CORK CITY COUNCIL

KINSALE ROAD LANDFILL SITE

Waste Licence Register No: W0012-02

Annual Environmental Report

January 2008 – December 2008

Prepared by:-

Cork City Council,
Kinsale Road Landfill Site,
Cork.

31st January 2009

DOCUMENT CONTROL SHEET

Kinsale Road Landfill Site Annual Report

Reporting Period January 2008 to December 2008

User is Responsible for the Revision Status of this Document

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1 INTRODUCTION

1.1 Scope and Purpose of the Report

Cork City Council holds a Waste Licence (Register No. W0012-02) to operate a landfill site at the Kinsale Road, Cork. The aim of this Annual Environmental Report is to provide a review of activities at Kinsale Road landfill site within the past 12 months.

1.2 Background to the Report

The Landfill site at Kinsale Road has been in operation since the 1960's. The site was issued with a waste licence by the Environmental Protection Agency (EPA) on 2nd February 2000 (Register No. 12-1), with a new licence issued on 29th November 2002 (Register No. W0012-02).

In accordance with Condition 11.6 of the Waste Licence, Cork City Council is required to submit to the Agency for its agreement, an Annual Environmental Report for its activities during the previous 12 months.

The first Annual Environmental Report covering the period February 2nd 2000 to February 1st 2001 was submitted to the Agency in March 2001 and this report covers the period from January 2008 to December 2008

1.3 Site Location and Operator details

The landfill is owned and operated by Cork City Council, City Hall, Cork. The address of the facility is as follows.

Kinsale Road Landfill Site,
Ballyphehane,
Curraghconway,
Inchisarsfield,
South City Link Road,
Cork.

The National Grid Reference for the site is 168033E 069658N.

The facility contact details are as below

- Facility Manger: John Twomey
- Contact No: 021 4705913 / 086 1706878
- Fax No: 021 4319930

- Deputy Facility Manger: Kevin Ryan
- Contact No: 021 4705911 / 086 8152765
- Fax No: 021 4319930

- Landfill Technician: Cathy Healy
- Contact No: 021 4705914 / 086 6079113

- Supervisor: Pascal Cooney
- Contact No: 086 2855462

- Junior Foreman: Michael Reck
- Contact No: 086 8597721

- Weighbridge Operator
- Contact No: 021 4705920

- Environment Department,
  12 Mary Street,
  Cork
- Contact No: 021 4924726
- Fax No: 021 4924054

- City Hall
- Contact No. 021 4924000 / 4966222

2 SITE DESCRIPTION AND ACTIVITIES

2.1 Description of the Site

The facility is a municipal solid waste and non-hazardous industrial waste disposal facility. The site (including former landfilling areas) is approximately 72 hectares.

The facility accepts domestic and commercial MSW and limited quantities of approved non-hazardous industrial sludges. The facility also includes a Civic Amenity Site and a Landfill Gas Combustion plant that operates on site.

The facility is located within 3 km of Cork City at the South City Link Road, in the townlands of Ballyphehane, Curraghconway and Inchisarsfield. The site occupies a large expanse of low-lying peat bog, bounded by the north and east by the Trabeg River, to the west by the South City Link Road and on the south by the Tramore River and South Ring Road.

The site has been operational since the early 1960's. The majority of the developments (commercial and residential) within 500m of the landfill have occurred subsequent to the commencement of waste disposal operations.

Cork City Council proposes to continue landfilling at the facility to waste contour levels as set out in Waste License W0012-02. Works are ongoing at the site to upgrade the facility in accordance with the conditions of the Waste Licence. These works include perimeter fencing, leachate collection and treatment system, surface water collection and road infrastructure.

2.2 Waste Management activities at the Facility

Waste Activities Licensed at the Kinsale Road Landfill Site are restricted to those outlined in Part 1 of the Waste Licence as outlined below: -

Licensed Waste Disposal Activities, in accordance with the Third Schedule of the Waste Management Acts 1996 – 2003.

Class 1	**Deposit on, in or under land (including landfill):**
	This activity is limited to the disposal of the waste types specified in this licence up to a maximum of 100,000 tonnes per annum.
Class 2	**Land treatment, including biodegradation of liquid or sludge discards in soils:**
	This activity is limited to the disposal of non hazardous sludge at the landfill up to a maximum of 7,500 tonnes per annum.
Class 4	**Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons:**
	This activity is limited to the operation of leachate and stormwater retention ponds.
Class 5	**Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment:**
	This activity is limited to the disposal of the certain wastes in exceptional circumstances into lined discrete cells.
Class 7	**Physico-chemical treatment not referred to elsewhere in this Schedule (including evaporation, drying and calcination) which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1 to 10 of this Schedule:**
	This activity is limited to the operation of the leachate treatment plant.
Class 11	**Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule:**
	This activity is limited to the processing and mixing of construction and demolition waste prior to disposal at the facility.
Class 12	**Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule:**
	This activity is limited to repackaging waste in an accident/emergency situation.
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:**
	This activity is limited to the storage of waste prior to its disposal.

Licensed Waste Recovery Activities, in accordance with the Fourth Schedule of the Waste Management Acts 1996 – 2003.

Class 2	**Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes):**
	This activity is limited to the composting of green waste accepted subject to a limit of 1000m^3 at any one time at the facility and the storage of waste oils at the civic waste facility.
Class 3	**Recycling or reclamation of metals and metal compounds:**
	This activity is limited to the recovery of metal and metal compounds at the construction and demolition facility and at the civic waste facility.
Class 4	**Recycling or reclamation of other inorganic materials:**
	This activity is limited to the recovery of inorganic materials at the construction and demolition facility and the storage of inorganic materials at the civic waste facility.
Class 10	**The treatment of any waste on land with a consequential benefit for an agricultural activity or ecological system:**
	This activity is limited to the use of various suitable wastes as intermediate cover and in the closure/restoration stage of the landfill subject to the agreement of the Agency.
Class 11	**Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule:**
	This activity is limited to the use of processed wastes in roadways, drains etc. at the facility.
Class 12	**Exchange of waste for submission to any activity referred to in a preceding paragraph of this Schedule:**
	This activity is limited to the possible exchange of waste being delivered to the facility in exchange for processed waste subject to the agreement of the Agency.
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:**
	This activity is limited to the temporary storage of waste prior to inspection, recycling, recovery and /or reuse at the facility or elsewhere.

2.3 Quantities and Composition of Waste Received, Disposed of and Recovered.

Kinsale Road landfill site is licensed to deposit up to a maximum of 100,000 tonnes of waste per annum. The waste types and quantities allowed for disposal as per Schedule A of the Waste Licence and are as per Table 2.3 below.

Table 2.3 Waste Types.

Waste Type	Maximum (tonnes per annum)
Household & Commercial waste	98,000
Industrial non-hazardous sludge	1,500
Construction Materials containing asbestos - EWC 17/06/05*	500 Note 1
TOTAL FOR DISPOSAL	100,000
Construction & Demolition Waste	300,000 Note 2
Waste to be imported for restoration purposes	100,000
Green waste for composting	Note 3
Wastes accepted for storage at the civic waste facility prior to recycling, reuse or reclamation	5,000
TOTAL FOR RECOVERY	405,000

Note 1: Subject to restrictions in Condition 5.
Note 2: Construction and demolition waste may be accepted for recovery for use as daily cover, in site construction works and landfill restoration.
Note 3: Limited to 1000m^3 at any one time.

Table 2.3.1 Quantities of Waste received prior to reporting period.

	Non-Hazardous Waste	*Hazardous Waste*	*Total Waste Landfilled (Dec - 2008)*
Deposited in landfill prior to report period.	2.6 million tonnes estimated	Not known if any	2.66 million tonnes estimated
C&D waste stored at C&D facility prior to report period.	15,000 tonnes	Nil	

Table 2.3.2 Quantities of Waste disposed of by landfilling during the reporting period (monthly).

Month	*Waste deposited/landfilled (tonnes)*
Jan-08	3,309
Feb-08	3,760
Mar-08	2,764
Apr-08	9,766
May-08	3,403
Jun-08	2,869
Jul-08	2,979
Aug-08	2,724
Sep-08	3,306
Oct-08	10,882
Nov-08	10,553
Dec-08	10,984
Total	67,298

The above figure includes approximately 7,400 tonnes of waste transferred from the area where the phase 3 capping works contract was carried out and from the development works associated with the new playing pitch.

Table 2.3.3 Composition of Waste disposed of by landfilling during reporting period.

Waste description	*Quantity (tonnes)*
Household waste deposited at landfill	27,719
Commercial waste deposited at landfill	20,236
Industrial Non-Hazardous sludges deposited at landfill	0

Table 2.3.4 Classes of Waste received for recovery / recycling off site.

Waste Description	*EWC Code*	*Name of Recovery Company*
Paper	20 01 01	Indaver
		Cork Recycling
Metal	20 01 06	Pouladuff Dismantlers
Timber	20 01 07	CTO Environmental
Plastic	20 01 03	Cork Recycling
Glass Bottles	20 01 02	Rehab Recycling Partnership
Aluminium Cans	20 01 05	Rehab Recycling Partnership
Oil	13 00 00	ENVA
Green Waste	20 02 01	CTO Environmental Solutions
Cardboard	20 01 01	Cork Recycling
WEEE	20 01 35	KMK
Aerosols	16 05 04	Eco Safe Systems
Paints	20 01 27	Eco Safe Systems
Car Batteries	16 06 01	KMK
Household Batteries	16 06 01 / 16 06 02 16 06 04 / 20 01 34	KMK

2.3.5 Landfill Inputs and Outputs (Waste and Recycling). See table at end of Section.

2.4 Landfill Capacity

2.4.1 Filling Sequence

The active area of the landfill is divided into 13 cells as detailed in Drawing 11 Rev B entitled "Cell Filling Sequence" (Section 7.3) submitted to the Agency on 13th March 2000.

2.4.2 Remaining Capacity

Cork City Council in compliance with the Waste Management Acts 1996 - 2003 must ensure that a location for the disposal of domestic waste is available and it is not possible at this time to give a definitive date for achievement of finality.
Measures have been implemented to conserve void space and the remaining capacity will be a function of the inputs and Operational Procedures.

The gross void space remaining on the 31st December 2008 is estimated at 94,000 m^3.
The void space that can be practically filled is estimated at 90,000 m^3.

2.5 Methods of waste acceptance and deposition

The waste acceptance procedures in operation at the site are in accordance with Operational Procedure OP/06 "Load Receipt and Acceptance" and Operational Procedure OP/12 "Waste Inspection at the Working Face".

Waste deposition is in accordance with Operational Procedure OP/11 "Disposal of Non-Hazardous Waste".

At the end of the working day waste is covered in accordance with Operational Procedure OP/16 "Placement of Daily Cover".

2.6 Economic Contribution

Provision made for operational expenditure in the reporting period was € 2.5 million. This can be broken down as:

	2008 Provision (€)
Salaries & Wages	747,700
City Council Plant	88,300
Plant Hired	402,700
Materials - Cover Soil	150,000
- Road Making Materials	50,000
Maint. of Buildings	40,000
Site Security	70,000
Materials / Chemicals	35,000
Recycling Cost for Civic Amenity Site	65,000
E.P.A. Licence and Monitoring	200,000
Maint. of Mechanical and Electrical Plant	160,000
Vermin Control	100,000
ESB, Telephone	110,000
Miscellaneous	70,000
Sampling & External Testing at Lab.	200,000
Landscaping of capped areas	10,000
Sewer Connection - County Council Levy	12,000
Total	2,510,700

Domestic Recycling	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
WEEE	96.58	67.5	70.04	68.1	65.56	62.3	67.54	67.10	71.38	60.84	15.42	69.74
Commercial WEEE (in)	51.72	30.36	26.40	37.48	26.84	22.72	28.48	23.64	35.82	25.36	29.48	29.14
Plastic	2.4	1.6	0.92	1.64	1.2	0.88	1.18	1.04	1.24	1.08	1.08	1.56
Cardboard	10.04	7.76	6.94	7.12	8.16	7.04	7.08	6.30	7.28	7.46	6.66	8.54
Paper	13.56	14.94	12.52	12.54	11.18	13.62	15.18	11.92	12.42	12.58	12.90	15.72
Metal	5.26	6.2	6.34	6.96	7.6	6.9	9.72	5.22	6.88	6.24	5.14	4.56
Green Waste (CA)		4.48	13.6	13.58	27.3	39.32	26.92	27.52	33.30	12.08	18.96	
Christmas Trees	69.42	4.5	0.1									
Timber (CA)	14.78	13.12	6.8	14.42	17.48	10.36	16.04	10.98	11.98	14.64	7.26	
Glass	9.78	3.74	1.62	5.56	4.48	5.94	3.22	2.80	6.18	4.34	3.36	4.48
Drink Cans	0.3	0.18	0.06	0.2	0.12	0.12	0.04	0.18	0.02	0.24		0.18
Batteries	1.48		1.14	0.2	0.94		3.12			1.86		
Oil	1.54		0.56		2.06		0.78		1.64		1.48	
Tetra Packs						2.22						
CA Site Recycling Total inc. WEEE Out	225.14	124.02	120.64	130.32	146.08	148.70	150.82	133.06	152.32	121.36	72.26	104.78

Commercial Recycli	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
Timber Waste	557.91	570.22	544.32	590.24	666.64	699.22	751.68	689.78	708.64	620.26	470.84	452.26
Green Waste	136.72	158.58	158.18	164.14	311.94	299.93	258.8	259.76	174.24	143.72	133.70	88.00

Total	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
Timber Waste	572.69	583.34	551.12	604.66	684.12	709.58	767.72	700.76	720.62	634.9	478.1	452.26
Green Waste	206.14	167.56	171.88	177.72	339.24	339.25	285.72	287.28	207.54	155.8	152.66	88

Total
782.10
367.44
15.82
90.38
159.08
77.02
217.06
74.02
137.86
55.50
1.64
8.74
8.06
2.22
1629.50

Total
7322.01
2287.71

Total
7459.87
2578.79

3 SITE DEVELOPMENT WORKS

3.1 Site Development Works during the Reporting Period.

The Waste Licence sets out conditions relating to the completion of certain works within the designated periods following the date of grant of the licence. The works referred to generally formed part of site development works.

Contract No. 7 – Phase 3 Capping Works

This Contract involved the capping of a further area of approximately 3.4 hectares of the landfill site on the southwestern sides. The works were substantially completed in 2007 with some topsoiling and grass seeding carried out in Spring 2008. The works included:

- Clearance of site
- Regrading of the existing formation level
- Installation of sub-liner drainage pipes for gas and leachate collection
- Smoothing of site
- Preparation of ground to receive the separation layer
- Placing of separation layer
- Placing of gas collection layer
- Placing of impermeable LLDPE barrier liner with associated geotextiles
- Placing of drainage layer
- Placing of subsoil layers
- Installation of pipes in gas and drainage layers
- Installation of gas extraction wells, chambers and associated pipework
- Topsoiling and landscaping

An area of approximately 1.0 acre (0.41 hectare) has been seeded with a special grass mix as part of a research & development initiative between U.C.C., Bord Gais and Cork City Council to produce bio-methane (gas from grass) to fuel transportation vehicles, such as buses, City Council fleet etc.

The Contract also included for extensive upgrading works at the existing Contaminated Surface Water Conditioning Plant.

Contract No. 8 – Access Road and Playing Pitch

This Contract included:

- Construction of approximately 1.63 hectares of landfill cap
- New access road measuring approximately 420 linear metres
- Playing Pitch 140 metres long x 90 metres wide.

This Contract was substantially completed by December 2008 with final completion scheduled for March 2009.

M&E works for landfill gas and leachate management

M & E works are ongoing. These include maintenance of the Leachate Conditioning Plant and the continuing installation of the landfill gas collection network.

MISCELLANEOUS WORKS:

1. Ongoing maintenance of Site Roads.

2. Regular cleaning of Gravel Trap at Leachate Conditioning Plant with replacement of gravel as required.

3. Ongoing sampling & testing with respect to the trial project for the treatment of leachate using natural systems - in association with UCC.

4. Eirebloc is now accepting shredded timber from the timber processing facility at Kinsale Road Landfill from CTO Env. Ltd. The shredded timber is processed to manufacture inserts for pallets employing up to 35 staff at Lissarda. The facility manufactures approx. 30 million units per annum.

INVESTIGATIVE WORKS:

a) Feasibility Study by Consultants appointed by Cork City Council, for the provision of a South City Maintenance Depot on a 4.5 hectare area of the north-western corner of the Landfill Site, bounded on the northern side by the E.S.B. pitch and putt course and on the western side by the South City Link Road.

b) Site investigation carried out by a third party on a site being transferred from Cork City Council to Blue Demons, on which the Landfill Site Boundary passes through. This site is bounded by Woodies Hardware Store on the northern side, and by the road linking the South City Link Road to the Kinsale Road on the southern side.

3.1.1 Proposed Development Works for 2009

- **Design and execution of further Capping Works**
- **Construction of a waste transfer station**

Other planned works for 2009 are:

- SCADA system upgrade (reporting/management system).
- Installation /renewal of control valves and systems to optimise gas collection.
- Installation /renewal of control valves and systems to optimise storm water treatment.
- Reed beds – further planting and replacement of ineffective plants as required.
- Provision of new gas monitoring wells and gas extraction wells as required.
- Upgrading of site roadways.
- Miscellaneous minor capital works and works arising from Operational Procedures.

- Further experimental works into the treatment of leachate using natural systems (trial project) - in association with UCC.
- Investigate the potential of constructing a pilot R & D bio-methane facility and visitor centre in association with UCC and Bord Gais.

The estimated cost of Site Development Works programmed to be carried out in 2009 is approximately €4.0 million (subject to availability of funds).

4 ENVIRONMENTAL INCIDENTS AND COMPLAINTS

4.1.1 Incidents

(An Incident is defined in Condition 1.7 of Waste Licence W0012-02).

Condition 10 and 11 of the Waste Licence requires Cork City Council to make written records of environmental incidents and complaints. Operational Procedure 0P/17 "Recording of Complaints and Suggestions" describes the internal reporting of Non Conformances and incidents relating to the facility. Cork City Council documents all non-conformances and incidents on an internal Non Conformance Report Form SF/05.
The following Registers are attached:
A register of Incidents;
A register of Non-Conformances; and
A register of Non–Compliances.

4.2 Complaints

Condition 10.4 of the Waste Licence requires Cork City Council to make written records of all complaints relating to the operation of the facility.

Complaints are dealt with in accordance with the Operational Procedure OP/17 "Recording of Complaints / Suggestions".

A register of complaints is detailed in the Complaints Log below.

4.3 Analysis of Complaints

The complaints for 2008 are illustrated in the bar chart in figure 4.3.

Total number of complaints was 8 (26 in 2007) in this reporting period. 4 (19 in 2007) of these were odour related due to capping works.

JANUARY - COMPLIANTS LOG

Log No.	REFERENCE	COMPLAINT DATE	COMPLAINANT NAME	ADDRESS	COMPLAINT TYPE	ACTION DATE
1	KRLS0178	14/01/08	Michael O'Shea	35 Greenhills, Sth douglas Rd	height of soil on site	14/01/08

MARCH - COMPLIANTS LOG

Log No.	REFERENCE	COMPLAINT DATE	COMPLAINANT NAME	ADDRESS	COMPLAINT TYPE	ACTION DATE
1	KRL0179	06/03/08	Ann O'Mahony	36 rosebank ,douglas rd	odour	06/03/08

APRIL - COMPLIANTS LOG

Log No.	REFERENCE	COMPLAINT DATE	COMPLAINANT NAME	ADDRESS	COMPLAINT TYPE	ACTION DATE
1	KRLS0180	08/04/08	Michael O'Shea	35 Greenhills east, south douglas rd	noise and dust problems	09/04/08

SEPTEMBER - COMPLIANTS LOG

Log No.	REFERENCE	COMPLAINT DATE	COMPLAINANT NAME	ADDRESS	COMPLAINT TYPE	ACTION DATE
1	KRLS0181	22/09/08	Tom Henry	22 Green Lawn, turners cross	flies	23/09/08

OCTOBER - COMPLIANTS LOG

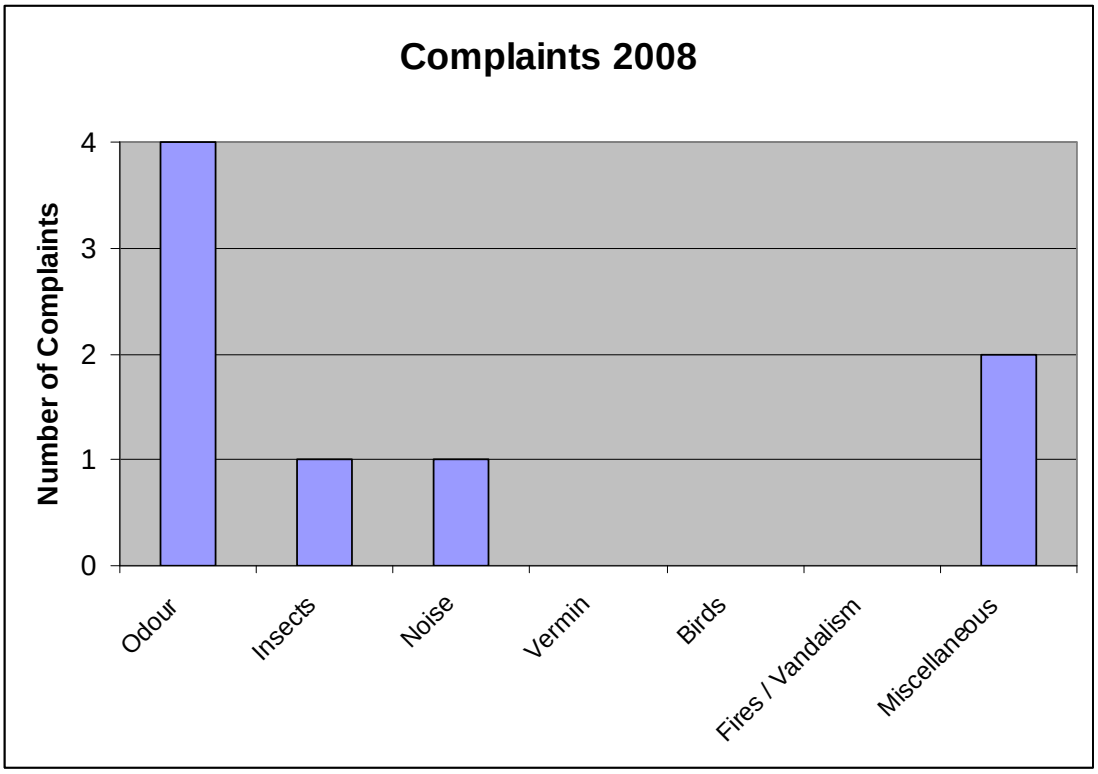
Log No.	REFERENCE	COMPLAINT DATE	COMPLAINANT NAME	ADDRESS	COMPLAINT TYPE	ACTION DATE
1	KRLS/0182	16/10/08	Dermot Nash	4 Dunmahon Est, South Douglas rd, Cork	odour	16/10/08

NOVEMBER - COMPLIANTS LOG

Log No.	REFERENCE	COMPLAINT DATE	COMPLAINANT NAME	ADDRESS	COMPLAINT TYPE	ACTION DATE
1	KRLS/0183	17/11/08	Eileen O' Connell	Greenhills Court	Odour	17/11/08
2	KRLS/0184	13/11/2008	Derry Nash	Dunmahon Estate	Odour	13/11/2008
3	KRLS/0185	17/11/2008	Pat Dunne	Greenhills Estate	Trabeg Stream	17/11/2008

Complaints Received 2008

Complaint	2008
Odour	4
Insects	1
Noise	1
Vermin	0
Birds	0
Fires / Vandalism	0
Miscellaneous	2
Total	8



4.4 Review of Nuisance Controls

In accordance with Condition 7 of the Waste License Cork City Council are required to ensure that vermin, birds, flies, mud, dust and litter do not give rise to nuisances at the facility or in the immediate area of the facility.
Cork City Council ensures that the activities are carried out in a manner such that odours do not result in significant impairment or interference with amenities or the environment beyond the facility boundary.
The road network in the vicinity of the facility is kept free from any debris caused by vehicles entering or leaving the facility. Any such debris or deposited materials is removed without delay.

Litter Control
Litter fencing has been erected and is maintained around the site and around the perimeter of the active tipping area.
All litter control infrastructure is inspected on a daily basis and any defect in the litter netting is remedied immediately.
Litter picking teams are organised as required to collect all loose litter or other waste, placed on or in the vicinity of the facility.
All vehicles delivering waste to and removing waste and materials from the facility are appropriately covered.
Other litter controls include the containment of the active tip face in as small an area as possible as well as the daily covering of the tip face with hession or soil.

Dust Control
In dry weather, site roads and any other areas used by vehicles are sprayed with water as and when required to minimise airborne dust nuisance.
Prior to exiting the facility, all waste vehicles use the vehicle wash.

Bird Control
Birds are prevented from gathering on and feeding at the facility by the use of birds of prey (falcons and hawks) and other bird scaring techniques such as visual deterrents (balloons, flashers and streamers) and a shotgun. This is carried out under contract.

Odour
Odour from the landfill site is minimised through the extraction of landfill gas, placement of daily cover over the active tip area and through the application of odour control substances.
In 2008, 4 no. odour complaints were received. These complaints were mostly due to a threefold increase in waste tonnages accepted from September 2008 onwards. CCC has responded to these complaints by way of daily use of an odour neutralising machine placed at the active area.

Flies
The nuisance caused by flies is minimised by placing cover material on a daily basis over the deposited waste and by placing soil over the active tip area over the weekend. Fly control substances may also be used by the pest control company as required.

Vermin

Vermin are controlled through the use of baiting as deemed necessary by the pest control experts.

Noise

Noise is minimised / controlled by operating the facility between the hours of 8am – 3.45pm. Contractors may operate between the hours of 8am – 6pm.

Incident Log: 2008

Date	Log No.	Originator	Incident	Suggestion	Completion Target Date	Responsibility	Actions	Resolved Date	Sign.	Supplier / Contractor / Consultancy involved
03/01/2008	541	CH	PM10 out of operation	contact EMS to repair	10/01/2008	CH	contact EMS	23/01/2008	CH	CCC/EMS
10/01/2008	542	CH	flare & engines down 10/01/08	contact IPS to investigate problem	10/01/2008	CH	due to a block	10/01/2008	CH	CCC/IPS
11/01/2008	543	CH	gas well exceedences 21/12/07-11/01/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
21/01/2008	544	CH	gas well exceedences 12-21/01/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
05/02/2008	545	CH	gas well exceedences 22/01-05/02/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
12/02/2008	546	CH	gas well exceedences 06-12/02/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
22/02/2008	547	CH	PM10 out of operation 14-21/02/08	investigate	21/02/2008	CH	flow halted no	21/02/2008	CH	CCC
07/03/2008	548	CH	gas well exceedences 23/02-06/03/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
14/03/2008	549	CH	gas well exceedences 07-14/03/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
14/03/2008	550	CH	PM10 overlimit 06/03/08	due to welding to repair enclosure door	06/03/2008	CH	due to repair	06/03/2008	CH	CCC/foreman
26/03/2008	551	CH	gas well exceedences 15-25/03/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
31/03/2008	552	CH	gas well exceedences 26-31/03/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
01/04/2008	553	CH	conductivity at pond overlimit 27/02&05/03/08	investigate	01/04/2008	CH	reedbed resu	01/04/2008	CH	CCC
08/04/2008	554	CH	gas well exceedences 01-07/04/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
10/04/2008	555	CH	leachate conditioning plant out of operation	investigate	10/04/2008	CH	problem with	10/04/2008	CH	CCC/Avonmore
15/04/2008	556	CH	dissolved methane overlimit	check diffusers	21/04/2008	CH	clean diffuser	21/04/2008	CH	CCC/Avonmore
18/04/2008	557	CH	gas well exceedences 05-18/04/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
21/04/2008	558	CH	leachate conditioning plant out of operation 21-22/04/08	cleaning diffusers	22/04/2008	CH	cleaning diffu	22/04/2008	CH	CCC/Avonmore
23/04/2008	559	CH	flare and engines down 22/02/08	contact IPS to investigate problem	23/04/2008	CH	received resp	23/04/2008	CH	CCC/IPS
13/05/2008	560	CH	gas well exceedences 19/04-12/05/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
21/05/2008	561	CH	leachate conditioning plant & scada out of op 17-20/05/08	due to a power outage	20/05/2008	CH	power returne	20/05/2008	CH	CCC/ESB
27/05/2008	562	CH	gas well exceedences 13-26/05/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
29/05/2008	563	CH	leachate conditioning plant out of operation 22-26/05/08	get avonmore to check out problem	26/05/2005	CH	problem with	26/05/2008	CH	CCC/Avonmore
30/05/2008	564	CH	dissolved methane overlimit may 08	cleaned diffusers looking at other solutions	ongoing	JT/KR/CH	investigating	ongoing	JT/KR/CH	CCC/Avonmore
04/06/2008	565	CH	leachate conditioning plant 03-04/06/08	problem with 6" valve get fixed	04/06/2008	CH	fix 6" valve	04/06/2008	CH	CCC/Avonmore
10/06/2008	566	CH	gas well exceedences27/05-09/06/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
17/06/2008	567	CH	gas well exceedences 10-17/06/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
30/06/2008	568	CH	gas well exceedences 18-30/06/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
08/07/2008	569	CH	gas well exceedences 01-07/07/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
11/07/2008	570	CH	scada out of operation 05-11/07/08	upgrade scada	11/07/2008	CH	upgraded sca	11/07/2008	CH	CCC/JD/PD
17/07/2008	571	CH	gas well exceedences 08-17/07/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
21/07/2008	572	CH	dissolved methane overlimit 10&17/07/08	cleaned diffusers looking at other solutions	ongoing	JT/KR/CH	investigating	ongoing	JT/KR/CH	CCC/avonmore
23/07/2008	573	CH	leachate conditioning plant out of operation 22-23/07/08	cleaning diffusers	23/07/2008	CH	cleaned diffus	23/07/2008	CH	CCC/Avonmore
29/07/2008	574	CH	gas well exceedences 18-29/07/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
31/07/2008	575	CH	dissolved methane overlimit 24&30/07/08	cleaned diffusers looking at other solutions	ongoing	JT/KR/CH	investigating	ongoing	JT/KR/CH	CCC/Avonmore
31/07/2008	576	CH	pH at discharge not in operation 29/07-01/08/08	avonmore to fix probe	31/07/2008	CH	fix ph probe	01/08/2008	CH	CCC/Avonmore
07/08/2008	577	CH	gas well exceedences 30/07-07/08/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
12/08/2008	578	CH	leachate conditioning plant out of operation 11-12/08/08	investigate and then avonmore to fix	12/08/2008	CH	problem with	12/08/2008	CH	CCC/Avonmore
14/08/2008	579	CH	gas well exceedences 08-14/08/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
27/08/2008	580	CH	gas well excedences 15-27/08/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
13&16/08/08	581	CH	CO overlimit 13&16/08/08	contact Bioverda as to why this happened	18/08/2008	CH	fault with swit	18/08/2008	CH	CCC/IPS
05/09/2008	582	CH	leachate conditioning plant out of operation 29/08-04/09/08	scheduled cleaning of discharge lines	04/09/2008	CH	discharge line	04/09/2008	CH	CCC/Avonmore
11/09/2008	583	CH	gas well exceedences 05-11/09/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
11/09/2008	584	CH	leachate conditioning plant out of operation 11/09/08	investigate and then avonmore to fix	11/09/2008	CH	sensor proble	11/09/2008	CH	CCC/Avonmore
26/09/2008	585	CH	gas well exceedences 12-25/09/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
06/10/2008	586	CH	gas well exceedences 26/09-05/10/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
14/10/2008	587	CH	gas well exceedences 06-14/10/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
24/10/2008	588	CH	gas well exceedences 15-24/10/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
04/11/2008	589	CH	gas well exceedences 25/10-04/11/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/FTC/IPS
06/11/2008	590	CH	leachate conditioning plant out of operation 01-06/11/08	get avonmore to check out problem	06/11/2008	CH	problem with	06/11/2008	CH	CCC/Avonmore
11/11/2008	591	CH	leachate conditioning plant out of operation 08-10/08	get avonmore to check out problem	10/11/2008	CH	damaged cab	10/11/2008	CH	CCC/Avonmore
14/11/2008	592	CH	gas well exceedences 05-14/11/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC
17/11/2008	593	CH	leachate conditioning plant out of operation 15-18/11/08	get avonmore to check out problem	18/11/2008	CH	problems with	18/11/2008	CH	CCC/Avonmore
25/11/2008	594	CH	gas well exceedences 15-24/11/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas t	ongoing	JT/KR/CH	CCC/IPS/FTC

Date	Log No.	Originator	Incident	Suggestion	Completion Target Date	Responsibility	Actions	Resolved Date	Sign.	Supplier / Contractor / Consultancy involved
25/11/2008	595	CH	leachate conditioning plant out of operation 15-28/11/08	get avonmore to check out problem	28/11/2008	CH	damaged cab	28/11/2008	CH	CCC/Avonmore
02/12/2008	596	CH	Leachate conditoning plant and TOC problems	avonmore & CEMS sorting problems	27/11&04/12/08	CH	damage to TC	27/11&04/12/08	JT/KR/CH	CCC/CEMS/Avonmore
03/12/2008	597	CH	CO overlimit @ TVO1	request info from Bioverda on problem	10/12/2008	CH	due to proble	10/12/2008	CH	CCC/Bioverda
09/12/2008	598	CH	gas well exceedences 26/11-09/12/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas	ongoing	JT/KR/CH	CCC/FTC/IPS
09/12/2008	599	CH	CO monitor damaged	IES called into repair monitor waterlogged	10/12/2008	CH	repaired wate	10/12/2008	CH	IES
22/12/2008	600	CH	gas well exceedences 10-22/12/08	ongoing measures being put in place	ongoing	JT/KR/CH	ongoing gas	ongoing	JT/KR/CH	CCC/FTC/IPS

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Non Conformance Log: January - December 2008

Date	Log No.	Originator	Incident	Status	Suggestion	Completion Target Date	Responsibility	Actions	Resolved Date	Sign.	Supplier / Contractor / Consultancy involved
18-Mar-08	KRLS/NCR/0147	CH	birds in greenhills estate	3	Samantha Murphy(bird control person) & Pat Foley went to investigate	19-Mar-08	KR	following investigation birds observed were non vermin but oyster catchers	19-Mar-08	KR	Bird Control Contractor
29-May-08	KRLS/NCR/0148	CH	birds in greenhills estate	3	Bird Control Contractor & Pat Foley went to investigate	29-May-08	CH	birds were not pests	29-May-08	CH	Bird Control Contractor
04-Dec-08	KRLS/NCR/0149	CH	strong odour in greenhills	3	checked tip to ensure weekly soil cover was ongoing- being covered as per proccedures	04-Dec-08	KR	de odouriser machine brought to tip area and until end of day's operations	04-Dec-08	KR	Site Management

Note: Status
1 .. Evaluated by Management
2.. Action in Progress
3.. Resolved

Non Conpliance Log: 2008

Date	Log No.	Originator	Incident	Suggestion	Completion Target Date	Responsibility	Actions	Resolved Date	Sign.	Supplier / Contractor / Consultancy involved
05-Jun-08	1	EPA	dissolved methane over limit may 08	various measures being considered to resolve problem		CH/JT/KR	considering putting aerator into lagoons, getting diffusers cleaned	23-Jul-08	CH	CCC/Avonmore

5 ENVIRONMENTAL MANAGEMENT PROGRAMME

5.1 Environmental Objectives

1 Environmental Objective 1: Operation of the Facility in accordance with the Conditions of the new Waste Licence W0012-02

Objective 1: Operate the facility in accordance with the Waste Licence W0012-02				
Responsibility: Facility Management			**Start Date:** 29th Nov 2002 **Revised Date:** October 07	
Target: To operate the landfill site in accordance with the waste licence and all the associated conditions as laid down by the EPA				
Ranking:			**Score:**	
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Waste Licence W0012-02 was granted on the 29th November 2002	NA	EPA	Done
2	All deviations from the Licence in the form of Non Compliances, Non Conformances, Incidents and Complaints are reported to the Agency as they arise	As they arise	Facility Management	On going
3	In the event of the City Council not being able to meet the time constraints of a given Licence Condition, the Facility Management will contact the EPA with respect to extending the deadline.	As they arise	Facility Management	On going
Objectives Completed: **Signature:** _____ **Date:** _____				

2 Environmental Objective 2 : Establish infrastructure at the facility in accordance with the timeframe of the new Waste Licence W0012-02

Objective 2: Establish infrastructure at the facility in accordance with the timeframe of the Waste Licence W0012-02				
Responsibility: Facility Management		**Start Date:** 29th Nov 2002 **Revised Date:** Jan 08		
Target: Establish infrastructure at the facility in accordance with the timeframe of the Waste Licence – initiate proceedings for the new capping Contract 07 – (Phase 3 Capping Works)				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Invite submissions for tenders for Phase 3 Capping Contract. This capping phase will be at the SW Corner of the landfill site ~ 34,000 m^2	May 06	FTC (Project Manager PM) & JT (John Twomey)	Done
2	Assess tenders and seek clarifications from most economically advantageous contractor	Aug - Oct 06	FTC (PM) & Env. Dept.	Done
3	Inform successful contractor	Nov 06	FTC (PM) & Env. Dept.	Done
4	Issue construction drawings Contract 07	Feb 07	FTC (PM) & RE (Resident Engineer)	Done
6	Mobilise Contractor for Contract 07	Feb 07	Facility Management / FTC	Done
7	Advise EPA of Infrastructure development status.	Done & ongoing	Facility Management	Ongoing
8	Specified Works Supervision	As occurs		Ongoing
9	Works due to last 15 months	March 08		Works completed
Objectives Completed: **Signature:** _____ **Date:** _____				

3 Environmental Objective 3: Control of Litter

Objective 3: Control of litter				
Responsibility: Facility Management			**Start Date:** January 01 **Revised Date:** Nov 08	
Target: To control litter on the landfill site				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Move & erect mobile netting for active cell as required.	As required	KR	Ongoing
2	Nominate operative responsible for litter picking and control.	As required	KR	Ongoing
3	Review if additional resources are required	As required	KR	Ongoing
4	Erect mobile netting prior to entering new cells	When entering a new cell	KR	Ongoing
5	Active Area will be moved in Feb 08	Feb 08	Mgt team	Ongoing
6	Moved in to new active area July 08 – extensive drainage network put in place & netting erected			Ongoing
Objectives Completed: **Signature:** _____ **Date:** _____				

4 Environmental Objective 4 : Continue composting of biodegradable waste

Objective 4: Composting of biodegradable waste			
Responsibility: Facility Management		**Start Date:** February 01 **Revised Date:** Nov 08	
Target: To set up a sustainable on site composting operation that will allow for the diversion of 100% of segregated green waste from landfill.			
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Promote segregated waste collection and delivery of green material to Landscaping Contractors	Ongoing	Env. Dept.	Ongoing
2	Compost green waste at the facility	As required	CTO	Ongoing
3	Increase public awareness of the timber and green waste processing facility at the Civic Amenity Site	Ongoing	Env. Dept.	Ongoing
4	Continue to improve quality of compost with the aim of achieving Class I compost	Ongoing	Facility Mgt.	Ongoing
5	Investigate possible use of compost for the top soiling of the capping contract - compost was mixed in to soil during final stage of capping in July 08	Dec 07 & ongoing	Facility Mgt.	Ongoing
6	Investigate the possible use of compost as a domestic soil conditioner – no progress on this as yet.	June 08 Spring 09	Facility Mgt.	Ongoing
Objectives Completed: **Signature:** _____ **Date:** _____				

5 Environmental Objective 5: Control of odours

Objective 5: Control of odours			
Responsibility: Facility Management		**Start Date:** February 01 **Revised Date:** Nov 08	
Target: To ensure that the activities shall be carried out in a manner such that odours do not result in significant impairment or interference with amenity areas or the environment beyond the facility boundary.			
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Place cover material over active cells on a daily basis	As cells are filled	Contractors	Ongoing
2	Cover any exposed waste due to works with 300mm of shredded timber or soil	As required	Contractors or as directed by Facility Management	Ongoing
3	Install additional gas extraction wells as cells are closed off	As required	Bioverda Power Systems	Ongoing
4	Connect new gas extraction wells to combustion plant	As required	Bioverda Power Systems	Ongoing
5	Additional air sampling at odour sensitive locations if requested	As required	CH	Ongoing
6	Review programme & Operational practices versus complaints	As complaints arise	Facility Management	Ongoing
7	Complete 'Odour Control Form' when deemed appropriate as requested by the EPA	As issue arises	Technicians	Ongoing
	Odour neutralising sprayer deployed at the active area			Ongoing
Objectives Completed: **Signature:** _____ **Date:** _____				

6 Environmental Objective 6: Continue with the operation of the WEEE collection area

Objective 6: Continue with the operation of the WEEE collection area				
Responsibility: Senior Engineer Environment & Facility Management			**Start Date:** January 03 **Revised Date:** Nov 08	
Target: To increase the availability and accessibility of the WEEE recycling facilities at the Civic Amenity Site				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	All waste electrical and electronic items are stored in the WEEE compound - WEEE can be delivered to the CA Site by domestic users and by registered EEE retailers		Facility Management	Done & ongoing
2	Set up register of EEE retailers who may avail of the drop off facility	Dec 05	Env. Dept. & Facility Management	Done
3	Inputs from EEE retailers are recorded on the Weighbridge Computer All WEEE outputs to 'KMK' are recorded on the WB computer also		Facility Management	Done
4	Assess storage needs with regard to smaller items of WEEE (computers & TVs)	Aug 06	Facility Management	Done & ongoing
5	Advertise the availability of the WEEE drop off facility to the public with the aim of diverting WEEE from the waste stream and to reduce indiscriminate disposal of such materials		Env. Dept	Done & ongoing
6	Apply new safety procedure with respect to manual handling of WEEE	Jan 08	Facility Mgt.	Ongoing
7	New Battery Collection Scheme introduced in Sept 08 – all batteries now accepted free of charge from members of the public & from retailers	Sept 08	Facility Mgt.	Ongoing
Objectives Completed: **Signature:** _____ **Date:** _____				

7 Environmental Objective 7: Commission a feasibility study for the South City Maintenance Depot on the site of the old C & D area

Objective 7: Commission a feasibility study for the South City Maintenance Depot for Cork City Council on the site of the old C & D area				
Responsibility: Facility Manager & appointed consultants		Start Date: March 06 Revised Date: Nov 08		
Target: Commission a feasibility study for the building of a South City Maintenance Depot for Cork City Council on the site of the old C & D area				
Task	Details	Due Date	By Whom	Status
1	Invite tenders for the study	March 06	Env. Dept & Facility Management	Done
2	Appoint successful consortium	May 06	Facility Management	Done
3	Carry out feasibility study – starting with site investigation work etc.	June 06	Consultants & Site Investigation Contractor	Done
4	Report due from Consultants in Feb 07	Feb 07	RPS / MCOS	Report received – June 07
5	Based on report - decide as to feasibility of the construction of the South City Maintenance depot on the site	Spring 08	Inter-departmental group	Still in discussions regarding next course of action
6	Appointed consultants have recommended further site investigations Awaiting decision from City Manager	Spring 09		
Signature: _____			Date:_____	

8 Environmental Objective 8: Identify opportunities for reduction in the quantities of water used on site including recycling and reuse initiatives where possible

Objective 8: Identify opportunities for reduction in the quantities of water used on site including recycling and reuse initiatives where possible				
Responsibility: Facility Management		Start Date: October 07 Revised Date: Nov 08		
Target: To identify areas where water reduction initiatives may identified and implemented on site				
Task	Details	Due Date	By Whom	Status
1	Identify primary uses for water on site Site offices Civic Amenity Site Wheel wash Tractor bowser for dust suppression on roads Roadside Sprinkler System CTO facility (dust suppression)	Jan 08	KR	Ongoing
2	Identify current and past usage of water on site water meters (x2) water bills	Jan 08	KR	Ongoing
3	Identify areas for potential water use conservation (both methods and facilities) New bowser tanker purchased in Jan 09 Water at wheel wash is recycled on a daily basis Sprinklers for haul roads only turned on as necessary	Jan 08	KR	
4	Produce final report with recommendations	June 09	KR	
Objectives Completed: Signature: _____ Date: _____				

9 Environmental Objective 9: Place final cap & Upgrade the Temporary Leachate / Contaminated Storm-Water Plant

Objective 9: Place final cap & Upgrade the Temporary Leachate / Contaminated Storm-water Plant				
Responsibility: Facility Manager			**Start Date:** May 02 **Revised Date:** Nov 08	
Target: To place a final cap on the entire landfill to the specified standards as set out in the EPA Licence & to treat all leachate generated as required				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Main details of next capping phase outlined in Objective 2		FTC, JT	Done
2	In addition to the capping the Temporary Leachate / Contaminated Storm-water Plant will be upgraded (Contract 07) Plant upgraded – awaiting commissioning – Jan 09	Start date – Feb 07	FTC, MOC	Done
4	Capping works & plant upgrade / construction - 15 months	March 08 – completion Dec 08	FTC, MOC	Completed
5	Continue with final capping of completed cells – next phase of capping – Phase 4 – provisional start date Spring 2010	Spring 10		
Objectives Completed: **Signature:** _____ **Date:** _____				

10 Environmental Objective 10: Carry out an Energy Efficiency Audit

Objective 10: Carry out a Resource Use and Energy Efficiency Audit				
Responsibility: John Walsh, Energy Agency / Barry O' Riordan – Clerical Officer			Start Date: Oct 07 Revised Date: Nov 08	
Target: To carry out an audit of the energy efficiency of the site to identify opportunities for reduction in the use of energy in on site processes				
Task	Details	Due Date	By Whom	Status
1	Initial audit to be carried out on the following:			
2	Energy Usage – Identify energy usage on Site	Nov 07	BOR / JW	Done
3	Quantify Energy usage on site: Checking ESB bills, meter reading	Nov 07	BOR / JW	Done
4	Fuel Usage – jeeps, tractor			
5	Produce Report on findings with recommendations for potential areas increased efficiencies for energy and raw materials use	March 08	BOR / JW	Report completed – first draft under consideration
6	Preliminary report produced in December 08 – final report to be complied – Spring 09	Spring 09	KR	
Objectives Completed: Signature: _____ Date:				

11 Environmental Objective 11: Continue with tree planting regime around site perimeter

Objective 11: Continue with the tree planting regime around site perimeter

Responsibility: Facility Management

Start Date: Oct 05

Revised Date: Nov 08

Target: To plant additional trees around the site perimeter for aesthetic purposes and to promote natural habitats

Task	Details	Due Date	By Whom	Status
1	Identify suitable areas and species for planting	Oct -05	JG	Done
2	Seek quotations from suitable contractors	Nov 05	JG	Done
3	Plant trees in agreement with contractor, with consideration of trees species (willow, alder, poplar), age and stand height.	Dec – March 05/06	KR	Done
4	Continue with tree planting regime as required – Trees along SW corner of site – along the leachate trench require re-planting due to capping works	January 08	Appointed contractor	
5	Investigate areas for replanting with respect to trees / saplings removed for construction purposes during the current capping contract Tree planting on hold for the present time until contract works have been completed	March 08	Facility Mgt	
6	Christmas trees along NE perimeter are inspected & cleared of weeds on an ongoing basis by landscaping contractor	Ongoing		

Objectives Completed:

Signature: _____ **Date:** _____

12 Environmental Objective 12: Construction of a new road from the site offices to the northern boundary and to create a playing pitch

Objective 12: Construction of a new road from the site offices to the northern boundary of the site and to create a playing pitch				
Responsibility: FTC & Site Management			**Start Date:** Sept 06 **Revised Date:** Nov 08	
Target: To develop a playing pitch on the site of the soil stockpile and to construct a new / permanent roadway from the site offices to the northern boundary				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	FTC Consulting Engineers have been commissioned to design & prepare tenders for the construction & development of a new road & playing pitch.	Sept 06	FTC	Done
2	Site investigation works	Dec 06 – Jan 07	GEOTEC	Done
3	Public procurement & tenders – Aug 07 Assessment of tenders underway Oct 07	Aug 07	CCC Admin	Done
4	Commencement of works – May 08	May 08	Contractor	Ongoing
5	Works to be completed – March 09 Some delays due to weather issues	March 09	Contractor	
Objectives Completed: **Signature:** _____ **Date:** _____				

13 Environmental Objective 13: Assess the potential for the treatment of landfill leachate using natural systems

Objective 13: Assess the potential for the treatment of landfill leachate using natural systems				
Responsibility: KR			**Start Date:** Oct 04 **Revised Date:** Nov 08	
Target: To develop & construct a means of treating landfill leachate using natural systems incorporating reeds beds and peat /compost cells				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Commence desktop survey & background reading on the project	Jan 05	KR	Done
2	Design the infrastructure for the project	Spring 05	KR	Done
3	Seek quotations & build infrastructure Quotations received August 05 – building work delayed	Summer 05	KR	Done
4	Building of project commenced January 06 Pumps & pipework installed	Jan 06 Feb 07	Appointed contractors	Done
5	Commence sampling & allow project to run its course	April 07	KR	Done & Ongoing
6	Project showing promising results Ongoing quarterly updates & presentations given to Senior Engineer & Facility Manager Presented report at Environ 08 Conference in Dundalk in Feb 08			Ongoing
7	Produce report on finding & assess potential for use on a large scale	Project due to run until Autumn 09	KR	
Objectives Completed: **Signature:** _____ **Date:** _____				

14 Environmental Objective 14: Carry out an assessment of use of raw materials in all processes on site, having particular regard to reduction of waste generated

Objective 14: Carry out an assessment of use of raw materials in all processes on site, having particular regard to reduction of waste generated				
Responsibility: KR		Start Date: Oct 07 Revised Date: Nov 08		
Target: To reduce the amount of raw materials used on site with an emphasis on reduction of waste generated				
Task	Details	Due Date	By Whom	Status
1	Identify areas of raw materials usage on site Energy – as per energy audit Water – as per Objective 8 Oil & lubricants Materials associated with waste operations: Cover materials – hession, timber chip, soil Litter netting Road making materials, stone, concrete Office supply equipment – paper etc. Cleaning agents Sampling equipment Elements of the report have been put together - Provisional report should be ready Spring 09	Jan 08	KR	
2	Quantify raw material usage where possible and identify areas over which CCC has control	~~March 08~~ Spring 09	KR	
3	Produce report with recommendations for reduction of use raw material use and generation of waste	~~June 08~~ Summer 09	KR	
Objectives Completed: Signature: _____ Date: _____				

15 Environmental Objective 15: Drill new wells for the collection of Landfill Gas

Objective 15: Drill new wells for the collection of Landfill Gas				
Responsibility: **Facility Management & appointed contractor**		**Start Date:** Sept 08 **Revised Date:**		
Target: To drill new wells for the collection of landfill gas in the area directly opposite the site offices				
Task	**Details**	**Due Date**	**By Whom**	**Status**
1	Identify area for drilling of new wells for the collection of landfill gas	Sept 08	JT / Bioverda Power Systems	Done
2	Meet with contractor & Bioverda Power Systems to discuss engineering issues involved & plan for drilling	Sept 08	JT / Contractor / BPS	Done
3	Contractor to revert to CCC with plan for drilling & moving existing pipework & price for works involved	Nov 08	Contractor	
4	Drilling of wells to commence & connection to pipe network to LF Gas combustion plant thereafter	Spring 09	Contractor	
Objectives Completed: **Signature:** _____ **Date:** _____				

16 Environmental Objective 16: Development of North-Central Area of site

Objective 16: Development of North-Central Area				
Responsibility: Facility Management & appointed contractor		Start Date: Nov 08 Revised Date:		
Target: To restore & cap the North-Central area of the site with an aim to developing an events area for the provision of amenities				
Task	Details	Due Date	By Whom	Status
1	Preliminary discussions held with appointed consultants to discuss the size & scope of the project	Sept 08	MOB / JT / FTC	Done
2	Contract documents to be prepared for Spring 09	Spring 09	FTC	
3	Following revisions & finalisation of plans Invite submissions of interest for tenders from contractors – area of site ~ 1 hectare	Dates to yet to be finalised		
4	Assess tenders and seek clarifications from most economically advantageous contractor			
5	Inform successful contractor			
6	Issue construction drawings Contract 09			
7	Mobilise Contractor for Contract 09			
8	Advise EPA of Infrastructure development status.			
9	Specified Works Supervision			
Objectives Completed: Signature: _____ Date: _____				

17 Environmental Objective 17: Prepare documents for next phase of Landfill Capping – Phase 4

Objective 17: Capping Phase 4				
Responsibility: Facility Management & appointed contractor			Start Date: Nov 08 Revised Date:	
Target: To restore & cap the remaining active areas on site				
Task	Details	Due Date	By Whom	Status
1	Preliminary discussions to be held with appointed consultants to discuss the size & scope of the project	Summer 09	MOB / JT / FTC	Done
2	Contract documents for Phase 4 Capping to be prepared end 2009	Dec 09	FTC	
3	Following revisions & finalisation of plans Invite submissions of interest for tenders from contractors	Dates to yet to be finalised		
4	Submit SEW to EPA for approval			
5	Assess tenders and seek clarifications from most economically advantageous contractor			
6	Inform successful contractor			
7	Issue construction drawings			
8	Mobilise Contractor for contract			
9	Advise EPA of Infrastructure development status.			
Objectives Completed: Signature: _____ Date: _____				

5.2 Site Management Structure

The Staff Management Structure for the facility is detailed in the Organisational Chart. The responsibilities of the site staff are listed below.

Facility Manager

The Facility Manager has overall responsibility for operation of the facility in accordance with the conditions of the Waste Licence and best operational practices.

The Facility Manager co-ordinates all of the activities and contractors on site and implements procedures and practices in accordance with the Environmental Management Programme.

Deputy Facility Manager

The Deputy Facility Manager assists the Facility Manager in the management in the facility, acts as Facility Manager in his absence and is responsible for the daily operation of the landfill site.

Site Supervisor and Junior Foreman

The Supervisor and Junior Foreman are responsible for ensuring that the site staff carry out their designated duties, and liaises with the Facility Manager in the implementation of procedures and practices at the facility. They have completed the FAS "Waste Management" course.

Relief Site Supervisor

The Relief Site Supervisor performs the functions of the Site Supervisor in the event of his / her absence. The Relief Site Supervisor has also completed the FAS "Waste Management" course.

Weighbridge Operator

The Weighbridge Operator records incoming waste and controls access to the facility.

Senior Executive Chemist

The Senior Executive Chemist co ordinates the surface water, ground water and leachate sampling at the facility. Duties include the interpretation of monitoring carried out by Cork City Council and by outside contractors and the preparation of the quarterly reports on environmental monitoring.

Landfill Technicians

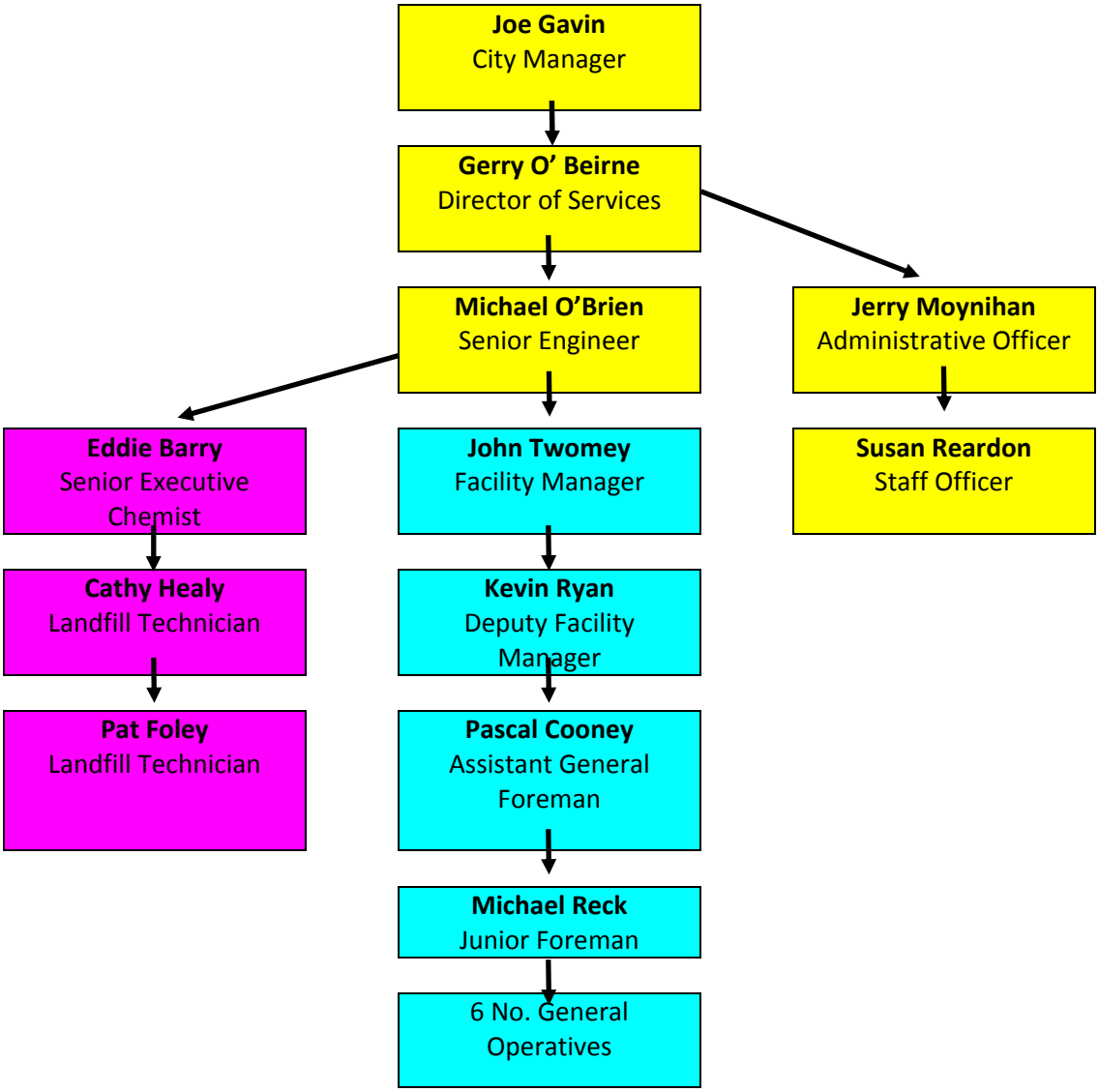
The Environmental Technicians carry out monitoring, sampling and analysis at the facility under the supervision of the Senior Executive Chemist and are based at the landfill site.

Staff Officer Environment

The Staff Officer Environment (not based on site) is responsible for the maintenance of the Waste Licence public file including dealing with queries from the public. Duties also include liaising with waste contractors regarding acceptance of waste and accounts etc.

5.2.1 Organisational Chart

The Management Structure of Kinsale Road Landfill Site, including Environmental Monitoring (Laboratory) and Administration (City Hall).



6 (a)

Summary Report on Emissions

Noise Emissions

Monitoring Locations

Within the Landfill B1-B4
B1 is located just north of the reception area or west perimeter.
B2 is located to the north perimeter.
B3 is located to the east perimeter.
B4 is located to the south perimeter.

Outside the Landfill A1-A4

A4 is located north of landfill in Secondary school Grounds (Christ King).
A1 is located at the end of Greenhills.

Monitoring Details

Monitoring was carried out on the 22 December 2008 by S E Chemist.
The instrument used was the Cell 495, Type 1.

Monitoring Results

The results (day-time) are presented below. The 1/3 octave results are at end of section. Previous years results are in brackets.

	Leq(A)	L10	L90
B1	64 (60) (57)	67	57
B2	53 (60) (53)	55	49
B3	54 (53) (48)	57	51
B4	62 (63) (61)	64	61
A1	56 (58) (51)	57	55
A4	58 (59) (54)	60	55

Interpretation

Limits
The dB(A) Leq 30 minutes should not exceed 55 during the day and 45 at night at the sensitive locations A1 and A4.

Results and Interpretation.

It was an overcast, damp day with little wind.
The over riding noise source at each location was traffic.

B1 was higher than last year. The timber shredder was in operation at the time of the survey this time. It generally adds 5-6 dB(A) to the background traffic.
B2 was lower than last year. The impacts here are traffic, works depot and ESB transformer station outside Landfill. The Landfill is over the brow of the hill and the timber shredder is shielded.
B3, towards Greenhills, was same as last year. The major impact at B3 is traffic. The works operations around the landfill and construction at the playing fields were not contributing.
B4 was noisy and similar to previous years. This station is dominated by heavy traffic on the South Ring road at about 100 metres away. No noise could be heard from the landfill filling face.
It would not be possible to separate landfill impact from traffic and other sounds in order to check compliance with the licence. The nearest outside station A4 (Christ King School) was about same as last year. Subjectively, sound levels here are always due to traffic, birds and schoolchildren rather than landfill.
A1 (end of Greenhills) was a little lower than last year. The construction work in Nemo Rangers' grounds has ended for two years now and there was no noise from the landfill.

The landfill does not operate at night.

One third Octave Band Analysis
The charts are in the Appendix.
The one-third-octave band analysis shows that the noise regime in the landfill and surrounding areas is dominated by traffic noise. The B4 position (South) is clearly dominated by traffic. B2 (North) has a peak at 100 Hz that may be attributed to the ESB Transformer. B2 and B3 lose some of the higher pitched levels due to distance. The overall pattern at each station is similar indicating the predominant traffic influence from surrounding roads.

Landfill Gas

Buildings

Limits

The limits in the licence are 1% v/v (20% LEL) for methane and 1.5% v/v for carbon dioxide

Monitoring Details

Six buildings are monitored on a weekly basis.
The instrument used was the Gasdata LMSX and the monitoring was carried out by the Landfill Technicians.

Summary of the Results

No methane was detected and only minute traces of CO2.
The Park and Ride had no methane shows.

Interpretation
No landfill gases are entering the buildings. Works have been carried out on the leachate pumping sump and the flaring system. Duct and chamber sealing was carried out by the contractor during the period of maintenance in 2005. A fan extractor and stack were installed within the car parking area in 2006 as an additional safety measure.

Gas Monitoring Wells

Trigger Levels

These are 1.0 % v/v for methane and 1.5% v/v for carbon dioxide "measured in any service duct or manhole on at or immediately adjacent to the facility and/or at any point located outside the body of the waste."

Monitoring Details

The instrument used was the Gasdata LMSX and the monitoring was carried out by the Landfill Technicians.
The wells (DP) in the old landfill area across the South Link Road are into the body of the waste and were designed to check for gas generation not migration. There are 15 wells drilled around the periphery of the old landfill

site across the South Link Road - 137 to 175; these would most likely be drilled into some waste.
The wells to the north, east and south of the landfill LG1-LG19 are drilled into soil surrounding the landfill and are designed to check for migration of methane laterally to surrounding areas.
Due to shows of gas, in the eastern and north eastern periphery about fifty new wells off site in the green area between Greenhills and the landfill have been installed. Many of these new wells were designed to function as venting wells/monitoring wells. From 2005, the wells closest to the landfill periphery (LG) have been use as monitoring wells and the middle wells for venting purposes (two weeks venting and one week closed). Wells are drilled to different depths, have different sensitivities and there are local soil factors that make it difficult to assess trends and comparisons.

Monitoring Results (2007 Results in (brackets)

Old Landfill Area
Park and Ride
The 15 periphery wells that are monitored on a daily or weekly basis around the old landfill site across the south Link Road show the presence of gas on the odd occasion.
137 and 139 showed gas on occasion most linked to flare going down. 138 and 140 yield infrequent shows of gas. The wells 141-146 show very little gas -141 gave 5 shows due to flare going down (none last year). The wells 171-175, monitored weekly, showed no gas (2 last year in 175).
(*There are high levels of gas in DP3 but DP4 showed zero in 2008. These DP wells are drilled into waste and are not proper monitoring wells as defined in the license*).
Trials have shown that there is insufficient gas in this sector for power generation although gas is pulled for destruction by flaring. The Park and Ride building showed no evidence of gas in 2008.

Present Landfill Area

There are no shows of gas in the wells monitored in **southern** and **western** perimeters of the landfill.
There is one well showing very small amounts of gas in the **northern sector**, LG1, the range was 0 - 3%v/v.The possible reasons for the presence of gas in this well in the northern sector are the new positioning of the well, waste in the new well location and the influence of the interception trench.
In the **eastern sector** of the landfill, methane levels began exceeding trigger limits in 2002 and this led to increased monitoring on a daily and weekly basis in addition to the monthly monitoring normally undertaken up to then.
The interception trench (2004) and venting procedures have stabilised gas levels in the eastern perimeter wells and reduced if not eliminated gas shows in wells further east although the situation in LG9A and LG10A is anomalous.

Charts showing methane concentrations over the years at eastern landfill periphery wells LG1, LG5A, LG6A, LG7A, and LG8A that have shown gas in the past are in the attached Appendix. The well labels increase in number from north to south e.g. LG5 is in north east corner and LG9 towards south east.
It is important to note that the LG5A - LG8A wells were closed more often in 2006, 2007 and 2008 than in the preceding years when there was more venting.
The general trend in all these wells is that gas levels are very variable with time. There are some indications that gas levels peak about April and also indications that levels increase after rain.
The second half of 2008 showed higher levels than in the first half of the year.
LG5 has shown no gas since 2005.
LG5A drilled close to LG5, seems to have gas more consistently, this may be due to it being a deeper well. It is also located immediately adjoining a ventilation pit.
LG6 has no gas.
LG6A is high in gas, this peaked in May 2005.
LG7 has virtually no gas.
LG7A peaked in Dec 2004 and has declined considerably in gas levels. It has virtually no gas now.
LG8A peaked in 2004 and has reduced a little since.
LG9, LG10 and LG11 have become inoperative and have been replaced by the new wells, LG9A and LG10A, these new wells are much closer to the landfill and may be contaminated by leachate. They are showing very high levels of gas and this needs further investigation. LG 11 had the highest shows of gas in this sector in the past.
Some of the new wells, with the tag A, drilled in proximity to the older wells generally show a stronger presence of gas than the older wells. This may be due to the greater depth drilled, the variability of the gas in the area, the sensitivity of the wells drilled or the soil disturbance.

There are very many other wells east of the LG5-11 line but these are being used for venting as well as monitoring so more variations in monitoring trends would be expected. Gas readings are taken following a few days and then a week of closure; the wells are then vented for three weeks.
There has been a steady decline in gas in these wells since 2004 and there is virtually no gas in these wells now. The shallow gas wells in Greenhills Estate that are monitored on a monthly basis gave no show of gas. Other wells such as at Nemo Gate show no gas.

<u>Interpretation</u>

The wells to the south and west show no evidence of methane migration.
Gas concentrations in the eastern periphery wells declined to lower levels in 2005 and continued at the lower level in 2006, 2007 and 2008 (although there

are fluctuations). The decline could be due to the installation of the interception trench in late 2004 preventing the flow of gas eastward. It could also be due to the venting measures to the east. The wells east of the landfill periphery have reduced considerably in gas. The shallow gas wells in Greenhills were free of gas in 2007 and 2008.
Since the beginning of 2005, there are slight shows of gas on the northern boundary. This may be due to the installation of the interception trench to the east or to local deposits of waste next to the monitoring well.
Interpretation of gas presence and passage through soil is inherently difficult and there are extraneous confounding factors such as atmospheric pressure, temperature, soil water saturation, biological processes or soil disturbance as well as capping.
Due to the decrease in shows of gas readings in a number of the wells as mentioned above, it is proposed to reduce the frequency of monitoring in 2009. A request shall be presented to the Agency in due course.

Measures to Control Gas

The analysis of trace components in the gas did not conclusively establish the origin of the gas. Consultants who examined the data suggested that the gas could be derived from the landfill, historical private waste deposits in the area east of the landfill or from the peat itself.
A programme of measures to control gas from the possible sources listed above is in place since early 2005. These measures incorporate an intensive monitoring regime at stations inside and outside the Landfill, suction and flaring of gas on 36 new wells constructed on the eastern periphery of landfill, a 700 metre long interception trench along the eastern periphery and vent pits.
The measures being taken are controlling the situation. The advice received was to initiate a slow and steady reduction of gas.
The situation in LG9A and 10A needs further investigation and remedial works will follow further investigation.

Carbon Dioxide

The carbon dioxide levels were exceeded in most wells.
Where there is presence of carbon dioxide in preference to methane, it may be due to aerobic landfill conditions. The presence of oxygen will also be more noticeable in these wells (as is the case). Aerobic conditions are more likely to occur at shallow, uncapped landfill sites or any other condition that allows air into the refuse - such as at perimeter locations. Carbon dioxide has asphyxiate but no explosive properties.
The majority of the wells have increased levels of carbon dioxide in the summer time probably due to warmer conditions promoting microbiological activity.

Gas Combustion Plant Intake

There are no limits in the licence.
The instrument used was the Gasdata LMSX and the monitoring was carried out by the Landfill Technician on a weekly basis.
Methane concentrations varied from 30-56 (24-50) %v/v and CO2 concentrations 3-29 (10-30) %v/v.
Summer concentrations are generally higher than winter.

Emissions from Landfill Gas Combustion Plant

Monitoring Requirements

Inlet

Methane	weekly monitoring	as %v/v
Carbon dioxide	weekly monitoring	as %v/v
Oxygen	weekly monitoring	as %v/v
Total Sulphur	Annually	
Total Chlorine	Annually	
Total Fluorine	Annually	

Outlet

SO2	Annually
NOx	Annually
CO	Continuous
Particulates	Annually
TA Luft Cl I, II, III organics	Annually
HCL	Annually
HF	Annually

Carbon Monoxide Continuous Monitoring of the Burners TV01 and TV02

Limits for Carbon Monoxide Continuous Monitoring (last year results in brackets)

The limits in the licence are 1300 mg/m3 for 30-minute average and 650 for daily average.
The Agency by letter dated 17/07/03 has asked that concentrations exceeding 2800 mg/m3 for the 30-minute averages and concentrations exceeding 1400mg/m3 for the daily averages be regarded as incidents and reported.

TVO1
The 30-minute average varied from 0-14,156 (0—5634) mg/m3.
There were 9 exceedances (1) at engine start up.
Daily averages varied from 0-1032 (410-1134) mg/m3.

TVO2
The 30-minute averages varied from 0-2642 (0-2626) mg/m3.
There was no exceedance (0).
Daily averages varied from 0-831 (0-557) mg/m3.

TV02 has been removed in agreement with the Agency in October 2008.

Emission Limits on Outlet

The license limits on the emissions are as follows.

NOx as NO2	500 mg/m3
CO	650 mg/m3
Particulates	130 mg/m3
TA Luft CLI	20 mg/m3 (at mass flows>0.1kg/hr)
TA Luft CLII	100 mg/m3 (at mass flows>2 kg/hr)
TA Luft CLIII	150 mg/m3 (at mass flows>3 kg/hr)
HCL	50 mg/m3 (at mass flows>0.3kg/hr)
HF	5 mg/m3 (at mass flows>0.05kg/hr)

Monitoring Results

Report received from Odour Monitoring Ireland in Appendix.
All results in the exhaust from the engine TVO1 and landfill flare are within the emission limit values for the parameters CO, NOx, particulates, TNMVOC, TOC, HCl /HF and total flow. While no limits are given in license for SO2, results were low.
The Report estimates that the methane destruction in the landfill flare is 99%.

Emissions to Sewer

Methane (Results in brackets are for previous year)

Headspace and aqueous probe methane measurements that are automatic and continuous have now been discontinued because they are very inaccurate.
The replacement monitoring system in operation is based on samples taken from the discharge and subjected to GC analysis in the Cork City Laboratory. The Cork City Council results show that the 34 (45) samples taken showed a range in concentration from 0.1-1.6 (03-1.2) mg/l. The limit in the Licence is 0.2mg/l and 20 (26) samples exceeded. The monitoring shows that the conditioning plant reduces methane concentrations by about 98%.
Additional measures such as agitation in the leachate balancing prior to discharge through the aeration lanes are being considered as a means for further methane reduction.

Flow

Leachate is collected, conditioned and discharged to the sewer.
Potentially contaminated water not suitable for immediate discharge to river was formerly collected and discharged to the sewer but this now goes to the reedbeds.
The flow through the conditioning plant (6 inch line) varied from 0-26 (0-23) m3 per hour. There was one exceedance (0). The licence requirement is 25 m3/hr.
The cumulative flow, recorded by the Scada system, in 2008 was 68,000m3 (104,243) (122,627) (121,454) m3. The flow recorded was down this year due to several factors: clogging of pipe, breakdown of Scada during June / July and two breakages of the line in December. Further capping of the landfill site (3.4 ha) may have also contributed.

pH

The pH results are from 6.6-8.7 (7.5-8.0). Licence requirement is 7-9.

24 Hour Composite Concentrations (Results in brackets are for previous year)

Samples are taken every month.
BOD values are always low, probably due to ammonia suppression in the test.
The ammonium results varied from 16-360 (130-360) mg/l. The limit for ammonium is 600mg/l for 95% of the samples. All the samples taken complied with the license.
The other parameters: pH, sulphate and suspended solids are well within the limits.

24 Hour Composite Loads

There are **no limits** in the licence.
Ammonium is the parameter that is of most concern all the other parameters are low in concentration and load.
The ammonium load in 2008 varied from 5-104 (11-125) kg/day.

Discharge from the Stormwater Retention / Reed bed facility

Status

This facility has been constructed and reeds planted in 2004. It was commissioned in 2005

Results

Reedbed Discharge (Results in brackets are for previous year)

No sample from 16 (0 from 33) exceeded the suspended solids limit of 35 mg/l.
The ammonium values ranged from 0.6-11.8 (0.2-31) mg/l and BOD values ranged from 0.8-9 (2-24) mg/l.

Dust Deposition

Monitoring Locations

Dust
D1 is located towards the western perimeter on the present landfill.
D2 is located towards the northern perimeter.
D3 is located towards the eastern perimeter.
D4 is located towards the southern perimeter.
D5 is located in the old landfill across the South link Road.

Dust Monitoring Results

The five stations are monitored every quarter (20 samples/year)
The **limit** in the licence is 350mg/m2/day.
All samples well below limit of 350 mg/m2/day.
The stations are within the landfill and may not affect the outside environment.

6 (b)

Summary of Results and Interpretation of Environmental Monitoring

Asbestos in Soil

Monitoring Locations

The locations are Heatherton Park, NW of lab, north perimeter, north east corner, and south perimeter.

Monitoring Details

The samples were taken by City Council personnel from the topsoil. The analysis is by an outside agency (ACS) and the Report is attached.

Monitoring Results

No asbestos was found in any of the five samples.

Groundwater Monitoring

Limits

There are no limits on the licence.

Monitoring Locations

A map of the approximate locations is at the end of this section.
The groundwater flow is from west to east.

BR1 and OB1 are bedrock and overburden wells on the northern perimeter of the landfill.
BR2 and OB2 are located on the north-east perimeter.
BR3 and OB3 are located on the eastern perimeter (down gradient).
BR7 and OB7 are located on the southern perimeter. OB7 is located in area where refuse is being deposited and is contaminated with fresh leachate.

The wells NW1 to NW9 are designed to check the efficiency of the leachate collection system. NW1 is in the south west corner just north of the Tramore stream and just east of the South City Link. The wells move in numbered order, anti clockwise, to the north east corner (NW9). The wells are on the landfill side of the streams. The well NW9 has been re-drilled outside the collection drain in 2001.

Monitoring Details

All samples were taken and analysed by City Council laboratory personnel. The analysis for pesticides, PAH, organochlorines are undertaken in the U.K.

Monitoring Results and Discussion

Monitoring Results (Results in brackets are for last year)

Ammonium in Wells

Overburden Wells
The overburden wells show no pollution in OB1 and OB2 but very high ammonium levels in OB3, 5.5-440 (300-400) mg/l and less so in OB7, 4.7-52 (30-40) mg/l. These shallow wells are drilled into or very near the body of the waste and at peripheral locations and would be expected to show pollution.

Bedrock Wells
Groundwater to the southwest, west and north show no pollution but that to the north east shows a trace and the well to east (BR3) is heavily contaminated with ammonium concentrations in range 550-740 (300-400) mg/l. This may be due to the well location in the area where there is insufficient pumping. This is being investigated.

Annual Survey

The **Annual Survey** for a longer list of parameters for BR1 and BR7 did not show any concentration of concern. Heavy metals were at or below limits of detection (0.001 mg/l) and cyanide was below detection limit of 0.005mg/l. TOC varied 1-59 (1-102) mg/l. Pesticides were below detection.
PAH's were below detection.
High concentrations of potassium, sodium and alkalinity were also observed in BR3.

NW Wells

The wells NW1 to NW9 are designed to check the efficiency of the leachate collection system consisting of the collection drain and the sheet pile wall in front of NW 1 and 2.
The average concentrations over time is shown in Table 1.

Table 1

Mean Total Ammonium (mg/l)

	NW1	NW2	NW3	NW4	NW5	NW6	NW7	NW8	NW9
01-02	64	135	25	53		28	119	31	-
2003	35	-	25	35		21	35	27	0.5
2004	24	-	18	26		67	85	21	0.2
2005	dry	dry	16	20		78	167	13	0.1
2006	24	dry	25	37		98	73	43	0.3
2007	21	27	21	26	3.3	113	47	15	0.3
2008	20	24	47	30	0.3	129	63	15	0.1

The table shows that ammonia concentrations are high particularly around NW6 and NW7.

The mean water well levels show no major change over the years.

Biological Surveys of Streams

Monitoring Locations

Tramore Stream

Sample sites listed in downstream order as follows.
Samples were taken at the beginning of the old landfill (E) roughly equivalent to EM1, just below the South City Link roughly EM2 (C), halfway along landfill near OB7 (D) and near EM6 (F) below all landfill and downstream of confluence with Trabeg.

Trabeg

Samples were taken at farthest possible upstream point although still in landfill near EM7 (A) and, before confluence with Tramore, near EM8 (B)

Monitoring Details

These surveys were undertaken by the Aquatic Services Unit at UCC in June. The Report is attached.
The licence conditions specify an annual kick sampling biological assessment of the Tramore and Trabeg streams. This was not possible for the Trabeg because of its structure.
Landfill leachate is now going to sewer and Carrigrenan treatment plant.

Interpretation

Biological quality is graded from Q1 (bad) to Q5 (good).

Tramore Stream

The Tramore site upstream of the landfill remained at Q2 level (moderately or seriously polluted). The sites within the landfill were of same quality to last year, Q1-Q2 which remain moderately or seriously polluted again in 2008.
The downstream station on the Tramore shows the impact of the Trabeg in addition. The station had the same rating as last year (Q1-Q2).

Trabeg stream

The sites are unsuited to kick sampling and difficult to assign a Q rating. The upstream is probably Q1-2 and downstream not better than Q2. This is due to the influence of overflowing combined storm & sewer chambers further upstream of the Landfill Site.

Surface Water Monitoring

Limits

There are no limits on the licence.

Monitoring Locations

Tramore River:

The Tramore River flows to the south of the landfill.
EM0 is about one km upstream of all landfill.
EM1 is just upstream of the bridge on the Kinsale Road and just above all landfill.
EM9 is upstream of the bridge over the South Link Road - at the end of the old landfill across the South Link Road and just before the present landfilling area.
EM2 is at the beginning of the present landfill and just below the bridge over the South Link Road. It is almost in the same location as EM9.
EM10, as shown in the licence documents, has been moved from the point of confluence of the Tramore and Trabeg to about 20 yards upstream in the Tramore and has been renamed EM11. Sampling at a confluence is not good practice- samples taken could represent either the Tramore or the Trabeg or a varying mixture of the two. This EM11 site is also too near the landfill to ensure adequate mixing of the discharges and receiving waters. Mixing is not complete at this site and the sample may not always fully represent the dilution in the stream.
EM6 is about 300 yards downstream of the confluence of the Tramore and Trabeg. At this point, discharges from the landfill are adequately mixed with the receiving waters. This was the historical sampling point for the downstream sample. Possibly at times it may be affected by the back up of tidal waters but it remains the best option for a downstream sample

Trabeg Stream

EM7 and EM8 are on the Trabeg stream that skirts around the north and east of the landfill and then joins the Tramore. EM7 is upstream and EM8 is downstream.

Monitoring Details

The samples were taken and analysed by Cork City Council laboratory personnel
The stations are listed in downstream order (the first station- EM0 is furthest upstream)

Interpretation

Surface water monitoring is very variable with time and little significance can be placed on comparison between annual quarters.

Ammonium and BOD

There can be some contamination of the upstream waters on occasion and this has been noticed in the ecological report.
Because of the variability to be expected in surface waters there is no clear trend over the quarters.
There are four attached charts portraying the quality for BOD and NH4 at upstream (EM 1) and downstream (EM6-10) for Tramore river locations and also upstream (EM7) and downstream (EM8) for the Trabeg river. These charts span the period 2000-2008.
Tramore
Generally, upstream Tramore (EM1) has BOD values varying from 1-2.5 (0.5-1.3) mg/l in 2008 but in the past these have ranged up to 5.5 mg/l.
Downstream values (EM6-10) ranged from 1-3 (1.8-5.7) mg/l in 2008 but in the past have ranged up to 27mg/l.
Generally, EM1 has ammonium values ranging from 0.01-0.05 (<0.01-0.38) mg/l in 2008 but in the past have ranged up to 2mg/l.
Downstream values ranged from 0.01-0.04 (0.01-0.4) mg/l in 2008 but in past have ranged up to 22mg/l.
The waters upstream and downstream show little pollution although the very high values that occurred downstream in the past do not happen now. The ecological study show more evidence of pollution, upstream and downstream.
Trabeg
Generally, upstream Trabeg (EM7) have BOD values varying from 6-14 (4-7) mg/l in 2008 but in the past have ranged up to 14mg/l.
Generally downstream values (EM8) have BOD ranging from 8-12 (5-13) mg/l in 2008 but in past have ranged up to 13 mg.
EM7 has ammonium values varying from 0.01-0.08 (0.02-0.6) mg/l in 2008 but in the past have ranged up to 20 mg/l.
EM8 has ammonium values varying from 0.02-0.37 (0.04-0.6) mg/l in 2008 but in the past have ranged up to 37 mg/l.
The waters upstream and downstream show severe pollution (as also in ecological studies).

Other Parameters
The more extended annual list of heavy metals, pesticides, PAH, organochlorines etc does not show any remarkable trend or concentrations. There is generally little difference between upstream and downstream values for these parameters.

Weekly Visual Inspections
Normally there is nothing unusual reported. The most common observation over the stretch of waters inspected is muddy. EM8 (downstream- Trabeg) is generally described as stagnant and greenish. Algae are occasionally observed at the downstream locations and this is not surprising because they are relatively stagnant, at the top of the tide.
EM7 (upstream in the Trabeg) displays sewage fungus indicating heavy pollution upstream of landfill.

Particulates and Odour

Particulates (Results for previous year in brackets)

Particulates as measured by the total suspended particulate parameter were below the EU limits and guide values in 2008 as in 2007.
Particulates as measured by the PM10 parameter are measured outside and within the landfill. There is a trigger level of 50 ug/m3 for boundary monitoring. It would not be possible to separate ambient levels and the contribution from the facility.
The station outside the landfill, where samples are being taken daily for PM10, had two days (one day) in the year when concentrations exceeded 50 ug/m3. One of these exceeding samples was due to welding works on the enclosure. There needs to be 35 daily samples exceeding the 50ug/m3 figure to breach the EU standard.
Within the landfill PM10 samples are taken quarterly and two samples (0) exceeded the 50 ug/m3 level.

Odour

Odour Monitoring Ireland Ltd carried out the odour monitoring.
There are no limits in the licence.
Some small increases in downwind odour threshold concentrations were observed across the data set but these increases are not statistically significant due to the inherent difficulties in interpretation of ambient-based olfactometry results (i.e. impossible to take account for the dilutional aspects of the atmosphere, etc.). The highest odour threshold concentration was detected at monitoring location O9 (alongside active face). A landfill gas odour was detected in the vicinity of this monitoring location. Landfill gas odour was also detected at monitoring location O8 (compost area). Hydrogen sulphide concentrations recorded at each monitoring location were less than 3ppb in ambient air. Elevated ambient air concentrations of PID continuous TVOC's were detected at monitoring locations O8 and O9. GCMS screens

illustrated a large array of volatile organic compounds present in the air stream at all monitoring locations. All ambient air concentrations were low and well within any respective exposure threshold concentrations. Monitoring location O9 recorded the highest TVOC concentration, which was located closest to the active face. It would appear that traffic based emissions have a significant effect on the profile of compounds detected during TD GCMS based surveys for odours in urban locations.

Nuisances

Monitoring Locations

Weekly visual inspections describe the appearance of the landfill from Amberly Heights (south of the landfill), Greenhills Estate (north east) and Heatherton Park (north).

Results (last years in brackets)
There were 147 (159) observations.
No rodents were observed (0).
No flies were observed (0).
Odour was observed on 5 (0) occasions.
Birds were noticed on 4 (2) occasions.
Noise was observed on 0 (1) occasions.
Loose litter was seen on 2 (3) occasions.

Compost

The compost as analysed by BNM almost satisfies the limits for Grade 2 compost.
It just exceeded the limits for lead and zinc for Grade 1.

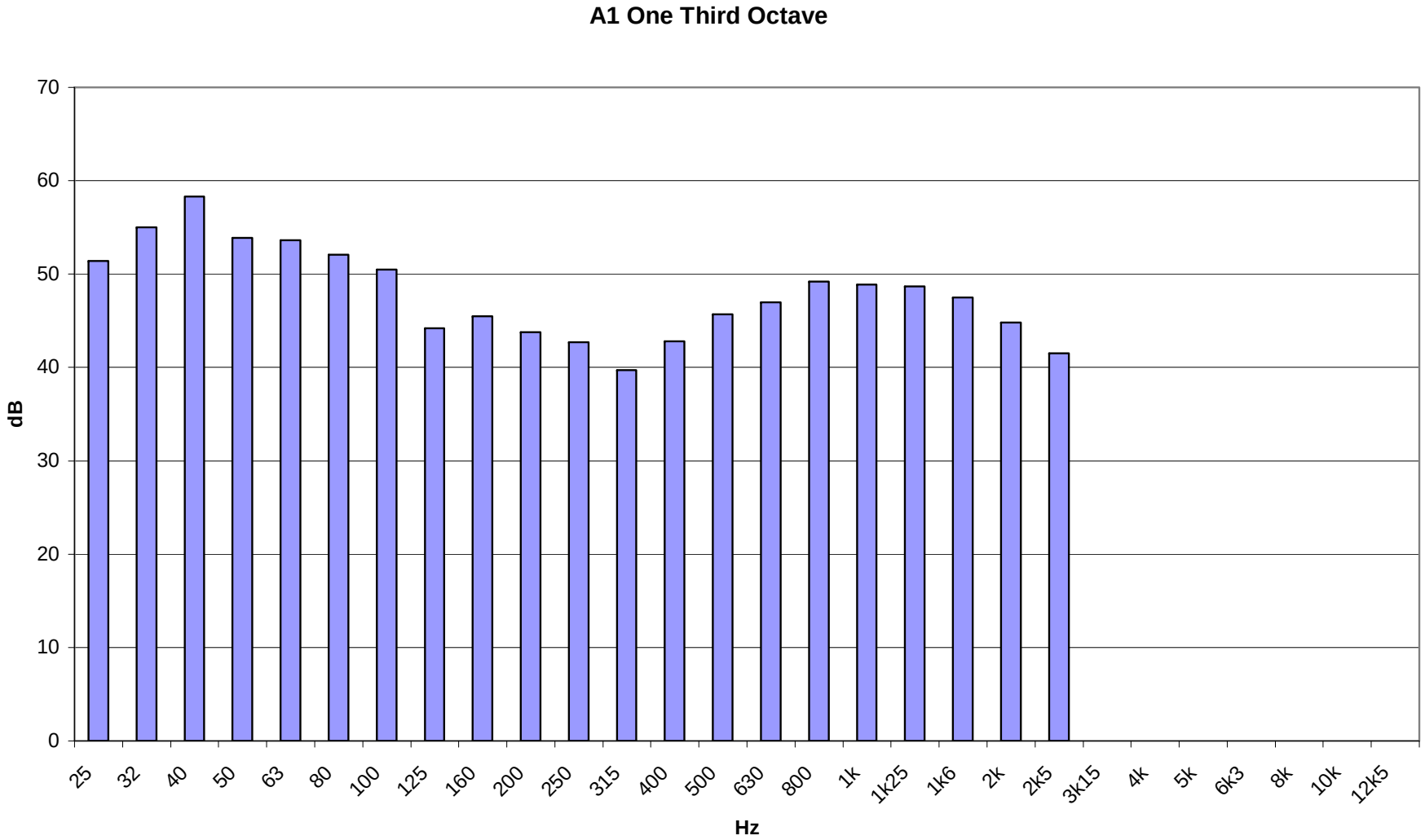
Appendix

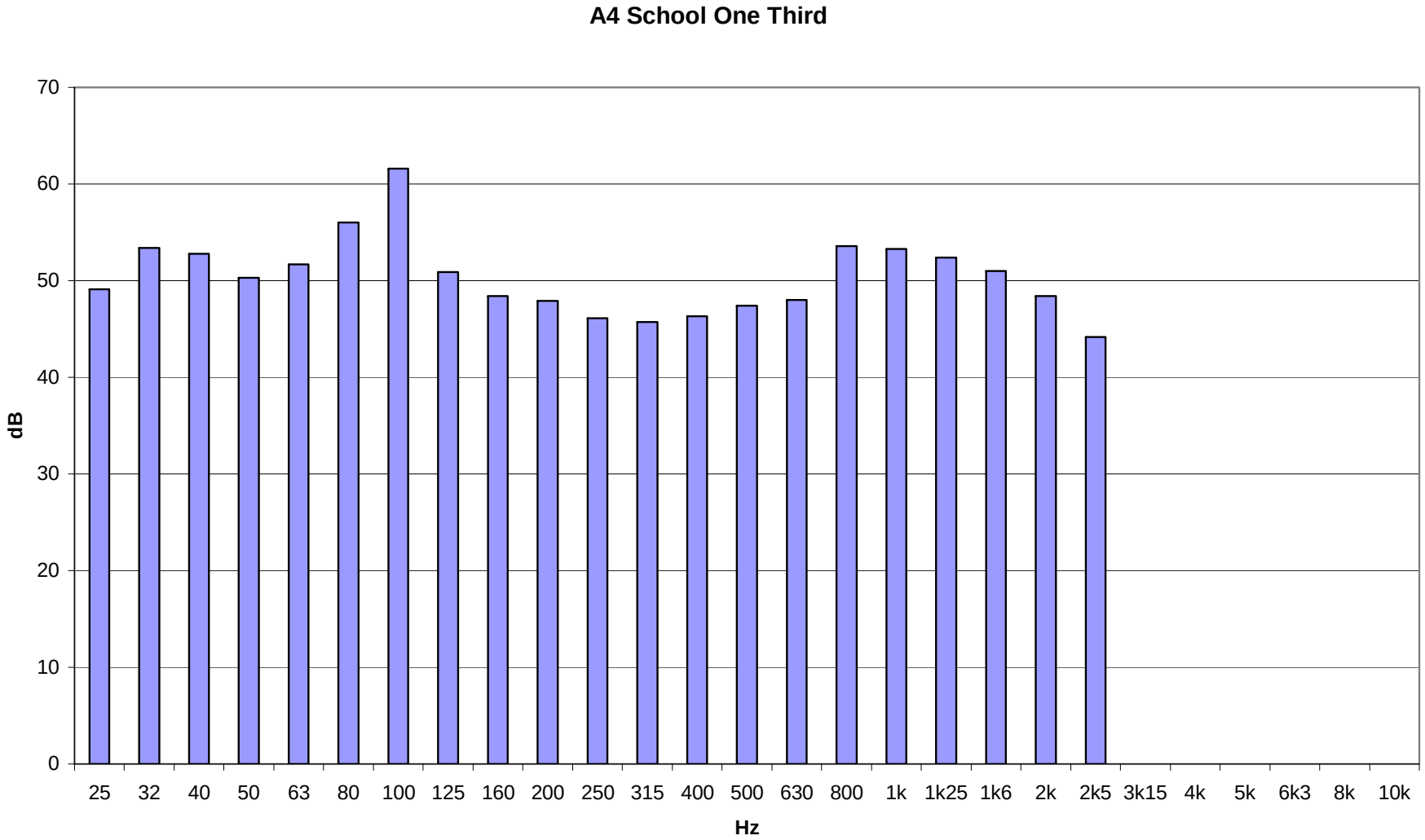
- **Graphs**
- Noise Monitoring
- Landfill Gas
- Surface Water

Reports

- Biological Survey of Streams Report
- Asbestos Monitoring Report
- Air Emissions testing of the Flare Unit & Gas Utilisation Engines

Noise Monitoring Graphs

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70
60
50
40
30
20
10
0
dB
25
32
40
50
63
80
100
125
160
200
250
315
400
500
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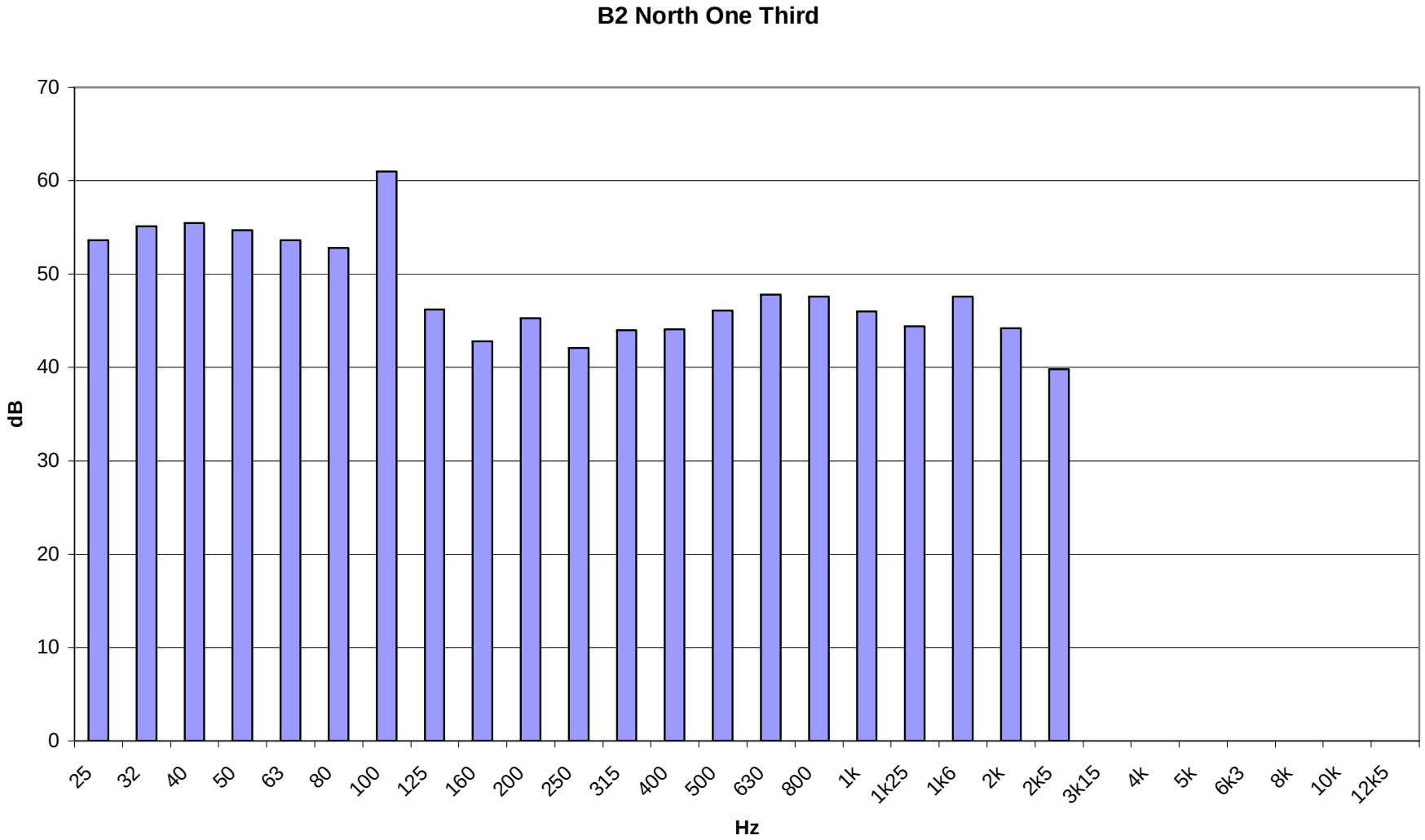
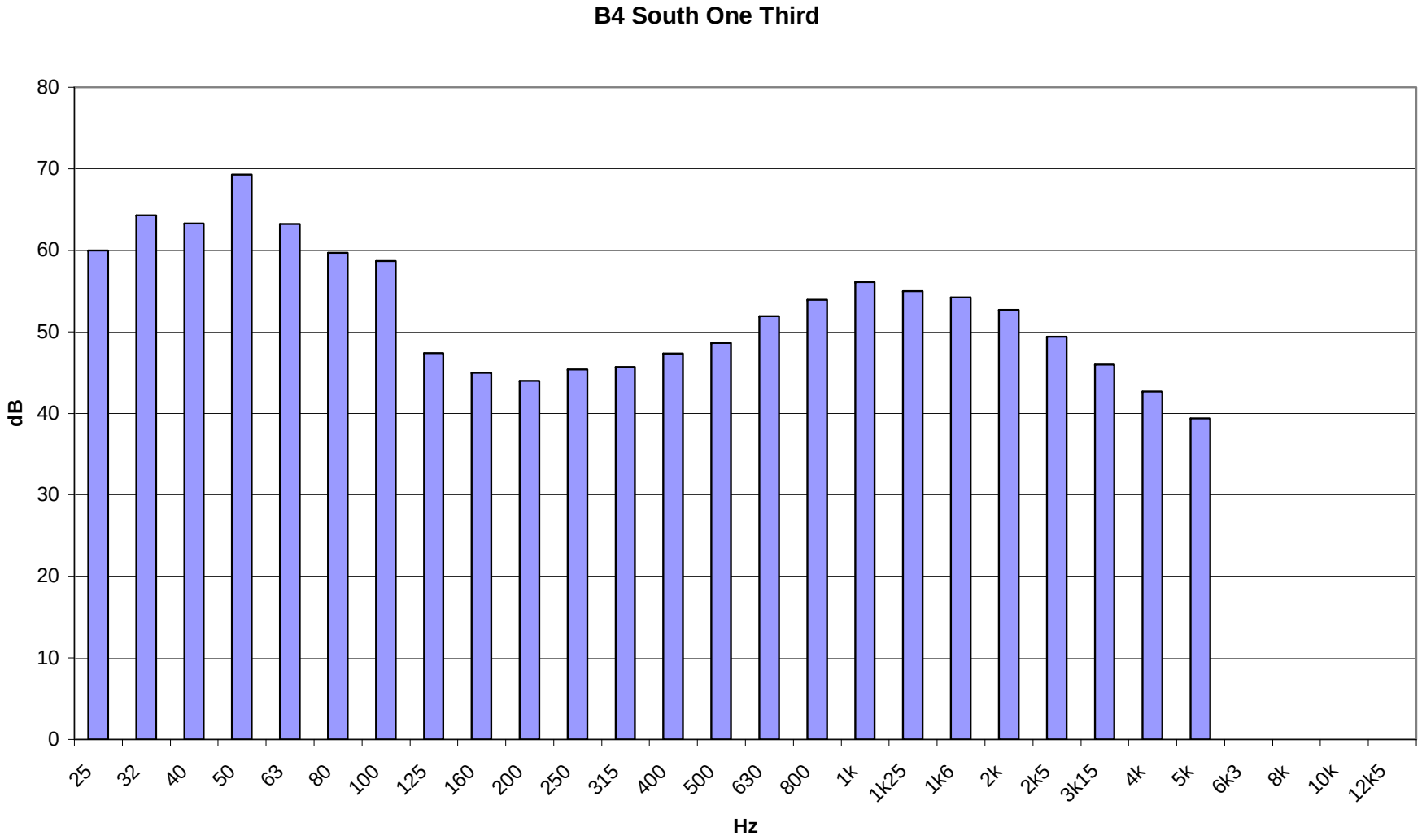
3k15
4k
5k
6k3
8k
10k
Hz


B2 North One Third
dB
70
60
50
40
30
20
10
0
25
32
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1k
1k25
1k6
2k
2k5
3k15
4k
5k
6k3
8k
10k
12k5
Hz


B4 South One Third
dB
80
70
60
50
40
30
20
10
0
25
32
40
50
63
80
100
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200
250
315
400
500
630
800
1k
1k25
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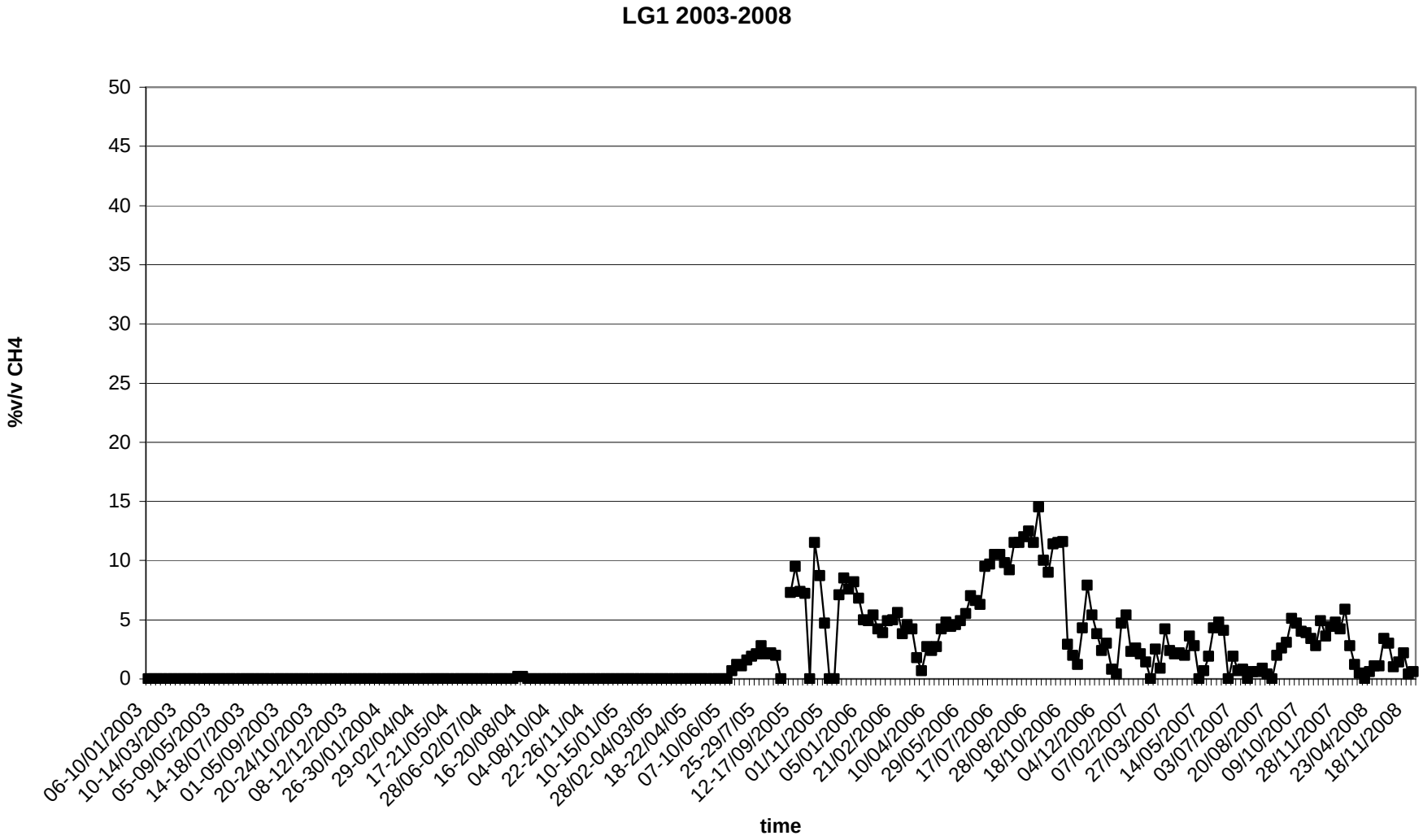
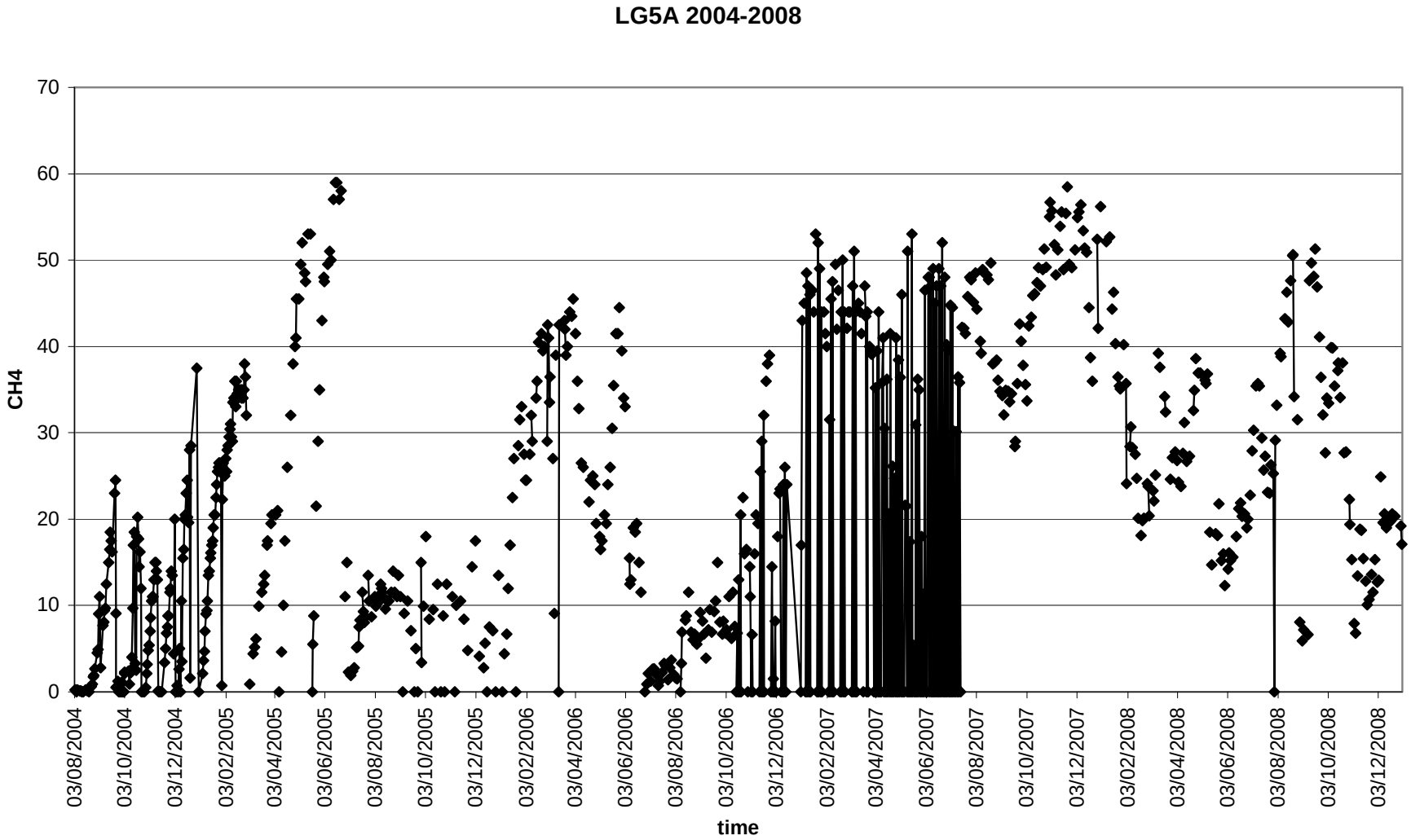
4k
5k
6k3
8k
10k
12k5
Hz

Landfill Gas Graphs

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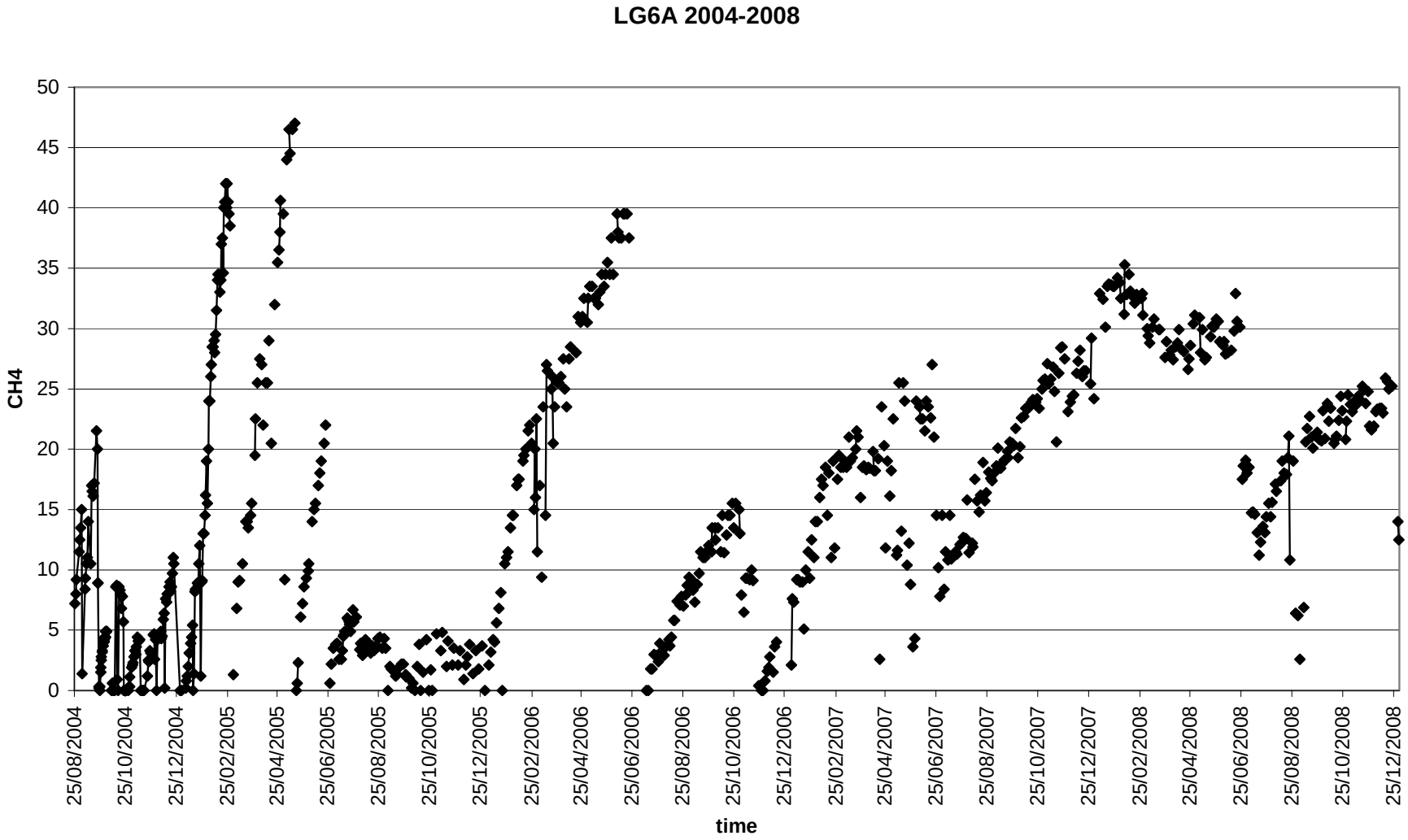
CH4
70
60
50
40
30
20
10
0
03/08/2004
03/10/2004
03/12/2004
03/02/2005
03/04/2005
03/06/2005
03/08/2005
03/10/2005
03/12/2005
03/02/2006
03/04/2006
03/06/2006
03/08/2006
03/10/2006
03/12/2006
03/02/2007
03/04/2007
03/06/2007
03/08/2007
03/10/2007
03/12/2007
03/02/2008
03/04/2008
03/06/2008
03/08/2008
03/10/2008
03/12/2008
time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CH4
50
45
40
35
30
25
20
15
10
5
0
25/08/2004
25/10/2004
25/12/2004
25/02/2005
25/04/2005
25/06/2005
25/08/2005
25/10/2005
25/12/2005
25/02/2006
25/04/2006
25/06/2006
25/08/2006
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25/12/2006
25/02/2007
25/04/2007
25/06/2007
25/08/2007
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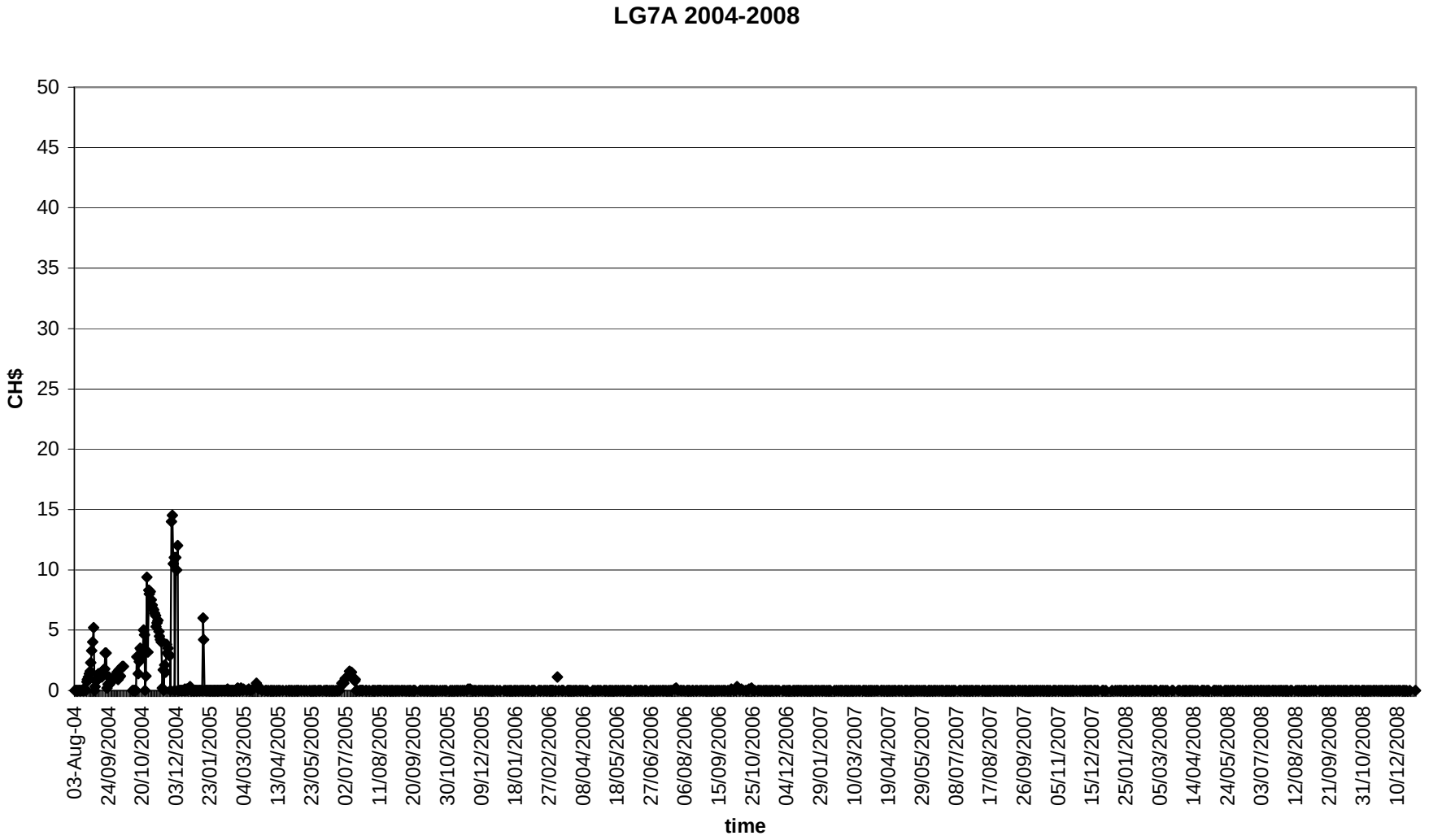
25/02/2008
25/04/2008
25/06/2008
25/08/2008
25/10/2008
25/12/2008
time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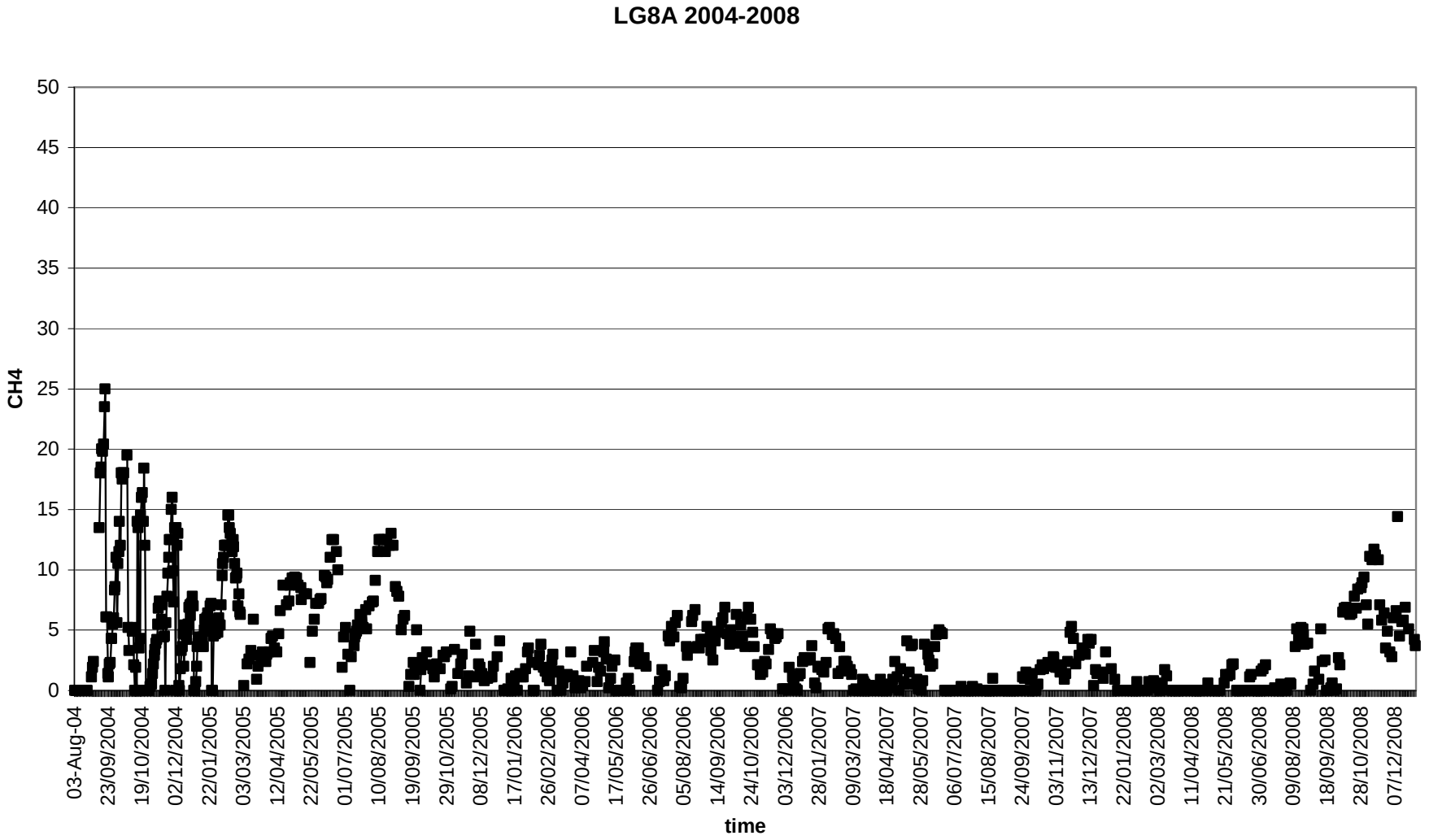
CH$
50
45
40
35
30
25
20
15
10
5
0
03-Aug-04
24/09/2004
20/10/2004
03/12/2004
23/01/2005
04/03/2005
13/04/2005
23/05/2005
02/07/2005
11/08/2005
20/09/2005
30/10/2005
09/12/2005
18/01/2006
27/02/2006
08/04/2006
18/05/2006
27/06/2006
06/08/2006
15/09/2006
25/10/2006
04/12/2006
29/01/2007
10/03/2007
19/04/2007
29/05/2007
08/07/2007
17/08/2007
26/09/2007
05/11/2007
15/12/2007
25/01/2008
05/03/2008
14/04/2008
24/05/2008
03/07/2008
12/08/2008
21/09/2008
31/10/2008
10/12/2008
time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CH4
50
45
40
35
30
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20
15
10
5
0
03-Aug-04
23/09/2004
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22/01/2005
03/03/2005
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22/05/2005
01/07/2005
10/08/2005
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26/02/2006
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26/06/2006
05/08/2006
14/09/2006
24/10/2006
03/12/2006
28/01/2007
09/03/2007
18/04/2007
28/05/2007
06/07/2007
15/08/2007
24/09/2007
03/11/2007
13/12/2007
22/01/2008
02/03/2008
11/04/2008
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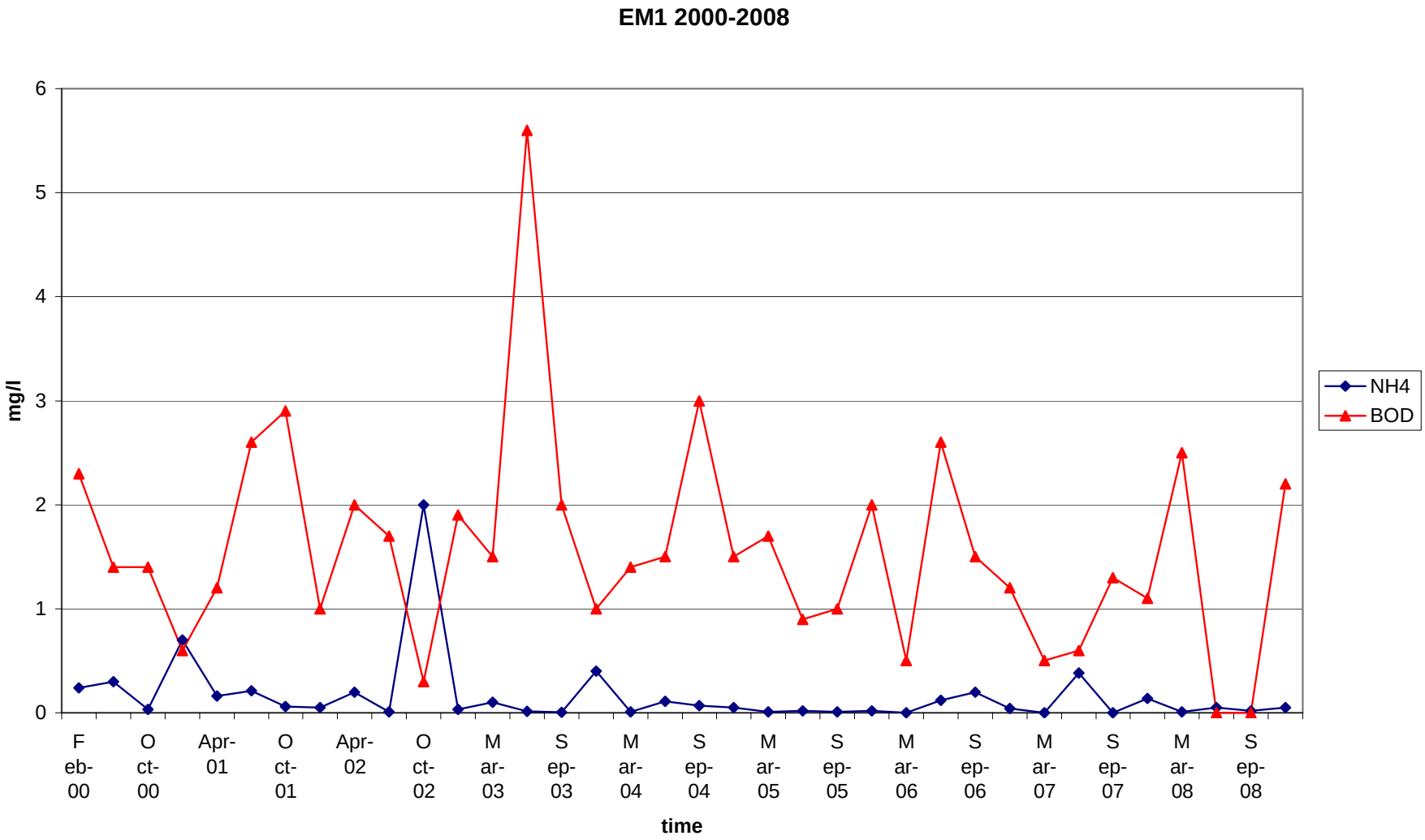
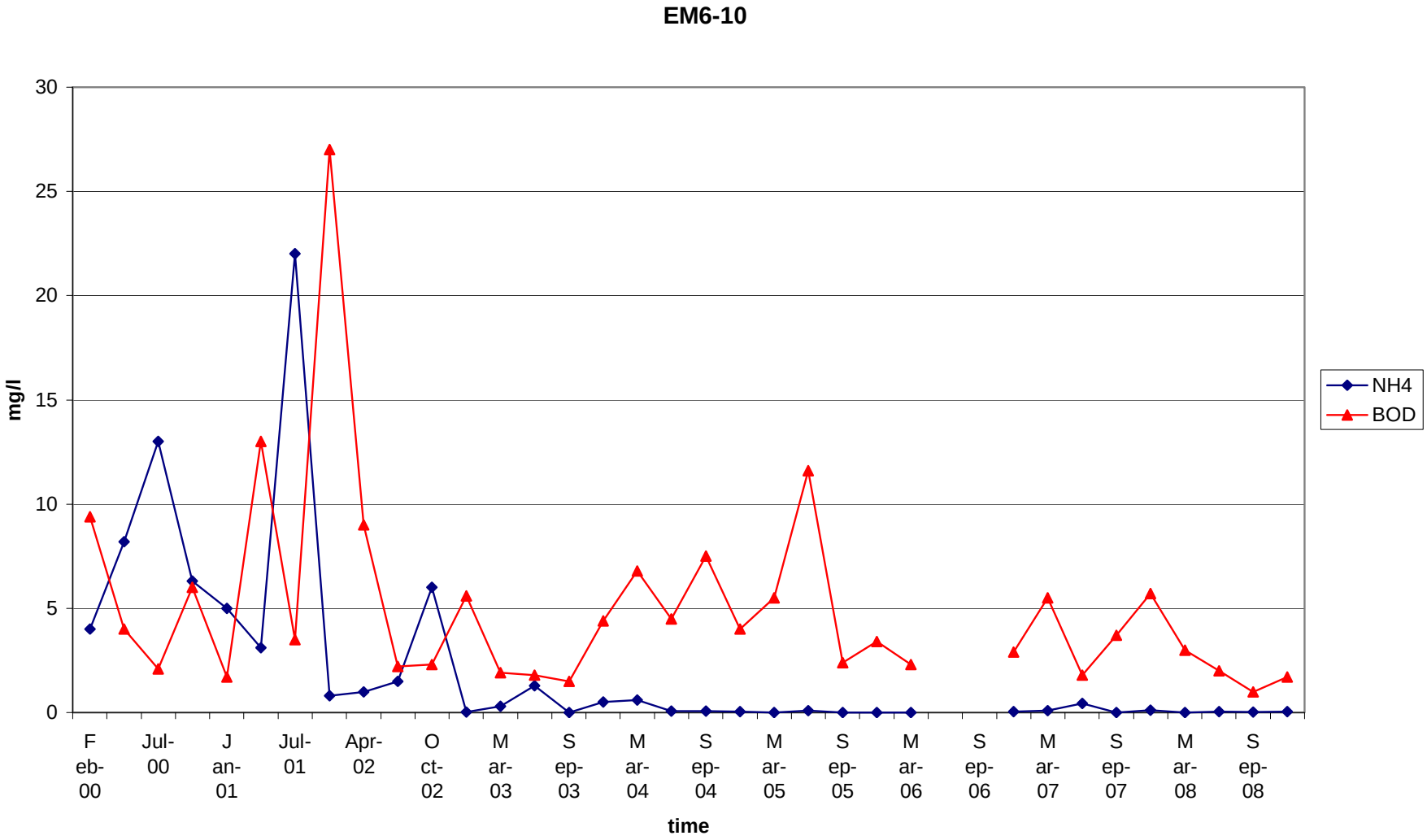
30/06/2008
09/08/2008
18/09/2008
28/10/2008
07/12/2008
time

Surface Water Monitoring Graphs

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30
25
20
15
10
5
0
mg/l
NH4
BOD
F eb- 00
Jul- 00
J an- 01
Jul- 01
Apr- 02
O ct- 02
M ar- 03
S ep- 03
M ar- 04
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S ep- 05
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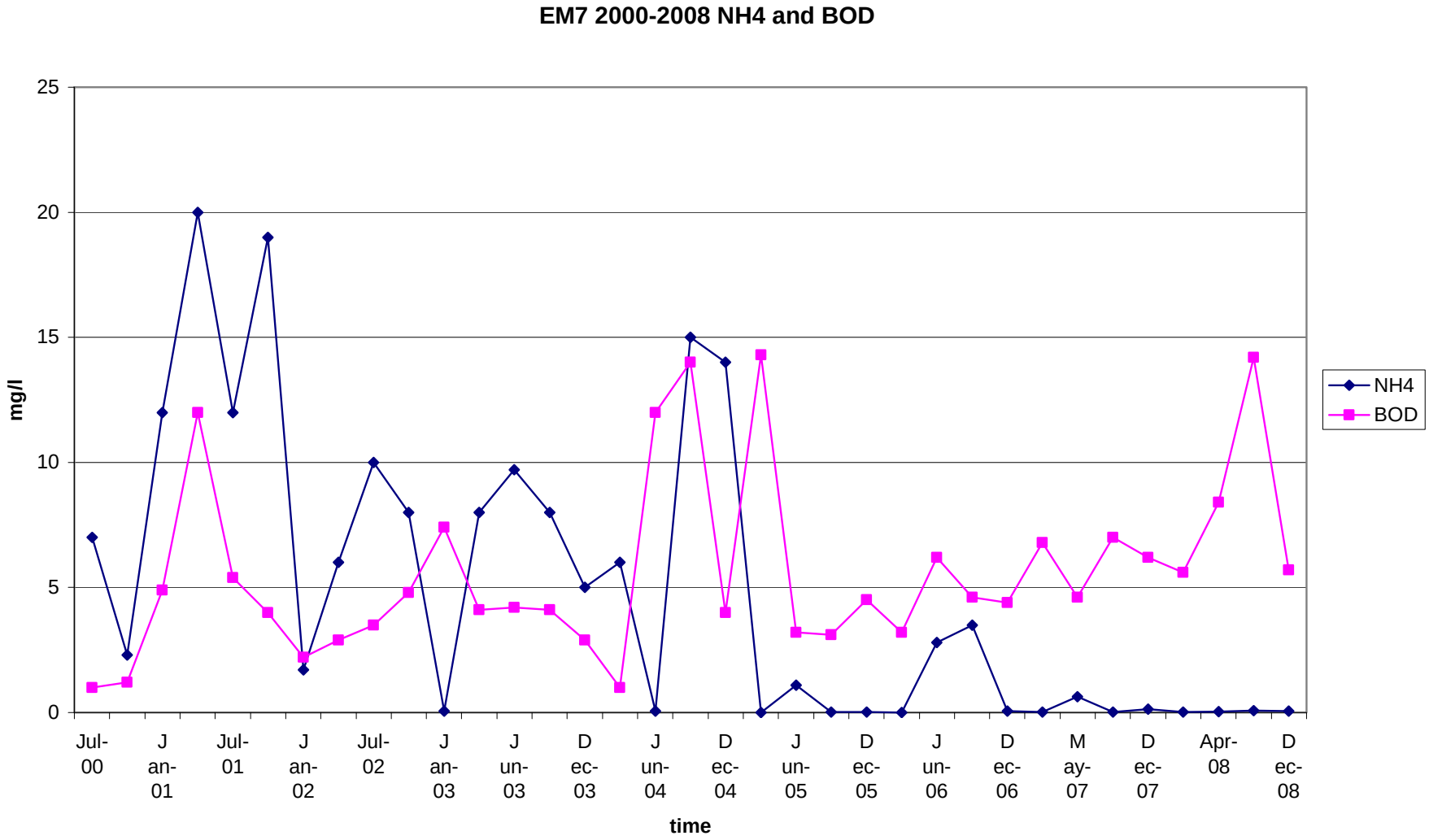
M ar- 07
S ep- 07
M ar- 08
S ep- 08
time


EM7 2000-2008 NH4 and BOD
mg/l
25
20
15
10
5
0
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jun-03
Dec-03
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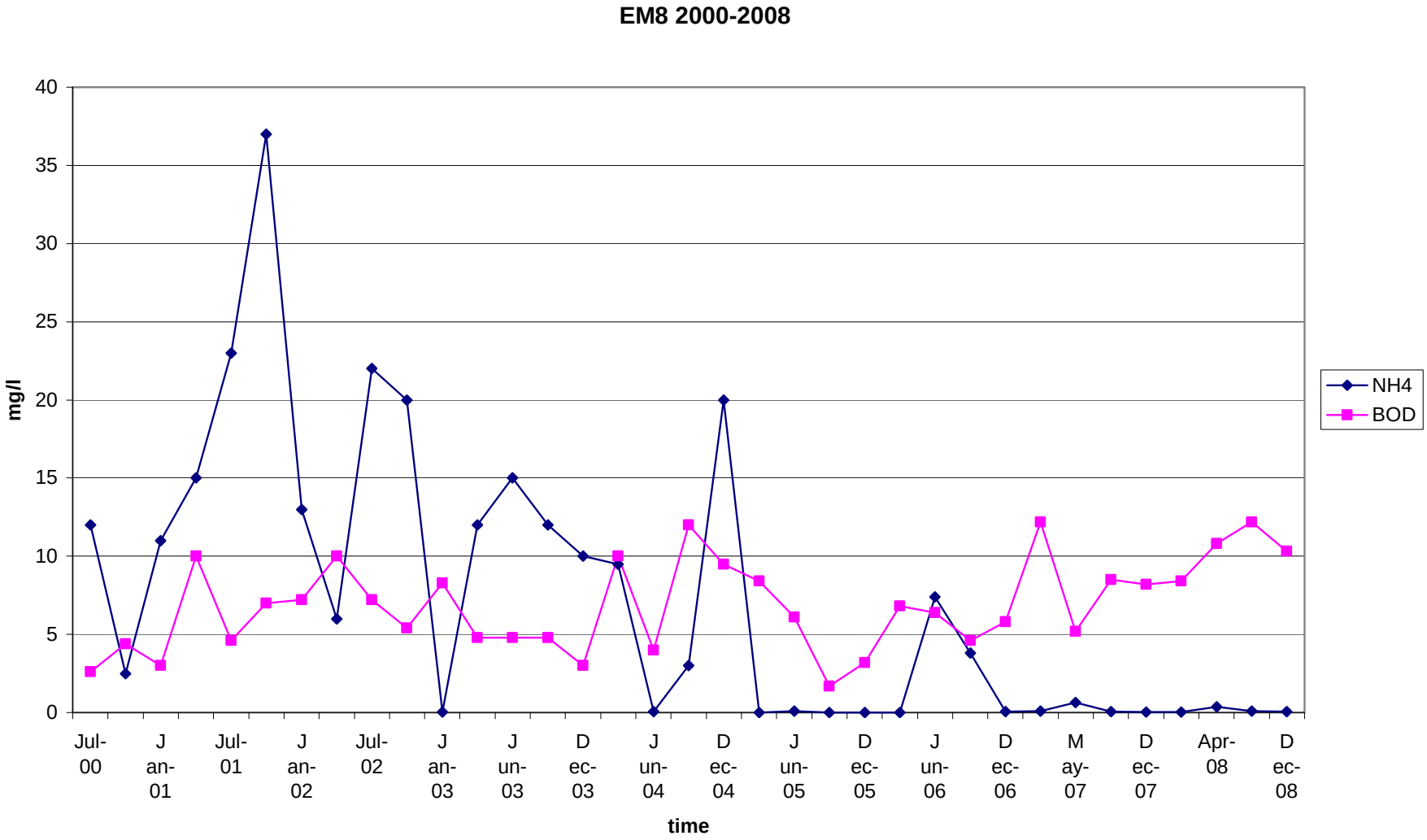
May-07
Dec-07
Apr-08
Dec-08
time
NH4
BOD


EM8 2000-2008
mg/l
40
35
30
25
20
15
10
5
0
Jul-00
Jan-01
Jul-01
Jan-02
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Jan-03
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
May-07
Dec-07
Apr-08
Dec-08
time
NH4
BOD

6 ENVIRONMENTAL MONITORING AND CONTROL

The following areas were monitored during the reporting period:

6 (a) Summary Report on Emissions

6.1 Noise

6.2 Landfill Gas

6.3 Emissions from Bioverda Power Systems Ltd.

6.4 Emissions to Sewer

6.5 Discharge from Storm Water Pond and Reed Beds

6.6 Dust

6 (b) Summary of Results and Interpretation of Environmental Monitoring

6.7 Asbestos in Soil

6.8 Ground Water

6.9 Biological Survey of Streams

6.10 Surface Water

6.11 Particulates and Odour

6.12 Nuisances

6.13 Water Balance

Appendix

Graphs

- Noise Monitoring
- Landfill Gas
- Surface Water

Reports

- Biological Survey of Streams Report
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- Air Emissions testing of the Flare Unit & Gas Utilisation Engines

AN ASSESSMENT OF THE WATER QUALITY STATUS OF SELECTED SITES ON THE TRAMORE AND TRABEG RIVERS USING BIOLOGICAL METHODS

(SEPTEMBER - 2008)

Commissioned by: Cork City Council
Carried out by: Aquatic Services Unit – UCC.
(October 2008)

Introduction

As part of the their waste licence conditions for the Kinsale Road Landfill, Cork City Council commissioned the Aquatic Services Unit, to undertake a biological assessment of the water quality status of selected sites on the Tramore and Trabeg rivers. Both rivers flow adjacent to or through the site of the landfill and have in the past, at least, been impacted by leachate from the landfill. The fieldwork for the 2008 monitoring was undertaken in September.

Methods

Two samples (combined as one composite) were taken at each site using a kick-sample technique, where this was possible. Each sample was collected in areas of moderate to shallow swift current in coarse substrate usually comprising small to large stones and cobbles. The samples were then sieved to remove silt and poured into a white sorting tray. There the macroinvertebrates present are identified and their notional abundance estimated. The macroinvertebrate data arising is then assessed using the same biotic index system used by the Environmental Protection Agency (EPA) in their on going monitoring of biological quality in Irish rivers. The index assigns a score to the macroinvertebrate collection at a given site depending on the relative proportion of pollution sensitive and pollution tolerant organisms present. The greater the number and diversity of pollution sensitive types present (particularly, certain mayflies, stoneflies and cased caddis flies) the higher the score or quality class assigned to a given site. The highest score category is Q5 which indicates pristine water quality conditions and is recognised by having a high proportion of pollution sensitive species and very few or any pollution tolerant forms, whereas Q1 at the other end of the scale indicates gross pollution. The table below indicates the Q-value scores, which can be assigned and the corresponding degree of pollution associated with them.

Q-Value	**Degree of Pollution**
Q5, Q4-5, Q4	Unpolluted
Q3-4	Slightly Polluted
Q3, Q2-3	Moderately Polluted
Q2, Q 1-2, Q1	Serious to Gross Pollution

It's important to point out that few sites on the Tramore and Trabeg rivers have sites, which could be said to be ideal for this system of biological monitoring, and some are completely un-suitable (e.g. Sites A and B). In the latter cases the flow is very sluggish and the bottom material consists mainly of mud or peaty mud. In these cases, general observations and experience were used in order to gauge the likely biological water quality status.

Results

Samples were taken on September 18th, 23rd and 25th of September 2008 at sites the positions for which were agreed with the EPA and listed in the conditions of the licence.

Site A *(Trabeg River: Upstream Site)*

The site is very slow flowing and with a bottom of mud; it was drained in the past. It the most upstream sampled on the Trabeg and is showing a continuation in the slight improvements noted in 2007. Again there was no out-gassing from the bottom sediment, which had a loose covering of filamentous green algae (~10% cover). The wet summer of 2008 helped to keep the site well flushed and the water was generally clear with only a slight to moderate cloudiness. An extensive bed of *Callitriche* sp. (Water-starwort) was again in evidence (Plate 1).

The right bank was heavily overgrown with luxurious herbaceous vegetation. *Phalaris arundinacea* (Reed canary-grass) dominating along with nettles, with scattered Great Willowherb (*Epilobium hirsutum*) and Hedge bindweed (*Calystegia sepium*), along with Creeping thistle (*Cirsium arvense*), Broad-leaved dock (*Rumex obtusifolius*), and Water Pepper (*Persicaria hydropiper*). The left bank was dominated by Willow upstream and then with nettle, Fuchsia and Hedge bindweed.

Net-sweeps through the marginal algae, the water column and the surface of the mud contained large numbers of chironomid larvae, mainly Tanypodinae and a few Orthocladinae, while the snails *Lymnaea peregra* and *Planorbis* sp. were common. A single water boatman (Corixidae) was also present in the sample along with a 3-spined stickleback fish. Although these results show that the site is still polluted, they mark a very marginal improvement on the 2006 results. Water quality rating of Q1-2 would still be appropriate for this site.

Site B *(Trabeg River: 2nd Site Downstream)*

This site is like Site 1 in being a very slack flow site dominated by a muddy bottom. In channel plant cover comprised a few small rafts of Water-starwort (~5% cover) toward the left bank (Plate 2) without plant cover in-channel but marginally with about 5% cover of Fool's Watercress (*Apium nodiflorum*) and Water pepper (*Persicaria hydropiper*) on the right side of the channel. The right bank had Willow and Alder samplings nettle, bindweed, grass, creeping thistle and Water Figwort. The left bank featured nettle, bramble, Willow, Hedge bindweed and Angelica, with scattered clumps of Reed Canary-grass (*Phalaris arundinacea*) marginally, in-channel. Pond-net sweeps through the superficial mud yielded a domination of chironomid larvae (especially Tanypodinae and to a lesser extent *Chironomus* and Orthocladinae), there were also a few *Asellus*. The water was clear and again no out-gassing as in previous years. This is believed to be a result of the wet summer again in 2008 as in 2007. Although the conditions are not suitable for using the EPA Q-rating system, there is no doubt that the water quality is very poor and certainly not better than Q2.

Site C *(Tramore River: most upstream site within the landfill boundary)*

This site is at a fording point in the Tramore River within the precincts of landfill and at the same point is crossed by a kind of bridge for carrying pipes. The in-channel area immediately above this point is dominated by in-channel emergent vegetation including Branched bur-reed (*Sparganium erectum*), Broad-leaved pondweed (*Potamogeton natans*), Great Reed mace (*Typha latifolia*), also with Fool's Watercress, Watercress (*Rorippa nasturtium-aquaticum*) abundant at the margins (Plate 3). At the crossing point itself there was ~40% loose, silted filamentous green algal cover on substrate. Immediately downstream *Sparganium erectum* dominated with some Watercress. Both banks were dominated by Willow with some Alder.

Kick-samples were taken in silted gravel at the crossing point where the flow was extremely slack at the time and not ideal for kick-sampling. The results are at presented in the table below. They indicate grossly polluted conditions prevailing at the site with perhaps a slight deterioration compared with 2007.

Macroinvertebrates in Site C kick-samples

Common Name of Group	**Scientific Name**	**Notional Abundance**
Mayfly	*Baetis*	+
Non-biting Midges	Chironomidae	+++
Water Beetles	Haliplid adult	+
Wandering Snail	*Lymnaea peregra*	++++
Snail	*Planorbis* sp.	++/+
Pea Mussels	Sphaeridae	+++
Leeches	*Helobdella stagnalis*	+
	Glossiphonia	+++
Water Hog Louse	*Asellus*	+++
Segmented worms	Tubificidae	++++
Water mites	Acari	+++
EPA Q-value		**Q 2**

Site D *(Tramore River: 2nd site downstream of boundary)*

This site is at the 2007 location. The sampling point is at a constriction in the river (3.5m wide) where the channel flows over a small rock weir immediately downstream of a sluggish stretch, which is dominated by Broad-leaved Pondweed (bank to bank) (Plate 4). The right bank is dominated by Great Reed-mace (*Typha latifolia*), frequent Fool's Watercress and common Woody Nightshade (*Solanum dulcamara*) and further downstream by Great Willowherb, Hedge Bindweed and Soft Rush (Juncus effusus). The green alga, *Vaucheria* (~30% cover) was abundant on the angular limestone cobbles/ boulders of the weir, which also had pockets of gravel and coarse sand beneath. The left bank has Great Willowherb (frequent), Nettle (common), frequent *Phalaris* and dense pockets of Fool's watercress (Plate 4).

In channel the substrate of the kick-sampling area (just on the weir) comprised angular limestone cobbles and small boulders with numerous clumps of *Vaucheria* in a moderate turbulent flow. The water was slightly cloudy. See Table below for results.

Kick-sample results Site D:

Common Name of Group	Scientific Name	Notional Abundance
Mayfly nymphs	Baetis	++
Uncased Caddis	*Rhyacophila dorsalis (pupa)*	+
Non-biting Midges	Chironomidae	++++
Wandering snail	*Lymnaea peregra*	+/+
Snail	*Planorbis* sp.	+++/+
Snail	*Potamopyrgus jenkinsi*	++/+
Pea mussels	*Sphaeridae*	++/+
Water Hog louse	*Asellus*	++++
Leeches	*Helobdella stagnalis*	+
Leeches	*Glossiphonia complanata*	++
Segmented worms	*Oligochaetae*	+++
Water mites	*Acari*	++
EPA Q-value		**Q2**

Site E *(Tramore River upstream of the landfill: outside the boundary to the west)*

Access to the site had become extremely difficult but it was opened up by City Council staff through bank-side vegetation clearance from the road. Here the channel, which has been generally over-widened upstream as a result of drainage, narrows through the eye of a small bridge (W6780 6943) – Plate 5. This site was chosen as it is the only one in this section of channel which can be sampled; the listed site (200m u/s) is pure sandy mud and therefore unsuitable. The substrate under the bridge (2-3m wide) is very coarse - angular cobbles and some boulders, with a little gravel and coarse sand - Plate 5. The substrate is silted and the water cloudy. The depth was about 25-30cm and the flow moderate and turbulent.

The site is very shaded and effectively plant free. Immediately upstream of the bridge the channel is much wider (>10m) and comprises deeply silted channel with filamentous green alga on the mud surface along with large stands of *Typha* and *Sparganium erectum*, which are now encroaching on virtually the entire channel (Plate 6). Alder and willow dominate the LHS Bank, while the RHS bank has had its Willow, Alder, Gorse, and Bramble largely levelled since summer 2008. There is also a large growth of the alien invasive species Japanese Knotweed (*Fallopia japonica*) just upstream of the bridge. During the survey the water appeared well backed-up, possibly a tidal influence and there was again a strong smell of hydrocarbons, possibly the result of urban or highway surface run-off. The site remains seriously polluted.

Kick-sample results Site E:

Common Name of Group	Scientific Name	Notional Abundance
Non-biting Midges	Chironomidae	+
Water Hoglouse	*Asellus aquaticus*	++++
Pea mussels	Sphaeridae	+++
Leeches	*Glossiphonia complanata*	++++
	Helobdella stagnalis	+++
Segmented worms	Oligochaeta	
	Tubificidae	++++
Fish	3-spined Stickleback	+
EPA Q-value		**Q2**

***Site F** (150m downstream of the confluence of the Tramore and Trabeg Rivers).*

This site was downstream of the second small weir about 150m downstream of the confluence of the Tramore and Trabeg Rivers (Plate 7). Samples were taken in relatively gravel patches covered with silt with a covering of filamentous green algae and a little *Ulva*/*Enteromorpha* algae (~90% algal cover) in a moderate laminar flow around 20cm in depth. The substrate comprised small stones, coarse gravel and coarse sand, with frequent small cobbles (Plate 8). The left bank was backed by Gorse and bramble with a wide in-channel margin of *Phalaris* and Fool's Watercress. The right bank was dominated by emergent Fool's watercress with a little Brooklime (*Veronica beccabunga*), the bank was backed by willow and gorse. The left bank was dominated by an emergent stand of Fool's Watercress, Watercress and grass (Creeping Bent – *Agrostis stolonifera*) backed by Willow.

A replicate kick sample was taken at each side of the stream. A juvenile flat fish was again observed at the site, probably flounder. The water quality was very similar to that recorded in 2007 and again grossly polluted.

Kick-sample results Site F:

Common Name of Group	**Scientific Name**	**Notional Abundance**	
		Right Side	Left Side
Non-biting Midges	Chironomidae	+++	+++/+
Wandering Snail	*Lymnaea peregra*	++/+	+
Snail	*Potamopyrgus jenkinsii*	++++D	++++D
Pea mussels	*Sphaeridae*	+++	+++
Rams-horn Snails	Planorbid	+	
Freshwater shrimp	*Gammarus*	+	
Water Hog-louse	*Asellus*	+++	+++
Leech	*Helobdella stagnalis*	+	++
	Glossiphonia	++	+
	Erpobdella		+
Segmented worms	Tubificidae	++	+++
Fish	[1]Flounder	+	
Fish	3-spined stickleback	+	+
EPA Q-value		**Q1-2**	**Q1-2**

Conclusion

Overall the two Trabeg Sites were similar in quality or perhaps very marginally improved compared to the 2007 survey, which may have related to the greater rainfall during summer 2008. The Tramore site upstream of the landfill (Site E) showed a slight deterioration in quality before it reached the landfill, with quality dropping from Q3 to Q2. The Tramore River sites within the landfill (C, D and F) showed no obvious improvement on the 2007 results.

[1] Not found in kick-sample but present at the site

CONFIDENTIAL REPORT

Client:
Cork City Council,
Landfill Office,
Kinsale Road Landfill Site,
South Link Road,
Cork.

Title:
Analysis of Soil Samples

Attention: Ms. Cathy Healy

Report ref. ACS 8-428

Order no: 257093

Date recd: 20th October 2008

Report by: P. G. Byrne

Copies to:

Date: 23rd October 2008

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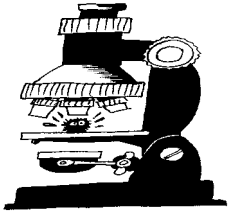

A C S Limited

INTRODUCTION

Five samples of soil taken from the landfill listed below were received for determination of the presence and type of asbestos.

TESTS

A representative portion of each sample was first oven dried for several hours at a temperature in excess of 110 degrees Centigrade. The lumps of clay were broken up using a pestle and mortar before the samples were brushed through a 3 mm sieve and both fractions weighed (the 1st weight in grammes) in the table below is the fraction under three microns). The fraction larger than 3 mm (whose weight is in brackets) was mainly small stones and other vegetation and this was examined for fragments of asbestos containing materials and then discarded. A single layer of the finer fraction was spread on to a large glass tray and examined by stereo microscopy at a magnification of 10x. The sample was then vigorously raked with a dissecting needle (in a magnet like fashion any white asbestos fibres will adhere to the needle). In order to examine the representative fraction this operation was repeated several times for each sample. No inert fibrous material was found in any of the samples examined.

RESULTS

Site :- Kinsale Road Landfill Site, Cork

Sample Identification	Laboratory No.	Result
Site 1 - Heatherton Park 85.5, (64.1)	08/1220	No asbestos detected – most of the sample was fine clay
Site 2 – near D2 64.1, (99.8)	08/1221	No asbestos detected – the sample contained a number of large stones
Site 3 – near OB2 64.1, (85.5)	08/1222	No asbestos detected – sample contained bits of timber
Site 4 – near PS3 64.1, (57.0)	08/1223	No asbestos detected – sample had the least number of small stones
Site 5 – near IPS 106.9 (85.5)	08/1224	No asbestos detected – sample similar to sample 1

Note: This report refers exclusively to the samples submitted for analysis.

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AIR EMISSION TESTING OF ONE LANDFILL FLARE AND ONE GAS UTILISATION ENGINES LOCATED IN KINSALE ROAD LANDFILL, BALLYPHEHANE,CURRAGHCONWAY, INCHISARSFIELD, SOUTH CITY LINK ROAD, CORK

PREFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF CORK CITY COUNCIL

PREPARED BY:	Dr. John Casey
ATTENTION:	Ms. Cathy Healy
REFERENCE:	Waste licence W0012-1
DATE:	07th January 2009
REPORT NUMBER:	2009.A18 (1)
REVIEWERS:	

TABLE OF CONTENTS

Document Amendment Record

Client: ***Cork City Council***

Title: Air emission testing of one Landfill flare and one gas utilisation engines located in Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork

Project Number: 2009.A18 (1)			**Document Reference:** Air emission testing of one Landfill flare and one gas utilisation engines located in Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork		
2009A18 (1)	Document for review	JWC	BAS	BAS	07/01/2009
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

1. Introduction

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 1 No. Enclosed ground flare and 1 No. Gas utilisation engine at Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork. The emission testing was carried out in compliance with the requirements of *Waste licence W0012-1*.

Odour Monitoring Ireland was requested by Cork City Council to perform emission testing of the 1 flare and 1 gas utilisation stacks respectively located within Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork. 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 Kinsale Rd Landfill 1 No. Enclosed flare and 1 No. Gas utilisation engine at Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork.

Sample location	Parameter	Analytical method
1 Landfill Flare and 1 Gas utilisation engines TV01 outlets	Volumetric airflow rate & Temperature (^{0}C)	Pitot in accordance with ISO10780:1994. Theoretical calculated for Landfill flare
1 Landfill Flare and 1 Gas utilisation engines TV01 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
1 Gas utilisation engines TV01 outlets	Total non methane VOC's	Charcoal tube/GCFID and non methane TOC analyser and FID analyser
1 Landfill Flare and 1 Gas utilisation engines TV01 outlets	Total Volatile Organic Carbon	Portable Signal 3030PM FID calibrated with Propane
1 Gas utilisation engines TV01 outlets	Particulates	TCR Tecora isokinetic Particulate sampler with QMA (Quartz) high temperature filters.
1 Landfill Flare and 1 Gas utilisation engines TV01 outlets	Hydrogen chloride and hydrogen fluoride	Impinger train containing 0.10 molar sodium hydroxide and deionised water solution
Inlet gas stream	Total Sulphur, Hydrogen chloride and hydrogen fluoride	Impinger train containing 0.10 molar sodium hydroxide and deionised water solution

This report presents details of this monitoring programme. This environmental monitoring was carried out by Dr. John Casey, Odour Monitoring Ireland on the 09th December 2008. 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 landfill flare and gas utilisation engine stack located in Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork

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 measurements were calculated from the CEMS monitoring system within the landfill flare control building. Additionally airflow measurement was performed on the inlet header gas main using a pitot tube and digital manometer. Outlet airflow rate measurements on the gas utilisation engines stacks were carried out in accordance with ISO 10780:1994 where possible. Temperature traverse measurements were performed across the stack in one plane only. A magnesium oxide K type and PT100 thermocouple was used for measuring temperature in the landfill flares and gas utilisation engines.

2.2 In stack analysis

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 non-methane volatile organic compounds (TOC)

In order to obtain samples for speciated VOC assessment, a static sampling method was used where air samples were collected in 60 litre pre-concentrated NalophanNA sampling bags using a vacuum sampling device. The sampler operates on the “lung principle” whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump filling the bag inside.

All sample bags were pre-flushed with sample air in order to prevent any reductions in the actual VOC due to sample bag surface binding. A leak check was preformed on the sample set-up by placing a Primary flow calibrator inline after the sorption tube (SKC 226-09). Once sample acquisition was completed, the sample bag was transferred to another room and connected to the sample pump tube and Primary flow calibrator. A charcoal/anasorb sorbent was chosen to efficiently bind and pre-concentrate speciated VOC for analysis by GCFID/GCMS in accordance with established and accredited methodologies. Sealed SKC sorbent tubes (SKC 226-09) were used throughout the study to maintain repeatability and integrity. In addition, the sorbent tube has a second plug to detect any breakthrough. All sampling for speciated VOC’s was preformed in accordance with EN13649:2002.

In order to pre-concentrate speciated VOC upon each sorbent, a pre-calibrated controlled volume of sample air was drawn through each tube by a SKC pump for a period 30 to 60 minutes. Each SKC pump was pre-calibrated with their specific sorbent using a Bios Primary flow calibrator (NIST traceable certified). Each pump was calibrated to a flow of between 90 to 120 ml min^{-1} depending on the sample, sample pump and sorbent tube as recommended by the sorbent manufactured, analysing laboratory and sampling/test methodology. When sampling was completed all tube were sealed and stored in flexible airtight containers and transported to the laboratory. All sample blanks were handled in the same manner to the sample tubes with the exception of being exposed to the flue gas.

2.4 Heated Flame Ionisation Detector-Total hydrocarbon concentration (THC) determination

A heated portable MCERT accredited FID (Signal) (Test method EN12619:1999 and EN13526:2002), 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 [THC] m^{-3} as propane.

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.

The following procedure was used for operating the FID:

1. The FID was switched on and the oven temperature and sample line temperature were allowed to stabilise. The set-point temperatures were 181 ^{0}C sample line temperature and 200^{0}C oven temperature. This took approximately 45 minutes.
2. The Hydrogen / He fuel and Propane calibration gases (500 ppm) were attached to the instrument.
3. Once temperatures had stabilised, the instrument was started and the ignition procedure was commenced.
4. Once ignited, the sample procedure was commenced and any VOC upon the sample line was baked off.
5. The analyser was zero calibrated and span calibrated. Zero air is supplied via the on board thermal oxidiser. There is less than 1% of range or 1.6 mg/m^3 in eight hours whichever is greater (see Section 6.1 of EN12619:1999 and Section 6.2.1 EN13526:2001.
6. The analyser calibration procedure was rechecked and recorded,
7. The sample line was checked by presenting calibration gas in the sample line. The value was confirmed to be the value and recorded. This reading must be less than 5% difference from the span/zero reading.
8. The probe was inserted into the stack.
9. The datalogger was commenced (10 second intervals) and manual readings were taking and recorded (every 1 minutes).
10. The instrument was re-spanned every approximately 45 minutes to confirm calibration reading and to isolate any drift.
11. The recorded concentrations were converted for ppm TOC propane to mg/m^3 TOC using the equation contained in Annex E and F of EN12619:1999 and EN13526:2002, respectively.

The analyser is MCERT and TUV approved. The MCERTS certification covers EN12619:1999 and EN13526:2002.

2.5 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 30 -minute period.

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 $\pm$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 is 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 ISO10780:1994. The procedures as set out in *Section 2.1* 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 on two planes, 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 only.

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 ±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.

2.6 Total sulphur, Hydrogen chloride (HCL) and Hydrogen fluoride (HF) analysis

Volatile chloride and fluoride gas concentrations were determined using an impinger train containing 0.1 molar sodium hydroxide and deionised water solution, in which such gases are readily soluble. The sampling methodology was based upon USEPA Method 26 and the European Standard, EN 1911. Small sorption liquid volumes were used to attain lower limits of detection. Impingers were placed in series to ensure effective trapping of sulphur, chloride and fluoride gas concentrations.

The sampling probe was placed within the stack and sample air was drawn through a heated PTFE line and two glass midget impingers containing 0.1 molar Sodium hydroxide positioned in series. Sampled solutions were sealed and transported to the UKAS accredited laboratory for analysis via ion chromatography (RPS Analytical laboratory, Manchester, UK).

3. Results-Emission testing.

The results of testing for the landfill flare and one gas utilisation engines are presented in *Tables 3.1 to 3.5.*

3.1 Sampling time

Table 3.1 summarises the sampling time was carried out on the stack. *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. When monitoring was completed upon the one gas utilisation engine, the landfill flare was started up and allowed to stabilise.

All outlet gas samples were taken approximately 1.8 metres below the top of the stack for the landfill flare and 0.75 metres for TV01. 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. 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

Sampling for airflow rate was not performed in accordance with ISO 10780:1994 (Iso-kinetic sampling standard from which airflow rate must be determined) due to sample port position and access restrictions. *Table 3.3* summarises the theoretical airflow rate calculations for the Landfill gas flare. The data obtained for the two 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 concentrations

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, and O_2 are presented in *Tables 3.4 to 3.5*. 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 280.15 K.

3.4 Total hydrocarbon concentration (THC)

THC concentrations were monitored using a pre-calibrated Signal 3030 PM analyser. The results of THC are presented in *Tables 3.4 to 3.5.* 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) concentrations

Total non-methane volatile organic compound (TNMVOC) concentrations were monitored using sorbent tubes and analysis by GCFID. The results of TNMVOC's are presented in *Tables 3.4 to 3.5.* 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 sampling tubes on the day of sampling was 283.15 K.

For the concentration of TOC adsorbed on to the charcoal tube, the mass amount of absorbed volatile organic carbon was measured using gas chromatography flame ionisation detector (GC-FID). Once the sampled volume is known, the mass concentration of VOC within the sampled gas could be calculated.

For the flare, 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.

3.6 Total particulates

Total Particulates concentrations were monitored using a TCR Tecora automated Isokinetic Particulate sampler. The results of Total Particulates are presented in *Tables 3.4 to 3.5.* 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.

3.7 Total Sulphur, Hydrogen chloride (HCL) and Hydrogen fluoride (HF)

Total Sulphur, Hydrogen chloride and hydrogen fluoride concentrations were monitored using an impinger train containing 0.1 molar sodium hydroxide and deionised water solution, in which such gases are readily soluble. The results of hydrogen chloride and hydrogen fluoride are presented in *Tables 3.2 to 3.5.* 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 09th December 2008.

Parameter	Approx. Sampling period for 1 landfill flare	Approx. Sampling period gas utilisation engine
Inlet CH_4	30 minutes	40 minutes
Inlet O_2	30 minutes	40 minutes
Volumetric air flow rate	Theoretically calculated	Manually calculated
SO_2	30 minutes	40 minutes
NO_x	30 minutes	40 minutes
CO	30 minutes	40 minutes
O_2	30 minutes	40 minutes
CO_2	30 minutes	40 minutes
Stack gas temp	30 minutes	40 minutes
THC	-	40 minutes
Particulates	-	40 minutes
TNMVOC/TOC	30 minutes	40 minutes
Hydrogen chloride / fluoride	30 minutes	30 minutes
Inlet Total sulphur, chloride and fluoride	30 minutes	30 minutes

Table 3.2. Characteristics of raw inlet gas to the one enclosed Landfill flare gas burner and 1 No. Gas utilisation engine.

Inlet compound identity	Compound Loading Landfill Gas engine 1	Compound loading Landfill flare	Unit values
CH_4	34.12	34.18	%
CO_2	28.22	32	%
O_2	3.11	3.14	%
Total Landfill gas volumetric airflow rate	458	153	m^3/hr
Inlet total sulphur	35	--	mg/Nm^3
Inlet total chloride	18	--	mg/Nm^3
Inlet total fluoride	2.28	--	mg/Nm^3

Table 3.3. Theoretically calculated landfill gas exhaust volume and physical characteristics from the Landfill flare.

Parameter	Landfill Flare
Total Volumetric methane loading (m^3 hr^{-1})	52
Total Volumetric Oxygen loading (m^3 hr^{-1})	4.59
Ratio to complete combustion of methane assuming no excess Oxygen	9.97
Oxygen concentration level in flue gas (%)	9.00
Flue gas temperature (Kelvin)[2]	1,283
Theoretical and manually calculated Volumetric exhaust airflow rate (m^3 h^{-1})	1,171
Normalised average exhaust airflow rate (Nm^3/h)[3]	249

Notes: [1] denotes data from 09th December 2008.
[2] denoted converted from degrees Celsius to Kelvin (^0C + 273.15);
[3] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 3.4. Emission value results from landfill gas flare monitoring.

Flare No. 1	Conc.	Units	Adjusted units (mg/m^3)	Volumetric flow rate (m^3N/hr)	Emission conc (mgN/m^3)	Emission conc corrected to 3% O_2 (mgN/m^3)	Emission limit Values
TOC	2.00	ppm	3.20	249	3.43	5.17	<10 mg/Nm^3
HCL	4.31	mg/m^3	4.31	249	5.89	8.86	<50 mg/Nm^3 (at mass flow > 0.30 kg/hr)
HF	0.21	mg/m^3	0.21	249	0.287	0.43	<5 mg/Nm^3 (at mass flow > 0.050 kg/hr)
Temperature	1010	degrees	1283	249	-	-	>1273K
CO	2	ppm	2.50	249	2.5	3.76	<50 mg/Nm^3
O_2	9	%	9	249	--	--	--
Total NOx [as NO_2]	23	ppm	47.23	249	47.23	71.05	<150 mg/Nm^3
SO_2	8	ppm	22.86	249	22.86	34.38	--
CO_2	8.56	%	8.56	249	--	--	--
Volumetric airflow rate	-	-	-	249	-	-	<3,000 Nm^3/hr

.

Notes: [1] denotes refer to *Appendix II* for Oxygen correction calculations.

Table 3.5. Emission value results from gas utilisation engine TV01 monitoring.

Engine TV 01	Conc.	Units	Adjusted units (mg/m^3)	Volumetric flow rate (m^3N/hr)	Emission conc (mgN/m^3)	Emission conc corrected to 3% O_2 (mgN/m^3)[1]	Emission limit Values
TNMVOC[2]	3.91	mg/m^3	6.26	2,992	8.55	9.34	[2]20 mg/Nm^3
Average THC	293	ppm	468.80	2,992	468.80	512.30	--
HCL	3.15	mg/m^3	3.15	2,992	4.30	4.70	<50 mg/Nm^3 (at mass flow > 0.30 kg/hr)
HF	0.15	mg/m^3	0.15	2,992	0.205	0.22	<5 mg/Nm^3 (at mass flow > 0.050 kg/hr)
Temperature	430	degrees	703	2,992	--	--	--
CO	460	ppm	575	2,992	575	628.35	<650 mg/Nm^3
O_2	6.35	%	6.35	2,992	--	--	-
Total NOx [as NO_2]	154	ppm	316.25	2,992	316.25	345.59	<500 mg/Nm^3
SO_2	3	ppm	8.57	2,992	8.57	9.37	--
CO_2	12	%	12	2,992	--	--	--
Particulates	15.33	mg/m^3	15.33	2,992	39.46	43.12	<130 mg/Nm^3
Volumetric airflow rate	-	-	-	2,992	-	-	<3,000 Nm^3/hr

Notes: [1] denotes refer to *Appendix II* for Oxygen correction calculations.
[2] denotes Limit values TA Luft Organics Class I 20 mg/m^3, Class II 100 mg/m^3, Class III 150 mg/m

4. Discussion of results

Tables 3.1 to *3.5* present the results of the emission monitoring carried out on the one landfill flare burner and one gas utilisation engine located in Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork.

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 on the dataset. 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).

The methane emission amount on the exhaust of the flaring system was recorded using a FID analyser assuming all VOC in the exhaust gas was methane (worst case scenario). The values suggest a methane destruction efficiency of approximately 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 landfill flare. Actual measurements were performed on the gas utilisation engine TV01.
2. NO_x, SO_2, CO, O_2, Particulates, TNMVOC, HCL/HF and THC 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 8.2*;
5. NO_x, CO, Total Particulates, TNMVOC, HCL/HF, TOC and Volume flow were in compliance with the emission limit values contained in Section C5 of Waste licence W0012-02.

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.
3. ISO 10780, (1984). Stationary source emissions-Measurement of velocity and volume flow rate of gas streams in ducts.

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

7.1.1 Location of Sampling

Kinsale Road Landfill, Ballyphehane, Curraghconway, Inchisarsfield, South City Link Road, Cork.

7.1.2 Date & Time of Sampling

09th December 2008

7.1.3 Personnel Present During Sampling

Dr. John Casey, Odour Monitoring Ireland, Trim, Co. Meath.

7.1.4 Instrumentation

Testo 350 MXL/454 in stack analyser;
Federal Method 2 S type pitot and MGO coated thermocouple;
Testo 400 handheld and appropriate probes.
Ceramic and Inconel 625 sampling probes.
TCR Tecora Iso-kinetic Particulate sampling train
Portable Signal 3030PM FID calibrated with Propane
Model 303A hydrocarbon cutter
SKC pumps, BIOS primary flow calibrator.
DynaSampler and vacuum sampling barrel.

7.1.5 Standards

ISO 10780:1994
ISO 9096:2003
EN13284-1:2002
EN12619:1999
EN13526:2002
EN13649:2002

8. *Appendix II*-Example calculations and conversions

8.1 Conversion of 23 ppm Oxides of nitrogen to mg/Nm^3 at 273.15 Kelvin and 101.3 kPa (STP) for landfill flare No. 1

1 mole of an ideal gas occupies 22.4 litres at standard temperature and pressure of 273.15 Kelvin[1] and 101.3 kPa (STP), where a mole of any substance is equal to its molecular mass and expressed in grams.

This is known as molar mass (i.e. the volume occupied by one gram mole of a gas at STP).

Using the average recorded concentration (in ppm) for NO_2 during the survey, the conversion is as follows:

1 mole of NO_2 occupies 22.4 litres @ STP

46 grams (Molecular weight of NO_2) occupies 22.4 litres @ STP

mg m^{-3} NO_2 = 23 ppm × 46 / 22.4 = 47.23 mg/Nm^3

8.2 Additional calculations and correction of Oxygen concentration measured to reference Oxygen concentration of 3% (v/v) for 47.23 mg/Nm^3 of NO_X as NO_2 for landfill flare No. 1

If excess air is added to an enclosed landfill flare (i.e. to promote better combustion), measured flue gas emission concentration of non-combustion species will fall. Emission concentrations appear to be reducing, whilst in reality mass emission rates have remained constant (Environment Agency, 2002). Therefore, it is necessary to compare concentrations at a standard oxygen concentration.

The relationship between the measured oxygen concentration and measured emission species concentration is non-linear as oxygen from air is added or removed. For example, a halving of the flue gas oxygen content does not result in a doubling of the emission concentration. The oxygen concentration in the flue gases is a measure of the excess air over that required for theoretical complete combustion (i.e. stiochiometric air requirement). Therefore, the measured oxygen level is a measure of the dilution of the flue gases from the stoichiometric condition. The concentration of oxygen in dry air is 20.9% (v/v) and the proportion of excess air (X/V) can therefore be calculated from the following:

$$\frac{X}{V} = \frac{(O_2)_m}{(20.9 - (O_2)_m)} \quad \textbf{(Eqn 8.3.1)}$$

Where: X is the volume of excess air (m^3);
V is the stoichiometric volume of the flue gas (m^3);
$(O_2)_m$ is the percentage of oxygen (v/v) in the flue gas (on a dry basis).

If we know and calculate the following:

The volume of landfill gas was 153 m^3 hr^{-1} with a methane and oxygen concentration of 34% (v/v) and 3 %(v/v) as taken from the landfill gas analyser.

This equates to a methane and oxygen volume of 52.02 m^3 hr^{-1} and 4.59 m^3 hr^{-1}, respectively.

The stiochiometric ratio of oxygen to methane for combustion is **2:1** as shown below:

$$\mathbf{1}CH_4 + \mathbf{2}O_2 + 7.52\ N_2 \longrightarrow CO_2 + 2H_2O + 7.52\ N_2 + \text{Heat} + \text{Light}$$

Ambient air contains 20.9% (v/v) oxygen, therefore stiochiometric volume ratio of air required for complete combustion of methane is **9.97 times** methane volume.

Since the volume of oxygen in inlet landfill gas and stiochiometric ratio required is known, the total amount of intake air required for complete combustion is:

$$(52.02\ m^3\ h^{-1} \times 9.97) - 4.59\ m^3\ hr^{-1} = \mathbf{514\ m^3\ hr^{-1}}.\ \textbf{(Eqn 8.3.2)}$$

Therefore the total volume of flue gases exhausted through stack assuming total combustion and 0% (v/v) oxygen in flue gas is:

Volume of landfill gas + Volume of Inlet air = Total Volume of flue gas

153 m^3 hr^{-1} + 514 m^3 hr^{-1} = **677 m^3 hr^{-1} (Eqn 8.3.3)**

In reality excess inlet air is taken into the landfill flare gas burner to ensure this combustion.

The measured oxygen concentration within the flue gas of the landfill flare in Kinsale Rd Landfill was **9% (v/v)** dry gas basis.

Therefore excess amounts of inlet air are being taken in through the louver system. As the airflow rate measurement may be highly inaccurate a back calculation method is used to calculate the amount of excess air taken into the flare burner using known combustion volume and flue gas Oxygen concentration % (v/v). This is shown below:

The following units are known:

- Volume of flue gas assuming total combustion and 0% (v/v) oxygen in flue gas outlet $V_{Flue\ gas}$ = 677 m^3 hr^{-1};
- Volume of measured excess Oxygen % (v/v) in flue gas outlet $(O_2)_{outlet}$ = 9% (v/v);
- Volume of excess inlet air to increase flue gas to measured Oxygen % (v/v) concentration V_{inlet} = unknown
- Oxygen concentration in inlet air $(O_2)_{inlet}$ = 20.90% (v/v)

Using a back calculation formula, and numerous iterations using Solver formula equation in Microsoft Excel, the volume of excess air added to the landfill flare burner system is V_{inlet} = 504 m^3 hr^{-1} which equates to a total excess Oxygen volume $(O_2)_{volume}$ = 105 m^3 hr^{-1}. Based on this, the calculated total volume of flue gas from the landfill flare would be 1,171 m^3 hr^{-1}.

The following simple equation illustrates validation of the assumptions used and calculated:

$$\%O_{2Outlet} = \left(\frac{O_{2volume}}{V_{Fluegas} + V_{inlet}}\right) \times 100 \quad \textbf{(Eqn 8.3.4)}$$

Referring back to *Equation 8.3.1*, the percentage proportion of excess air can then be calculated as below:

$$\left(\frac{504}{677} = \frac{9}{20.9 - 9}\right) \times 100 \quad \textbf{(Eqn 8.3.5)}$$

Therefore the percentage proportion of excess air over required fuel air is 75%. *Equation 8.3.5* could also be used to calculate the volume of excess air.

Since the volume of excess air into the landfill flare burner is known, then the ratio of overall intake air over intake landfill gas can be calculated:

$$Ratio_{air} = \frac{504 m^3 hr^{-1}}{153 m3/hr} \quad \textbf{(Eqn 8.3.6)}$$

Therefore $Ratio_{air}$ = 3.29 which can be expressed as **1:3.29**. This is a common occurrence in landfill flare burners although a value closer to 9 is more frequent.

For oxygen correction, the following calculation can be performed:

$$C_r = C_m \times \frac{(20.9 - (O_2)_r)}{(20.9 - (O_2)_m)}$$ (**Eqn 8.3.7**)

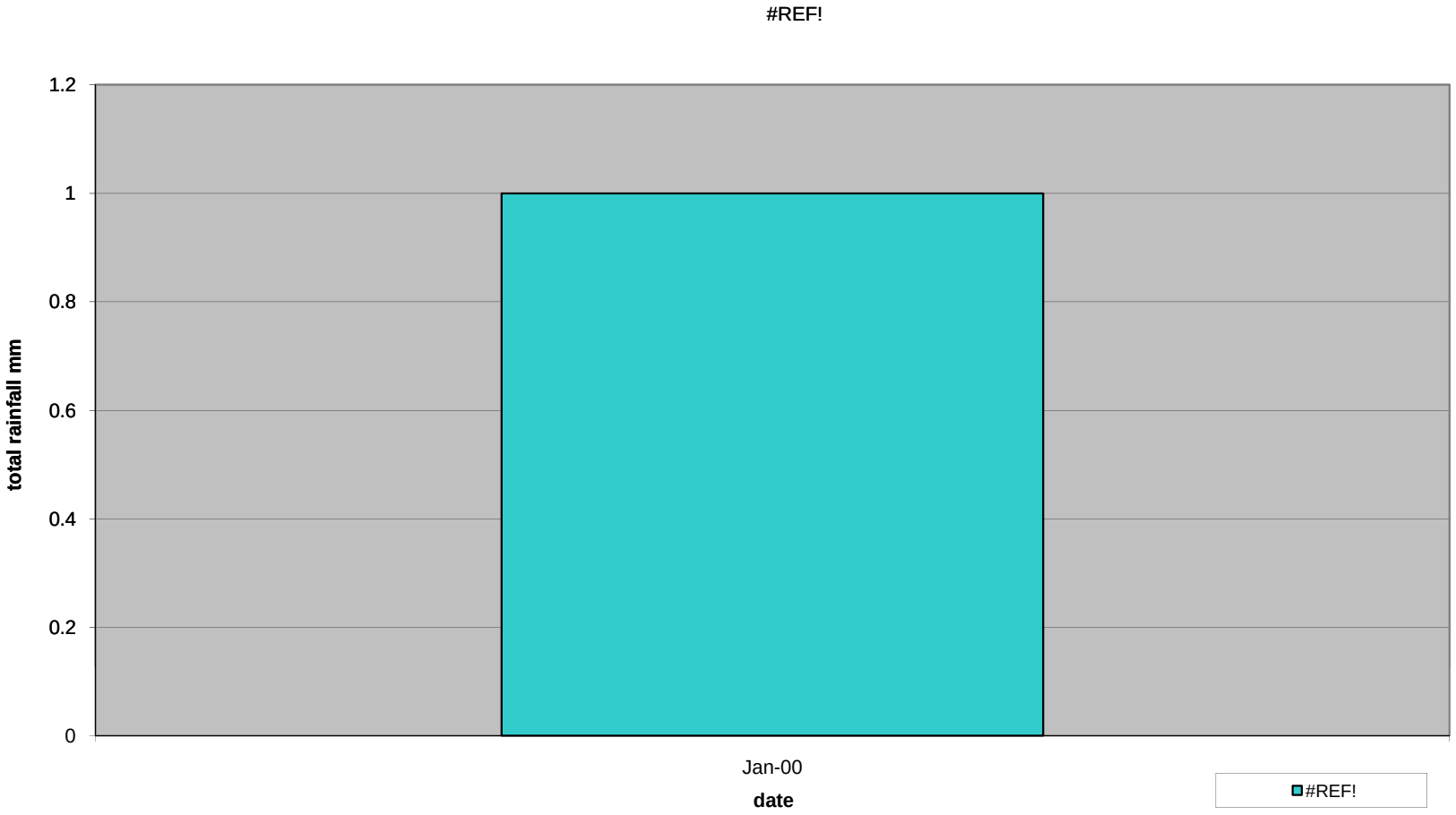
Where: C_r = referenced concentration;
C_m= measured concentration;
$(O_2)_r$ = reference oxygen concentration (3% (v/v) for Landfill flare burners);
$(O_2)_m$ = measured oxygen concentration in flue gas (10% (v/v)).

Hence the equation can be written as follows:

$$C_r = C_m \times \frac{17.9\%}{11.9\%} = C_r = C_m \times 1.50$$ (**Eqn 8.3.8**)

For a NO_2 concentration of 47.23 mg Nm^{-3} then the oxygen corrected value (3% (v/v)) would be as follows:

$C_r = 47.23 \times 1.50$ **= 70.80 mg m^{-3} at referenced to 3% oxygen (v/v) dry gas.**


#REF!
1.2
1
0.8
0.6
0.4
0.2
0
total rainfall mm
Jan-00
date
#REF!

7.2 Resource Consumption

Site machinery involved in the receipt, disposal and covering of refuse during the period involved the following plant: –
1 No. Compactor (2 Compactors from October 2008);
1 No. Excavators;
1 No. Dump truck (the dump truck worked periodically)
(The above machinery is owned and operated by Irish Landfill Services)

1 No. Tractor;
1 No. Water Bowser; and
1 No. tractor mounted Road Brush.
2 no. jeeps.
One of the jeeps runs on bio-diesel.
.
1 no. shredder, 1 no. compost turner and 1 no. manitou (with front loader) also operated on site at the Green Waste & Timber shredding facility (operated by CTO Env. Ltd.)

During the period approximately 15,000 litres of fuel was consumed on site by Cork City Council machinery.

The electricity and telephone costs for the reporting period were €48,800 and €5,500 respectively.
The majority of electricity used throughout the period was for office / canteen / weighbridge accommodation, leachate conditioning plant and pumping system, public lighting and vehicle washing operation.

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ODOUR, HYDROGEN SULPHIDE, MERCAPTANS AND ORGANIC ACIDS SAMPLING AND ANALYSIS WITHIN KINSALE ROAD LANDFILL, QTR.4 2008

PERFORMED ON BEHALF OF CORK CITY COUNCIL BY ODOUR MONITORING IRELAND

PREPARED BY: Dr. John Casey
ATTENTION: Ms. Cathy Healy
DATE: 05th Jan 2008
REPORT NUMBER: 2009A4(1)
DOCUMENT VERSION: Document Ver. 001
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Section **Page number**

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Client: ***Cork City Council***

Title: Odour, Hydrogen sulphide, mercaptans and organic acids sampling and analysis within Kinsale Road landfill, Kinsale Rd, Cork – Quarter 4.

Project Number: 2009.A4(1)			**Document Reference:** Ambient air monitoring in the vicinity of Kinsale Road landfill, Kinsale Rd, Cork- Quarter 4		
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1. Introduction and scope

1.1 Introduction

Odour Monitoring Ireland was commissioned by Kinsale Road Landfill, Cork City Council to preform:

- Odour sampling and analysis in accordance with the EN13725:2003,
- Hydrogen sulphide (H_2S) sampling and analysis using a Gold leaf Jerome analyser,
- Continuous Total volatile organic compound (TVOC) utilising a ppb Photo ionisation detector (PID),
- Ambient air sampling and analysis for Mercaptans and Organic acids using active pumped sorbent tubes and analysis by thermal desorption gas chromatography mass spectrometry (TD GCMS) (EPA TO17).

Sampling and analysis of Odour, Hydrogen sulphide (H_2S), Mercaptans and Organic acids is easily performed using established sampling and analysis methodologies. Odour sampling and analysis was performed in accordance with the EN13725:2003. All materials in contact with the inlet sample air stream were either stainless steel, Teflon or Nalophan. All sample bags were flushed with odourless air before commencement of the study. Lab based olfactometry is very limited in its ability to assess ambient odour concentrations unless they are in significant high concentration whereby downwind odour concentrations are in the region of greater than 100 $Ou_E\ m^{-3}$.

Grab Hydrogen sulphide sampling and analysis was performed using a Jerome gold leaf analyser. The range of detection for this instrument is from 3 ppb to 50ppm. Active pumped sampling of mercaptans and organic acids was performed using thermal desorption sorbent tubes followed by gas chromatography mass spectrometry analysis.

Results for this survey are presented in *Section 3*. All ambient odour threshold concentrations were less than 62 $Ou_E\ m^{-3}$. The highest odour threshold concentration was detected at monitoring location O9. Elevated ambient air concentrations of PID continuous TVOC's were detected at monitoring location O7A. GCMS screens illustrated a large array of volatile organic compounds present in the air stream at all monitoring locations. Monitoring location O3 recorded the highest TVOC concentration.

1.2 Scope of the work

The main objectives of this study include:

- Sampling and analysis of odours at 16 pre-selected locations in accordance with EN13725:2003,
- Sampling and analysis of H_2S at 16 pre-selected locations using a Jerome gold leaf analyzer. Sampling and analysis of H_2S will be performed at each of the 16 pre-selected locations on two separate days.
- Sampling and analysis of Mercaptan and Organic acids at 16 pre-selected locations using active diffusion tubes. Analysis will be performed using gas chromatography mass spectrometry (GCMS) whereby the top 5 compound concentrations of Mercaptan and organic acids will be reported. If such compounds were not present, additional volatile organic compounds were reported.

2. Materials and methods

This section describes the materials and methods used throughout the monitoring period on the December 2008.

2.1 Monitoring locations

Appendix A.1 illustrates a graphical display of the monitoring locations in the vicinity of the landfill. *Table 2.1* illustrates the geo-referenced easting and northing 6 grid coordinates for each monitoring location.

Table 2.1 Sampling locations for odour, H_2S, TVOC and active tube sampling.

Sampling location	Description	Coordinates	
-	-	Easting	Northing
O1	Western boundary, NW of civic amenity site	168081	69747
O2	Northern boundary	168373	70046
O3	Eastern boundary	168600	69691
O4	Southern boundary	168178	69276
O5	Outside main gate of landfill. Off the Kinsale Rd	167982	69648
O6	Inlet of leachate conditioning plant	168222	69651
O7A	Outlet of leachate conditioning plant	165576	69457
07B	Outlet of leachate conditioning plant	168575	69455
O8	East of civic amenity building, close to compost area	168222	69651
O9	Adjacent to active cell	168352	69492
A1	Frankfield estate, (southern boundary of Frankfield golf course located south, south west of landfill).	167902	68627
A2	Hazelwood grove, located south west of landfill	167393	69021
A3	End of Greenhills court, at eastern boundary of landfill	168978	69564
A4	North west of Greenhills estate, at north eastern boundary of landfill	168803	69901
A5	End of Heatherton park, located north of landfill	168478	70045
A6	Half moon lane, located north east of pitch & putt club	168215	70113

2.2 Meteorological data

Table 2.2 illustrates the average wind direction during the two-day monitoring period. Average wind speed was low for day 1. For Day 1 cloud cover was high with an octave rating of 4 to 5 (i.e. on a 8 point scale). Barometric pressure was approximately 1012 mm. Relative humidity ranged from 70 to 90% while temperature ranged from 10 to 15 degrees Celsius. For Day 2 cloud cover was low with an octave rating of 2 to 3 (i.e. on an 8 point scale). Barometric pressure was approximately 1013 mbar. Relative humidity ranged from 70 to 90% while temperature ranged from 12 to 17 degrees Celsius. This would be typical for this time period of the year in Southern Ireland.

Table 2.2 Meteorological conditions during the two-day monitoring period.

Parameter	Day 1- 08/12/08	Day 2- 09/12/08
Wind direction (From)	180 to 270	180 to 270
Wind speed (m s^{-1})	2 to 3	1 o 2
Cloud cover (Octaves)	2 to 3	2 to 3
Barometric pressure	1003 to 1013	1004 to 1010
Temperature (^{0}C)	4 to 8	5 to 10
Relative humidity (%)	70 to 90	70 to 90

2.3 Odour sampling

In order to obtain air samples for odour assessment, a static sampling method was used where air samples were collected in 60 litre pre-conditioned Nalophan^{NA} bags using a vacuum sampling device over a ten to twenty minute period. The sampler operates on the 'lung principle', whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump at a rate of 3 to 5 *l* min^{-1}. This caused the bag to fill through a stainless steel and PTFE tube whose inlet is placed in ambient air, with the volume of sample equal to the volume of air evacuated from the rigid container. All odour-sampling bags were pre-conditioned and flushed with odourless lab air to remove any interference from the sample material.

2.4 Olfactometry

Olfactometry using the human sense of smell is the most valid means of measuring odour (Dravniek et al, 1986) and at present is the most commonly used method to measure the concentration of odour in air (Hobbs et al, 1996). Olfactometry is carried out using an instrument called an olfactometer. Three different types of dynamic dilution olfactometers exist:

- Yes/No Olfactometer
- Forced Choice Olfactometer
- Triangular Forced Choice Olfactometer.

In the dynamic dilution olfactometer, the odour is first diluted and is then presented to a panel of screened panellists of no less than four (CEN, 2003) Panellists are previously screened to ensure that they have a normal sense of smell (Casey et al., 2003). According to the CEN standard this screening must be performed using a certified reference gas *n*-butanol. This screening is applied to eliminate anosmia (low sensitivity) and super-noses (high sensitivity). The odour analysis has to be undertaken in a low odour environment such as an air-conditioned odour free laboratory. Analysis should be performed preferably within 8 to 12 hours of sampling.

2.5 Odour measurement in accordance with the EN13725:2003

An ECOMA TO8 dynamic yes/no olfactometer was used throughout the measurement period to determine the odour threshold concentration of the sample air. The odour threshold

concentration is defined as the dilution factor at which 50% of the panel can just detect the odour. Only those panel members who pass screening tests with n-butanol (certified reference gas, CAS 72-36-3) and who adhered to the code of behaviour were selected as panellists for olfactometry measurements (CEN, 2003). Odour measurement was carried out in an odour free laboratory in accordance with EN13725:2003.

2.5.1 What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units ($Ou_E\ m^{-3}$).

The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123µg of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

2.6 Characteristics of landfill odours

Odours from landfills may arise due to:

- Fugitive landfill gas emission from active, intermediate and/or temporary cover on waste;
- Uncontrolled landfill gas leakages from side embankments and/or top surface within landfill;
- Volatilisation and air flow stripping of odourous gases from active face/active cell;
- Puff odour emissions from tipping and spreading of waste,
- Uncontrolled emissions from landfill flaring system and leachate treatment facility, etc. This is a non-exhaustive list.

Over 300 compounds have been identified as contributors to landfill odours. These compounds are either components of waste placed in the landfills or are degradation products. Carbon dioxide and methane make up the main constituent percentage of landfill gas and are essentially non-odorous. Other odourous compounds include organic acids (acetic acid, butyric acid; hexanoic acid), terpenes (limonene, alpha Pinene, alpha Carene), mercaptans (methanthiol, ethanthiol, etc.), amines (ethanolamine, dimethylamine, trimethylamine, etc.) and Hydrogen sulphide (Sheridan, 2003). Most of these compounds have very low odour threshold concentrations as illustrated in *Table 2.3*. Different concentrations and mixtures of these compounds can intensify or reduce odour threshold concentration, determined as synergism and antagonism, respectively.

Table 2.3 Odour threshold concentration of various odourous compounds commonly found in the air streams of landfill gas.

Compound name	Molecular Formula	Odour description	Odour threshold (ppm (v/v))
Mercaptans			
Allyl mercaptan	CH_2CHCH_2SH	Disagreeable, garlic	0.0001
Methyl mercaptan	CH_3SH	Rotten cabbage	0.0005
Propyl mercaptan	C_3H_7SH	Unpleasant	0.0005
Ethyl mercaptan	C_2H_5SH	Decayed cabbage	0.0003
Sulphides			
Hydrogen sulphide	H_2S	Rotten eggs	0.0005
Dimethyl di sulphide	$C_2H_6S_2$	Rotten cabbage/vegetables	0.0003- 0.0068
Carbon disulphide	CS_2	Intense Rubber/skunk	0.006-0.010
Amines			
Trimethyl amine	$(CH_3)_3N$	Pungent, fishy	0.0004
n-Butyl amine	$CH_3(CH_2)NH_2$	Sour, ammonia	0.080
Organic acids			
Acetic acid	CH_3COOH	Sour	1.0
Butyric acid	$CH_3(CH_2)_2COOH$	Sweet rancid	0.0004
Valeric acid	$CH_3(CH_2)_4COOH$	Rancid	0.0008

2.7 Hydrogen sulphide sampling and analysis

H_2S is commonly associated with landfills, WWTP and sludge operations. It is used as an indicator gas for the assessment of significant odour nuisance in the vicinity of landfills. Published data suggests that in order to prevent significant nuisance associated with landfill and composting operations Hydrogen sulphide concentrations should not exceed 30 ppb in the ambient environment. The only instrument capable of providing comparison with such reference levels is a Jerome metre or ppb continuous H_2S gas analyser. Both instruments are real time data-logging H_2S analysers. During this survey, Odour Monitoring Ireland used the Jerome gold leaf analyser for the measurement of ambient hydrogen sulphide levels.

H_2S measurement was performed during odour sampling. The Jerome metre is the only instrument capable of measurement H_2S in real time over the measurement range 3 ppb to 50 ppm in 1 ppb increments.

2.8 Active ambient sorbent tube monitoring for Mercaptans and Organic acids

Active sorbent tube analysis involves the adsorption/absorption of ambient specific volatile organic compound group through active sorption and analysis using thermal desorption gas chromatography mass spectrometry (TD GCMS). TD GCMS provides both semi-quantitative and qualitative results. Careful analysis of the results will allow for the identification of specific compounds that may be responsible for ambient odour but will not provide a basis of quantification of odour due to the complexities of odour synergistic. Isolation of the emission source and active sampling using an USEPA flux chamber will provide the only method of providing accurate quantification and development of emission rates. This is not required within this scope of work.

A specific two-bed sorption tube is used for accurate capture of Mercaptans and Organic acids. Tenax/Unicarb silcosteel coated active sorption tubes were used to bind the compounds upon the tube during the exposure event. Silcosteel coating upon the tube is provided to prevent reactive species such as Mercaptans breaking down and therefore will provide accurate capture for desorption upon the thermal desorption GCMS. They are then transported to the analysis laboratory in flexible airtight containers. Odour Monitoring Ireland is provided with a list of all compounds detected upon the sorption tubes whereby all Mercaptans and Organic acid species are presented within the report. The total volatile organic compounds were presented from the tube screen. All detection concentration results are presented in $\mu g\ m^{-3}$.

2.9 Continuous TVOC monitoring using a ppb Photo-ionisation detector (PID)

Additionally, Odour Monitoring Ireland performed ambient total volatile organic compounds (TVOC) analysis in ppb with a Photo-ionisation Detector (PID) at each selected location during odour sampling. A PID uses an Ultraviolet (UV) light source (*photo*) to ionise a gas sample and detect its concentration. Ionisation occurs when a molecule absorbs the high energy UV light, ejecting a negatively charged electron and forming of positively charged molecular ion. The gas becomes electrically charged. These charged particles produce a current that is easily measured at the sensor electrodes. Only a small fraction of the VOC's molecules are ionised. Therefore, PID measurements are non-destructive and therefore maintain sample integrity where samples can be bagged and used for further analysis (Sheridan, 2004).

3. Results

This section presents the result obtained throughout the study period.

3.1 Odour threshold concentration results

Tables 3.1 illustrate the odour threshold concentration results obtained during the monitoring period. All sampling and analysis was performed in accordance with the EN13725:2003.

Table 3.1. Odour threshold concentration results following monitoring of Kinsale Road Landfill, Kinsale Road, Cork.

Code	Date/Time	Sample number	Odour threshold conc. (Ou_E m^{-3})	Comment
1	08/12/2008	O1	42	No distinct odour
2	08/12/2008	O2	33	No distinct odour
3	08/12/2008	O3	36	No distinct odour
4	08/12/2008	O4	39	No distinct odour
5	08/12/2008	O5	45	No distinct odour
6	08/12/2008	O6	36	No distinct odour
7	08/12/2008	O7a	31	No distinct odour
8	08/12/2008	O7b	49	No distinct odour
9	08/12/2008	O8	57	No distinct odour
10	08/12/2008	O9	62	No distinct odour
11	09/12/2008	A1	53	No distinct odour
12	09/12/2008	A2	56	No distinct odour
13	09/12/2008	A3	49	No distinct odour
14	09/12/2008	A4	45	No distinct odour
15	09/12/2008	A5	57	No distinct odour
16	09/12/2008	A6	45	No distinct odour

The odour results presented on *Table 3.1* indicate that maximum odour concentration of 62 Ou_E m^{-3} was recorded at Sample locations O9. Location O9 is in close proximity to landfill activities and in an intermediately capped area.

3.2 Hydrogen sulphide and Total volatile organic compounds (TVOC) results

Table 3.2 illustrates the hydrogen sulphide and TVOC results obtained during the monitoring period.

Table 3.2. Hydrogen sulphide and TVOC (PID) measured during the odour and VOC audit at Kinsale Road Landfill, Kinsale Road, Cork.

Date/Time	Sample location	H_2S (ppb)	TVOC (ppb)
08/12/2008	O1	3	11
08/12/2008	O2	3	14
08/12/2008	O3	3	19
08/12/2008	O4	3	13
08/12/2008	O5	3	15
08/12/2008	O6	3	28
08/12/2008	O7A	3	36
08/12/2008	O7B	3	21
08/12/2008	O8	3	21
08/12/2008	O9	3	12
09/12/2008	A1	3	24
09/12/2008	A2	3	25
09/12/2008	A3	3	13
09/12/2008	A4	3	16
09/12/2008	A5	3	27
09/12/2008	A6	3	21

Notes: [1] denotes that Jerome H_2S analyser lower limits of detection is 3 ppb with a resolution of 1 ppb.

The hydrogen sulphide results presented on *Table 3.2* indicates no significant amount of hydrogen sulphide was detected within and in the vicinity of the Kinsale Road Landfill. The TVOC (as measured with the PID) results are presented on *Table 3.2*. Elevated TVOC concentrations were detected in the ambient air at monitoring locations O7A.

3.3 Speciated Volatile organic compound results

Tables 3.3 to 3.19 illustrate the speciated VOC results obtained during the monitoring period. All monitoring was performed in accordance with methodologies contained within USEPA Method TO17 and MDHS 72.

Table 3.3. Active sampling results for monitoring location O1.

Location	Compound	Concentration ($\mu g/m^3$)
O1	Toluene	6.80
	p-Xylene	3.64
	Decanal	23.37
	1R-.alpha.-Pinene	4.14
	Hexane	4.07
	Cyclopentane, 1,2-dimethyl-	17.98
	Total Volatile Organic Compounds	172.73

Table 3.4. Active sampling results for monitoring location O2.

Location	Compound	Concentration ($\mu g/m^3$)
O2	o-Xylene	26.71
	Benzene, 1-methyl-3-propyl-	9.17
	Ethylbenzene	14.12
	Undecane	2.46
	Tetradecanal	1.25
	Acetic acid	1.00
	Acetone	2.37
	Total Volatile Organic Compounds	59.70

Table 3.5. Active sampling results for monitoring location O3.

Location	Compound	Concentration ($\mu g/m^3$)
O3	Tetradecanal	7.21
	E-15-Heptadecenal	20.24
	Undecane	4.35
	3-Butenoic acid, ethyl ester	11.82
	2 Propionic acid	18.49
	1-Hexadecene	6.78
	D-Limonene	5.71
	Total Volatile Organic Compounds	202.98

Table 3.6. Active sampling results for monitoring location O4.

Location	Compound	Concentration ($\mu g/m^3$)
O4	Nonanal	3.17
	Propanamide	8.44
	Benzenecarboxylic acid	2.73
	Hexane, 2,5-dimethyl-	7.30
	Pentanal	2.73
	Heptadecane	2.54
	D-Limonene	3.33
	Total Volatile Organic Compounds	59.13

Table 3.7. Active sampling results for monitoring location O5.

Location	Compound	Concentration ($\mu g/m^3$)
O5	Heptane	7.39
	Acetic acid	13.34
	D-Limonene	11.80
	1-Tridecanol	11.60
	p-Xylene	6.71
	Formic acid	5.16
	Nonanal	4.77
	Total Volatile Organic Compounds	102.75

Table 3.8. Active sampling results for monitoring location O6.

Location	Compound	Concentration ($\mu g/m^3$)
O6	Ethyl alcohol	13.30
	1-Tridecanol	12.88
	Propanamide	1.65
	1-Nonadecene	12.02
	p-Xylene	2.90
	Octadecanal	3.90
	Benzenecarboxylic acid	3.87
	Tetradecanal	2.02
	Total Volatile Organic Compounds	133.17

Table 3.9. Active sampling results for monitoring location O7A.

Location	Compound	Concentration ($\mu g/m^3$)
O7A	Isopropoxycarbamic acid	2.32
	Ethanamine	10.78
	Decane	7.13
	o-Xylene	2.36
	Octanal	3.76
	Toluene	2.43
	Heptane	3.61
	Total Volatile Organic Compounds	84.32

Table 3.10. Active sampling results for monitoring location O7B.

Location	Compound	Concentration ($\mu g/m^3$)
O7B	Propene	36.14
	Acetic acid	2.04
	Benzene	3.65
	Undecane	5.70
	Butylbenzoic acid	5.94
	Hydrazine	3.01
	p-Xylene	6.80
	Total Volatile Organic Compounds	88.96

Table 3.11. Active sampling results for monitoring location O8.

Location	Compound	Concentration ($\mu g/m^3$)
O8	Decanal	5.53
	Nonanal	12.33
	Methyl Alcohol	2.69
	D-Limonene	2.18
	Ethylbenzene	2.00
	1-Hexadecanol	2.13
	Benzoic acid	3.56
	Total Volatile Organic Compounds	58.59

Table 3.12. Active sampling results for monitoring location O9.

Location	Compound	Concentration ($\mu g/m^3$)
O9	o-Xylene	2.08
	1R-.alpha.-Pinene	2.97
	Isobutane	4.87
	Toluene	6.72
	p-Xylene	21.71
	Acetic acid	2.11
	Tetradecanal	15.02
	Total Volatile Organic Compounds	121.87

Table 3.13. Active sampling results for monitoring location A1.

Location	Compound	Concentration ($\mu g/m^3$)
A1	1-Tridecanol	9.72
	Propanamide	15.27
	o-Xylene	3.39
	Decanal	7.14
	Isopropoxycarbamic acid	4.38
	Ethanamine	28.28
	4-Fluorohistamine	4.94
	Total Volatile Organic Compounds	39.27

Table 3.14. Active sampling results for monitoring location A2.

Location	Compound	Concentration ($\mu g/m^3$)
A2	Butanoic acid	2.36
	2-Octanamine	12.15
	Formic acid	3.15
	Dimethylamine	2.83
	Cyanic acid, propyl ester	4.03
	Benzene, 1-methyl-3-(1-methylethyl)-	3.03
	Hexanal	4.04
	Total Volatile Organic Compounds	75.04

Table 3.15. Active sampling results for monitoring location A3.

Location	Compound	Concentration ($\mu g/m^3$)
A3	D-Limonene	12.49
	o-Xylene	6.51
	Pentanol	2.53
	Acetic acid	0.46
	Isopropyl Alcohol	8.51
	Decanal	2.51
	2-Propanol	9.58
	Total Volatile Organic Compounds	61.08

Table 3.16. Active sampling results for monitoring location A4.

Location	Compound	Concentration ($\mu g/m^3$)
A4	Nonanal	2.53
	Hexanal	6.76
	Benzeneethanamine	3.55
	Methyl Alcohol	2.57
	Nonane	3.55
	Acetophenone	1.01
	Acetic acid	2.38
	Total Volatile Organic Compounds	35.70

Table 3.17. Active sampling results for monitoring location A5.

Location	Compound	Concentration ($\mu g/m^3$)
A5	Undecane	1.63
	Decanal	2.80
	Acetic acid	1.76
	p-Xylene	2.77
	Ethanamine	2.29
	1-Pentanamine	2.06
	Propionic acid	15.69
	Total Volatile Organic Compounds	137.57

Table 3.18. Active sampling results for monitoring location A6.

Location	Compound	Concentration ($\mu g/m^3$)
A6	1-Octadecanamine	2.35
	Butylbenzoic acid	3.97
	Tetradecanal	1.48
	Propanamide	2.29
	Benzaldehyde	4.05
	Octanal	3.96
	Acetic acid	4.32
	Total Volatile Organic Compounds	69.21

Table 3.19. TVOC concentration results from monitoring locations at Kinsale Road Landfill, Kinsale Rd, Cork.

Monitoring Location	Analysis	TVOC concentration (ug/m^3)
O1	TVOC	172.73
O2	TVOC	59.70
O3	TVOC	202.98
O4	TVOC	59.13
O5	TVOC	102.75
O6	TVOC	133.17
O7A	TVOC	84.32
O7B	TVOC	88.96
O8	TVOC	58.59
O9	TVOC	121.87
A1	TVOC	39.27
A2	TVOC	75.04
A3	TVOC	61.08
A4	TVOC	35.70
A5	TVOC	137.57
A6	TVOC	69.21

Tables 3.3 to 3.19 illustrate the active sorption GCMS screens obtained during the survey period. As can be observed a minimum number of mercaptans and organic acids were detected during the monitoring event. Acetic acid, and substituted long chain volatile fatty acids were detected at low ambient air concentrations at all monitoring locations. A large array of alkanes and aromatics were detected (*see Tables 3.3 to 3.18*). *Table 3.19* illustrates a comparison between the total speciated volatile organic compounds (TVOC's) detected at all monitoring locations. Monitoring location O3 recorded the highest TVOC concentration.

4. Conclusions

The following conclusions are drawn from the study:

1. All sampling and analysis was performed in accordance with the EN13725:2003.
2. All ambient odour threshold concentrations were less than 62 Ou_E m^{-3}. The highest odour threshold concentration was detected at monitoring location at O9.
3. Hydrogen sulphide concentrations recorded at each monitoring location were less than 3ppb in ambient air.
4. *Table 3.3* to *3.19* illustrates a large array of volatile organic compounds were detected in the air stream at all monitoring locations during the active sampling exercise. All ambient air concentrations were low and well within any respective exposure threshold concentrations. There are a wide array of mercaptans and organic acids present in the ambient air. Acetic acid and substituted long chain volatile fatty acids were detected at low ambient air concentrations at all monitoring locations. A large array of alkanes and aromatics were detected (*see Tables 3.3 to 3.18*).
5. *Table 3.19* illustrates a comparison between the total volatile organic compounds (TVOC's) detected at all monitoring locations. Monitoring location O3 recorded the highest TVOC concentration.

5. Appendix I –Monitoring locations in graphical format

BORD NA MÓNA

BORD NA MÓNA HORTICULTURE LIMITED

ANALYSIS OF GREENWASTE COMPOST FROM CTO ENVIRONMENTAL SOLUTIONS

Kinsale Road August

REPORT NO: **GW 081202**

ATTENTION:

Aidan Stafford,
CTO Environmental Solutions,
Rosstown,
Middleton
Co. Cork

PREPARED BY:

Dr Bill Carlile
Chief Research Scientist,
Bord na Móna.

Dearbháil Ní Chualáin,
Scientist,
Bord na Móna ltd.

DATE: 22 December 2008

Table of Contents

1 Introduction

No details of this compost sample are known. No details of the composting process are known.

This report outlines the parameters under which the analysis was carried out, and provides detailed results of the laboratory tests. This sample was labelled ‘Kinsale Road August

2 Results of Analysis

Compost Testing and Analysis Service

Report ref: GW 081202

Sample reference: GW 081202
Sample matrix: not known

Maturity Tests
Oxygen Uptake Rate

Sample no	$mmolO_2/kg$ OS/h
GW 081202	4.4

Self Heating Test

Sample no	Maximum temperature reached (°C) (ambient 21°C)
GW 081202	15

Plant Nutrient and Organic Matter Content
Water Soluble Nutrients

pH	**EC** $\mu S.cm^{-1}$	**NH_4-N** $mg.L^{-1}$	**NO_3-N** $mg.L^{-1}$	**PO_4-P** $mg.L^{-1}$	**K** $mg.L^{-1}$
7.77	411	2	68	2	382

Total Plant Nutrients and Carbon Content (Dry Wt. Basis)

N %	**P** **%**	**K** %	**C** %	**C:N** %
1.48	1.71	5.93	23.60	15.9

Heavy Metals (Dry Wt. Basis)

Cd $mg.kg^{-1}$	**Cr** $mg.kg^{-1}$	**Cu** $mg.kg^{-1}$	**Hg** $mg.kg^{-1}$	**Ni** $mg.kg^{-1}$	**Pb** $mg.kg^{-1}$	**Zn** $mg.kg^{-1}$
0.575	124	63.6	0.13	33.8	145	402

Physical Analysis

H_20 %	**Bulk Density (as received)**‡ $g.L^{-1}$
55.4	476

Particle Size Analysis (Dry Wt. Basis)

>31.5 mm %	**16.5-31.5mm %**	**8-16.5mm %**	**4-8mm %**	**2-4mm %**	**1-2mm %**	**<1mm %**
<0.01	<0.01	<0.01	7	6	73	13

Contaminants (Dry Wt. Basis)

Sieve size	Stones %	Metals %	Plastic %	Glass %	Other %
<1mm	n/d	n/d	n/d	n/d	n/d
1-2mm	n/d	n/d	n/d	n/d	n/d
2-4mm	<0.01	<0.01	<0.01	<0.01	<0.01
4-8mm	0.39	<0.01	<0.01	<0.01	<0.01
8-16mm	0.10	<0.01	<0.01	<0.01	<0.01
16-31.5mm	0.03	<0.01	<0.01	<0.01	<0.01
>31.5mm	<0.01	<0.01	<0.01	<0.01	<0.01

Microbiological Analysis

Faecal Coliforms (MPN/g)	**Salmonella** (sp/25g)
<10	**Not detected**

Note:

N/A NOT AVAILABLE

Results given on a fresh weight basis except where indicated

Samples will be kept for three months

[f]Yield is expressed as % of control plants grown in 100% peat in relation to plants grown in 10%, 25%, 50% and 100% GW.

[†]DBD=Dry bulk density (after drying at 105°C for 12 hours)

[±]MBD=Moist bulk density (sample as received)

CBW=Composted Biowaste

MP=Multipurpose Peat (fertilised peat)

Compost Testing and Analysis Service
Interpretation of Results Sheet

Ref: IR-1

Below are detailed maximum values or desirable ranges of values for mature biowaste compost. Results are on a fresh wt. basis except where indicated.

Plant Nutrient and Organic Matter Content

Exchangeable Nutrients

pH*	**SC*** $\mu S.cm^{-1}$	**NH4-N mg.L^{-1}**	**NO3-N** mg.L^{-1}	**P** mg.L^{-1}	**K** mg.L^{-1}
6.9-8.3	**2000-6000**	**<1-500**	**<1-240**	**50-120**	**620-2280**

***Water soluble

Total Plant Nutrients and Carbon Content (Dry wt. Basis)

N %	**P** **%**	**K** **%**	**ASH** **%**	**C:N**	**Mg** **%**	**Ca** **%**
0.8-1.9	**0.4-1.1**	**0.6-1.7**	**24-51**	**≤25**	**0.18-0.78**	**1.57-5.07**

Heavy Metals (Dry Wt. Basis)

Class	**Cd** mg.kg-1	**Cr** mg.kg-1	**Cu** mg.kg-1	**Pb** mg.kg-1	**Hg** mg.kg $^{-1}$	**Ni** mg.kg-1	**Zn** mg.kg-1
I	**0.7**	**100**	**100**	**100**	**0.5**	**50**	**200**
II	**1.5**	**150**	**150**	**150**	**1**	**175**	**400**

Physical Analysis

H_20 **%**	**DBD**** g.L^{-1}	**MBD** g.L^{-1}
55-76	**120-369**	**500-820**

Contaminants (Dry Wt. Basis)

vs.L-1	**0.5.L^{-1}** Free	**0.5-2.L^{-1}** Low	**>2.L-^{1}** Significant	
Foreign Material (Metal, Glass, Plastic etc)	**<0.1%** Free of foreign material	**0.1-0.5 %** Potentially free	**>0.5%** Marked quantity (Noticeable)	**>2%** Significant quantity (distinct)
Stones	**<5%** Low	**>5%** Significant		

Microbiological Analysis

Faecal Coliforms (MPN/g)	**Salmonella** (sp/25g)
<1000	**Absent in 25g**

**Denotes Bord na Móna suggested standard

Oxygen Uptake Rate

Bord na Móna Maturity Indicator Values (OS = organic solids)

mmolO_2/kg OS/h**	**Compost Process Stage**
>26	Very Unstable
16-25	Unstable
11-15	Moderately Stable
5-10	Stable
<5	Completely stable

Costings

Test	**Cost per sample (€)**
Maturity Analysis	
Self heating test, Specific Oxygen Uptake Rate	
Chemical Analysis	
trace elements	
Physical Analysis	
Moisture, Foreign Material (gravel and stones)	
Microbiological analysis	
Salmonella	
Cost per sample ex VAT	**€275.31**

Landfill Gas Modelling has been carried out using the Land GEM version 3.20. This is the US EPA approved model.

LandGem Input Data

The EPA have previously requested that specific default parameters be used, these are:

- potential methane generation capacity Lo =(inventory conventional) 100 m^3/tonne
- methane generation rate k =0.04 $year^{-1}$ (inventory conventional)
- no known co-disposal (i.e. no hazardous waste)
- assumption that landfill gas generation is 50% methane 50% carbon dioxide by volume

The LandGEM model estimated that 14,259,970 m^3 of landfill gas was generated in 2008 by the landfill.

It should be noted that the model is designed for use as a gas *prediction* model only, and has limited capacity to generate an accurate and reliable estimate of landfill gas *generation* from landfill – particularly one as varied as Kinsale Road.

In order to estimate landfill gas generation and emissions to atmosphere, on-site data has been used. In 2008, the following quantities of landfill gas were utilised at the landfill gas compound operated by Bioverda Power Systems (formerly Irish Power Systems):

Engine Throughput	2,181,240 m^3
Flare Throughput	6,061,920, m^3
Total Captured Gas	8,243,160 m^3

For the purpose of this calculation, it is estimated that approximately 70% of landfill gas generated on site is captured, i.e. that 8,243,160 m^3 represents 70% of the total generated volume. Therefore, it is estimated that approximately 11,775,943 m^3 of landfill gas was generated by the landfill in 2008. This figure is less than the estimate given by the LandGEM model. Reasons for this may include:

- The model overestimates gas production.
- The capture rate figure of 70% is too high and that less gas is actually captured by the collection network.
- A greater quantity of gas was captured by the engines and flare than was recorded.
- The methane concentration in the gas being utilised is greater than the 50% assumed by the LandGEM model.

Conclusion & Discussion

It is not realistic to expect a model with so many estimated input values to predict accurately the volumes and tonnages of landfill gas generated and methane emitted to atmosphere.

The following data inputs are estimates for which there is no available factual information:

- waste inputs from 1964 to late 1990's
- location of waste inputs during the period from 1964 to late 1990's
- volumes of waste under cap
- types of waste inputs
- operating efficiency of generators and gas collection system
- clay liner thickness and location across the site

Due to the number of assumptions made to complete the models, it is believed that the calculation carried out based on "on-site" data from the Bioverda Power Systems is more accurate.

FEHILY TIMONEY & COMPANY

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DESIGNED: AR **CHECKED:** AR

DATE: 12-Dec-08 **REVISION:** A

JOB NUMBER: CE08-011-01

CALC NUMBER: **2**

FILE FileQ:\2006\011\04\CCC_CC_ Design Report RevA.xlsSheetCalc

SHEET Cover

PROJECT: Kinsale Road Sanitary Landfill - Reporting related to the 2008 AER

DESCRIPTION: 2008 Gas Model Calculation

Rev	Date	Purpose and Description	Prepared	Checked	Reviewed	Approved
A	12-Dec-08	The purpose of this calculation set is to prepare a gas model calculation (using the LandGem software package from the US EPA) for Kinsale Road Landfill for inclusion in the 2008 AER.	AR	AR	JM	JM
B	30-Dec-09	Calculation Sheet headers removed as requested by CCC.	AR	AR	JM	JM

SLOPE STABILITY REPORT

KINSALE ROAD LANDFILL
CORK

WASTE LICENCE W0012-02

ORIGINAL

SLOPE STABILITY REPORT

KINSALE ROAD LANDFILL
CORK

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SLOPE STABILITY REPORT

KINSALE ROAD LANDFILL
CORK

WASTE LICENCE W0012-02

User is Responsible for Checking the Revision Status of This Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue to client	AG			28/01/09

Client: Cork City Council

Keywords: Kinsale Road, landfill, capping, slope stability, waste licence W0012-02

Abstract: This slope stability report was prepared in order to comply with the waste licence. Analyses of rotational and translational slip failures of the waste slopes are presented.

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APPENDICES

1. Introduction

1.1. Purpose

This report presents the results of a slope stability assessment carried out for Kinsale Road Landfill. This is in accordance with Condition 8.8 and Schedule E of the EPA waste licence issued to the site.

1.2. Site Description

Kinsale Road Landfill is located to the south of Cork City, adjacent to the South Ring Road and operates under Waste Licence Reg. No. W0012-02.

1.3. Slope Stability Analysis Method

SLOPE/W software of GEO-SLOPE International Ltd. was used to assess the stability of Kinsale Road Waste Management Facility's waste embankments. SLOPE/W is a general software tool for the slope stability analysis of earth structures. It uses the limit equilibrium method of analysis by using the idea of dissecting a potential sliding mass into vertical slices. It assesses the factor of safety for both, moment and force equilibrium based on various methods, including Bishops, Janbu and Morgenstern-Price.

Using this software, it is possible to deal with complex stratigraphy, highly irregular pore-water pressure conditions, a variety of linear and nonlinear shear strength models, virtually any kind of slip surface shape, concentrated loads and pressure lines. Limit equilibrium formulations based on the method of slices are also being applied more and more to the stability analysis of structures such as tieback walls, nail or fabric reinforced slopes, and even the sliding stability of structures subjected to high horizontal loading arising, for example, from ice flows.

Traditionally, the factor of safety is defined as that factor by which the shear strength of the soil must be reduced in order to bring the mass of soil into a state of limiting equilibrium along a selected slip surface. The results of the analysis show the overall stability of the embankment expressed as a factor of safety. The definition of factor of safety used within SLOPE/W is:

$$F = \frac{\text{Available restoring moment (or forces)}}{\text{Total disturbing moment (or forces)}}$$

1.4. Limitations of Slope Stability Analysis

Updated shear strength parameters for the landfill waste has been estimated based on parameters used by Kolsch (1995).

Groundwater or leachate in landfills may occur in irregular perched bodies as opposed to interconnected liquid bodies. For the purposes of this analysis a natural groundwater/leachate table only has been assumed in analyses based on available 2007/2008 leachate/groundwater levels recorded on site.

1.5. Factors Controlling the Stability of Landfill Slopes

The factors controlling the stability of landfill slopes are:

- Slope geometry
- Geology
- Properties of the landfill wastes
- Properties of the supporting soil
- Groundwater/leachate levels within the waste
- Groundwater levels in the supporting soil
- Surcharge.

2. Design Criteria

2.1. Slope Geometry

Using the latest topographical survey by Focus Surveys Ltd. presented on Drawing No. 00-004_1, Rev ZZN, updated 05 January 2009, typical cross-sections through the waste slopes of the site were taken at the locations shown on Drawing CE08-011-07-004 Rev A. The side slopes analysed were the steepest observed areas and are representative of both final capped and temporary slopes on site.

Section A-A (which includes a temporary slope on the northern-west side of the landfill) is approximately 7 m high, 130 m long and has a maximum slope near the toe of the slope of 1:2 (vertical: horizontal). Section B-B is located towards the western side of the landfill, is approximately 15 m high and 160 m long, with a maximum slope of 1:5.9. Section C-C is located towards the southwest side of the landfill, is approximately 17 m high and 300 m long, with a general slope of 1 in 16 and a maximum slope of 1:1.7 near the toe of the slope. Section D-D is approximately 20 m high and 260 m long, with a maximum slope of 1:3 within the upper active area. The sections are presented in Figures 3.1 to 3.4. All four slopes were capped, grassed slopes with the exception of an area of active filling near the top of slope D-D.

2.2. Geology

The Geological Survey of Ireland (GSI) maps and website for this area along with our knowledge of the site from previous site investigations show that the site is underlain by Carboniferous age limestone, mudstone and sandstone.

The GSI website also shows that alluvial and glacial deposits are extensive in this area. Previous site investigations show that the landfill is underlain by deposits of compressed peat, alluvial silty clay and glacial till (gravelly clay or gravel).

2.3. Physical Make-up

The slopes considered for analyses are assumed to consist of the following layers, as derived for previous slope analyses on the site:

- 0.5 to 1.5 m layer temporary clay capping material
- Waste body comprising of new waste and older waste
- Underlying peat, silty clay, glacial till and bedrock

2.4. Waste Parameters

Table 2.1 below shows the parameters used for the landfill waste materials.

Table 2.1: Shear Strength Parameters for Waste Materials

Material	Waste (Old)	Waste (Fresh)
Cohesion (c')	10 kN/m^2	10 kN/m^2
Effective friction angle (ϕ')	22°	15°
Unit weight γ	11 kN/m^3	9.5 kN/m^3

The parameters shown in Table 2.1 above are the typical range of values from published papers on the properties of waste. For the purpose of this analysis, the waste has been divided into both fresh waste and underlying old waste.

2.5. Properties of the Supporting Soil and Capping Layer

Table 2.2 below shows the parameters used for the clay capping and the underlying strata.

Table 2.2: Shear Strength Parameters for Supporting Materials

Material	Clay Capping	Peat	Silty Clay	Glacial Till
Cohesion, c', kN/m^2	4	0	0	0
Friction angle, ϕ', °	29	15	26	33
Bulk unit weight, γ, kN/m^3	18	14	19	20

2.6. Leachate Levels within the Waste Material

To assess the effects of leachate levels within the waste, the level of leachate at each section location was obtained from monthly monitoring data for 2007 and 2008. The levels used for the analysis represent (i) Typical groundwater levels during 2007/2008; (ii) Maximum groundwater level recorded during 2007/2008. The leachate levels modelled were as follows:

Table 2.3: Dept and Elevation of Groundwater Adopted in Models

Scenario	Elevation of Groundwater at Top of Slope(mAOD)
(i)	4
(ii)	13

2.7. Surcharge

A modelled surcharge 20 kN/m^2 was conservatively applied to the slopes during the analyses to simulate the movement of vehicles on the slopes. It should be noted that without applying this surcharge, the calculated Factor of Safety for the sections will improve.

3. Results

3.1. Slope Stability Analyses

Sixteen models were run for four representative sections to assess the slope stability of the landfill waste embankments for both managed (typical levels) and elevated (maximum levels) leachate conditions. The results of those analyses are summarised in Tables 3.1 and 3.2 with factors of safety calculated for Bishop, Janbu and Morgenstern-Price methods. Tables 3.1 and 3.2 present the location of each slope, the material parameters applied, the leachate level simulated, and the length of the relevant slip.

Typical slope analyses are presented graphically for each slope and are presented in Figures 3.1 through 3.4.

3.2. Modelled Results for Managed Leachate Levels

Factors of safety for potential slope failures (Table 3.1) for managed leachate levels (4.0 mAOD) ranged from 1.53 to 3.03. A factor of safety of 1.0 indicates the slope is in equilibrium and on the point of failure. Factors of safety greater than 1.0 indicate a margin of safety against failure. A factor of safety of 1.3 or greater is appropriate for landfill interim side slopes, with this value increasing to 1.5 for final side slopes after capping is complete.

3.3. Model Results for Elevated Leachate Levels

Factors of safety for potential slope failures (Table 3.2) for elevated leachate levels (13.0 mAOD) ranged from 1.53 to 2.78. These results are calculated using a model which assumes that leachate levels at the top of the sections was equal to the maximum levels recorded during 2007/2008 monitoring (at one location) and assume leachate levels just below ground level at the toe of the slopes.

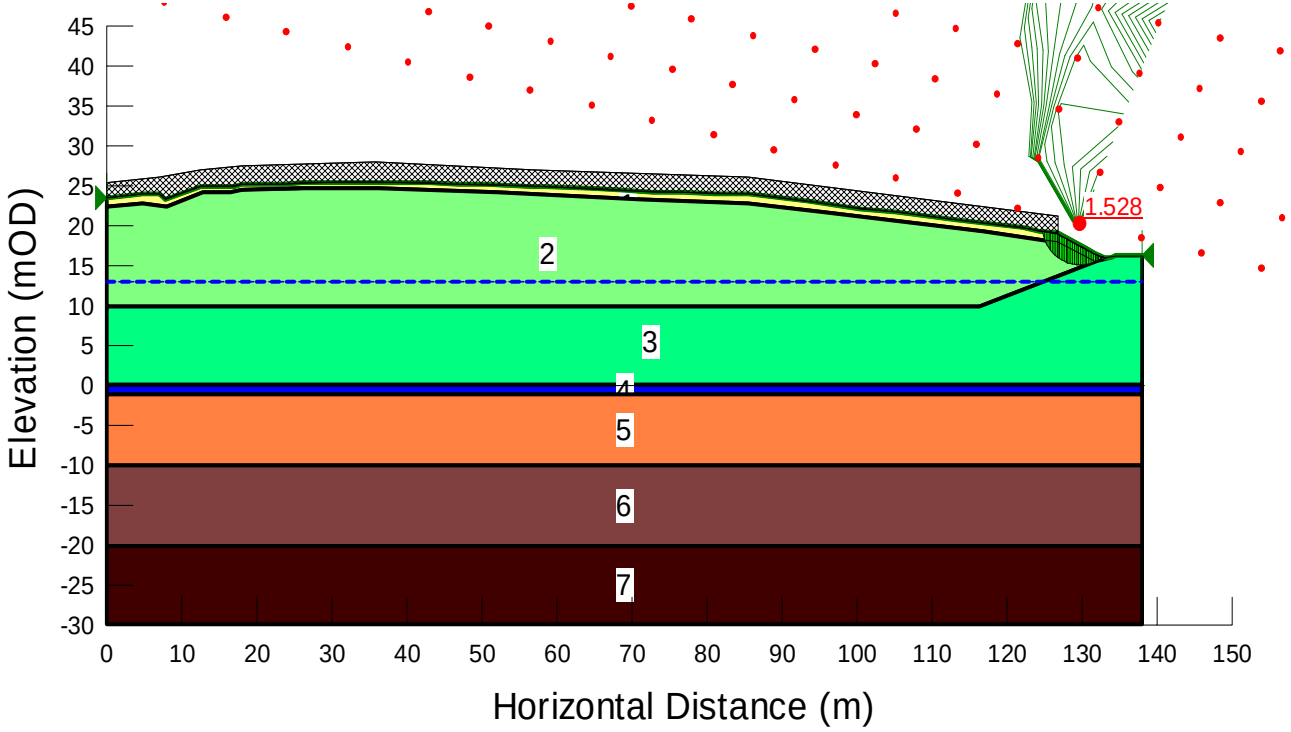
Table 3.1: Slope Analysis Results

Slope name	Leachate Level at top of slope (mAOD)	Morgenstern-Price FoS	Bishop FoS	Janbu FoS	Slip Length (m)	Slip type & location
Section A-A	4.0	1.83	1.84	1.53	8	Shallow rotational slip near toe of waste
Section B-B	4.0	3.03	3.03	2.76	75	Deep rotational slip in cap, waste & peat
Section C-C	4.0	2.58	2.58	2.43	40	Deep rotational slip in clay cap, waste and peat
Section D-D	4.0	2.63	2.63	2.40	42	Deep rotational slip in clay cap, waste and peat

Table 3.2: Slope Analysis Results

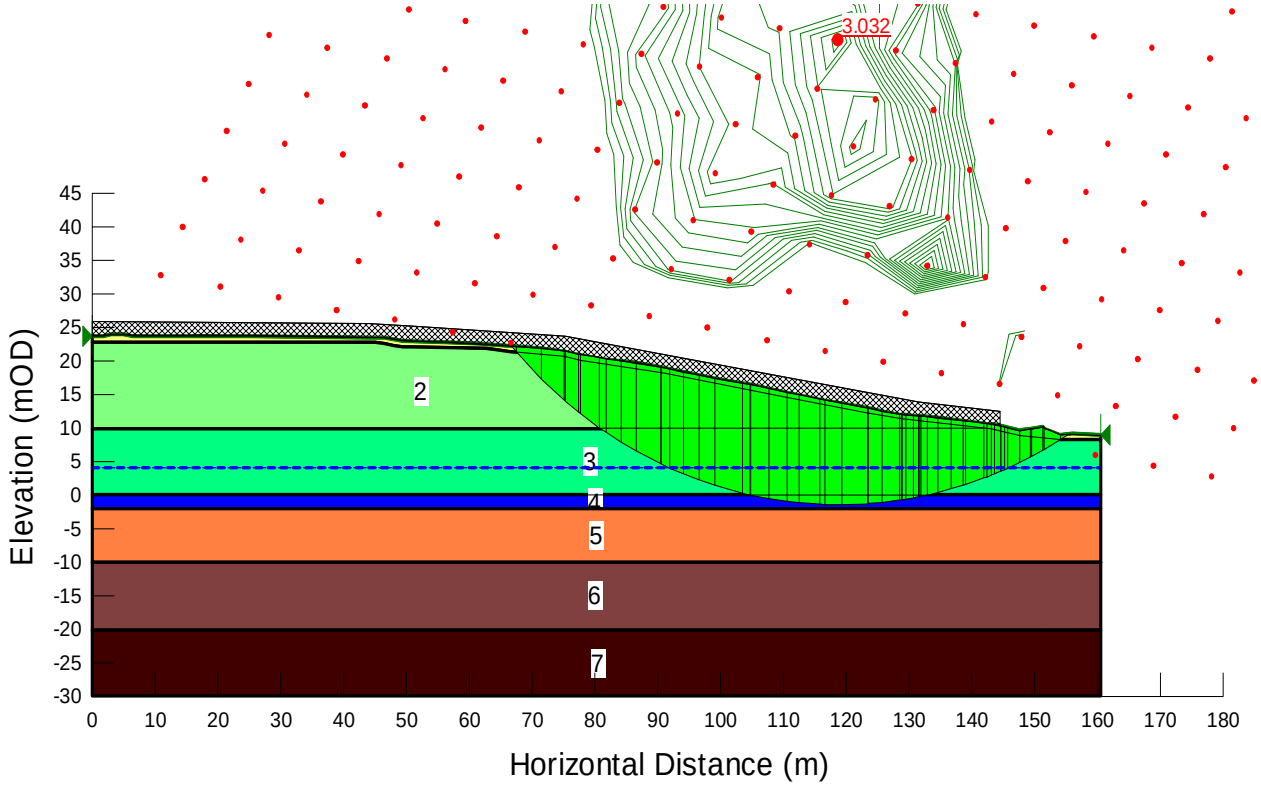
Slope name	Leachate Level at top of slope (mAOD)	Morgenstern-Price FoS	Bishop FoS	Janbu FoS	Slip Length (m)	Slip type & location
Section A-A	13.0	1.83	1.84	1.53	8	Shallow rotational slip near toe of slope
Section B-B	13.0	1.81	1.80	1.68	77	Deep rotational slip in clay cap, waste and peat
Section C-C	13.0	2.78	2.78	2.59	40	Deep rotational slip in clay cap, waste and peat
Section D-D	13.0	2.31	2.30	2.11	42	Deep rotational slip in clay cap, waste and peat

Figure 3.1: Typical slope failure for Section A-A (Morgensten-Price Method) for Groundwater Level of 13m AOD.



Material #: 1 Description: Clay Cap Wt: 18 Cohesion: 4 Phi: 29
Material #: 2 Description: New Waste Wt: 9.5 Cohesion: 10 Phi: 15
Material #: 3 Description: Old Waste Wt: 11 Cohesion: 10 Phi: 22
Material #: 4 Description: Peat Wt: 14 Cohesion: 0 Phi: 15
Material #: 5 Description: Silty Clay Wt: 19 Cohesion: 0 Phi: 26
Material #: 6 Description: Glacial Till Wt: 20 Cohesion: 0 Phi: 33
Material #: 7 Description: Rock Wt: 23 Cohesion: 1000 Phi: 45

Figure 3.2: Typical slope failure for Section B-B (Morgensten-Price Method) for Groundwater Level of 13m AOD.



Material #: 1 Description: Clay Cap Wt: 18 Cohesion: 4 Phi: 29
Material #: 2 Description: New Waste Wt: 9.5 Cohesion: 10 Phi: 15
Material #: 3 Description: Old Waste Wt: 11 Cohesion: 10 Phi: 22
Material #: 4 Description: Peat Wt: 14 Cohesion: 0 Phi: 15
Material #: 5 Description: Silty Clay Wt: 19 Cohesion: 0 Phi: 26
Material #: 6 Description: Glacial Till Wt: 20 Cohesion: 0 Phi: 33
Material #: 7 Description: Rock Wt: 23 Cohesion: 1000 Phi: 45

Figure 3.3: Typical slope failure for Section C-C (Bishop Method) for Groundwater Level of 4mAOD.

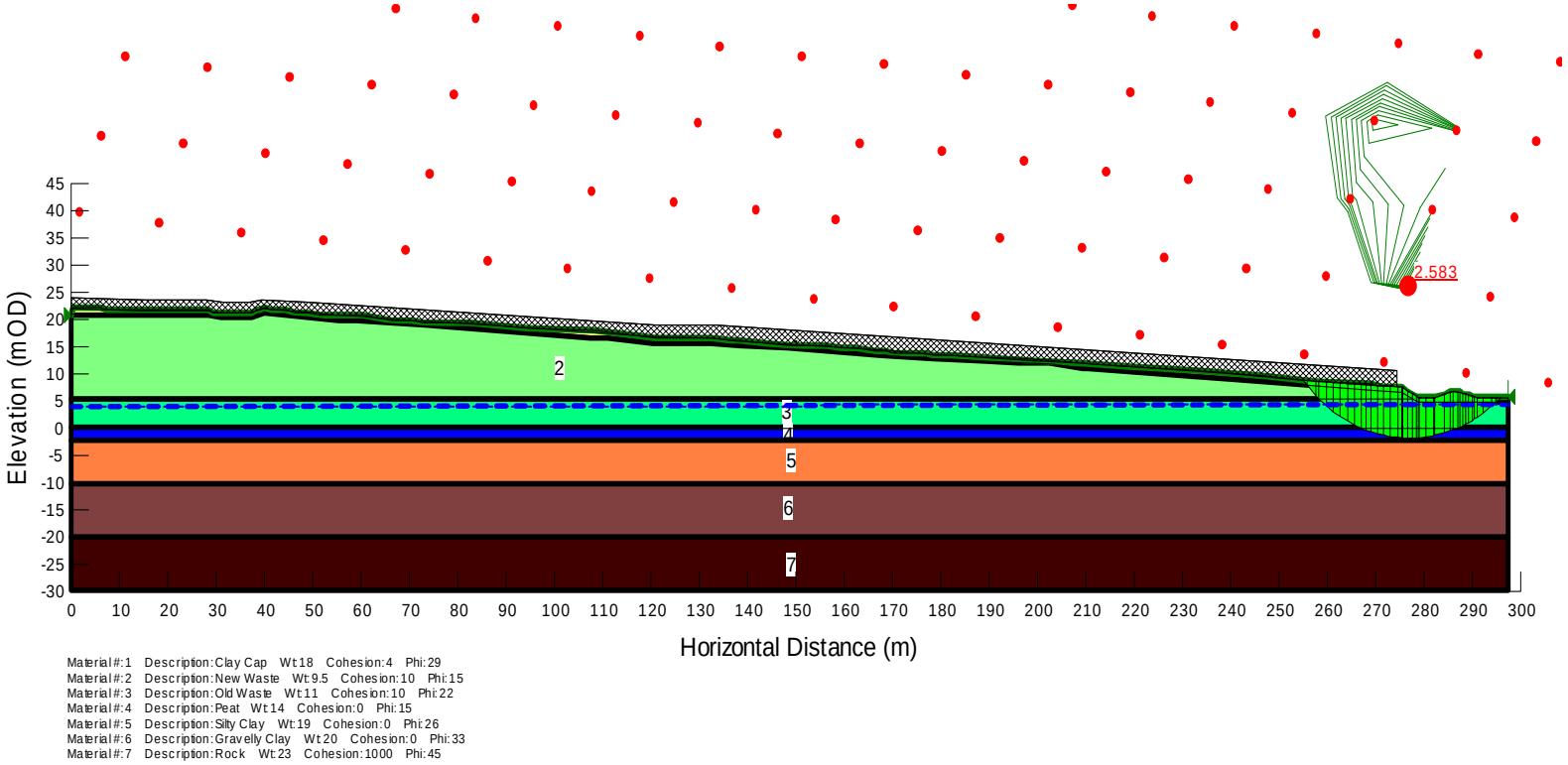
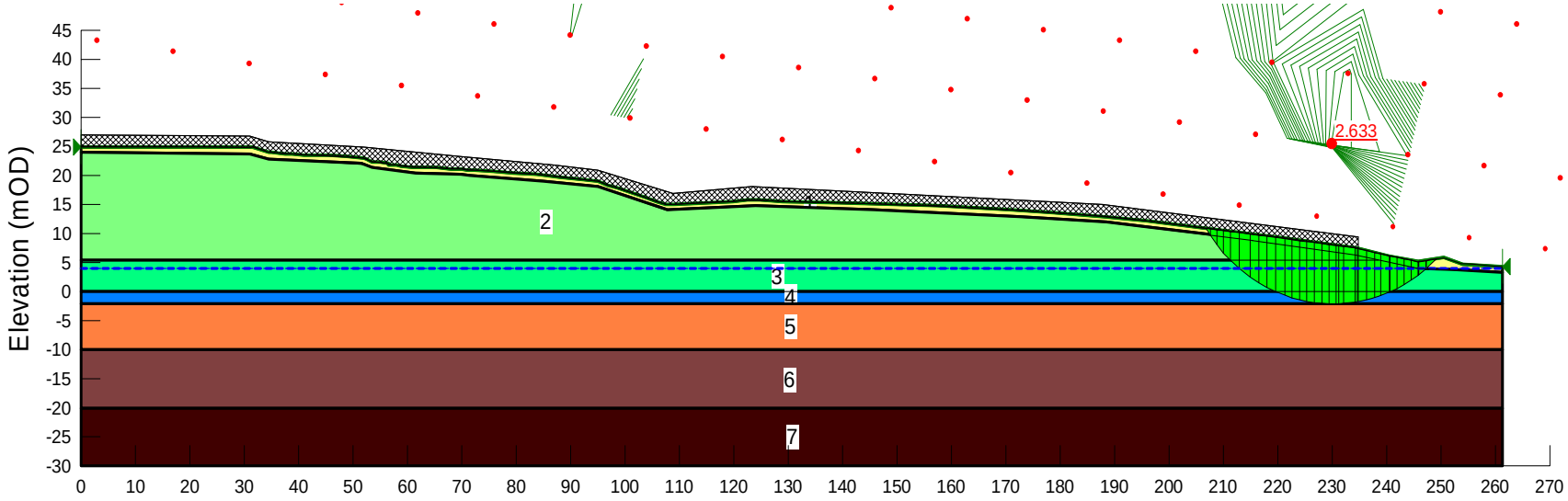


Figure 3.4: Typical slope failure for Section D-D (Janbu Method) for Groundwater Level of 4 mAOD.



4. Discussions and Conclusions

Factor of safety values against deep-seated rotational or shallow translational failures of the landfill embankment within the waste and underlying strata ranged from 1.53 to 3.03. The lengths of the potential failures are in the range of 8 m to 77 m. Out of the total eight case scenarios, all of the analyses have a factor of safety of 1.5 or above.

It is noted that a groundwater level of 4 mAOD is considered to be the most representative model based on the readings taken during 2007 and 2008. This analysis gave factors of safety which were well above 1.5 for the slopes analysed.

Based on the analysis models presented, the landfill side slopes studied in this report are considered to be stable under the typical groundwater conditions encountered during the 2007/2008 readings, however if groundwater levels are allowed to rise close to the maximum levels recorded during 2007/2008, then the factor of safety of the steepest slopes may fall below the required minimum of 1.5 for final slopes and 1.3 for interim slopes.

In order to maintain a factor of safety of 1.5 or greater for final capped slopes and 1.3 or greater for temporary slopes, leachate and groundwater levels must be regularly monitored to prevent a build up of levels within the waste body, which could cause potential instability of the landfill slopes. In addition, by removing the surcharge applied to the top of the slopes, the factor of safety calculated for the models will improve. It is recommended that the surcharge risk on steep temporary slopes on the site be removed or managed in order to minimise this risk.

5. References

1. Kolsch (1995) Material values for some mechanical properties of domestic waste, Proceedings 5th Sardinia International Landfill Symposium, Vol 2, pp 711-729.

2. E Kavazanjian, JR, N Matasovic & R C Bachus (1999), Large diameter static and cyclic laboratory testing of municipal solid waste, Vol 3, Sardinia Landfill Symposium pp 437-444.

3. S Thomas, A A Aboura, J P Gourc, P Gotteland, H Billard, T Delineau, T Gisbert, J F Ouvry and M Vuillemin, (1999), Vol 3, Sardinia Landfill Symposium, pp 445-452.

4. Gifford Consulting Engineers Report. Kinsale Road Landfill Slope Stability Report Ref 2001/011/08/KRL-WRL_SlopeStabReport.doc (3 Dec 2001).

5. Survey provided by Focus Surveys Ltd., Kinsale Road Landfill Site, Ref: 00-004_1 Rev ZZN, dated October 2007, updated January 2009.

Appendix A

Drawing Number: CE08-011-07_004 Rev A

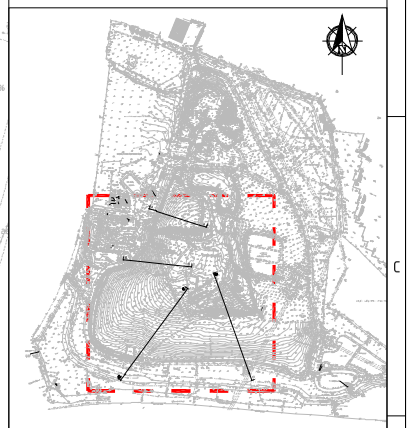
Drawing Title: Existing Topographic Survey showing section lines for Slope Stability Analysis

LEGEND

Line of Section for Slope Stability Analysis

NOTES

1. Based on Topographic Site Survey Drawing Number 00-004_1 Rev ZZN (05-01-09) Received from Focus Surveys Ltd.
2. Refer to Report CE08-011-07 RPT 001 Slope Stability, for Figures Relating to Sections
   - Section A-A : Figure 3.1
   - Section B-B : Figure 3.2
   - Section C-C : Figure 3.3
   - Section D-D : Figure 4.4



LOCATION MAP

Scale 1:20000

LOCATION OF SECTION LINES

Scale 1:2000

Rev.	Drawn	Chkd	Appd	Date	Description
A	MJM	PC	PK	21.01.09	ISSUE TO CLIENT
Revision History				Rev Origin	

Name of Client

CORK CITY COUNCIL

Name of Job

KINSALE ROAD LANDFILL
2008 ANNUAL
ENVIRONMENTAL REPORT

Title of Drawing

EXISTING TOPOGRAPHIC SURVEY
SHOWING SECTION LINES
FOR SLOPE STABILITY ANALYSIS

Scales Used	This Drawing was printed to
1:2000	A3

Dwg. No.	Rev.
CE08-011-07-004	A

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Scale 1:2000 (0m, 10.00m, 20.00m, 30.00m, 40.00m, 50.00m, 60.00m, 70.00m, 80.00m, 90.00m, 100.00m)

ORIGINAL DRAWING SIZE A1 - (841 x 594)

NATURAL SCALE (10, 0, 10, 20, 50, 100mm)

1.1 Methodology

To calculate the water balance for Kinsale Road Landfill Site, it is necessary to divide the site into areas according to prevailing hydrological conditions. Previous water balance calculations for the site divided the site into fourteen areas, (Water Balance Assessment, December 2003[1]). However, due to the completion of Phase 3 capping and the construction of the access road and playing pitch, the site is now divided into 16 areas. The format has been retained and updated for this report to reflect the ground conditions (i.e. areas capped, areas being filled etc) for the reporting period, as shown in Drawing CE08-011-07-003 Rev 0 and summarised in Table 1.1.

Table 1.1: Summary of Subdivisions for Water Balance Calculations

Description	Area (ha)	Infiltration Coefficient	Surface Water Runoff (m^3)	Infiltration as Leachate (m^3)
Area 1 (i)†	7.78	0.49	31,513	30,277
Area 1 (ii) †	8.05	0.49		
Area 1 (iii) †	8.23	0.49		
Area 1a (i) †	1.51	1	0	9,718
Area 1a (ii) †	1.24	1		
Area 1a (iii) †	1.06	1		
Area 2	5.31	0.13	35,566	5,315
Area 3	4.14	0.20	25,495	6,374
Area 4	2.20	0.77	3,895	13,040
Area 5	0.99	0.76	1,825	5,778
Area 6	4.03	0.13	26,989	4,033
Area 7	2.36	0.00	18,191	0
Area 8	5.49	0.005	42,064	211
Area 9	7.20	0.86	7,755	0
Area 10	1.43	0.0	10,976	0
Area 11	2.35	0.86	2,531	15,546
Area 12	8.36	0.00	64,351	0
Area 13	3.96	0.1	27,442	3,049
Area 14*	3.31	0.005	25,352	127
Area 15*	1.26	0.005	9,651	48
Total	**61.67**		**333,595**	**93,517**

†Areas 1 and 1a are subdivided as shown based on the filling sequence on site, as shown on Drawing CE08-011-07-003

* Infiltration coefficient for Area 14 (Phase 3 Capping Area) and Area 15 (Playing Pitch) was taken as the same as that for Area 8 (Phase 2 Capping Area).

Infiltration coefficients for each area were calculated using the HELP programme[2], and validated against actual site flows in a previous water balance report[1].

[1] Q:\2003\011\14\Reports\CCC-HA_Rpt001-C (Water Balance).doc

[2] Hydrologic Evaluation of Landfill Performance, HELP V3.07, developed by Environmental Laboratory, USAE Waterways Experiment Station for US EPA Risk Reduction Engineering Laboratory.

Rainfall data and evapotranspiration figures for the reporting period were obtained from Met Eireann for Cork Airport, located approximately 3 km south of the site. The monthly rainfall data is provided in Table 1.2. Table 1.2 also shows the potential evapotranspiration (PE) for the same period, and the effective rainfall.

Table 1.2: Rainfall Data (in mm): Cork Airport 2008

Month	Incident Rainfall (mm)	Evapotranspiration (mm)	Effective Rainfall (mm)
January	193.1	9.8	183.3
February	51.8	15.1	36.7
March	113.2	33.1	80.1
April	54	53.0	0.0
May	75.6	73.0	0.0
June	128.9	85.6	43.3
July	155.8	71.2	84.6
August	165.1	57.7	107.4
September	123.6	100.5	0.0
October	139.8	22.6	117.2
November	79.4	13.1	66.3
December	60.2	9.4	50.8
Totals	**1340.5**	**544.0**	**769.8**

Note: For months where evapotranspiration was greater that incident rainfall, the effective rainfall was taken as 0 mm.

It should be noted that the effective rainfall for this AER period (769.8 mm) was far greater when compared to the previous AER period (588.9 mm): i.e. during the 12 months of 2008, 30.7 % more effective rainfall fell than for the 12 months of 2007

The fraction of effective rainfall estimated to infiltrate into the ground is represented by the infiltration coefficient. For the purposes of this water balance calculation, several infiltration values were estimated, depending on the cover nature of that area. It is noted that these coefficients are conservative estimates only, and actual values will vary locally.

1.2 Annual Water Balance (2008)

Table 1.3 represents a summary of the monthly water balance for the site in 2008. The areas and infiltration coefficients used are provided in Table 1.1.

Table 1.3: Summary of Monthly Water Balance

Month	Leachate (m^3)	Surface Water Runoff (m^3)
January	22,311	79,195
February	3,866	15,869
March	9,599	34,592
April	0	0
May	0	0
June	5,056	18,779
July	10,064	36,686
August	12,750	46,677
September	0	0
October	13,356	50,924
November	7,244	28,793
December	5,353	22,081
Totals	**89,599 $m^{3\dagger}$**	**333,595 m^3**
Average Flow	**2.84 l/s**	**10.57 l/s**

†The difference between this figure and the figure quoted in Table 1.1 above is due to the absorption of rainfall by the waste body, which has been accounted for on a monthly basis, but not defined by area.

1.3 Emissions to Groundwater

An estimate of emissions to groundwater can be made by either

- Assuming that the difference in the predicted leachate volume generated and that processed through the leachate conditioning plant is released into the groundwater system, or

- Using the hydrogeological properties of the underlying strata (peat), assuming a leachate head and calculating a vertical throughput flow.

The first method does not take account of breakout of leachate at the lower parts of the cap. Hence the second method will be used for the purpose of this report.

Using the parameters for the peat and silty clays given in the original waste licence application, the vertical leachate leakage is estimated.

The leachate head has been obtained from leachate wells at the site and the piezometric head of the confined bedrock groundwater aquifer from the monitoring wells (see Drawing CE08-011-07-001 Rev A for location of wells). This data is presented in Table 1.5. Table 1.4 shows the depths to water as measured from the Top of the Chamber (TOC) for each respective well in January 2008.

Table 1.4: Depths to Water

Monitoring Location	Easting	Northing	Depth to Water from TOC Measured (m)	TOC (m)OD
BH1	168336	69570	8.02	25.4
L1	168334	69571	6.42	25.32
BH2	168222	69584	inaccessible	20.3
L2	168219	69582	inaccessible	20.41

Table 1.5: Vertical Gradients

	Well Pairs	Water Level (mOD)	dl	dx	$^{dl}/_{dx}$
Leachate/Bedrock Monitoring Boreholes	BH1	17.38	1.52	-22.09	-0.0688
	L1	18.9			
	BH2	-	-	-27.76	-
	L2	-			

Note on Table 1.5: Water / leachate levels measured in January 2009

The equation for leakage to groundwater is given as follows:

$$Leakage = \frac{k(h_1 - h_2)}{b}$$

Where:

k = hydraulic conductivity, this value varies in the site from a maximum of 1.8 x 10^{-9} m/sec (1.56 x 10^{-4} m/day) to a minimum of 4.5 x 10^{-10} m/sec (3.89 x 10^{-5} m/day).

b = clay thickness = 8 m (south of site) and 2 m (north of site)

h_1 = *head of leachate* = 18.9 m OD (south, leachate level in borehole L1) and 4.5 m OD (north, assumed)

h_2 *(groundwater level in bedrock)* = 3.4 m OD (average for site, obtained from CCC 2008 monitoring data)

Because the peats and clays reduce in depth to the north, and because leachate head increases greatly to the south, calculations have been made for the northern and southern portions of the site separately.

1.3.1 Northern Portion of the Site

$$\text{Leakage} = \frac{3.9\times10^{-5}\times(4.5-3.4)}{2} \quad \text{or} \quad = \frac{1.6\times10^{-4}\times(4.5-3.4)}{2}$$

for the range of permeability values.

Therefore:

Leakage = 8.8 x 10^{-5} to 2.1 x 10^{-5} m^3/day per m^2 landfilled area in northern portion of site

The area of waste in northern portion of site = 232,500 m^2

Hence in the northern portion of the site, leakage to bedrock ranges from:

4.98 m^3/d to 20.46 m^3/d

1.3.2 Southern Portion of Site

$$\text{Leakage} = \frac{3.9\times10^{-5}\times(18.9-4.2)}{8} \quad \text{or} \quad = \frac{1.6\times10^{-4}\times(18.9-4.2)}{8}$$

for the range of permeability values.

Therefore:

Leakage = 7.16 x 10^{-5} to 2.94 x 10^{-4} m^3/day per m^2 landfilled area in southern portion of site

The area of waste in southern portion of site = 274,630 m^2

Hence in the southern portion of the site - leakage to the bedrock ranges from:

19.66 m^3/d to 80.7 m^3/d

Leakage	Minimum (m^3/yr)	Maximum (m^3/yr)
Leakage in the North Portion (m^3/yr)	1,817.7	7,467.9
Leakage in the South Portion (m^3/yr)	7,175.9	29,455.5
Total Leakage to the bedrock aquifer (m^3/yr)	**8,993.6**	**36,923.4**

This compares to a figure of 5,195 m^3/year calculated for the Waste Licence Application. The difference in figures is accounted for largely by the increase in the leachate leakage calculated for the southern area of the site. This is a result of additional data on the leachate head in the area, obtained from a 2003 site investigation. The maximum figure calculated for the 2007 AER was 26,491.7 m^3, and the increase over the 2008 period is due mainly to the decreased groundwater level in bedrock for the site i.e. from 4.2 m in 2007 to 3.4 m in 2008. Furthermore, the increase in leachate leakage may be associated with the increase in leachate production during 2008 (See Section 1.4 below).

1.4 Leachate Volumes

The volumes of leachate produced, conditioned and discharged to sewer at the Kinsale Road Sanitary Landfill are provided in Table 1.5.

Table 1.5: Leachate Conditioning and Production Volumes (2008)

Month	Estimated Leachate Produced (m^3)	Volume of Treated Leachate (m^3)	Monthly surplus/deficit (m^3)
January	22,311	7,359	14,952
February	3,866	6,672	-2,806
March	9,599	5,853	3,746
April	0	4,816	-4,816
May	0	5,543	-5,543
June	5,056	2,293	2,763
July	10,064	4,341	5,723
August	12,750	4,820	7,930
September	0	7,334	-7,334
October	13,356	8,676	4,981
November	7,244	5,098	2,543
December	5,353	6,191	-518
Annual Total	**89,599 m^3**	**68,996 m^3**	**21,621 m^3**

Note on Table 1.5: Leachate is treated on site at the leachate conditioning plant.

The monthly surpluses/deficits given in the above table are not unexpected as there is a time lag between incident rainfall and leachate recovery. The use of monthly meteorological data in calculations may also lead to minor underestimation of leachate production values.

The figure of 89,599 m^3 of leachate produced in 2008 is 23.8% more than the 2008 figure (72,390 m^3). This increase in leachate production is likely to be due to the increased effective rainfall. Table 1.5 has shows that the leachate management infrastructure on site is performing with sufficient reliability and at sufficient capacity to treat collected leachate.

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DATE: 15-Jan-09 **REVISION:** A

JOB NUMBER: CE08-011-07

CALC NUMBER: **1**

FILE \\ftc05dr\RCP\2008\CE08\011\07\Calculations\Water Balance\CE0801107_Water Balance 2008.xls

SHEET Cover

PROJECT: Kinsale Road Sanitary Landfill - Reporting related to the 2008 AER

DESCRIPTION: 2008 Water Balance Calculation

Rev	Date	Purpose and Description	Prepared	Checked	Reviewed	Approved
A	15-Jan-09	2008 Water Balance Calculation for inclusion in 2008 AER	AR	JM	JM	

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JOB NUMBER: CE08-011-07
CALC NUMBER: 1
FILE \\ltc05dr\RCP\2008\CE08\011\07\Calculations\Water Balance\CE0801107_Water Balance
SHEET Calcs

PROJECT: **Kinsale Road Sanitary Landfill - Reporting related to the 2008 AER**
DESCRIPTION: **2008 Water Balance Calculation**

Ref.	**Page** 2 of 4	Output

1.0 Introduction and Purpose

The purpose of this calc set is to complete the water balance calculation for the Kinsale Road Landfill Site for inclusion with the site's 2008 Annual Environmental Report. Results presented in the following pages, and the associated reports were issued electronically to the site for inclusion with the report.

Water Balance Calculation
Kinsale Road AER 2008

2008			SURFACE WATER VOLUMES (m³)																
Month	Rainfall (mm)	ER (mm)	Area 1	Area 1a	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10	Area 11	Area 12	Area 13	Area 14	Area 15	Totals
January	193.1	183.3	7,272	0	8,468	6,070	927	434	6,426	4,331	10,015	1,846	2,613	603	15,321	6,534	6,036	2,298	79,195
February	51.8	36.7	1,457	0	1,697	1,216	186	87	1,288	868	2,007	370	524	121	3,070	1,309	1,210	460	15,869
March	113.2	80.1	3,176	0	3,699	2,651	405	190	2,807	1,892	4,375	806	1,141	263	6,692	2,854	2,637	1,004	34,592
April	54	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	75.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	128.9	43.3	1,779	0	2,001	1,435	219	103	1,519	1,024	2,367	436	618	142	3,621	1,544	1,427	543	18,779
July	155.8	84.6	3,476	0	3,910	2,803	428	201	2,967	2,000	4,624	853	1,207	278	7,074	3,017	2,787	1,061	36,686
August	165.1	107.4	4,512	0	4,964	3,559	544	255	3,767	2,539	5,871	1,082	1,532	353	8,982	3,830	3,539	1,347	46,677
September	123.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	139.8	117.2	4,922	0	5,416	3,882	593	278	4,110	2,770	6,406	1,181	1,671	385	9,799	4,179	3,861	1,470	50,924
November	79.4	66.3	2,783	0	3,062	2,195	335	157	2,324	1,566	3,622	668	945	218	5,541	2,363	2,183	831	28,793
December	60.2	50.8	2,134	0	2,348	1,683	257	120	1,782	1,201	2,777	512	725	167	4,249	1,812	1,674	637	22,081
Totals	**1340.5**	**769.8**	**31,513**	**0**	**35,566**	**25,495**	**3,895**	**1,825**	**26,989**	**18,191**	**42,064**	**7,755**	**10,976**	**2,531**	**64,351**	**27,442**	**25,352**	**9,651**	**333,595**

Rainfall	Evapotranspiration	Effective Rainfall
193.1	9.8	183.3
51.8	15.1	36.7
113.2	33.1	80.1
54	53.0	0.0
75.6	73.0	0.0
128.9	85.6	43.3
155.8	71.2	84.6
165.1	57.7	107.4
123.6	100.5	0.0
139.8	22.6	117.2
79.4	13.1	66.3
60.2	9.4	50.8

2008	GROUNDWATER/LEACHATE VOLUMES (m³)																		
Month	Area 1	Area 1a	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10	Area 11	Area 12	Area 13	Area 14	Area 15	Totals	Absorption by waste	Total Leachate	Total Groundwater
January	6,987	2,764	1,265	1,518	3,105	1,376	960	0	50	11,341	0	3,701	0	726	30	12	33,836	183	22,311	11,341
February	1,400	554	254	304	622	276	192	0	10	2,273	0	742	0	145	6	2	6,780	642	3,866	2,273
March	3,052	1,207	553	663	1,356	601	419	0	22	4,954	0	1,617	0	317	13	5	14,779	227	9,599	4,954
April	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	1,709	536	299	359	734	325	227	0	12	2,681	0	875	0	172	7	3	7,938	201	5,056	2,681
July	3,340	1,046	584	701	1,434	635	443	0	23	5,237	0	1,709	0	335	14	5	15,507	206	10,064	5,237
August	4,335	1,135	742	890	1,820	807	563	0	30	6,649	0	2,170	0	426	18	7	19,590	191	12,750	6,649
September	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	4,729	1,238	809	971	1,986	880	614	0	32	7,254	0	2,367	0	464	19	7	21,372	762	13,356	7,254
November	2,674	700	458	549	1,123	498	347	0	18	4,101	0	1,339	0	263	11	4	12,084	739	7,244	4,101
December	2,051	537	351	421	861	382	266	0	14	3,145	0	1,026	0	201	8	3	9,267	769	5,353	3,145
Totals	**30,277**	**9,718**	**5,315**	**6,374**	**13,040**	**5,778**	**4,033**	**0**	**211**	**47,635**	**0**	**15,546**	**0**	**3,049**	**127**	**48**	**141,152**	**3,918**	**89,599**	**47,635**

Name	Description	Area (ha)	Infiltration coefficient	Runoff coefficient	Waste-bearing?
Area 1 (i)	Semi-Active Area (Jan-May 2008)	7.78	0.49	0.51	✓
Area 1 (ii)	Semi-Active Area (June-July 2008)	8.05	0.49	0.51	✓
Area 1 (iii)	Semi-Active Area (Aug 2008 - Present)	8.23	0.49	0.51	✓
Area 1a (i)	Active area (Jan-May 2008)	1.51	1	0.00	✓
Area 1a (ii)	Active Area (June-July 2008)	1.24	1	0.00	✓
Area 1a (iii)	Active Area (Aug 08 - Present)	1.06	1	0.00	✓
Area 2	Phase 1 Capped Area	5.31	0.13	0.87	✓
Area 3	Soil Storage Area	4.14	0.2	0.80	✓
Area 4	Pitch & Putt Course	2.20	0.77	0.23	✓
Area 5	Adjacent to C & D Facility	0.99	0.76	0.24	✓
Area 6	C & D Facility	4.03	0.13	0.87	✓
Area 7	Office/CA Area	2.36	0	1.00	✓
Area 8	Phase 2 Capped Area	5.49	0.005	0.995	✓
Area 9	Tramore River Bank	7.20	0.86	0.14	
Area 10	Lined Lagoon areas	1.43	0	1.00	✓
Area 11	Eastern Access Road	2.35	0.86	0.14	✓
Area 12	Marsh/Trabeg River Area	8.36	0	1.00	
Area 13	Blackash Road Area	3.96	0.1	0.90	✓
Area 14	Phase 3 Capped Area	3.31	0.005	0.995	✓
Area 15	Playing Pitch Development	1.26	0.005	0.995	✓
Total		61.67	-	-	

Waste Deposition	
Month	Tonnes
Jan-08	2,611
Feb-08	9,166
Mar-08	3,241
Apr-08	3,435
May-08	3,220
Jun-08	2,869
Jul-08	2,943
Aug-08	2,724
Sep-08	3,306
Oct-08	10,882
Nov-08	10,553
Dec-08	10,984

Absorptive Capacity of waste 0.07

Notes to Table
No Infiltration of Leachate -
86% of Area 9 water infiltrates to groundwater not to Leachate
Active area of filling changed throughout 2008 as shown.

Summary of Results (not linked to Tables above)

Name	Surface Water Runoff (m³)	Infiltration as Leachate (m³)
Area 1	31,513	30,277
Area 1a	0	9,718
Area 2	35,566	5,315
Area 3	25,495	6,374
Area 4	3,895	13,040
Area 5	1,825	5,778
Area 6	26,989	4,033
Area 7	18,191	0
Area 8	42,064	211
Area 9	7,755	0
Area 10	10,976	0
Area 11	2,531	15,546
Area 12	64,351	0
Area 13	27,442	3,049
Area 14	25,352	127
Area 15	9,651	48
Total	**333,595**	**93,517**

Leachate Volumes Produced and Treated
Kinsale Road AER 2004

2008 Figures

Month	Estimated Leachate produced (m^3)	Conditioning Plant Treated (m^3)			Difference (m^3)
		Main Plant	Temporary Plant	Total	
January	22,311	7,359	0	7,359	14,952
February	3,866	6,672	0	6,672	-2,806
March	9,599	5,853	0	5,853	3,746
April	0	4,816	0	4,816	-4,816
May	0	5,543	0	5,543	-5,543
June	5,056	2,293	0	2,293	2,763
July	10,064	4,341	0	4,341	5,723
August	12,750	4,820	0	4,820	7,930
September	0	7,334	0	7,334	-7,334
October	13,356	8,375	301	8,676	4,981
November	7,244	4,701	397	5,098	2,543
December	5,353	5,871	320	6,191	-518
Total	**89,599**	**67,978**	**1,018**	**68,996**	**21,621**

	Predicted Leachate produced (m^3)	Conditioning Plant Treated (m^3)
Average flow (l/s)	**2.84**	**2.19**