev B1

(Appendix A). The results and interpretations of the monitoring exercise were reported in the Quarter 2 environmental reporting submission to the EPA.

Table 27: Environmental Noise Monitoring Locations including Noise Sensitive Locations in and around KTK Residual Landfill.

Media	Location	Eastings	Northings
Noise Monitoring	N1A	285661	211438
	N2A	285878	211396
	N3A	286123	211106
	N4A	286029	210959
	N5A	285618	211022
	N6A	285550	211230
	N8A	285461	211459
	N12A	285710	210641
	N14A	286258	210888
	N16A	286389	211154

8.7.2 Environmental noise monitoring locations

A Cirrus CR:831A sound level meter was used to take the noise measurements at the facility. This instrument is a Type 1 data logging integrated sound level meter and is in accordance with the requirements of IEC Publication 651. The meter is calibrated annually.

However, prior to monitoring at each location a field calibration is carried out, to calibrate the meter at 97.3 dB, using the Cirrus CR:513A acoustic calibrator. This calibrating instrument was also calibrated in November 2009.

Prior to each measurement the instrument was mounted on a tripod at approximately 1.4 – 1.5 metres above ground level and 3.5 m away from any sound reflecting objects as specified in ISO 1996: Acoustics – Description and Measurement of Environmental Noise (Part 1). The Time Weighting used was 'fast' and the Frequency Weighting was 'A' weighted.

In addition, a wind shield was used to reduce potential wind interference during measurements. The wind speed at each location during the monitoring period was less than 5 m/s as required in ISO 1996: Acoustics – Description and Measurement of Environmental Noise (Part 2).

Cognisance was given to the following documents during preparation for the noise survey and writing of this report:

- Environmental Noise Survey Guidance Document, 2nd Edition. EPA 2006;
- Integrated Pollution Control Licensing – Guidance Note for Noise in Relation to Scheduled Activities, EPA 1995;
- Landfill Manuals – Landfill Monitoring, 2nd Edition, EPA 2003;
- ISO 1996-1:2003 Acoustics Description, Measurement and Assessment of Environmental Noise – Part 1: Basic quantities and assessment procedures; and
- ISO 1996-2: 2007 Acoustics – Description and Measurement and Assessment of Environmental Noise – Part 2: Determination of environmental noise levels.

The following parameters were measured at the nine monitoring locations in compliance with Schedule 6.1.1 and Table B.4 of waste licence W0081-03.

- **LAeq**, 30 min - the equivalent continuous noise level in dB(A) over a specified measurement interval i.e. 30 minutes;
- **LA10**, 30 min - the noise level in dB(A) equalled or exceeded for 10% of the measurement interval i.e. 30 minutes;
- **LA90**, 30 min – the noise level in dB(A) equalled or exceeded for 90% of the measurement interval i.e. 30 minutes; and
- Frequency Analysis i.e. 1/3 octave band analysis.

8.7.3 Environmental noise monitoring survey results

The results of noise monitoring conducted at the KTK Landfill facility in May 2010 are presented in Table 28 below. Interpretation of these results were included as part of the Quarter 2 2010 environmental monitoring report submitted to the Agency. The report concluded that elevated noise levels were attributed to traffic noise on adjacent public roads plant movements within the site.

Table 28: Environmental Noise Monitoring Results from a survey conducted in May 2010 at KTK Landfill

Location	Date & Time	Wind Speed m/s	LAeq dB(A)	LA10 dB(A)	LA90 dB(A)
N1A	21/05/10 14.57 hrs	1.2	68	63	49
N2A	21/05/10 12.08 hrs	1.2	53	52	49
N3A	21/05/10 12.48 hrs	1.0	50	48	40
N4A	21/05/10 13.29 hrs	2.0	45	48	38
N5A	21/05/10 16.30 hrs	1.6	48	62	38
N6A	21/05/10 14.10 hrs	1.8	60	65	39
N8	21/05/10 15.35 hrs	1.2	65	67	45
N12	21/05/10 10.23 hrs	1.4	61	58	39
N14	21/05/10 11.08 hrs	1.6	58	63	37
N16	21/05/10 09.28 hrs	2.0	55	53	39

8.8 Surface Water Monitoring

8.8.1 Surface water monitoring locations

Surface water monitoring was conducted at the facility in accordance with Schedule C.3 of Waste Licence Register No. W0081-03. Down-gradient surface water monitoring stations SW4, SW5, SW6 and SW7 are detailed in Table 29 with monitoring locations illustrated on Drawing KTK/602 Rev B1 (Appendix A).

Monitoring of surface water at the facility comprised weekly visual inspections and quarterly sampling and analyses, which are discussed in more detail below.

Table 29: Surface Water Monitoring Locations at KTK Landfill

Media	Location	Eastings	Northings
Surface Water	SW4	285512	211006
	SW5	285612	211014
	SW6	285664	211014
	SW7	285533	211140

8.8.2 Surface water quality sampling methodology and results 2010

Surface water monitoring was conducted on a quarterly basis at the four locations detailed in Table 29. Surface water sampling involved the submergence of the designated sample container into the surface water body. During submergence every effort is made to keep the container steady so as to prevent sediment disturbance.

Quarterly surface water samples were analysed for parameters stipulated in Table C.3 Storm Water/Surface Water Monitoring of Waste Licence Register No. W0081-03. Details and analyses of all surface water sampling were forwarded to the Agency in Quarterly reports 1 to 4 of 2010. During 2010, sampling was carried out by KTK Landfill Staff during Quarters 1, 2 and 3. Golders completed the sampling in Quarter 4 and included analysis for annual parameters as required by the Licence.

A summary of concentrations from a number of indicator parameters down-gradient of the facility recorded during the reporting period are presented in Figures 15 to 18. Dissolved oxygen readings were not taken during Quarter 1 of 2010 and so are not represented on the graph (Figure 18). Overall, the results for SW4, SW5 and SW6 during 2010 were below EPA EQS limits for surface waters, with some exceptions including iron, manganese and ammoniacal nitrogen. These sampling locations are located in boggy areas which can negatively impact results in dry periods, and iron and manganese are noted by the Agency are being naturally occurring in surface waters in Ireland. SW7 is the monitoring location at an oil water separator outlet for the surface water management system. This showed elevated parameters during 2010, however this surface water management system has been isolated with all water collected being pumped to a temporary storage lagoon in 2010, with the exception of two weeks between 29th Oct and 16th November, as detailed in the Quarter 4 2010 report.

Figure 15: pH Levels Detected in Surface Water Samples Retrieved from SW4 - SW7 during 2010

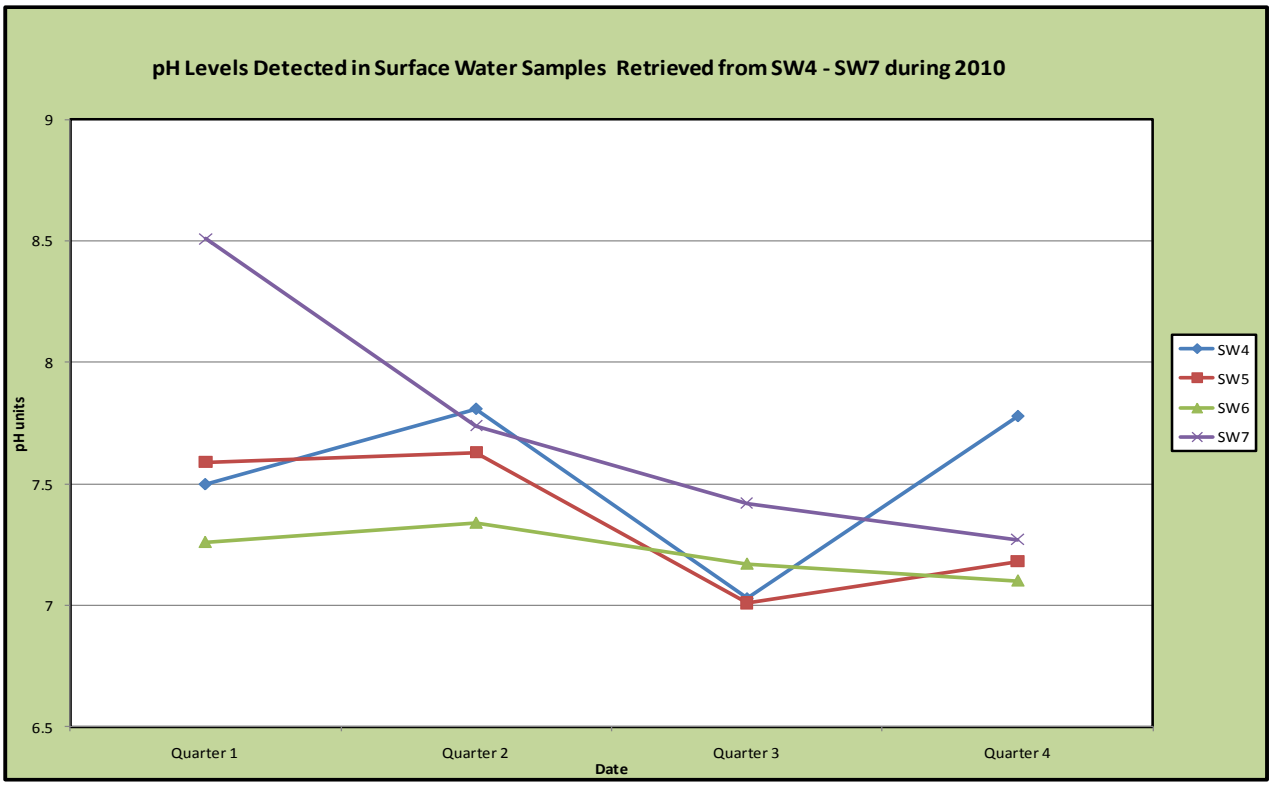


Figure 16: Electrical Conductivity Levels Detected in Surface Water Samples taken from locations at KTK Landfill during 2010

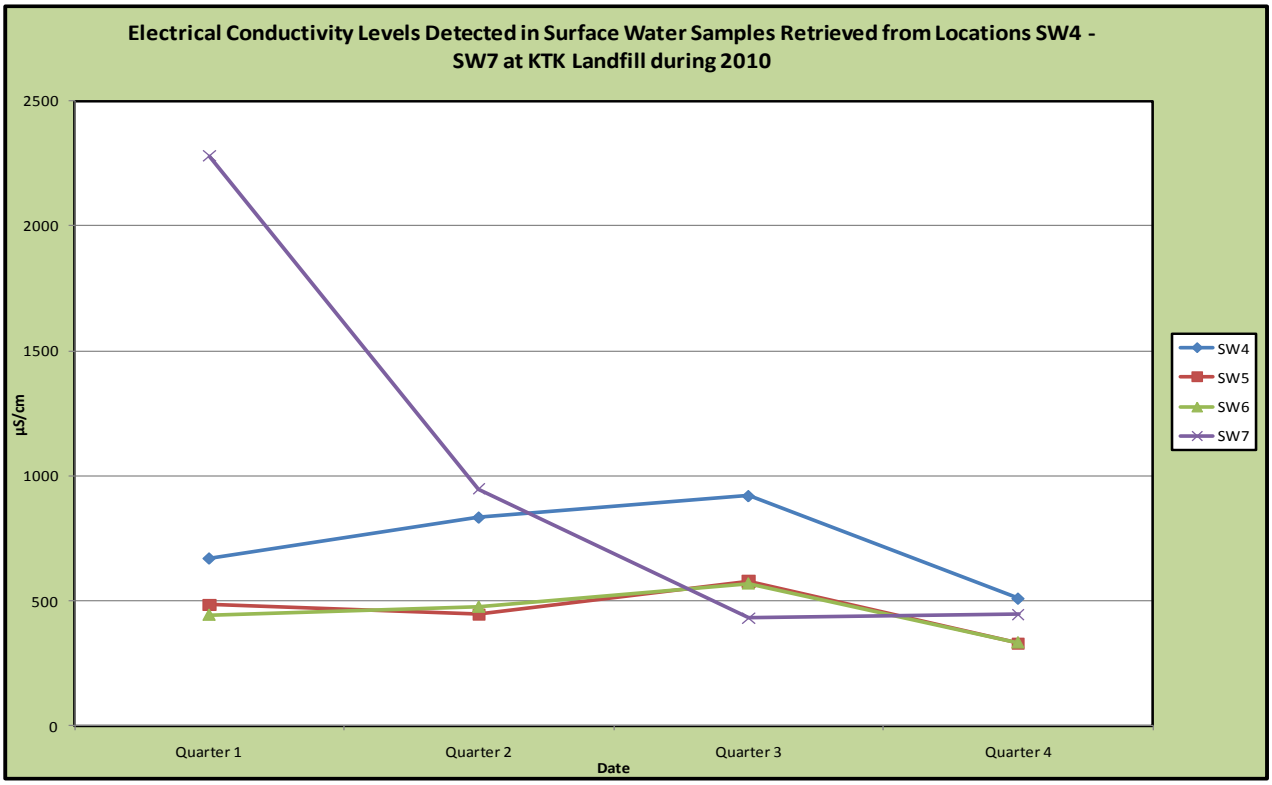


Figure 17: Chloride Levels Detected in Surface Water Samples Retrieved from Monitoring Locations SW4 - SW7 at KTK Landfill

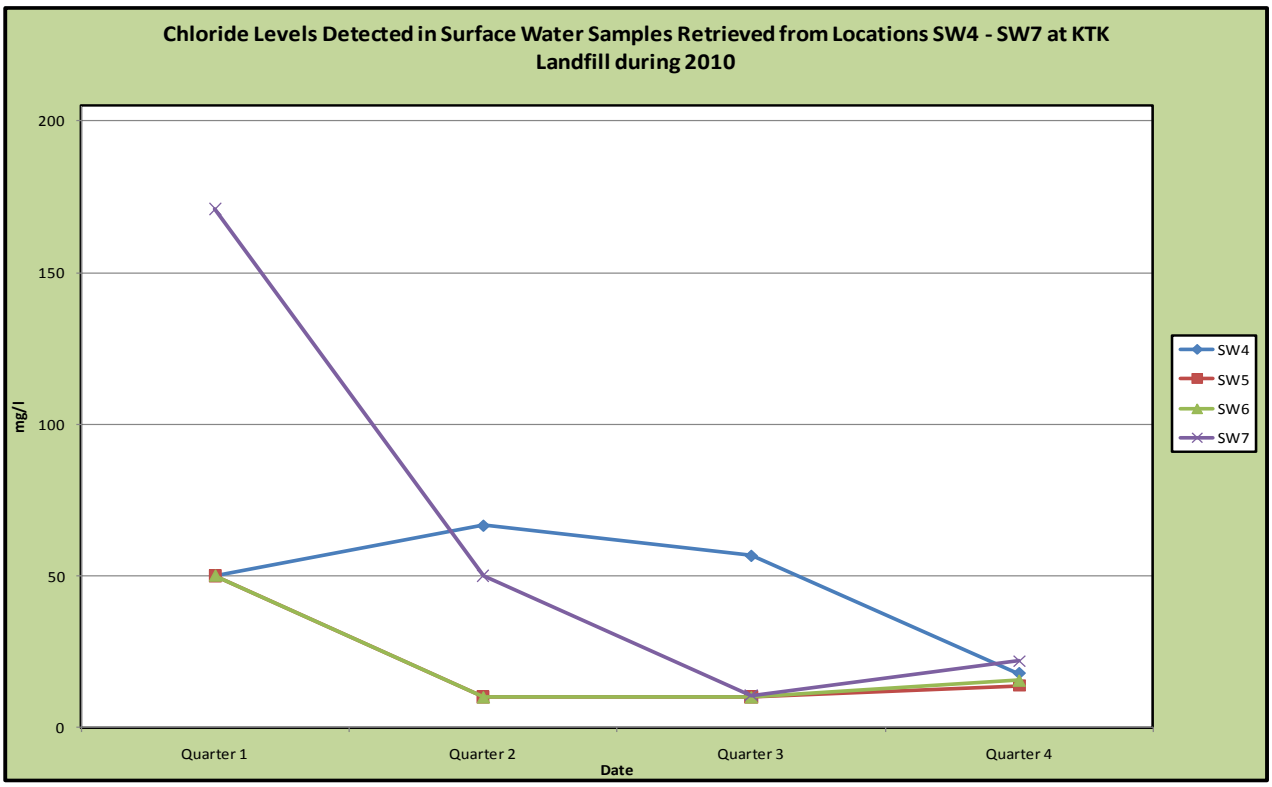
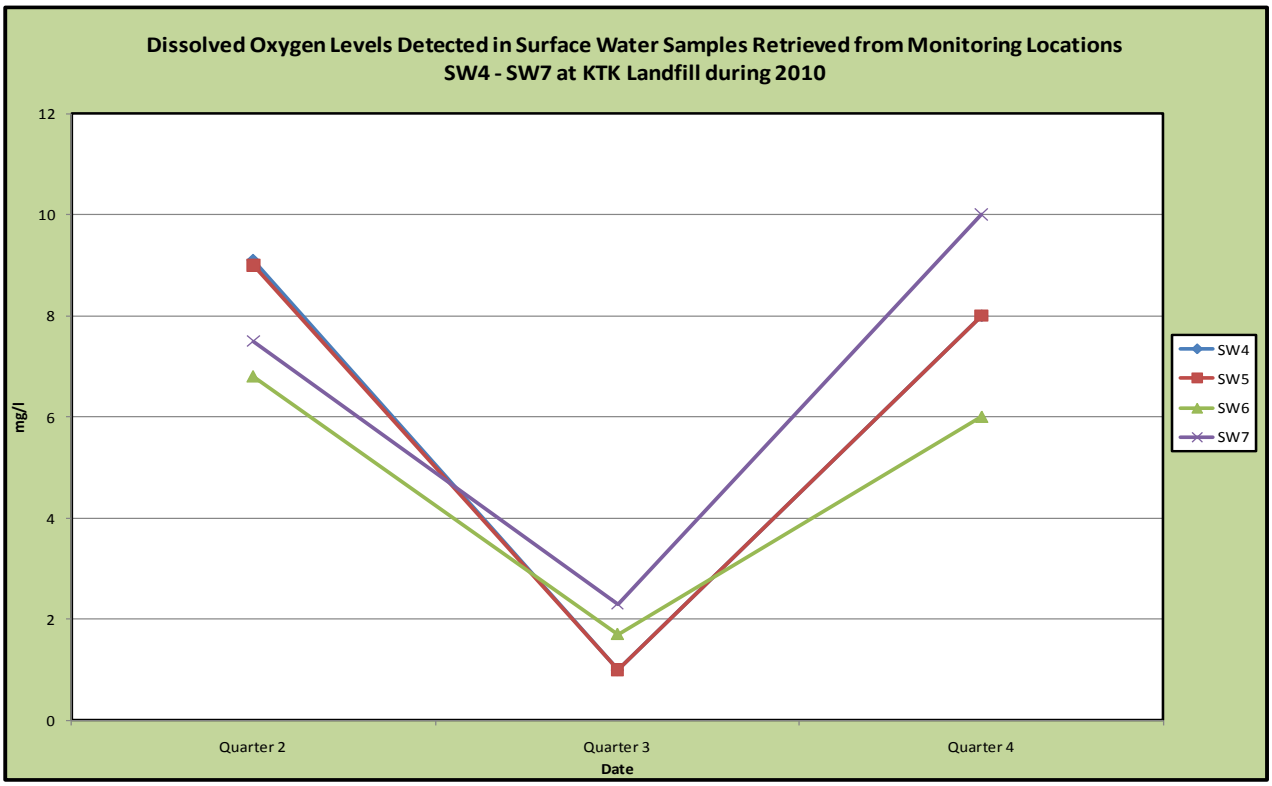


Figure 18 : Dissolved Oxygen Levels detected in Surface Water samples retrieved from Monitoring Locations SW4 - SW7 at KTK Landfill during 2010



8.8.3 Surface water visual inspections

A visual inspection of surface water was carried out towards the southern end of the landfill. Surface water visual inspections comprise four locations down-gradient of the landfill (SW4, SW5, SW6 and SW7).

The inspection entailed walking along the stream banks and checking for any signs of potential pollution such as littering, iridescence or odour. Details of all visual inspections have been furnished to the Agency in the subsequent quarterly reports.

8.9 Meteorological Reporting

Details of meteorological monitoring conducted at the facility during 2010 are outlined in Section 18: "Meteorological Report".

8.10 Asbestos Fibre Monitoring

Schedule C.3 Asbestos Fibre Monitoring of the Waste Licence W0081-03, for KTK Landfill, specifies that asbestos fibre monitoring be completed annually. The monitoring was carried out on 12 November 2010.

8.10.1 Methodology

Asbestos fibre monitoring was carried out on 12 November 2010. The monitoring was carried out by ACS Ltd. Five air tests were taken in accordance with U.K. Health and Safety Executive procedure HSG 248 (2005).

8.10.2 Results

The results of the asbestos monitoring for the reported period are in full compliance with licence conditions and no fibres were detected in any of the 5 no. samples. A summary of the validated results is presented in Table 30 below.

Table 30: Asbestos Fibre Monitoring Results

Filter ID	Slide Ref.	No. of Fibres Counted	Air Volume (Litres)	Fibre Conc. (Fibres/ml)
North East Corner	10/pb/568	0	480	<0.01
South East Corner	10/pb/569	0	480	<0.01
Middle at area 1205	10/pb/570	0	480	<0.01
South west corner	10/pb/571	0	480	<0.01
North west corner	10/pb/572	0	480	<0.01

9.0 RESOURCE AND ENERGY CONSUMPTION SUMMARY 2010: OCM REPORT 2010

The main resources consumed at the facility during the reporting period were electricity, water for potable supply, vehicle wheel cleaning and dust suppression, diesel fuel and hydraulic oils. The details are listed in Table 31.

Table 31: Usage of Energy and Resources during 2010 at KTK Landfill

Resource	Units	Consumption
Electricity	kWhr	1,055,620
Water, Potable Supply	Litres	61,552
Water, Dust suppression	Litres	1,400,000
Water, Wheel Cleaning Unit	Litres	2,279,600
Total Water (dust suppression, potable & wheel cleaning)	Litres	3,741,152
Diesel	Litres	151,114
Hydraulic Oils	Litres	2,902
Grease	kg	88
Imported Aggregates	Tonnes	5,529

Diesel, hydraulic oil and grease consumption has increased during 2010 due to increased capping activities. Water consumption was down on the 2009 figure due to the wet summer reducing the requirement for dust suppression and reduced traffic movements on site reducing wheel wash operations. The amount of imported aggregates was down on the 2009 figure.

Electricity consumption during 2010 was significantly increased above the 2009 figure by 60% due to the installation of a second leachate Reverse Osmosis treatment plant.

9.1 Resource Recovery and Energy Production Summary

KTK Landfill Ltd landfill gas utilisation plant exported 24,049,100 kWhr of electricity to the national grid during 2010. This is up 11.3% on 2009 exported energy of 21,598,500 kWhr.

The main materials recovered at the facility during the reporting period were woodchip and soils. The details are listed in Table 32 below.

Table 32: Material Recovery and Electricity Production during 2010

Resource	Units	Recovered
Electricity Produced	kWhr	24,049,100
Waste lubricating oil recovered from landfill gas utilisation engines	Litres	53,300
Woodchip recovered for roadway construction	Tonnes	1,831
Inert material recovered for internal engineering purposes (intermediate cover and Profiling for final capping	Tonnes	58,259
Soil and topsoil recovered for final capping (70,000m^3)	m^3	80,500

10.0 VOLUME OF LEACHATE TRANSPORTED / DISCHARGED OFF SITE.

Table 33: Volume of leachate transported or discharged off-site during 2010

Month	Volume (m^3)
Sewer Discharge	**34,110**
Tanking Offsite	**67,381.50**
Total removed from site	**101.491.5**

11.0 REPORT ON DEVELOPMENT WORKS UNDERTAKEN DURING THE REPORTING PERIOD, AND A TIMESCALE FOR THOSE PROPOSED DURING THE COMING YEAR.

11.1 Developments During 2010

The following development work was undertaken during 2010. The key works undertaken during the reporting period 1 January – 31 December 2010 are depicted in Table 34 below.

Table 34: Key works undertaken during 2010

Date	Event
January – December 2010	Placement of site regulating layer to form profile suitable for placement of final capping.
June 2010	Installation second Ro Plant treating 120m^3/day.
September 2010	Installed bulk storage tanks for Sulphuric and Caustic Soda used in the Reverse Osmosis Treatment process.
January - December 2010	Completed stage 1 final permanent capping. Total LDPE placed as of 31st December 2010 was 70,000m^2 of 160,000m^2 i.e. 42% of the total site covered. Restoration soils and topsoil were placed over the same area and seeding and grass establishment achieved by year end.

11.2 Proposed Development During 2011

It is the policy of KTK Landfill to continuously improve the infrastructure and operating standards of the facility where possible. To this end a number of significant improvements are proposed to be undertaken during 2011, subject (where appropriate) to the Agency's approval.

11.3 Landfill Leachate Management

Leachate treatment capacity by Reverse Osmosis and sewer discharge of treated effluent (permeate) of 150m^3/day to be maintained for 2011.

11.4 Restoration

KTK undertook significant restoration/final capping works in 2010 achieving 42% of final capping works completed. It's the intended to continue lining works on the site to its final completion in 2011. This will equate to application of an additional 92,000 m^2 of liner, placement of restoration subsoils and installation of final gas and leachate infrastructure network.

In addition KTK will supplement existing waste streams with Commercial and industrial wastes for a defined period to enable the filling of shallow areas on the site prior to final profiling to enable completion of capping works.

11.5 Landfill Gas Management and Utilisation

Landfill Gas Management at KTK Landfill comprises collection, flaring and utilisation of gas. It started in 2003 as a joint venture company between G.A.S Energietechnologie GmbH and Greenstar Ltd to form Greenstar Gas Energy. Its aims were to supply, operate and maintain a Landfill Gas Utilisation Plant at the KTK Landfill Ltd. Site. Bioverda then took over the running of the gas plant in January 2010. The electricity produced is sold to a private utility company at pre-agreed rates and the plant burns 1,950 m^3/hr of landfill gas at 50% methane and has a maximum electrical output of 3.6MW. Furthermore the site has a total operational flaring capacity of 4,000 m^3/hr and back up flaring capacity of 2,500 m^3/hr.

11.6 Monitoring Infrastructure

No changes to the monitoring infrastructure are planned for 2011.

12.0 SITE SURVEY SHOWING EXISTING LEVELS OF THE FACILITY AT THE END OF THE REPORTING PERIOD.

Please refer to Drawing KTK/602, Rev. B1 presented in Appendix A. The annual topographical survey was conducted at the site in January 2011.

13.0 ESTIMATED AND ANNUAL CUMULATIVE QUANTITIES OF LANDFILL GAS EMITTED FROM THE FACILITY.

It is estimated that approximately 22,087,508 m³ of landfill gas were extracted during 2010 for utilisation and flaring. Please refer to the summary in Table 35 overleaf. Full details are presented in Appendix D.

Table 35: Summary of Annual Quantities of Landfill Gas Collected for Utilisation and Flaring at KTK Landfill during 2010

Month	Total Quantity of LFG Collected	Quantity of CH_4 Collected	Quantity of CO_2 Collected	Gas Quality (% v/v) (Total figure is averaged)		
	(m^3)	(kg CH_4)	(kg CO_2)	CH_4	CO_2	O_2
January 2010	2,509,417	766,435	1,498,001	41.9	30.4	2.6
February 2010	2,091,173	645,441	1,284,282	42.6	32.6	1.3
March 2010	2,177,626	668,059	1,382,244	42.5	33.2	1.7
April 2010	2,051,129	636,073	1,322,902	42.1	32.8	1.9
May 2010	2,067,733	630,410	1,323,312	41.2	32.7	1.7
June 2010	1,837,700	584,248	1,201,867	40.5	32.6	1.6
July 2010	1,853,100	593,575	1,191,540	40.5	29.0	2.8
August 2010	1,557,600	533,607	1,050,196	47.8	34.4	1.8
September 2010	1,549,900	516,940	1,024,179	46.6	33.6	1.5
October 2010	1,599,400	538,744	1,050,211	46.3	34.6	1.8
November 2010	1,425,788	458,085	898,418	42.1	29.7	3.0
December 2010	1,366,942	448,206	852,804	43.3	30.1	3.1
Total Collected	**22,087,508**	**7,019,823**	**29,124,470**	**43.1**	**32.1**	**2.1**

14.0 ESTIMATED ANNUAL AND CUMULATIVE QUANTITY OF INDIRECT EMISSIONS TO GROUNDWATER.

The potential sources of indirect emissions into groundwater are:

Landfill Base

The landfill site has a composite base lining system comprising a HDPE geomembrane and one metre thick layer of compacted clay. A leak location survey of the HDPE geomembrane after placement of the drainage stone layer was completed and defects to the HDPE liner were repaired in accordance with industry standards.

Surface Water Collection & Treatment System

Surface water from the paved access road and service platform is collected and discharged into a surface water infiltration area. However, prior to final discharge into the ground, surface water is conveyed via a buried PVC sewer pipe to a concrete silt settlement tank and a Class 1 Klargester surface water bypass separator. The quality of the surface water discharge downstream of the separator is measured quarterly at the monitoring manhole identified as SW7.

Treated Sewage Effluent

There are two BioCycle waste water treatment units on the site which treat the canteen and office waste water prior to discharge into a percolation area. In summary as the landfill is fully contained there will be minimal to nil indirect emissions to ground water.

15.0 ANNUAL WATER BALANCE CALCULATION AND INTERPRETATION

The weather data, used for the purposes of the annual water balance calculations is derived from the weather station at KTK Landfill, Casement Aerodrome (Evapotranspiration and Evaporation). This data is depicted in the following Table 36.

Table 36: Climatological Data (mm) at KTK Landfill during 2010

Month	KTK Rainfall Data (mm)	Evapotranspiration (Casement) (mm)	Evaporation (Casement) (mm)	Average Monthly Temperature (KTK) (^{o}C)
January 2010	53.8	6.65	9.80	1.6
February 2010	47.4	11.73	17.50	2.07
March 2010	50.6	35.68	51.69	5.23
April 2010	29.20	58.00	84.06	8.36
May 2010	33.80	76.14	107.97	10.50
June 2010	38.60	89.99	123.42	14.82
July 2010	84.60	78.80	114.40	15.09
August 2010	32.4	68.04	97.55	13.64
September 2010	122	45.01	63.95	13.01
October 2010	53.4	27.52	39.03	9.84
November 2010	92.2	10.75	14.97	4.70
December 2010	24	4.24	6.12	-0.01
Total 2010	**662.00**	**512.55**	**730.46**	
Average 2010				**8.24**

A water balance is used to calculate the difference between rainfall on landfilled areas and the various losses prior to leachate generation. See Figure 19 for the water balance calculations.

Concentrate from the Reverse Osmosis treatment plants is re-circulated within the waste mass, a common practise in Europe where Reverse Osmosis units are operated on landfills and is as per agreement with the agency. Leachate is not currently being re-circulated until further capping works are completed.

Operating experience on the site has revealed that large quantities of the incident rainfall or leachate that is re-circulated from the sumps on the landfill base is and will be absorbed by the dry C&I wastes deposited in the KTK Landfill. Absorption rates are estimated to be in the range of 0.11 and 0.15 cubic metres per tonne of waste.

16.0 METEROLOGICAL REPORT 2010

The site is equipped with a Davis Vantage Pro 2 meteorological station, which produces monthly climatological summaries comprising wind speed (km/hr), rain (mm) and temperature (˚C). Other data is collected from the Casement Aerodrome met station. Monthly Rainfall, Evapotranspiration and Temperature data are depicted in Table 36.

17.0 SCHEDULE OF ENVIRONMENTAL OBJECTIVES AND TARGETS FOR THE FORTHCOMING YEAR

This Schedule of Objectives and Targets and Environmental Management Programme has been developed by Golder Associates Ireland, in conjunction with KTK Landfill Limited.

The Schedule of Objectives and Targets and the Environmental Management Programme, has been developed in accordance with Conditions 2.2.2.2 and 2.2.2.3 of Waste Licence W0081-3 and, Clause 4.3.3 of ISO 14001:2004 Environmental Management Systems – Requirements with Guidance for Use, and with reference to KTK Landfill's Environmental Management System.

The aim of the Schedule of Objectives and Targets and the Environmental Management Programme, is to outline a set of achievable objectives and targets, aimed at meeting the commitments set out in the KTK Landfill Ltd Environmental Policy (see Appendix 1) and to mitigate the significant environmental aspects associated with KTK Landfill Ltd operations.

KTK Landfill Ltd is an ISO 14001: 2004 certified company (Certification No. SGR 05/66145). It is the policy KTK Landfill Ltd to continually seek to improve its environmental performance. This commitment is outlined in the Company's Environmental Policy. This Policy commits the organisation to setting targets and objectives, aimed at improving environmental performance and mitigating the potential impacts that the Facility may have on the environment.

KTK Landfill Ltd is licensed under the Waste Management Act 1996. Conditions 2.2.2.2 and 2.2.2.3 of Waste Licence W0081-3 require that KTK Landfill Ltd maintain a Schedule of Objectives and Targets and an Environmental Management Programme.

The Schedule of Objectives and Targets and the Environmental Management Programme shall *'as a minimum provide for a review of all operations and processes, including an evaluation of practical options, for energy and resource efficiency, the use of cleaner technology cleaner production, and the prevention, reduction and minimisation of waste, and shall include waste reduction targets'.* The Schedule of Objectives and Targets and the Environmental Management Programme *'shall consider a five year period as a minimum.'*

17.1 Definitions

Condition 2.2.2.3 of Waste Licence W0081-3 sets out that an Environmental Management Program shall consist of a timed schedule for achieving the (Licensee's) Environmental Objectives and Targets. The EMP shall include; the designation of responsibility for targets, the means by which they will be achieved, the time within which they will be achieved.

An Environmental Objective; as defined by ISO 14001:2004 is an 'overall environmental goal, consistent with the (Company's) environmental policy, that an organisation sets itself to achieve.'

An Environmental Target; as defined by ISO 14001:2004, is a 'detailed performance requirement, applicable to the organisation or part thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.'

Figure 19: Annual Water Balance

Figure 19 - Leachate Generation Calculations

Actual Rainfall from on-site Weather Station.

Evaporation Data (Class A Pan Totals) from Met Eireann Casement Aerodrome Weather Station

Evapotranspiration Data From Met Eireann Casement Aerodrome Weather Station

Site Name: KTK Landfill Site, Brownstown and Carnalway, Kilcullen, Co. Kildare

Irish National Grid Reference:

East 285680.75

Annual Environmental Report: From 1st January 2010 to 31st December 2010

North 211471.37

Operator: KTK Landfill Ltd

Site Status: Licence No. W081-03

Period	Capped Area m2	(1)Active Fill Area	Total Area of Active Fill (m^2)	Evaporation (m)	Total Penman Potential Evapotranspiration (m)	Actual Rainfall (m)	(2)Infiltration through Active Area (m^3)	Vegetated Restored Area	Vegetated Restored Area (m^2)	(3)Effective Rainfall (mm)	(2)Infiltration Vegetated Restored Area (m^3)	(4)Weight of Material Deposited (Tonnes)	(5)Absorbtive Capacity of the waste (m^3/t)	Volume of Water Absorbed (m^3)	(6)Volume of Water Consumed in LFG Production (m^3)	Volume of Leachate Removed Off-Site (m^3)	(7)Leachate Stored Within Site (m^3/month)
Jan-10	15,000	Phase 1/2/3/4/5	95,037	0.0098	0.0067	0.0441	3,725	Phase 5 & 6	49,963	0.037	936	6,880	0.05	344	0	16,277	0
Feb-10	34,000	Phase 1/2/3/4/5	76,037	0.0175	0.0117	0.0366	2,118	Phase 5 & 6	49,963	0.025	621	4,139	0.05	207	0	12,892	0
Mar-10	34,000	Phase 1/2/3/4/5	76,037	0.0517	0.0357	0.0593	2,544	Phase 5 & 6	49,963	0.024	590	7,247	0.05	362	0	4,399	0
Apr-10	40,000	Phase 1/3/4/5	70,037	0.0841	0.0580	0.0327	0	Phase 5 & 6	49,963	0.000	0	6,524	0.05	326	0	3,634	0
May-10	55,000	Phase 1/3/4/5	91,973	0.1080	0.0761	0.0449	0	phase 6	13,027	0.000	0	4,186	0.05	209	0	3,285	0
Jun-10	55,000	Phase 1/3/4/5	91,973	0.1234	0.0900	0.0452	0	phase 6	13,027	0.000	0	9,623	0.05	481	0	13,814	0
Jul-10	55,000	Phase 1/3/4/5	91,973	0.1144	0.0788	0.0817	2,253	phase 6	13,027	0.003	19	10,251	0.05	513	0	12,780	0
Aug-10	70,000	Phase 1/3/4	76,973	0.0975	0.0680	0.0435	0	phase 6	13,027	0.000	0	7,484	0.05	374	0	8,785	0
Sep-10	70,000	Phase 1/3/4	76,973	0.0639	0.0450	0.1027	5,444	phase 6	13,027	0.058	376	9,333	0.05	467	0	7,690	0
Oct-10	70,000	Phase 1/3/4	76,973	0.0390	0.0275	0.0377	1,400	phase 6	13,027	0.010	66	7,193	0.05	360	0	4,954	0
Nov-10	70,000	Phase 1/3/4	76,973	0.0150	0.0108	0.1200	8,661	phase 6	13,027	0.109	712	7,616	0.05	381	0	5,894	3,098
Dec-10	70,000	Phase 1/3/4	76,973	0.0061	0.0042	0.0662	4,860	phase 6	13,027	0.062	404	2,966	0.05	148	0	7,089	0
Total				**0.7304**	**0.5125**	**0.7146**	**31,005**			**0.328**	**3,723**	**83,443**		**4,172**	**0**	**101,491**	**3,098**

Notes:

(1) The active area is assumed to be that area of the site where no vegetation has been planted.

(2) The actual rainfall data less 50% of evaporation were used to calculate the infiltration through the active fill area, and 50% of the effective rainfall was assumed to infiltrate through the vegetated restored area.

(3) Effective Rainfall is assumed to be actual rainfall minus evapotranspiration

(4) Weight of waste deposited includes all covering and engineering material used, including woodchip.

(5) An absorbtive capacity of 0.15m^3/t was used based on site experiences, i.e. dry absorbtive wastes (paper, cardboard) and cover material (woodchip, fines)

(6) Assumes anaerobic fermentation of wastes consumes 27 litres of water for every tonne of waste over the life time of the waste - "*The Engineering of a Sustainable Landfill" Jonathan Derham, MCOS, 1995.*

(7) The storage capacity of the basal area of landfill, assuming level does not exceed 1.0m above liner, is 4,300m^3/hr.

Table 37: Programme of Objective and Targets 2007 to 2012 - Progress Quarter 4 (December 2010)

Ref. No.	Objective	Ref. No.	Target	ENV Aspect	Resources Required	Person Responsible	Time Frame for Completion	Progress as of 26th January 2011.
O - 1	Lower the environmental impacts associated with fugitive landfill gas emissions by continually developing the Facility's Gas Utilisation Infrastructure and landfill gas management techniques.	T - 1.1	Undertake quarterly VOC surveys of the waste surface over the next 5 years, to establish the areas were fugitive emissions are most prevalent.	1,9	External Consultant (circa €1,800 per survey)	Site Manager	Ongoing	
		T - 1.2	Installation of gas extraction boreholes were fugitive emissions have been identified from the VOC surveys.	1,9	Circa €1,700 per borehole.	Site Manager	Ongoing	
		T - 1.3	Achieve 70% utilisation of landfill gas extracted by 2012 by undertaking landfill gas modelling of the waste body to establish the most the environmentally beneficial method for managing landfill gas. i.e. By maximising landfill gas utilisation and minimising flaring.	1,9	External Consultant (circa €2,500 per model)	Site Manager	2012	Current utilisation at 58%. October 2010 was 88%. November was 79% and December was 78%.
		T - 1.4	Support University College Dublin Research Project commissioned to investigate the most effective cover material for achieving maximum odour neutralisation.	1,9	UCD €10,000	GM Landfill Group	Project Completed Dec 2009	

Ref. No.	Objective	Ref. No.	Target	ENV Aspect	Resources Required	Person Responsible	Time Frame for Completion	Progress as of 26th January 2011.
		T - 1.5	Monitor and review the effectiveness of the perimeter odour neutralising infrastructure installed in 2005 and maintain record of performance.	1,9	Assistant Site Manager (80 man hours)	Site Manager	Project Completed	
		T – 1.6	Reduce fugitive emissions by completion of final permanent capping. 40% completed in 2009. 65% to be completed by end 2011.	1, 9	Site management, consultants, contractor (est €4M)	Site Manager	2012	Slightly behind target. 43% completed by the end of 2010. Capping to recommence March/April 2011.
O - 2	Lower the potential environmental impacts (i.e. risk of spillage, CO_2 emissions) associated with the off site transport of leachate.	T - 2.1	Divert leachate disposal from tankering offsite to direct discharge to sewer, by on-site treatment with agreement of EPA and KCC Achieve 50% diversion rate by 2010 and a 75% diversion rate by 2012	2	External Consultant (€2,500)	Site Manager	Ongoing	Total volume of leachate removed 2010 is 101491.5m^3 Total that went to sewer 34110m^3 or 33.6% in 2010.
		T - 2.2	Design and commission on-site leachate treatment plant to reduce leachate to domestic strength and dissolved methane levels in leachate to below the regulatory requirement of 0.14 mg/l. Increase plant capacity to 150m^3/day	2	Circa €600,000	Site Manager	December 2009 July 2010	Completed Completed

Ref. No.	Objective	Ref. No.	Target	ENV Aspect	Resources Required	Person Responsible	Time Frame for Completion	Progress as of 26th January 2011.
O - 3	Lower the potential environmental nuisance associated with dust by improving dust management techniques	T - 3.1	Source road washing/sweeping plant for permanent operation on site	7	Circa €8,000 pa	Site Manager	Complete	
		T - 3.2	Investigate available technology options for dust suppression activities, that minimises water usage.	7	Assistant Site Manager (20 man hours)	Site Manager	Complete	
O - 4	Implement CRAMP	T – 4.1	Complete design, contractor selection, and engineering works associated with stage 1 area of final permanent capping of approx 70,000m^2 Complete design, contractor selection, and engineering works associated with stage 2 area of final permanent capping of approx 45,000m^2	1, 9	External consultants and contractors	Site Manager	June 2010 July 2011	Completed On Target
O - 5	Minimise the amount of natural resources (water, power etc) consumed at the Facility.	T - 5.1	Update the existing utilities report on an annual basis so as to identify operational resource consumption	4	External Consultant (circa €1,000 pa)	Site Manager	Ongoing	
		T - 5.2	Review Energy Audit of Facility and identify opportunities for improved energy efficiency.	4	Site Manager (20 man hours)	Site Manager	Jan 2011	Currently being reviewed by OCM
		T – 5.3	Carry out assessment of the use of raw material at the Facility and identify opportunities for the improved efficiency in the use of raw materials.	4	Assistant Site Manager (40 man hours)	Site Manager	December 2010	Defer to June 2011

Ref. No.	Objective	Ref. No.	Target	ENV Aspect	Resources Required	Person Responsible	Time Frame for Completion	Progress as of 26th January 2011.
		T - 5.4	Carry out assessment of water usage at the facility and identify opportunities for improved efficiency of water usage.	4	Assistant Site Manager (40 man hours)	Site Manager	Ongoing	
		T – 5.5	Use storm water for dust suppression activities when available.	4	Tanker Trailer and bowser	Site Supervisor	Ongoing	
O - 6	Improve Health, Safety and Welfare	T - 6.1	Review and amend site safety statement so that it is consistent with other sites within the Greenstar Landfill Group	8	Assistant Site Manager (40 man hours)	Site Manager GM Landfill Group	June 2010	Complete
		T - 6.2	Reduce lost time injuries by 5% over the next five years	8		All site Personnel	Ongoing	
		T - 6.3	Develop Accident Prevention Plan	8	Assistant Site Manager (80 man hours)	Site Manager GM Landfill Group	Project Completed June 2007	
O-7	Training	T - 7.1	Continue to train staff on a regular basis in EMS system, waste licence and Emergency Response.		Assistant Site Manager	Site Manager	Ongoing Annual Basis	
O-8	Operations	T - 8.1	Encourage all site hauliers to comply fully with the Waste Collection Permit Regulations		Site Manager	Site Manager	Ongoing	

18.0 FULL TITLE AND WRITTEN SUMMARY OF ANY PROCEDURES DEVELOPED BY THE LICENSE WHICH RELATES TO THE FACILITY OPERATION

KTK Landfill Ltd achieved ISO 14001:2004 certification on 12 December 2005 (certificate number IE05/66145). The awarding body was SGS Ltd Systems and Service Certification in association with UKAS Environmental Management.

As part of KTK Landfill ISO14001 certification all procedures were reviewed and amended to comply with requirements of ISO 14001. A full list of all procedures is outlined in Table 38 below.

Table 38: Procedures and Written Summary of any Procedures Developed by the Licencee Which Relate to the Operation of the Facility

Ref.	Titles
KTKP 1	Environmental Aspects
KTKP 2	Legislation & Other Requirements
KTKP 3	Training & Awareness
KTKP 4	Communication
KTKP 5	Control of Documents
KTKP 6	Emergency Preparedness & Response
KTKP 7	Monitoring & Measurement
KTKP 8	Objectives, Targets & Programme
KTKP 9	Non-conformance, corrective & preventative action
KTKP 10	Control of Records
KTKP 11	Internal Audit
KTKP 12	Management Review
KTKP 13	Complaints
KTKP 15	Control of Contractors & Visitors (Safe Systems of Work)
KTKP 18	Suppression of Dust
KTKP 19	Construction of Site Roads
KTKP 20	Fuel Storage & Distribution
KTKP 21	Vermin Control
KTKP 22	Handling Tipping Vehicles on site
KTKP 25	Completion of Daily Site Condition Reports
KTKP 26	Waste Acceptance Procedures
KTKP 27	Recyclable material leaving site
KTKP 28	Maintenance
KTKP 29	Permit To Work Systems
KTKP 37	1500 Haase Flare Operation - Start-up
KTKP 38	1500 Haase Flare Operation - Shutdown
KTKP 39	1500 Haase Flare Operation – Startup Troubleshooting
KTKP 40	2500 Haase Flare Operation – Startup
KTKP 41	2500 Haase Flare Operation - Shutdown
KTKP 42	Deutz Gas Engine TGB 620 – Start Up Procedure
KTKP 43	Deutz Gas Engine TGB 620 – Shut Down Procedure
KTKP 44	Deutz Gas Engine TGB 620 – Start Up Procedure Following Common Fault Acknowledgement

KTKP 45	Blower Station Rosemount Analyser (CH_4, CO_2 & O_2) Calibrations
KTKP 46	Drilling and Installation of a Landfill Gas Extraction Well
KTKP 47	Gas Collection Pipework Fusion Welding
KTKP 48	Landfill Gas Management Plan
KTKP 49	Odor Management Plan
KTKP 50	Engineering Materials Management Plan
KTKP 51	Ammonia Delivery Procedure
KTKP 52	Leachate and Landfill Gas Condensate Management
KTKP 53	Acceptance of Soil Material Containing Non-Infectious Sharps
KTKP 54	Emptying Bunds
KTKP 55	Combined Space Entry
KTKP 56	Ro Plant Operation and Maintenance
KTKP 57	Procedure on emptying leachate bunded area
KTKP 58	Delivery of Bulk Caustic 30% ww
KTKP 59	Delivery of Bulk Sulphuric Acid 96-98%

19.0 REPORTED INCIDENTS AND COMPLAINTS SUMMARY

A record for reported incidents during the 2010 reporting period is presented in Table 39. A total of 16 incidents were recorded during the reporting period. Of the reported incidents for 2010 12 related to elevated levels of landfill gas in perimeter monitoring wells and 2 related to elevated levels of gas in the site gas utilisation plant and the ESB sub-station. As per the recommendations of The Agency inspectors during audit of KTK Landfill Site on 23 November 2004 a full report on the assessment of landfill gas migration in the vicinity of KTK Landfill and Silliot Hill Landfill was submitted to the Agency on 7 April 2005. This assessment concluded that the most likely source of elevated landfill gas levels in monitoring wells located outside the body of waste at KTK Landfill is from the historical uncontained landfilling operations at the Silliot Hill facility and are therefore not in any way connected with KTK landfill.

Significant reductions in gas levels measured from April 2007 to June 2008 was attributed to ongoing works at Silliot Hill during 2007 and 2008 including the installation of additional gas extraction wells at that facility. It is understood that significant works at Silliot Hill were carried out and completed during 2009 which included the capping of that facility and the installation of large diameter gas extraction wells. Despite these works, elevated levels of CH_4 persisted into 2010 in the first quarter, reducing during the second and third quarter before spiking again in December 2010. The CO_2 levels followed a similar but more erratic pattern.

Two incidents related to the site's surface water management system, these were communicated by faxes submitted to the Agency in November 2010.

A register of complaints recorded during the reporting period is attached in Table 40. A total of 3 complaints were received from 2 complainants during the reporting period. This is substantially down on 2009 with 18 complaints received from 7 complainants. Any minor gas infrastructure malfunctions identified at the KTK facility with the potential to generate odours were quickly identified and corrected as part of the site daily monitoring and inspections regime. All complaints were resolved to the satisfaction of complainants. The facility is located in proximity to Silliot Hill Integrated Waste Management Facility which includes a civic amenity area, an open air transfer station and a completed partially lined landfill site with a history of landfill gas migration, all of which have potential to generate odours.

19.1 Reported Incidents and Complaints Summary

Incidents

The list of Incidents at KTK Landfill for the reporting period 1 January 2010 to 31 December 2010 are outlined in Table 39.

Table 39: List of Incidents during 2010

Number	Date	Description	Action
I 148	26//01/2010	Elevated CH_4 levels at G4, G6, G7, & G8. Elevated CO_2 levels at G1, G3, G4, G5, G6, G7, G8, G14, & G15.	Incident Report Submitted.
I 149	16//02/2010	Site gas utilisation plant MV substation on northern boundary of site in close proximity to perimeter landfill gas monitoring location G2 Methane was detected >1% v/v within MV substation.	Incident Report Submitted.
I 150	23/02/2009	Elevated CH_4 levels at G1, G2, G3, G4, G6, G7, G8, & G10. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G14, & G15.	Incident Report Submitted.
I 151	30//03/2010	Elevated CH_4 levels at G1, G2, G3, G4, G6, G7, G8 & G10. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G14, & G15.	Incident Report Submitted.
I 152	21//04/2010	Elevated CH_4 levels at G3, G4, G6, G7, & G8. Elevated CO_2 levels at G1, G3, G4, G5, G6, G7, G8, G14, & G15.	Incident Report Submitted.
I 153	28//05/2010	Elevated CH_4 levels at G2, G3, G4, G7, & G8. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8, G14, & G15.	Incident Report Submitted.
I 154	23/06/2010	Elevated CH_4 levels at G1, G3, G4, G7, & G10. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G14, & G15.	Incident Report Submitted.

I 155	26/07/2010	Elevated CH_4 levels at G1, G2, G4, G7, & G10. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8, G10 G14, & G15.	Incident Report Submitted.
I 156	25/08/2010	Elevated CH_4 levels at G4, G7, & G10. Elevated CO_2 levels atG1, G2, G3, G4, G5, G6, G7, G8, G10, G14, & G15.	Incident Report Submitted.
I 157	21/09/2010	Elevated CH_4 Levels at G3, G4, & G7. Elevated CO_2 levels at G1, G3, G4, G5, G6, G7, G8, & G14.	Incident Report Submitted.
I 158	27/10/2010	Elevated CH_4 Levels at G2, G3, & G4. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8, G14, & G15.	Incident Report Submitted.
I 159	09/11/2010	Surface water management.	Fax submitted on the 10 of November 2010.
I 160	15/11/2010	Surface water management.	Fax submitted on the 16 of November 2010
1 161	23/11/2010	Elevated CH_4 Levels at G4 & G7. Elevated CO_2 levels at G3, G4, G5, G6, G7, G8, G14, & G15	Interim Incident Report Submitted.
I162	10/12/2010	Methane was detected at >1% v/v within ESB Substation on western side of the landfill adjacent to perimeter gas monitoring location G7.	Incident Report Submitted.
I163	17/12/2010	Elevated CH_4 Levels atG1, G2, G3, G4, G7, G8, & G10. Elevated CO_2 levels at G1, G2, G3, G4, G5, G6, G7, G8,G9,G10, G11, G14, & G15	Incident Report Submitted.

19.2 Complaints

KTK Landfill maintains a register of complaints received in compliance with Condition 10.4 of the waste licence. A total of 18 complaints were received in relation to the operation of the facility for the reporting period. Complaints in relation to the operation of the facility are summarised in Table 40.

Table 40: Record of Complaints Received during 2010

Number	Date	Complainant	Description
2010-01	05/01/2010	Mrs Angela Tynan	LFG Odour
2010-02	25/02/2010	Mr Simon Durham	LFG Odour
2010-03	23/09/2010	Mr Simon Durham	LFG Odour

20.0 REVIEW OF NUISANCE CONTROLS AT KTK LANDFILL DURING 2010

KTK Landfill Ltd is committed to operating KTK landfill in the best possible manner using best available techniques to minimise impacts to the environment and local residential neighbours. KTK Landfill Ltd welcome communications from local residents and any interested parties and all reasonable and practical measures will be implemented to eliminate or minimise any issues or nuisances. The site substantially closed to the acceptance of commercial and industrial and asbestos wastes on 21 October 2008. All nuisance control measures continue to be implemented so as to ensure licence compliance.

20.1 Bird Control

While requirements were substantially reduced with the closure of the site to certain waste types in October 2008 bird control measures at the site continued as necessary to comply with site waste licence conditions. This involved the use of kites, distress calls and flare pistol.

20.2 Vermin Control

Site personnel regularly checked for evidence of vermin on-site during regular routine inspections. Rentokil were employed throughout the duration of the reporting period in order to control potential nuisance caused by rodents. Continuous baiting was carried out by Rentokil and adjusted as necessary to prevent any infestation of vermin.

20.3 Mud Control

A high pressure jet wheel wash system is employed on the site since February 2004 and uses a series of pressure sprayers to power wash vehicles from the wheels up to the cab. A self drive road sweeper is maintained on the site and is utilised as and when necessary to maintain all site roads in a clean condition.

21.0 REPORTS ON FINANCIAL PROVISION MADE UNDER THIS LICENCE, MANAGEMENT AND STAFFING STRUCTURE OF THE FACILITY, AND A PROGRAMME FOR PUBLIC INFORMATION

21.1 Financial Provision

Under condition 12.3.3 of the site licence KTK Landfill is required to maintain a financial provision to cover any liabilities incurred whilst carrying on the activities to which this licence relates. Detailed below are the financial provisions made for the facility

21.2 Closure Restoration and Aftercare Costs (Known Environmental Liabilities)

A capital provision for closure, restoration and aftercare continued to be deducted from Gate Revenues during 2010. As of the end of this reporting period a total amount of €8,327,777 has been accrued for closure, restoration and aftercare costs.

KTK landfill Ltd. is owned through its parent company Greenstar Ltd., by National Toll Roads plc. The company has a secure financial backing.

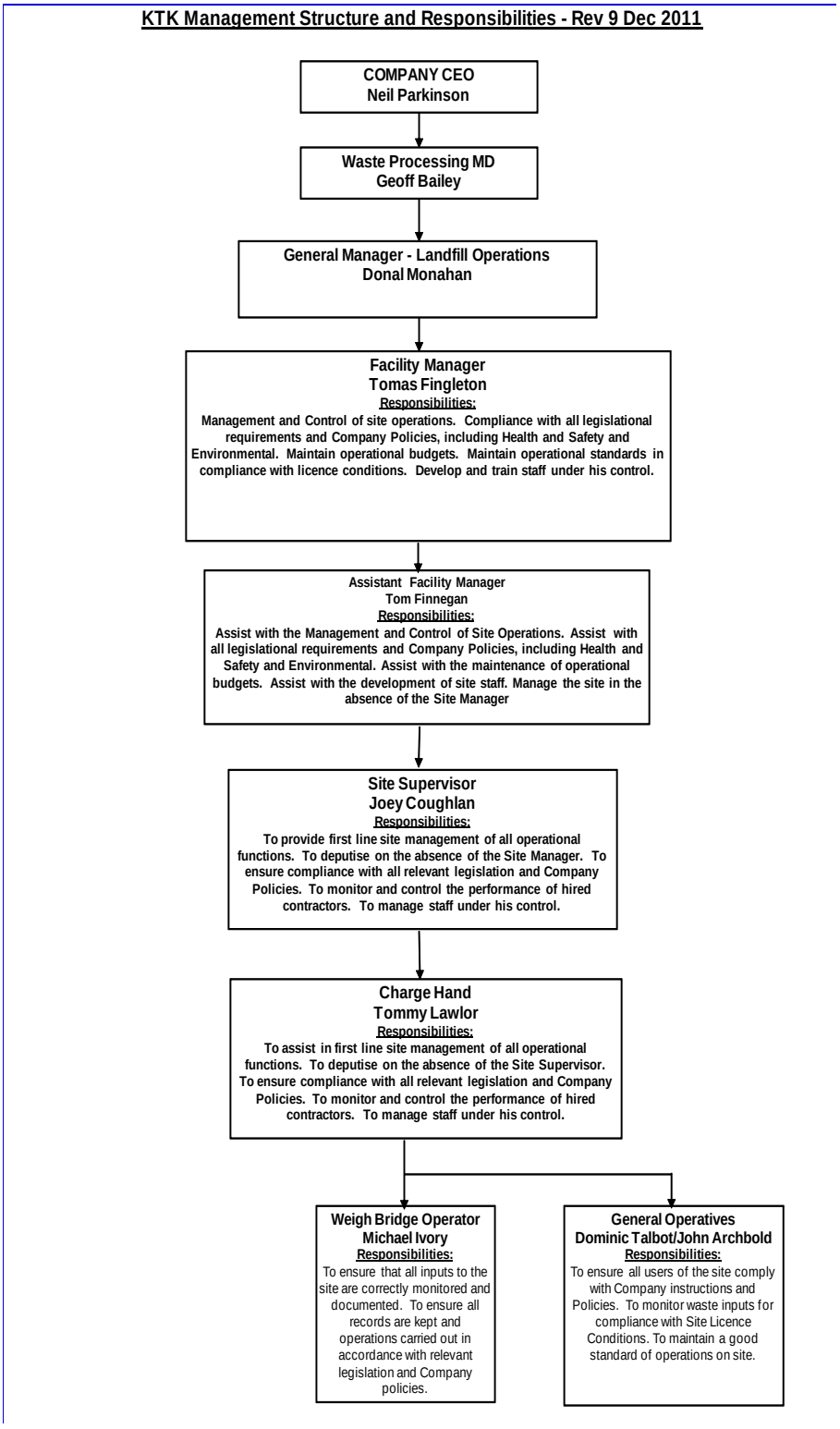
21.3 Financial Provisions for Unknown Environmental Liabilities

As part of Condition 12.3.2, the Licensee has completed fully costed Environmental Liabilities Risk Assessment for the site. This document outlines the potential unknown environmental liabilities associated

with the landfill and estimates the possible cost of these liabilities. Greenstar Ltd have accidental pollution liability insurance to the value of €6.5 million, which is well in excess of the cost that may arise from unknown liabilities.

22.0 MANAGEMENT STRUCTURE AT KTK LANDFILL DURING THE REPORTING PERIOD

Figure 20: Management Structure at KTK Landfill



Note Tomas Fingleton replaced Michael Bergin on the January 1 2011 as advised to the agency.*

22.1 Programme for Public Information

KTK pursues an active programme of disseminating information on its operations to interested parties. This is undertaken through a variety of means including site tours, the company website, presentations and open days.

KTK's community development fund made significant donations to a number of local groups during the course of 2010 including local schools, scouts, community centre, bowling club, sports facilities and the Kilcullen Christmas lights. A comprehensive public information programme developed in April 2000 continues to be used.

The communications programme contains 8 specific objectives:

- To promote public awareness of the Company's activities and environmental policies;
- To maintain an ongoing dialogue with authorities that have direct involvement with waste disposal activities;
- To make available Environmental Performance Data relating to KTK Landfill Ltd;
- To disseminate information relating to the operational and management of the site as appropriate;
- To encourage liaison between KTK Landfill Ltd, and local residents and those who may be affected by the sites operations;
- To provide general information on Waste Management Issues;
- To ensure all users and customers of the site are conversant with the requirements of the Site Licence; and
- To ensure that all objectives are, where possible, measurable and quantifiable.

The objectives of the programme are met through the following elements as appropriate:

- Personal Contact;
- Residents Meetings/Liaison Groups;
- Information Displays;
- Information Packs;
- Site Visits;
- Web Page;
- Educational Links; and
- Published Information.

23.0 POLLUTION RELEASE TRANSFER RECORD

Under EU Regulation 166/2006, all licensed facilities are obliged to prepare a PRTR which details all releases of pollutants and off-site transfer of pollutants and waste. Figures for releases to air, releases to storm-water and wastes transferred off-site were sent to the Agency in March 2011. The complete PRTR document was also uploaded to the dedicated EPA PRTR website.

Report Signature Page

GOLDER ASSOCIATES IRELAND LIMITED

Cróna Gray
Project Scientist

Thomas Vainio-Mattila
Project Director

CG/TVM/aw

Registered in Ireland Registration No. 297875
Town Centre House, Dublin Road, Naas, Co. Kildare, Ireland
Directors: M. Gilligan, A. Harris (British)
VAT No.: 8297875W

APPENDIX A

Drawing KTK/602 Rev B1

KTK LANDFILL LTD. OFFICE

2500m³/hr FLARE

PI 318

PI 318

JEEP TRACK

ACCESS ROAD

JEEP TRACK

Phase 1B

Phase 1A

Phase 2

Phase 3

Phase 4A

Phase 4B

Phase 5A

Phase 5B

Phase 6

ESB

AS BUILT ROAD

SAMPLING POINT LP-6

SAMPLING POINT LP-7

SAMPLING POINT LP-3

SAMPLING POINT LP-1

1500m³/hr FLARE

WEIGH BRIDGES AND OFFICE

MUD BLASTER WHEEL WASH AND PLANT

STORM WATER PERCOLATION AREA

SURFACE WATER MANAGEMENT AREA

G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G14 G15 G16

KTK-10 KTK-11 KTK-15S KTK-15D KTK-16 KTK-19 KTK-20 KTK/21 BH 4 BH 11d

97-5s\d 97-6s/d 97-7s/d

D1A N1A D2A N2A D3A N3A D4A N4A D5A N5A D6A N6A

CP1 CP2 CP3

SW4 SW5 SW6 SW7

N

LEGEND

FACILITY BOUNDARY

FENCE LINE

SURFACE WATER

NOISE MONITORING LOCATION

DUST MONITORING LOCATION

BOREHOLE WELL

GAS WELL

CATCH PIT

Client: KTK Landfill Ltd.

Project: ENVIRONMENTAL MANAGEMENT PLAN

Location: Brownstown, Kilcullen Co. Kildare

Title: SITE PLAN SHOWING LANDFILL INFRASTRUCTURE AND MONITORING LOCATIONS

Project No. 08507190001	Engineer GB	Drawing No. 602
File No. 602	Reviewed by GFP	
Created by GF		

Description	Date	Revision
ISSUE TO EPA	06/08	P
ISSUE TO EPA WITH Q2 REPORT	07/08	Q
ISSUE TO EPA Q3 REPORT	10/08	R
ISSUE TO EPA Q4 REPORT	01/09	S
ISSUE TO EPA AER 2008	03/09	T
ISSUE TO EPA Q2 REPORT 2009	07/09	U
ISSUE TO EPA Q3 REPORT 2009	10/09	V
ISSUE TO EPA Q4 REPORT 2009	01/10	W
ISSUE TO EPA AER 2010	02/10	X
ISSUE TO EPA Q2 REPORT 2010	07/10	Y
ISSUE TO EPA Q3 REPORT 2010	10/10	Z
ISSUE TO CLIENT	1/11	A1
ISSUE TO EPA AER 2011	03/11	B1

Scale 1:2,000A3 Date March 2011

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL.: 045 874411 - FAX:045 874549
www.golder.com - email:info@golder.ie

APPENDIX B

Air Emission Testing Reports Prepared by Odour Monitoring Ireland Ltd

APPENDIX C

Annual Private Well Analysis Results

ALcontrol Laboratories

Unit 18A
Rosemount Business Park
Ballycoolin
Dublin 11
Tel : (0035) 3188 29893

Golder Associates
Town Centre House
Dublin Road
Naas
Co. Kildare

Attention: Gareth Byrne

CERTIFICATE OF ANALYSIS

Date:	23 February 2010		
Customer:	D_GOLDASS_NAS-31		
Sample Delivery Group (SDG):	100209-127	**Report No.:**	73937
Your Reference:	09507190002		
Location:	KTK L		

We received 2 samples on Tuesday February 09, 2010 and 2 of these samples were scheduled for analysis which was completed on Tuesday February 23, 2010. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

All chemical testing (unless subcontracted) is performed at ALcontrol Hawarden Laboratories.

Asbestos testing - we are not accredited for screening soil samples for asbestos fibres. We are only accredited to identify asbestos fibres in bulk material (ACM).

Approved By:

Iain Swinton

Operations Director - Land UK & Ireland

UKAS TESTING
1291

Validated

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73937

Received Sample Overview

Lab Sample No(s)	Customer Reference	Depth (m)	Sampled Date
981284	DW10		
981249	DW8		

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73937

LIQUID

Results Legend

X Test

No Determination Possible

N

		Lab Sample No(s)	981249						981284						Total
		Sample ID	DW8						DW10						
		Depth (m)													
		Container	60g VOC Dublin	H2SO4 (Dublin)	HNO3 (Dublin)	Micro	PLAS BOT (D)	Plastic NaOH (D)	60g VOC Dublin	H2SO4 (Dublin)	HNO3 (Dublin)	Micro	PLAS BOT (D)	Plastic NaOH (D)	
Alkalinity as CaCO3	All						X						X		0 2
Ammonium	All			X						X					0 2
Anions by Kone (w)	All						X						X		0 2
Coliforms (W)	All					X						X			0 2
Conductivity (at 20 deg.C)	All						X						X		0 2
Dissolved Metals by ICP-MS	All				X						X				0 2
Dissolved Oxygen by Probe	All						X						X		0 2
Fluoride	All						X						X		0 2
Mercury Dissolved	All						X						X		0 2
Metals by iCap-OES Dissolved (W)	All				X						X				0 2
OC, OP Pesticides and Triazine Herb	All						X						X		0 2
pH Value	All						X						X		0 2
Phenols by HPLC (W)	All							X						X	0 2
SVOC MS (W) - Aqueous	All						X						X		0 2
Total Metals by ICP-MS	All						X						X		0 2
Total Organic and Inorganic Carbon	All						X						X		0 2
VOC MS (W)	All		X						X						0 2

Validated

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73937

Test Completion dates

SDG reference: 100209-127

Lab Sample No(s)	981249	981284
Sample ID	DW8	DW10
Depth		
Type	LIQUID	LIQUID
Alkalinity as CaCO3	11/02/2010	11/02/2010
Ammonium	11/02/2010	11/02/2010
Anions by Kone (w)	16/02/2010	16/02/2010
Coliforms (W)	23/02/2010	23/02/2010
Conductivity (at 20 deg.C)	18/02/2010	18/02/2010
Dissolved Metals by ICP-MS	11/02/2010	11/02/2010
Dissolved Oxygen by Probe	11/02/2010	11/02/2010
Fluoride	10/02/2010	10/02/2010
Mercury Dissolved	11/02/2010	11/02/2010
Metals by iCap-OES Dissolved (W)	10/02/2010	10/02/2010
OC, OP Pesticides and Triazine	15/02/2010	15/02/2010
pH Value	17/02/2010	17/02/2010
Phenols by HPLC (W)	23/02/2010	11/02/2010
SVOC MS (W) - Aqueous	12/02/2010	12/02/2010
Total Metals by ICP-MS	11/02/2010	11/02/2010
Total Organic and Inorganic	16/02/2010	16/02/2010
VOC MS (W)	17/02/2010	17/02/2010

Validated

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73956

Results Legend

\# ISO17025 accredited.
M *m*CERTS accredited.
* subcontracted test.
** This result relates to the % recovery of the surrogate standard added to the sample to check on the efficiency of the method. Acceptable limits for most organic methods are 70 - 130 %. The results of the individual compounds within the sample are not corrected for this recovery.

Component	LOD/Units	Method	Sample Identity	DW10	DW8
			Depth (m)		
			Sample Type	Water(GW/SW)	Water(GW/SW)
			Date Sampled		
			Date Received	09/02/2010	09/02/2010
			SDG Ref	100209-127	100209-127
			Lab Sample No.(s)	981284	981249
E.coli (on liquids)	CFU/100ml	SUB		0	0
Total Coliforms (W)	CFU/100ml	SUB		0	2
Total Alkalinity as CaCO3	<2 mg/l	TM043		385 #	280 #
Dissolved Oxygen	<1 mg/l	TM046		7.61 #	7.76 #
Total Organic Carbon	<3 mg/l	TM090		3.4 #	5.38 #
Ammoniacal Nitrogen as N	<0.2 mg/l as N	TM099		<0.2 #	<0.2 #
Fluoride	<0.5 mg/l	TM104		<0.5 #	<0.5 #
Conductivity (at 20 deg.C)	<0.014 mS/cm	TM120		0.681 #	0.494 #
Arsenic Dissolved	<0.12 µg/l	TM152		0.345 #	0.899 #
Barium Dissolved	<0.03 µg/l	TM152		64.6 #	40.8 #
Boron Dissolved	<9.4 µg/l	TM152		10.4 #	23.5 #
Cadmium Dissolved	<0.1 µg/l	TM152		<0.1 #	<0.1 #
Copper Dissolved	<0.85 µg/l	TM152		10.8 #	15.5 #
Lead Dissolved	<0.02 µg/l	TM152		0.145 #	1.36 #
Manganese Dissolved	<0.04 µg/l	TM152		0.208 #	54.4 #
Nickel Dissolved	<0.15 µg/l	TM152		1.63 #	2.88 #
Zinc Dissolved	<0.41 µg/l	TM152		9.33 #	46.6 #
Mercury Dissolved	<0.01 µg/l	TM183		<0.01 #	<0.01 #
Sulphate (soluble)	3 mg/l	TM184		12.1 #	11.6 #
Chloride	<2 mg/l	TM184		13.1 #	2 #
Nitrite	<0.05 mg/l	TM184		<0.05 #	<0.05 #
Phosphate (ortho as PO4)	<0.08 mg/l	TM184		<0.08 #	<0.08 #
Nitrate	<0.3 mg/l	TM184		7.22 #	0.406 #
Chromium (Unfiltered)	<3 µg/l	TM191		<3	<3
Phosphorus (Unfiltered)	<18.3 µg/l	TM191		19.9	73.4
Calcium Dissolved	0.012 mg/l	TM228		147	117
Sodium Dissolved	0.076 mg/l	TM228		6.78	1.59
Magnesium Dissolved	0.036 mg/l	TM228		11.1	2.31
Potassium Dissolved	2.335 mg/l	TM228		<2.34	<2.34
Iron Dissolved	0.019 mg/l	TM228		<0.019	1.1
pH value	<1 pH Units	TM256		8.4 #	8.4 #
Phenol	<0.002 mg/l	TM259		<0.002 #	<0.002 #
Cresols	<0.006 mg/l	TM259		<0.006 #	<0.006 #
Xylenols	<0.008 mg/l	TM259		<0.008 #	<0.008 #
2,3,5-Trimethylphenol	<0.003 mg/l	TM259		<0.003 #	<0.003 #
2-Isopropylphenol	<0.006 mg/l	TM259		<0.006 #	<0.006 #
Phenols Total of 5 Speciated	<0.025 mg/l	TM259		<0.025	<0.025

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73956

OC, OP Pesticides and Triazine Herb

Results Legend

\# ISO17025 accredited.
M *m*CERTS accredited.
* subcontracted test.
** This result relates to the % recovery of the surrogate standard added to the sample to check on the efficiency of the method. Acceptable limits for most organic methods are 70 - 130 %. The results of the individual compounds within the sample are not corrected for this recovery.

Component	LOD/Units	Method	Sample Identity	DW10	DW8
			Depth (m)		
			Sample Type	Water(GW/SW)	Water(GW/SW)
			Date Sampled		
			Date Received	09/02/2010	09/02/2010
			SDG Ref	100209-127	100209-127
			Lab Sample No.(s)	981284	981249
Dichlorvos	<0.01 µg/l	TM231		<0.01	<0.01
Mevinphos	<0.01 µg/l	TM231		<0.01	<0.01
Alpha-BHC (Lindane)	<0.01 µg/l	TM231		<0.01	<0.01
Diazinon	<0.01 µg/l	TM231		<0.01	<0.01
Gamma-BHC (Lindane)	<0.01 µg/l	TM231		<0.01	<0.01
Heptachlor	<0.01 µg/l	TM231		<0.01	<0.01
Aldrin	<0.01 µg/l	TM231		<0.01	<0.01
Beta-BHC (Lindane)	<0.01 µg/l	TM231		<0.01	<0.01
Methyl Parathion	<0.01 µg/l	TM231		<0.01	<0.01
Malathion	<0.01 µg/l	TM231		<0.01	<0.01
Fenitrothion	<0.01 µg/l	TM231		<0.01	<0.01
Heptachlor Epoxide	<0.01 µg/l	TM231		<0.01	<0.01
Parathion	<0.01 µg/l	TM231		<0.01	<0.01
o,p'-DDE	<0.01 µg/l	TM231		<0.01	<0.01
Endosulphan I	<0.01 µg/l	TM231		<0.01	<0.01
p,p'-DDE	<0.01 µg/l	TM231		<0.01	<0.01
Dieldrin	<0.01 µg/l	TM231		<0.01	<0.01
o,p'-TDE(DDD)	<0.01 µg/l	TM231		<0.01	<0.01
Endrin	<0.01 µg/l	TM231		<0.01	<0.01
o,p'-DDT	<0.01 µg/l	TM231		<0.01	<0.01
p,p'-TDE(DDD)	<0.01 µg/l	TM231		<0.01	<0.01
Ethion	<0.01 µg/l	TM231		<0.01	<0.01
Endosulphan II	<0.01 µg/l	TM231		<0.01	<0.01
p,p'-DDT	<0.01 µg/l	TM231		<0.01	<0.01
o,p'-Methoxychlor	<0.01 µg/l	TM231		<0.01	<0.01
p,p'-Methoxychlor	<0.01 µg/l	TM231		<0.01	<0.01
Endosulphan Sulphate	<0.01 µg/l	TM231		<0.01	<0.01
Azinphos-methyl	<0.01 µg/l	TM231		<0.01	<0.01

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73956

SVOC MS (W) - Aqueous

Results Legend

\# ISO17025 accredited.
M *m*CERTS accredited.
* subcontracted test.
** This result relates to the % recovery of the surrogate standard added to the sample to check on the efficiency of the method. Acceptable limits for most organic methods are 70 - 130 %. The results of the individual compounds within the sample are not corrected for this recovery.

Component	LOD/Units	Method	Sample Identity	DW10	DW8
			Depth (m)		
			Sample Type	Water(GW/SW)	Water(GW/SW)
			Date Sampled		
			Date Received	09/02/2010	09/02/2010
			SDG Ref	100209-127	100209-127
			Lab Sample No.(s)	981284	981249
1,2,4-Trichlorobenzene	<1 µg/l	TM176		<1	<1
1,2-Dichlorobenzene	<1 µg/l	TM176		<1	<1
1,3-Dichlorobenzene	<1 µg/l	TM176		<1	<1
1,4-Dichlorobenzene	<1 µg/l	TM176		<1	<1
2,4,5-Trichlorophenol	<1 µg/l	TM176		<1	<1
2,4,6-Trichlorophenol	<1 µg/l	TM176		<1	<1
2,4-Dichlorophenol	<1 µg/l	TM176		<1	<1
2,4-Dimethylphenol	<1 µg/l	TM176		<1	<1
2,4-Dinitrotoluene	<1 µg/l	TM176		<1	<1
2,6-Dinitrotoluene	<1 µg/l	TM176		<1	<1
2-Chloronaphthalene	<1 µg/l	TM176		<1	<1
2-Chlorophenol	<1 µg/l	TM176		<1	<1
2-Methylnaphthalene	<1 µg/l	TM176		<1	<1
2-Methylphenol	<1 µg/l	TM176		<1	<1
2-Nitroaniline	<1 µg/l	TM176		<1	<1
2-Nitrophenol	<1 µg/l	TM176		<1	<1
3-Nitroaniline	<1 µg/l	TM176		<1	<1
4-Bromophenylphenylether	<1 µg/l	TM176		<1	<1
4-Chloro-3-methylphenol	<1 µg/l	TM176		<2	<2
4-Chloroaniline	<1 µg/l	TM176		<1	<1
4-Chlorophenylphenylether	<1 µg/l	TM176		<1	<1
4-Methylphenol	<1 µg/l	TM176		<1	<1
4-Nitrophenol	<1 µg/l	TM176		<1	<1
4-Nitroaniline	<1 µg/l	TM176		<1	<1
Azobenzene	<1 µg/l	TM176		<1	<1
Acenaphthylene	<1 µg/l	TM176		<1	<1
Acenaphthene	<1 µg/l	TM176		<1	<1
Anthracene	<1 µg/l	TM176		<1	<1
Bis(2-chloroethyl)ether	<1 µg/l	TM176		<1	<1
Bis(2-chloroethoxy)methane	<1 µg/l	TM176		<1	<1
Bis(2-ethylhexyl) phthalate	<2 µg/l	TM176		<5	<5
Benzo(a)anthracene	<1 µg/l	TM176		<1	<1
Butylbenzyl phthalate	<1 µg/l	TM176		<1	<1
Benzo(b)fluoranthene	<1 µg/l	TM176		<1	<1
Benzo(k)fluoranthene	<1 µg/l	TM176		<1	<1
Benzo(a)pyrene	<1 µg/l	TM176		<1	<1
Benzo(ghi)perylene	<1 µg/l	TM176		<1	<1
Carbazole	<1 µg/l	TM176		<1	<1
Chrysene	<1 µg/l	TM176		<1	<1

Validated

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73956

SVOC MS (W) - Aqueous

Results Legend

ISO17025 accredited.
M *m*CERTS accredited.
***** subcontracted test.
****** This result relates to the % recovery of the surrogate standard added to the sample to check on the efficiency of the method. Acceptable limits for most organic methods are 70 - 130 %. The results of the individual compounds within the sample are not corrected for this recovery.

Component	LOD/Units	Method	Sample Identity	DW10	DW8
			Depth (m)		
			Sample Type	Water(GW/SW)	Water(GW/SW)
			Date Sampled		
			Date Received	09/02/2010	09/02/2010
			SDG Ref	100209-127	100209-127
			Lab Sample No.(s)	981284	981249
Dibenzofuran	<1 µg/l	TM176		<1	<1
Di-n-butyl phthalate	<1 µg/l	TM176		<1	<1
Diethyl phthalate	<1 µg/l	TM176		<2	<2
Dibenzo(a,h)anthracene	<1 µg/l	TM176		<1	<1
Dimethyl phthalate	<1 µg/l	TM176		<1	<1
Di-n-Octyl phthalate	<5 µg/l	TM176		<5	<5
Fluoranthene	<1 µg/l	TM176		<1	<1
Fluorene	<1 µg/l	TM176		<1	<1
Hexachlorobenzene	<1 µg/l	TM176		<1	<1
Hexachlorobutadiene	<1 µg/l	TM176		<1	<1
Pentachlorophenol	<1 µg/l	TM176		<2	<2
Phenol	<1 µg/l	TM176		<2	<2
N-nitrosodi-n-propylamine	<1 µg/l	TM176		<1	<1
Hexachloroethane	<1 µg/l	TM176		<1	<1
Nitrobenzene	<1 µg/l	TM176		<1	<1
Naphthalene	<1 µg/l	TM176		<1	<1
Isophorone	<1 µg/l	TM176		<1	<1
Hexachlorocyclopentadiene	<1 µg/l	TM176		<2	<2
Phenanthrene	<1 µg/l	TM176		<1	<1
Indeno (1,2,3-cd) Pyrene	<1 µg/l	TM176		<1	<1
Pyrene	<1 µg/l	TM176		<1	<1

ALcontrol Laboratories Analytical Services

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73956

VOC MS (W)

Results Legend
ISO17025 accredited.
M *m*CERTS accredited.
* subcontracted test.
** This result relates to the % recovery of the surrogate standard added to the sample to check on the efficiency of the method. Acceptable limits for most organic methods are 70 - 130 %. The results of the individual compounds within the sample are not corrected for this recovery.

Component	LOD/Units	Method	Sample Identity	DW10	DW8
			Depth (m)		
			Sample Type	Water(GW/SW)	Water(GW/SW)
			Date Sampled		
			Date Received	09/02/2010	09/02/2010
			SDG Ref	100209-127	100209-127
			Lab Sample No.(s)	981284	981249
Dichlorodifluoromethane	<1.3 µg/l	TM208		<1.3 #	<1.3 #
Chloromethane	<1.7 µg/l	TM208		<1.7 #	<1.7 #
Vinyl Chloride	<1.2 µg/l	TM208		<1.2 #	<1.2 #
Bromomethane	<2 µg/l	TM208		<2 #	<2 #
Chloroethane	<2.5 µg/l	TM208		<2.5 #	<2.5 #
Trichlorofluoromethane	<1.3 µg/l	TM208		<1.3 #	<1.3 #
1,1-Dichloroethene	<1.2 µg/l	TM208		<1.2 #	<1.2 #
Carbon disulphide	<1.3 µg/l	TM208		<1.3 #	<1.3 #
Dichloromethane	<3.7 µg/l	TM208		<3.7 #	<3.7 #
Methyl Tertiary Butyl Ether	<1.6 µg/l	TM208		<1.6 #	<1.6 #
trans-1,2-Dichloroethene	<1.9 µg/l	TM208		<1.9 #	<1.9 #
1,1-Dichloroethane	<1.2 µg/l	TM208		<1.2 #	<1.2 #
cis-1,2-Dichloroethene	<2.3 µg/l	TM208		<2.3 #	<2.3 #
2,2-Dichloropropane	<3.8 µg/l	TM208		<3.8 #	<3.8 #
Bromochloromethane	<1.9 µg/l	TM208		<1.9 #	<1.9 #
Chloroform	<1.8 µg/l	TM208		<1.8 #	<1.8 #
1,1,1-Trichloroethane	<1.3 µg/l	TM208		<1.3 #	<1.3 #
1,1-Dichloropropene	<1.3 µg/l	TM208		<1.3 #	<1.3 #
Carbontetrachloride	<1.4 µg/l	TM208		<1.4 #	<1.4 #
1,2-Dichloroethane	<3.3 µg/l	TM208		<3.3	<3.3
Benzene	<1.3 µg/l	TM208		<1.3 #	<1.3 #
Trichloroethene	<2.5 µg/l	TM208		<2.5 #	<2.5 #
1,2-Dichloropropane	<3 µg/l	TM208		<3 #	<3 #
Dibromomethane	<2.7 µg/l	TM208		<2.7 #	<2.7 #
Bromodichloromethane	<0.9 µg/l	TM208		<0.9 #	<0.9 #
cis-1,3-Dichloropropene	<1.9 µg/l	TM208		<1.9 #	<1.9 #
Toluene	<1.4 µg/l	TM208		<1.4 #	<1.4 #
trans-1,3-Dichloropropene	<3.5 µg/l	TM208		<3.5 #	<3.5 #
1,1,2-Trichloroethane	<2.2 µg/l	TM208		<2.2 #	<2.2 #
1,3-Dichloropropane	<2.2 µg/l	TM208		<2.2 #	<2.2 #
Tetrachloroethene	<1.5 µg/l	TM208		<1.5 #	<1.5 #
Dibromochloromethane	<1.7 µg/l	TM208		<1.7 #	<1.7 #
1,2-Dibromoethane	<2.3 µg/l	TM208		<2.3 #	<2.3 #
Chlorobenzene	<3.5 µg/l	TM208		<3.5 #	<3.5 #
1,1,1,2-Tetrachloroethane	<1.3 µg/l	TM208		<1.3 #	<1.3 #
Ethylbenzene	<2.5 µg/l	TM208		<2.5 #	<2.5 #
p/m-Xylene	<2.5 µg/l	TM208		<2.5 #	<2.5 #
o-Xylene	<1.7 µg/l	TM208		<1.7 #	<1.7 #
Styrene	<1.2 µg/l	TM208		<1.2 #	<1.2 #

SDG:	100209-127	**Customer:**	Golder Associates
Job:	D_GOLDASS_NAS-31	**Attention:**	Gareth Byrne
Client Reference:	09507190002	**Order No.:**	
Location:	KTK L	**Report No:**	73956

VOC MS (W)

Results Legend

\# ISO17025 accredited.
M *m*CERTS accredited.
* subcontracted test.
** This result relates to the % recovery of the surrogate standard added to the sample to check on the efficiency of the method. Acceptable limits for most organic methods are 70 - 130 %. The results of the individual compounds within the sample are not corrected for this recovery.

Component	LOD/Units	Method	Sample Identity	DW10	DW8
			Depth (m)		
			Sample Type	Water(GW/SW)	Water(GW/SW)
			Date Sampled		
			Date Received	09/02/2010	09/02/2010
			SDG Ref	100209-127	100209-127
			Lab Sample No.(s)	981284	981249
Bromoform	<3 µg/l	TM208		<3 #	<3 #
Isopropylbenzene	<1.4 µg/l	TM208		<1.4 #	<1.4 #
1,1,2,2-Tetrachloroethane	<5.2 µg/l	TM208		<5.2	<5.2
1,2,3-Trichloropropane	<7.8 µg/l	TM208		<7.8 #	<7.8 #
Bromobenzene	<2 µg/l	TM208		<2 #	<2 #
Propylbenzene	<2.6 µg/l	TM208		<2.6 #	<2.6 #
2-Chlorotoluene	<1.9 µg/l	TM208		<1.9 #	<1.9 #
1,3,5-Trimethylbenzene	<1.8 µg/l	TM208		<1.8 #	<1.8 #
4-Chlorotoluene	<1.9 µg/l	TM208		<1.9 #	<1.9 #
tert-Butylbenzene	<2 µg/l	TM208		<2 #	<2 #
1,2,4-Trimethylbenzene	<1.7 µg/l	TM208		<1.7 #	<1.7 #
sec-Butylbenzene	<1.7 µg/l	TM208		<1.7 #	<1.7 #
4-Isopropyltoluene	<2.6 µg/l	TM208		<2.6 #	<2.6 #
1,3-Dichlorobenzene	<2.2 µg/l	TM208		<2.2 #	<2.2 #
1,4-Dichlorobenzene	<2.7 µg/l	TM208		<2.7 #	<2.7 #
n-Butylbenzene	<2 µg/l	TM208		<2 #	<2 #
1,2-Dichlorobenzene	<3.7 µg/l	TM208		<3.7	<3.7
1,2-Dibromo-3-chloropropane	<9.8 µg/l	TM208		<9.8	<9.8
1,2,4-Trichlorobenzene	<2.3 µg/l	TM208		<2.3 #	<2.3 #
Hexachlorobutadiene	<2.5 µg/l	TM208		<2.5 #	<2.5 #
Tert-amyl methyl ether	<1 µg/l	TM208		<1 #	<1 #
Naphthalene	<3.5 µg/l	TM208		<3.5 #	<3.5 #
1,2,3-Trichlorobenzene	<3.1 µg/l	TM208		<3.1 #	<3.1 #
1,3,5-Trichlorobenzene	<10 µg/l	TM208		<10	<10

Table of Results - Appendix

SDG Number : 100209-127 **Client :** Golder Associates **Client Ref :** 09507190002

REPORT KEY

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03x10-7

NDP	No Determination Possible	#	ISO 17025 Accredited	*	Subcontracted Test	M	MCERTS Accredited
NFD	No Fibres Detected	PFD	Possible Fibres Detected	»	Result previously reported (Incremental reports only)	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control

Method No	Reference	Description	Wet/Dry Sample [1]
SUB		Subcontracted Test	
TM043	Method 2320B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part109 1984	Determination of alkalinity in aqueous samples	
TM046	Method 4500G, AWWA/APHA, 20th Ed., 1999	Measurement of Dissolved Oxygen by Oxygen Meter	
TM090	Method 5310, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 415.1 & 9060	Determination of Total Organic Carbon/Total Inorganic Carbon in Water and Waste Water	
TM099	BS 2690: Part 7:1968 / BS 6068: Part2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser	
TM104	Method 4500F, AWWA/APHA, 20th Ed., 1999	Determination of Fluoride using the Kone Analyser	
TM120	Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter	
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS	
TM176	EPA 8270D Semi-Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Determination of SVOCs in Water by GCMS	
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry	
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers	
TM191	Standard Methods for the examination of waters and wastewaters 16th Edition, ALPHA, Washington DC, USA. ISBN 0-87553-131-8.	Determination of Unfiltered Metals in Water Matrices by ICP-MS	
TM208	Modified: US EPA Method 8260b & 624	Determination of Volatile Organic Compounds by Headspace / GC-MS in Waters	
TM228	US EPA Method 6010B	Determination of Major Cations in Water by iCap 6500 Duo ICP-OES	
TM231	Agilent 6890 Gas Chromatograph system using an Agilent 5973 Mass Selective Detector (MSD)	Determination of Organochlorine and Organophosphorus Pesticides and Triazine Herbicides by GCMS	
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter	
TM259			

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

APPENDIX

APPENDIX

1. Results are expressed on a dry weight basis (dried at 35°C) for all soil analyses except for the following: NRA Leach tests, flash point, ammonium as NH_4 by the BRE method, VOC TICS, SVOC TICS, TOF-MS SCAN/SEARCH and TOF-MS TICS.
2. Samples will be run in duplicate upon request, but an additional charge may be incurred.
3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for both soil jars, tubs and volatile jars. All waters and vials will be discarded 10 days after the analysis is completed (e-mailed). All material removed during an asbestos containing material screen and analysed for the presence of asbestos will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.
4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.
5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.
6. When requested, the individual sub sample scheduled will be screened in house for the presence of large asbestos containing material fragments/pieces. If no asbestos containing material is found this will be reported as 'no asbestos containing material detected'. If asbestos containing material is detected it will be removed and analysed by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If asbestos containing material is present no further analysis will be undertaken. At no point is the fibre content of the soil sample determined.
7. If no separate volatile sample is supplied by the client, the integrity of the data may be compromised if the laboratory is required to create a sub-sample from the bulk sample – similarly, if a headspace or sediment is present in the volatile sample. This will be flagged up as an invalid VOC on the test schedule or recorded on the log sheet.
8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.
9. NDP – No determination possible due to insufficient/unsuitable sample.
10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals – total metals must be requested separately.
11. A table containing the date of analysis for each parameter is not routinely included with the report, but is available upon request.
12. **Surrogate recoveries** – Most of our organic methods include surrogates, the recovery of which is monitored and reported. For EPH, MO, PAH, GRO and VOCs on soils the result is not surrogate corrected, but a percentage recovery is quoted.
13. **Product analyses** – Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors employed.
14. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).
15. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 14).
16. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.
17. Our MCERTS accreditation for PAHs by GCMS applies to all product types apart from Kerosene, where naphthalene only is not accredited.
18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.
19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.
20. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.
21. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.
22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials – whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C4 – C10 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

LIQUID MATRICES EXTRACTION SUMMARY

ANALYSIS	EXTRACTION SOLVENT	EXTRACTION METHOD	ANALYSIS
PAH MS	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC MS
EPH	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC FID
EPH CWG	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC FID
MINERAL OIL	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC FID
PCB 7 CONGENERS	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC MS
PCB TOTAL	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GS MS
SVOC	DCM	LIQUID/LIQUID SHAKEN SVOC	GC MS
FREE SULPHUR	DCM	SOLID PHASE EXTRACTION	HPLC
PEST OCP/OPP	DCM/EA	SOLID PHASE EXTRACTION	GC MS
TRIAZINE HERBS	DCM/EA	SOLID PHASE EXTRACTION	GC MS
PHENOLS MS	DCM	SOLID PHASE EXTRACTION	GC MS
TPH by INFRA RED (IR)	TCE	LIQUID/LIQUID EXTRACTION	HPLC
MINERAL OIL by IR	TCE	LIQUID/LIQUID EXTRACTION	HPLC
SAPONIFIABLE	TCE	LIQUID/LIQUID EXTRACTION	HPLC
UNSAPONIFIABLE	TCE	LIQUID/LIQUID EXTRACTION	HPLC
GLYCOLS	DCM	LIQUID/LIQUID EXTRACTION	EZ FLASH

SOLID MATRICES EXTRACTION SUMMARY

ANALYSIS	D/C OR WET	EXTRACTION SOLVENT	EXTRACTION METHOD	ANALYSIS
Solvent Extractable Matter	D&C	DCM	SOXTHERM	GRAVIMETRIC
Cyclohexane Ext. Matter	D&C	CYCLOHEXANE	SOXTHERM	GRAVIMETRIC
Thin Layer Chromatography	D&C	DCM	SOXTHERM	IATROSCAN
Elemental Sulphur	D&C	DCM	SOXTHERM	HPLC
Phenols by GCMS	WET	DCM	SOXTHERM	GC-MS
Herbicides	D&C	HEXANE:ACETONE	SOXTHERM	GC-MS
Pesticides	D&C	HEXANE:ACETONE	SOXTHERM	GC-MS
EPH (DRO)	D&C	HEXANE:ACETONE	END OVER END	GC-FID
EPH (Min oil)	D&C	HEXANE:ACETONE	END OVER END	GC-FID
EPH (Cleaned up)	D&C	HEXANE:ACETONE	END OVER END	GC-FID
EPH CWG by GC	D&C	HEXANE:ACETONE	END OVER END	GC-FID
PCB tot / PCB con	D&C	HEXANE:ACETONE	END OVER END	GC-MS
Polyaromatic Hydrocarbons (MS)	WET	HEXANE:ACETONE	Microwave TM218.	GC-MS
C8-C40 (C6-C40)EZ Flash	WET	HEXANE:ACETONE	SHAKER	GC-EZ
Polyaromatic Hydrocarbons Rapid GC	WET	HEXANE:ACETONE	SHAKER	GC-EZ
Semi Volatile Organic Compounds	WET	DCM:ACETONE	SONICATE	GC-MS

Identification of Asbestos in Bulk Materials

The results for asbestos identification for soil samples are obtained from possible Asbestos Containing Material, removed during the 'Screening of soils for Asbestos Containing Materials', which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Visual Estimation Of Fibre Content.

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: -

Trace – Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in MDHS 100.

The identification of asbestos containing materials falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

APPENDIX D

Annual Quantities of Landfill Gas Collection for Flaring and Utilisation during 2010

Month	Utilisation (MWhr)	LFG Utilised (m3)	LFG % of Total	Total LFG Collected	Total LFG Collected	GAS QUALITY (% v/v)			Total Methane Collected	Total Carbon Dioxide Collected	Total Methane Collected
				(m3)	(m3/hr)	CH4	CO2	O2	(kg)	(kg)	(kg/day)
Jan-10	1082.4	584,842	23	2,509,417	3,373	41.9	30.4	2.6	766,435	1,498,001	24,724
Feb-10	1398.9	754,136	36	2,091,173	3,112	42.6	32.6	1.3	645,441	1,284,282	23,051
Mar-10	2128.3	1,123,828	52	2,177,626	2,927	42.5	33.2	1.7	668,059	1,382,244	21,550
Apr-10	1990.0	1,082,568	53	2,051,129	2,849	42.1	32.8	1.9	636,073	1,322,902	21,202
May-10	2102.9	1,120,745	54	2,067,733	2,779	41.2	32.7	1.7	630,410	1,323,312	20,336
Jun-10	1865.8	1,063,118	58	1,837,700	2,552	40.5	32.6	1.6	584,248	1,201,867	19,475
Jul-10	2353.1	1,332,109	72	1,853,100	2,501	40.5	29.0	2.8	593,575	1,191,540	19,148
Aug-10	2541.7	1,491,937	96	1,557,600	2,094	47.8	34.4	1.8	533,607	1,050,196	17,213
Sep-10	2222.5	1,271,821	82	1,549,900	2,153	46.6	33.6	1.5	516,940	1,024,179	17,231
Oct-10	2443.5	1,410,290	88	1,599,400	2,150	46.3	34.6	1.8	538,744	1,050,211	17,379
Nov-10	2095.1	1,157,752	81	1,425,788	1,980	42.1	29.7	3.0	458,085	898,418	15,269
Dec-10	1824.9	1,062,223	78	1,366,942	1,893	43.3	30.1	3.1	448,206	852,804	14,940
Total Collected	**24,049**	**13,455,369**	**61**	**22,087,508**	**2,530.2**	**43.1**	**32.1**	**2.1**	**7,019,823**	**14,079,958**	**19,293**

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Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ireland Limited
Town Centre House
Dublin Road
Naas
Co. Kildare
Ireland
T: +353 45 87 4411

Golder Associates

ODOUR & ENVIRONMENTAL ENGINEERING CONSULTANTS

Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922
Fax: +353 46 9483696
Mobile: +353 86 8550401
E-mail: info@odourireland.com
www.odourireland.com

TITLE: AIR EMISSION TESTING OF TWO LANDFILL FLARES AND THREE GAS UTILISATION ENGINES LOCATED IN KTK LANDFILL, BROWNSTOWN AND CARNALWAY, KILCULLEN, CO. KILDARE

PREFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF GREENSTAR HOLDINGS LTD.

PREPARED BY:	Dr. John Casey
ATTENTION:	Mr. Tom Finnegan
LICENCE NUMBER:	WL0081-3
LICENCE HOLDER:	Greenstar Holdings Ltd.
FACILITY NAME:	KTK Landfill Facility
DATE OF MONITORING VISIT:	11th Jan. 2011 rescheduled from 07th Dec. 2010 due to bad weather
NAME AND ADDRESS OF CLIENT ORGANISATION:	KTK landfill, Brownstown and Carnalway, Kilcullen, Co
NAME AND ADDRESS OF MONITORING ORGANISATION:	Odour Monitoring Ireland, Unit 32 DeGranville Court, Dublin Road, Trim, Co. Meath
DATE OF REPORTING:	03rd Feb 2011
NAME AND THE FUNCTION OF THE PERSON APPROVING THE REPORT:	Dr. Brian Sheridan, Managing Partner, Odour Monitoring Ireland
REPORT NUMBER:	2011A48(1)
REVIEWERS:	

TABLE OF CONTENTS

Document Amendment Record

Client: ***Greenstar Holding's Ltd.***

Project: Air emission testing of two Landfill flares and three gas utilisation engines located in KTK landfill, Brownstown and Carnalway, Kilcullen, Co Kildare.

Project Number: 2011A48(1)			**Document Reference:** Air emission testing of two Landfill flares and three gas utilisation engines located in KTK landfill, Brownstown and Carnalway, Kilcullen, Co Kildare.		
2011A48(1)	Document for review	B.A.S.	JMC	B.A.S	03/02/2011
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

Signing sheet

_____

Brian Sheridan Ph.D Eng

For and on behalf of Odour Monitoring Ireland

1. Executive Summary

The results of the monitoring exercise are contained in Section 2 of this report.

- NO_x as NO_2, TNMVOC, CO and TOC emissions from GE01, GE02, GE03, Flare 1 and Flare 2 were within the emission limit values specified in Waste licence W0081-3.

1.1 Monitoring Objectives

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 2 No. Enclosed ground flares and 3 No. Gas utilisation engines at KTK landfill, Brownstown and Carnalway, Kilcullen, Co Kildare. The monitoring was carried out at this facility as part of compliance monitoring with the requirements of Waste licence W0081-03. The emission testing was carried out by Odour Monitoring Ireland on behalf of Greenstar Holdings Ltd.

1.2 Special Monitoring Requirements

There were no special monitoring requirements for this campaign.

1.3 The substances to be monitored at each emission point

The parameters listed in *Table 1.1* were monitored using the appropriate instrumentation as illustrated in *Table 1.1*. All monitoring was carried out in accordance with Environmental Protection Agency Office of Environmental Enforcement (OEE) Air Emission Monitoring Guidance Note 2 (AG2).

Table 1.1. Monitored parameters and techniques for KTK Landfill 2 No. Enclosed flares and 3 No. Gas utilisation engines.

Sample location	Parameter	Analytical method
2 Landfill Flares and 3 Gas utilisation engines GE01, GE02 and GE03 outlets	Volumetric airflow rate & Temperature (^{0}C)	Pitot in accordance with EN13284-1 where possible. MGO coated K type thermocouple and PT100 Volumetric airflow rate theoretical calculated for Landfill flare.
2 Landfill Flares and 3 Gas utilisation engines GE01, GE02 and GE03 outlets	Oxides of nitrogen (NO_X as NO_2), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), and Oxygen (O_2)	Flue gas analyser, Testo 350/454 MXL
2 Landfill Flares and 3 Gas utilisation engines GE01, GE02 and GE03 outlets	Total non methane VOC's	Portable Signal 3030PM FID calibrated with Propane in accordance with EN13526:2002 non- methane hydrocarbon cutter. Charcoal tube/GCMS
2 Landfill Flares and 3 Gas utilisation engines GE01, GE02 and GE03 outlets	Total Volatile Organic Carbon	Portable Signal 3030PM FID calibrated with Propane in accordance with EN13526:2002.

This report presents details of this monitoring programme. This environmental monitoring was carried out Dr. John Casey, Managing Partner, Odour Monitoring Ireland on the 11th January 2011. The scheduled monitoring on the 7th of December 2010 could not be carried out due to safety concerns of using a cherry picker with the conditions on the site as a result of the recent heavy snow fall. Methodology, Results, Discussion and Conclusions are presented herein.

2. Monitoring Results

This section will present the results of the monitoring exercise.

2.1 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load
GE01	11/01/2011	Gas Utilisation Engine	Continuous	Landfill Gas	N/A	None	Landfill Gas
GE02	11/01/2011	Gas Utilisation Engine	Continuous	Landfill Gas	N/A	None	Landfill Gas
GE03	11/01/2011	Gas Utilisation Engine	Continuous	Landfill Gas	N/A	None	Landfill Gas
Flare 1[1]	11/01/2011	Landfill flare	Continuous	Landfill Gas	N/A	None	Landfill Gas
Flare 2[2]	11/01/2011	Landfill flare	Continuous	Landfill Gas	N/A	None	Landfill Gas

Note: [1] Flare 1 is located in the landfill gas compound
[2] Flare 2 is located down to the back of the facility

2.2 Monitoring Result Reference Conditions

Emission Point Reference	Temperature (K)	Pressure	Moisture Correction	Oxygen Correction (%)
GE01	K	101.3	Yes	5
GE02	K	101.3	Yes	5
GE03	K	101.3	Yes	5
Flare 1	K	101.3	Yes	3
Flare 2	K	101.3	Yes	3

2.3. Sampling Location Summary

Comment	Yes/No
Recommended 5 hydraulic diameters straight length before sampling plane	Yes
Recommended 2 hydraulic diameters straight length after sampling plane	Yes
Ports number <1.5m - 2 ports >1.5m - 4 ports	1 port on flares
Appropriate port size	Yes
Suitable working platform	Yes

Note: Temperature and airflow rate traverse measurements were performed across the stack in one plane only on the flares. Airflow rate was carried out on GE01, GE02 and GE03 in accordance with EN13284:2002.

2.4. Sampling time runs on the 11th Jan. 2011 for monitoring of two landfill flares and 3 gas utilisation engines.

Parameter	Approx. Sampling period for 2 landfill flares	Approx. Sampling period for 3 gas utilisation engines
Inlet CH_4	45 minutes	40 minutes
Inlet O_2	45 minutes	40 minutes
Volumetric air flow rate	Theoretically calculated	Manually calculated
SO_2	45 minutes	45 minutes
NO_x	45 minutes	45 minutes
CO	45 minutes	45 minutes
O_2	45 minutes	45 minutes
CO_2	45 minutes	45 minutes
Stack gas temp	45 minutes	45 minutes
THC	45 minutes	45 minutes
TNMVOC	-	45 minutes
TOC	45 minutes	-

2.5. Characteristics of raw inlet gas to 2 enclosed Landfill flares gas burner and 3 No. Gas utilisation engines.

Inlet compound identity	Flare 1	Flare 2	Unit values
CH_4	43.1	45.9	%
CO_2	31.02	30.5	%
O_2	1.2	1.1	%
Total Landfill gas volumetric airflow rate	854	499	m^3/hr

2.6. Theoretically calculated landfill gas exhaust volume and physical characteristics from the Landfill flare.

Parameter	Enclosed flare 1	Enclosed flare 2
Total Volumetric methane loading (m^3/hr)	368	229
Total Volumetric Oxygen loading (m^3/hr)	10.2	5.4
Ratio to complete combustion of methane assuming no excess Oxygen	9.57	9.57
Oxygen concentration level in flue gas (%)	9.15	10.03
Flue gas temperature (Kelvin)[2]	1328	1279
Theoretical calculated Volumetric exhaust airflow rate (m^3/h)	7,766	5,163
Normalised average exhaust airflow rate ($Nm^3\ h^{-1}$)[3]	1,596	1,102

Notes: [1] denotes data from 11th Jan. 2011.
[2] denoted converted from degrees Celsius to Kelvin ($^0C + 273.15$);
[3] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 2.4. Emission value results from landfill gas flare 1

Parameter	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission concentration to 3% (mgN/m^3)	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
Carbon monoxide (CO)	2	ppm	2.50	3.81	-	-	As Normal
Temperature	1055	degrees	1328.15K	-	-	>1273K	As Normal
Oxygen (O_2)	9.15	%	9.15	-	-	-	As Normal
Oxides of nitrogen (NO_X as NO_2)	28	ppm	57.50	87.60	15.51	150 mg/Nm^3	As Normal
Sulphur dioxide (SO_2)	122	ppm	348	531	-	-	As Normal
Carbon dioxide (CO_2)	10.03	%	10.03	-	-	-	As Normal
Total Organic Compound (TOC)	38	ppm	60.80	92.67	-	-	As Normal
Volumetric Airflow rate (Nm^3/hr)	-	-	-	1,048	-	<3,000	As Normal

Table 2.5. Emission value results from landfill gas flare 2

Parameter	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission concentration to 3% (mgN/m^3)	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
Carbon monoxide (CO)	2.5	ppm	3.13	5.15	-		As Normal
Temperature	1006	degrees	1279K	-	-	>1273K	As Normal
Oxygen (O_2)	10.03	%	-	-	-		As Normal
Oxides of nitrogen (NO_X as NO_2)	27	ppm	55.45	91.31	16.04	150 mg/Nm^3	As Normal
Sulphur dioxide (SO_2)	130	ppm	371.43	611.64	-	-	As Normal
Carbon dioxide (CO_2)	9.84	%		-	-	-	As Normal
Total Organic Compound (TOC)	21	ppm	33.60	55.33	-	-	As Normal
Volumetric Airflow rate (Nm^3/hr)	-	-	-	669	-	<3,000	As Normal

Table 2.6. Emission value results from GE01

Parameter	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission concentration to 5% (mgN/m^3)	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
Total Organic Compound (TOC)	345	ppm	552	594	5.26	1000 mg/Nm^3	As Normal
Temperature	387.5	degrees	661K	-	-	-	As Normal
Carbon monoxide (CO)	643	ppm	804	865	5.36	1400 mg/Nm^3	As Normal
Oxygen (O_2)	6.13	%	6.13	-	-	-	As Normal
Oxides of nitrogen (NO_X as NO_2)	104	ppm	213.57	229.91	4.22	500 mg/Nm^3	As Normal
Sulphur dioxide (SO_2)	74	ppm	211.43	227.60	-	-	As Normal
Carbon dioxide (CO_2	11.08	%	11.08	-	-	-	As Normal
Total non methane Volatile organic compounds (TNMVOC)	13	ppm	20.80	22.39	0.21	75 mg/Nm^3	As Normal
Volumetric Airflow rate (Nm^3/hr)	-	-	-	2,520	-	-	As Normal

Table 2.7. Emission value results from GE02

Parameter	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission concentration to 5% (mgN/m^3)	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
Total Organic Compound (TOC)	315	ppm	504	727	7.35	1000 mg/Nm^3	As Normal
Temperature	346.8	degrees	620K	-	-	-	As Normal
Carbon monoxide (CO)	563	ppm	704	1014	6.72	1400 mg/Nm^3	As Normal
Oxygen (O_2)	9.87	%	9.87	-	-	-	As Normal
Oxides of nitrogen (NO_X as NO_2)	91	ppm	186.88	269.38	5.31	500 mg/Nm^3	As Normal
Sulphur dioxide (SO_2)	96	ppm	274.29	395.39	-	-	As Normal
Carbon dioxide (CO_2	10.54	%	10.54	-	-	-	As Normal
Total non methane Volatile organic compounds (TNMVOC)	13.5	ppm	21.6	31.14	0.31	75 mg/Nm^3	As Normal
Volumetric Airflow rate (Nm^3/hr)	-	-	-	1908	-	-	As Normal

Table 2.8. Emission value results from GE03

Parameter	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission concentration to 5% (mgN/m^3)	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
Total Organic Compound (TOC)	328	ppm	525	556	4.72	1000 mg/Nm^3	As Normal
Temperature	355	degrees	628	-	-	-	As Normal
Carbon monoxide (CO)	432	ppm	540	572	3.42	1400 mg/Nm^3	As Normal
Oxygen (O_2)	5.89	%	5.89	-	-	-	As Normal
Oxides of nitrogen (NO_X as NO_2)	114	ppm	234	248	4.33	500 mg/Nm^3	As Normal
Sulphur dioxide (SO_2)	168	ppm	480	508	-	-	As Normal
Carbon dioxide (CO_2	11.32	%	11.32	-	-	-	As Normal
Total non methane Volatile organic compounds (TNMVOC)	12.8	ppm	20.48	21.69	0.2	75 mg/Nm^3	As Normal
Volumetric Airflow rate (Nm^3/hr)	-	-	-	2285	-	-	As Normal

3. Discussion of results

Tables 2.1 to *2.8* present the results of the emission monitoring carried out on the 2 landfill flares stack burner and three utilisation engines located in KTK landfill, Brownstown and Carnalway, Kilcullen, Co Kildare.

There was very little variation at one traverse in oxygen and flue gas temperature profiles across the stack during the monitoring exercise (i.e. less than 15% as recommended by the Environment Agency, UK (Environment Agency, 2002)).

A high temperature Inconel 625 and ceramic probe (Testo, Germany) was used to prevent variations in CO emissions data. Normal stainless steel probes when subjected to temperatures above 600^0C can release CO from within the structure of the material and cause the recording of erroneous results (Environment Agency, 2002).

Correction of data to 3% & 5% oxygen was performed. Due to possible inaccuracies in airflow rate measurement, it was not possible to determine the oxygen intake of the flare through the louver system using measurement. Since the volume of intake air required for complete combustion was known and the oxygen concentration in the exhaust flue gas was known, the volume of intake excess fuel air could be theoretically calculated through numerous iterations using the Solver program (i.e. Microsoft Excel). This allows for the calculation of the volume of intake excess air through the louver landfill flare intake system (Environment Agency, 2002).

4. Conclusion

The following conclusions can be drawn from this study:

1. A theoretically exhaust flue gas volume was calculated for the landfill flares. Actual measurements were performed on the three gas utilisation engines GE01, GE02 and GE03.
2. NO_x as NO_2, SO_2, CO, O_2, TNMVOC, and TOC monitoring and analysis was carried out in accordance with specified requirements;
3. All data was standardised to 273.15 Kelvin, 101.3 kPa;
4. All data is presented as Oxygen corrected to 3% and 5% (v/v) using the appropriate equations;
5. NO_x as NO_2, TNMVOC, CO and TOC emissions from GE01, GE02, GE03, Flare 1 and Flare 2 were within the emission limit values specified in Waste licence W0081-3.

5. References

1. Environment Agency. (2002). Guidance for Monitoring Enclosed Landfill Gas Flares. www.environment-agency.co.uk
2. McVay, M., (2003). Personal communication. Environment Agency, Wales, UK.
3. Environmental Protection Agency. (2009). Air Emissions Monitoring Guidance Note 2 (AG2).
4. ISO 10780, (1984). Stationary source emissions-Measurement of velocity and volume flow rate of gas streams in ducts.

- IS EN13526:2002-Stationary source emissions-Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes-Continuous flame ionisation detector method.
- IS EN12619:1999-Stationary source emissions-Determination of the mass concentration of total gaseous organic carbon at low concentrations in flue gases-Continuous flame ionisation detector method.
- I.S. EN13649:2002-Stationary source emissions-Determination of the mass concentration of individual gaseous organic compounds-Activated carbon and solvent desorption method.

6. *Appendix I*-Sampling, analysis

6.1.1 Location of Sampling

KTK landfill, Brownstown and Carnalway, Kilcullen, Co Kildare,

6.1.2 Date & Time of Sampling

11th Jan. 2011

6.1.3 Personnel Present During Sampling

Dr. John Casey, Odour Monitoring Ireland, Trim, Co. Meath.
MCERTS level 1: MM0674

6.1.4 Instrumentation check list

Testo 350 MXL/454 in stack analyser;
Federal Method 2 S type pitot and MGO coated thermocouple;
L type pitot tube
Testo 400 handheld and appropriate probes.
Ceramic and Inconel 625 sampling probes.
Portable Signal 3030PM FID calibrated with Propane with non-methane hydrocarbon cutter.

ODOUR & ENVIRONMENTAL ENGINEERING CONSULTANTS

Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922
Mobile: +353 86 8550401
E-mail: info@odourireland.com
www.odourireland.com

AIR EMISSION TESTING OF TWO LANDFILL FLARES AND THREE GAS UTILISATION ENGINES LOCATED IN KTK LANDFILL, BROWNSTOWN AND CARNALWAY, KILCULLEN, CO. KILDARE

PREPARED BY:	Dr. John Casey
ATTENTION:	Mr. Michael Bergin
REFERENCE:	Waste licence W0081-3
DATE:	14th July 2010
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1. Introduction

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 2 No. Enclosed ground flare and 3 No. Gas utilisation engines at KTK Landfill, Brownstown and Carnalway, Kilcullen, Co Kildare. The emission testing was carried out in compliance with the requirements of *Waste licence W0081-3*.

Odour Monitoring Ireland was requested by Mr. Michael Bergin, Landfill Manager, KTK Landfill to perform emission testing of the 2 flares and 3 gas utilisations stacks (GE01, GE02 and GE03), respectively located within KTK Landfill, Brownstown and Carnalway, Kilcullen, Co Kildare. The parameters listed in *Table 1.1* were monitored using the appropriate instrumentation as illustrated in *Table 1.1*.

Table 1.1. Monitored parameters and techniques for KTK Landfill 2 No. Enclosed flare and 3 No. Gas utilisation engines, KTK Landfill, Brownstown and Carnalway, Kilcullen, Co Kildare

Sample location	Parameter	Analytical method
2 Landfill Flares and 3 Gas utilisation engines GE01, GE02 and GE03 outlets	Volumetric airflow rate & Temperature (^{0}C)	Pitot method in accordance with EN13284-1:2002. MGO coated K type thermocouple and PT100 Theoretical calculated for Landfill flare
2 Landfill Flares and 3 Gas utilisation engines GE01, GE02 and GE03 outlets	Oxides of nitrogen (NO_X), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), and Oxygen (O_2)	Flue gas analyser, Testo 350/454 MXL
2 Gas utilisation engines GE01, GE02 and GE03 outlets	Total non methane VOC's	Total non methane hydrocarbon cutter in conjunction with Portable Signal 3030 PM Heated FID
3 Gas utilisation engines GE01, GE02 and GE03 outlets	Total Volatile Organic Carbon	Portable Signal 3030PM FID calibrated with Propane
3 Gas utilisation engines GE01, GE02 and GE03 outlets	Total Particulates	TCR Tecora particulates sampling train in accordance with EN13284-1:2002

This report presents details of this monitoring programme. This environmental monitoring was carried out by Dr. Brian Sheridan, Odour Monitoring Ireland on the 02nd June 2010. Methodology, Results, Discussion and Conclusions are presented herein.

2. Materials and Methods

This section provides brief details of the methodology employed to perform emission testing of the three-landfill flares and three gas utilisation engine stacks located in KTK Landfill, Brownstown and Carnalway, Kilcullen, Co Kildare.

2.1 Volumetric flow rate and temperature measurement

The volumetric flow rate of the landfill flare was determined from theoretically calculated total volumetric flow rates using the assumptions presented in *Appendix II*. The inlet landfill gas velocity. Airflow rate measurement was performed in accordance with EN13284-1:2002, Stationary source emissions. Determination of low range mass concentration of dust-Manual gravimetric method. The following equipment was used through the airflow rate assessment.

These included:

- Testo 400 and 350/454 MXL handheld and differential pressure sensors,
- L type pitot probe,
- PT100 temperature probe,

The following control procedure was used through the measurement sequence for the gas utilisation engines:

1. Measurement was performed at two diameters at right angles to each other,
2. The internal diameter of the ductwork was measured and verified,
3. Approximately 5 duct diameters were available between the measurement point and the nearest obstruction,
4. The temperature profile across the stack was verified and did not differ by more than 5% from the average absolute temperature of the duct cross section,
5. Six individual samples points excluding the duct centre point was used to determine the average flow at specified locations across the duct diameter. No sample point was located within 20 mm of the duct wall.
6. The difference in the average airflow velocity across each diameter did not exceed 5% of the mean for all the diameters (2 in total).
7. The number of sample points across the 2 diameters was determined in accordance with EN13284-1:2002. The sample locations were marked upon the L type pitot using a water resistant marker.
8. The L type pitot was checked for any burrs and obstructions in the pitot orifices,
9. The absence of swirling flow was determined in accordance with EN13284-1:2002.
10. The measurement sequence was performed in accordance with the procedure described in Section 5 and Annex C-EN13284-1:2002.

The airflow rate measurement was used to ascertain the volumetric airflow from each engine in order to determine the mass emission rate from each engine.

2.2 In stack analysis of flue gases

Flue gas analysis was performed using a pre-calibrated Testo 350 MXL/454 flue gas analyser. Concentrations of oxygen, sulphur dioxide, carbon dioxide, temperature, carbon monoxide and oxides of nitrogen were measured using electrochemical cells within the analyser box and all data was logged electronically in 1 minute intervals during the sampling exercise. Data was downloaded from the control handheld using the Com soft software and average concentrations calculated are presented within. All results presented are at 273.15 K, 101.3 kPa on a dry gas basis.

2.3 Total Organic Compound determination

A heated portable FID heated line, controller and data logger was used to analyse the duct air stream for total hydrocarbon concentration. Once stabilised and calibrated using span gas (Propane-800 ppm; European standard), a sintered probe connected to a 181 ^{0}C heated line was place in the air stream. After stabilisation, the data logger was activated and commences reading. The FID remained analysing continuously for approximately 45 minutes in the duct air stream. Results were presented as mg [TOC] m^{-3} as propane. All measurement was performed in accordance with the methodologies contained within EN13526:2002 and EN12619:1999.

An FID operates on the principle where influent contaminated gas is mixed with hydrogen and the mixture is burned at the tip of a jet with air or oxygen. Ions and free electrons are formed in the flame and enter a gap between two electrodes, the flame jet and a collector, mounted 0.5-1.0 centimetres above the flame tip. A potential (400 volts) is applied across the two electrodes and with the help of produced ions, a very small current flows between the two electrodes. When an organic substance is introduced this is burned in the flame; a complex process takes place in which positively charged carbon species and electrons are formed. The current is greatly increased and therefore the sample is detected. The FID is a mass flow detector, its response depending directly on the flow rate of the carrier gas. Its response also varies with applied voltage and the temperature of the flame.

2.4 Total non-methane volatile organic compound determination

In order to measure total non-methane VOC, a total non-methane hydrocarbon cutter was placed in line with the FID whereby concentrations of total volatile organic carbon and total non-methane organic were displayed digitally upon the display. This allowed for the calculation of total non-methane VOC's. All results are presented in mg/Nm^{3} as propane which is in accordance with the EN13526:2002 and EN12619:1999.

2.5 Total Particulate sampling and analysis

Samples of the gas stream were extracted through a probe and filter holder arrangement containing a pre-conditioned and pre-weighed quartz fibre filter using a TCR automated iso-kinetic sampling train. Sampling was performed in accordance with BS EN13284-1:2002, where possible. Emissions were measured over approximately 15 -minute period in duplicate.

Upon completion of sampling, the filters were placed in its original container and sealed. All sampled were labelled and logged onto a laboratory submission sheet. All filters were sent to a UKAS accredited laboratory for gravimetric analysis. Filter head wash was also packaged into a sealed container for gravimetric analysis. Results are presented in mg Nm^{-3} at standard temperature of 273.15K and standard pressure of 101.3 kPa without correction for moisture content.

2.5.1 Total Particulate matter sampling methodology

2.5.1.1 Job preparation

A pre-site survey must first be taken to obtain the following information. Client details (name and address), description of stack to include name and location), sample platform/access, Hazards, Power supply and location, additional PPE required.

The Iso stack TCR Tecora automatic isokinetic particulates measurement equipment is fully inspected prior to use and its calibration stats observed. This includes:

Pitot tube-All pitot tubes are checked for damage/burrs, paying particular attention to the inlet holes. All dirt and blockages are removed.

Micro manometer-Digital differential pressure metres that are used are capable of measuring in the range of 0 Pa to 2250 Pa with a sensitivity of ±1 Pa. The instrument is checked for physical damage, battery life test and calibration status observed.

Nozzles-All nozzles used have been constructed in accordance with EN13284-1 and ISO 9096:2003. Each nozzle is physical checked for damage and removed if necessary. The nozzle calibration status is observed.

Flow metre-The flow metre is checked for blockages and obvious physical damage. Its calibration status is also observed.

Rope kit-All lifting tackle are physical checked for cuts and contamination.

Laboratory-The gravimetric testing house selected is UKAS accredited for the particular test method.

2.5.1.2 Filter selection and preparation

Stack conditions can vary for temperature, moisture, acidity, low and heavy particulate loading. Following the pre-site survey, the stack condition should be known and the appropriate filter can be selected and prepared as described below.

Filter mediums-glass wool, quartz wool, Low ash PVC membranes and a range of thimbles can be used depending on stack characteristics. Quartz filters were used in this instance as glass fibre filters can react to SO_3 and lead to overweight measurement.

Filters are prepared by drying in an oven at 180^0C for a period of 1 hour and placed in a dessicator to cool. The filters are weighed accurately on a 4-figure balance and then placed in clean filter holder before transport to site. Spare filters are also prepared.

2.5.2 Sampling location

2.5.2.1 Suitability of sampling location

Before sampling can commence, a preliminary velocity and temperature survey must be undertaken along the two sampling lines at nine equally concentric spaced areas in the stack. This is performed in accordance with ISO13284-1:2002. The following procedures were followed. The stack diameter is measured using a steel rod. The angle of gas flow must be less than 15^0 with regard to duct axis. There should be no local negative flow. The minimum velocity should be larger than 5 Pa for Pitot tube measurement. Sampling is undertaken from either four or eight sampling points on each plane. Sampling points shall be located either more than 3% of the sampling line length or more than 5 cm whichever is the greater value from the inner wall. If the ratio of the highest to the lowest dynamic pressure exceeds 9:1 of the ratio of the highest to lowest gas velocity exceeds 3:1, another sampling plane should be used. Sampling is undertaken from either four sampling points on each plane. Temperature is also measured at nine equally spaced points along the sampling line and average temperature calculated during the initial survey. Should the temperature at any of the sampling points differ by more that ±10% from that of the average, then that point must not be used.

The required number of sampling points can now be calculated using the following:

- 8 point sampling, circular stacks 0.067 X D, 0.25 X D, 0.75 X D, 0.933 X D.

2.5.2.2 Leak checks

A leak check is undertaken before and after the isokinetic sampling is carried out. This is to make sure that all intake volume is through the sampling nozzle.

2.5.2.3 Sampling

Once the isokinetic sampling flow rates have been calculated, the probe is inserted into the stack at 90^0 to the stack gas flow, as not to impinge any particulate matter on to the filter media prior to sampling. The filter head is allowed to attain stack temperature. The pump is started and the nozzle is turned into the flow and the timing device is started (automatic on TCR Tecora kit).

2.5.2.4 Duration of sampling

Duration of sampling time depends on:

- Ensuring adequate quantities of particulate matter on the filter for weighing (> 0.3% of the filter weight),
- Whether cumulative or incremental sampling is undertaken,
- The number of sampling points,
- The continuity of the plant operation.

2.5.2.5 Cumulative sampling

After the first sample is taken from the first sampling location, the probe is moved to the next position and the values recorded. This should be performed until all sampling points have been used. Sampling is continued till all locations are sampled.

2.5.2.6 Repeat Velocity and temperature readings.

Since the TCR Tecora is an automatic system, continuous velocity and temperature readings are carried out using the instrument. All data is stored upon the on board computer and recorded following the sampling event. The % DI (deviation) is also computed and recorded continuously.

2.5.2.7 Weighing of the sample

When finished, the sample filter is placed in its container and all particulate from the filter head is added to the particulate matter on the filter (i.e. filter wash).

The used filter is placed in an over at 160^0C for at least 1 hour and dried thoroughly, cooled and equilibrated is a dessicator and weighed as quickly as possible so as to avoid any errors to moisture. The gross weight of the filter should be measured to within $\pm$0.01 to 0.10 mg. The filter weight and any of the residual particulate matter from the filter head can then be used in the final report to calculate the particulate concentration.

3. Results-Emission testing.

3.1 Sampling time

Table 3.1 summarises the sampling time that was carried out on the individual stacks. *Table 3.2* illustrates the inlet landfill gas parameters as characterised from the CEMS analyser system operating within the landfill flare control building. Additionally, manual monitoring was performed using a GA2000 landfill gas analyser.

All outlet gas samples were taken approximately 1.80 metres below the top of the stack for the landfill flare No. 1 and 2 and 2.50 metres for GE01, GE02 and GE03. All sampling was performed through the existing 25mm and 100 mm sampling ports on the landfill flares and gas utilisation engines, respectively. A one-plane oxygen and temperature traverse was performed to assess any difference in oxygen concentrations and temperature across the sampling plane for the landfill flares. Temperature and Oxygen differences were less than the 15% deviation level as recommended by the UK Environmental Agency (Guidance for monitoring enclosed Landfill flares, 2002).

3.2 Volumetric flow rate results

Sampling for airflow rate was performed in accordance with EN13284-1:2002 for the gas utilisation engines. *Table 3.3* summarises the theoretical airflow rate calculations for the Landfill gas flares No. 1 and 2. The data obtained for the three gas utilisation engines was measured. *Table 3.3* includes the stack velocity, expressed in metres per second (m s^{-1}) and exhaust volumetric airflow rate expressed in m^3 hr^{-1} at both actual and standard reference conditions of 273.15 K, 101.3 kPa (i.e. standard temperature and pressure).

3.3 Flue gas concentration results

Flue gas concentrations were monitored using a pre-calibrated Testo 350/454 MXL flue gas analyser. The results of SO_2, NO_x as NO_2 + NO, CO, CO_2 and O_2 are presented in *Table 3.4*. The results of ppm have been converted to mg/Nm^3 at 273.15 K, 101.3 kPa, on a dry gas basis with correction for oxygen content. In accordance with EPA flare/gas utilisation engine monitoring requirements, Oxygen correction to 3% and 5% should be performed for landfill gas flares and gas utilisation engines, respectively. The average temperature of the gas analyser on the day of sampling was 290.15 K.

3.4 Total Organic Compound (TOC) results

TOC concentrations were monitored using a pre-calibrated Signal 3030PM analyser. The results of TOC are presented in *Table 3.4*. The results of ppm have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa, with correction for oxygen content. Conversion from ppm to mg m^{-3} was performed using a 1.60 multiplication factor for propane. In accordance with EPA monitoring requirements, Oxygen correction to 5% should be performed for gas utilisation engines. The average temperature of the FID on the day of sampling was 454 K.

3.5 Total non-methane volatile organic compound (TNMVOC) results

Total non-methane volatile organic compound (TNMVOC) concentrations were monitored using a total non methane hydrocarbon cutter. The results of TNMVOC's are presented in *Table 3.4*. The results are presented as mg Nm^{-3} at 273.15 K, 101.3 kPa, with correction for oxygen content. In accordance with EPA flare/gas utilisation engine monitoring requirements, Oxygen correction to 3% and 5% should be performed for landfill gas flares and gas utilisation engines, respectively. The average temperature of the FID on the day of sampling was 454 K.

3.6 Total particulates concentration result

Total Particulates concentrations were monitored using a TCR Tecora automated Particulates sampler. The results of Total Particulates are presented in *Table 3.4.* The results of mg/m^3 have been converted to mg/Nm^3 at 273.15 K, 101.3 kPa, with correction for oxygen content. In accordance with EPA flare/gas utilisation engine monitoring requirements, Oxygen correction to 3% and 5% should be performed for landfill gas flares and gas utilisation engines, respectively.

Table 3.1. Sampling time runs on the 02nd June 2010

Parameter	**Approx. Sampling period for 3 No. landfill flares**	**Approx. Sampling period for gas utilisation engines GE01, GE02, GE03 each**
Volumetric air flow rate	Theoretically calculated	Manually calculated
SO_2	30 minutes	30 minutes
NO_x	30 minutes	30 minutes
CO	30 minutes	30 minutes
O_2	30 minutes	30 minutes
CO_2	30 minutes	30 minutes
Stack gas temp	30 minutes	30 minutes
TOC	-	45 minutes
TNMVOC	-	45 minutes
Total Particulates		30 minutes

Table 3.2. Characteristics of raw inlet landfill gas to the 2 No. Enclosed Landfill flares gas burners.

Inlet compound identity	**2500 Enclosed flare Unit[1]**	**1500 Enclosed flare Unit**	**Unit values**
CH_4	46.10	36.60	%
CO_2	34.60	33.40	%
O_2	1.70	0.95	%
Total Landfill gas Volumetric airflow rate	713	429	m^3/hr

Notes: [1] denotes that flare only operates in standby in case of gas utilisation engine failure and is normally not operating.

Table 3.3. Theoretically and manually calculated landfill gas exhaust volume and physical characteristics from 2 No. Landfill flares.

Parameter	**2500 Enclosed flare Unit**	**1500 Enclosed flare Unit**
Total Volumetric methane loading (m^3/hr)	329	157
Total Volumetric Oxygen loading (m^3/hr)	12.12	4.10
Ratio to complete combustion of methane assuming no excess Oxygen	9.57	9.57
Oxygen concentration level in flue gas (%)	9.93	10.28
Flue gas temperature (Kelvin)	1,327	1,279
Theoretical Volumetric exhaust airflow rate (m^3/h)	7,328	3,793
Normalised average exhaust airflow rate (Nm^3/h ref 3%O_2)	924	481

Table 3.4. Emission value results from 2 landfill gas flare burners (2500 and 1500 Enclosed flare Units) and 3 gas utilisation engines GE 01 to GE 03 monitored at KTK Landfill facility, Kilcullen, Co. Kildare.

Compound identity (ref 3 and 5% O_2)	Units	2500 Enclosed flare Unit[1, 2]	1500 Enclosed flare Unit[1, 2]	Gas utilisation engine GE 01[1, 2,]	Gas utilisation engine GE 02[1, 2,]	Gas utilisation engine GE 03[1, 2,]	Emission limit values
Carbon monoxide (CO)	mg/Nm^3	2.04	4.20	694	1,050	859	1400 mg/Nm^3 for engines
Oxides of nitrogen (NO_X as NO_2)	mg/Nm^3	57	86	473	279	494	150 mg/Nm^3 for flare and 500 mg/Nm^3 for engines
Sulphur dioxide (SO_2)	mg/Nm^3	1,414	1,418	1,073	1,006	978	--
Oxygen (O_2)	%	9.93	10.28	6.79	7.42	6.46	--
Carbon dioxide (CO_2)	%	15.37	17.89	14.58	15.49	13.39	--
Total Organic Compound (TOC)	mg/Nm^3	3.84	3.52	582	782	496	1000 mgC/Nm^3 for engines
Total non methane Volatile organic compounds (TNMVOC)	mg/Nm^3	0.80	0.92	44	61	38	75 mgC/Nm^3 for engines
Volumetric air flow rate	(Nm^3/hr ref 3 and 5% O_2)	942	481	1,937	2,057	2,020	<3,000 ea.
Total particulates	mg/Nm^3	--	--	92	58	63	-
Temperature	Kelvin	1,327	1,279	713	728	721	>1273K for flares only
Inlet Methane loading	(kg/hr)	235	112	237	237	237	--
Exhaust Methane emission	(kg/hr)	0.0030	0.0013	1.04	1.48	0.93	--
Methane destruction efficiency	(%)	>99	>99	>99	>99	>99	--

Notes: [1] denotes refer to *Appendix II* for Oxygen correction calculations.
[2] denotes units normalised to 3% O_2 for flare and 5% O_2 for Gas utilisation engines GE01 to GE03.

4. Discussion of results

Tables 3.1 to *3.4* present the results of the emission monitoring carried out on the three-landfill flare stack burners and three utilisation engines located in KTK Landfill, Brownstown and Carnalway, Kilcullen, Co Kildare.

There was very little variation at one traverse in oxygen and flue gas temperature profiles across the stack during the monitoring exercise (i.e. less than 15% as recommended by the Environment Agency, UK (Environment Agency, 2002)).

A high temperature Inconel 625 and ceramic probe (Testo, Germany) was used to prevent variations in CO emissions data. Normal stainless steel probes when subjected to temperatures above 600^0C can release CO from within the structure of the material and cause the recording of erroneous results (Environment Agency, 2002).

Correction of data to 3% & 5% oxygen was performed. Due to possible inaccuracies in airflow rate measurement, it was not possible to determine the oxygen intake of the flare through the louver system using measurement. Since the volume of intake air required for complete combustion was known and the oxygen concentration in the exhaust flue gas was known, the volume of intake excess fuel air could be theoretically calculated through numerous iterations using the Solver program (i.e. Microsoft Excel). This allows for the calculation of the volume of intake excess air through the louver landfill flare intake system. These calculations were validated through use of the published Environment Agency equation (see *Eqn 8.3.1*) (Environment Agency, 2002).

Landfill methane destruction efficiency was calculated using the inlet methane loading concentration and the exhaust total methane hydrocarbon emission rate as presented in *Table 3.4*. As can be observed, the landfill flares and gas utilisation engines are achieving a methane destruction efficiency of greater than 99%. Typical reported concentrations of methane from landfill flare burner systems are in the order of 0.040% to 0.52%. The complete combustion of methane results in the formation of CO_2 and H_2O. The incomplete combustion of methane results in the formation of CO. CO concentration levels was low in the flue gas of the landfill flare.

5. Conclusion

The following conclusions can be drawn from this study:

1. A theoretically exhaust flue gas volume was calculated for the 2 landfill gas flare burners namely 2500, 1500 Enclosed flare units. Actual measurements were performed on the three gas utilisation engines GE01 to GE03.
2. NO_x, SO_2, CO, O_2, TNMVOC and TOC monitoring and analysis was carried out in accordance with specified requirements;
3. All data was standardised to 273.15 Kelvin, 101.3 kPa;
4. All data is presented as Oxygen corrected to 3% and 5% (v/v) using the appropriate equations as presented in *Section 8.3*;
5. NO_x as NO_2, CO, THC, TNMVOC's and Total particulates were in compliance for the landfill gas flares and gas utilisation engines exhaust stack and within the emission limit values contained within the Waste licence (i.e. *as per schedule B licence 81-3*).

6. References

1. Environment Agency. (2002). Guidance for Monitoring Enclosed Landfill Gas Flares. www.environment-agency.co.uk
2. McVay, M., (2003). Personal communication. Environment Agency, Wales, UK.

7. *Appendix I* - Sampling, analysis and calculation details

7.1.1 Location of Sampling

KTK Landfill, Brownstown, Kilcullen, Co. Kildare.

7.1.2 Date & Time of Sampling

02nd June 2010

7.1.3 Personnel Present During Sampling

Dr. Brian Sheridan, Odour Monitoring Ireland, Trim, Co. Meath.

7.1.4 Instrumentation

Testo 350 MXL/454 in stack analyser;
L type pitot and thermocouples;
Testo 400 handheld and appropriate probes.
Ceramic and Inconel 625 sampling probes.
Portable Signal 3030PM FID calibrated with Propane
Model 320A non-methane total hydrocarbon cutter
TCR Tecora Isokinetic sampling train.