EAST CORK LANDFILL
ROSSMORE
CARRIGTOHILL
CO CORK

ENVIRONMENTAL PROTECTION AGENCY

WASTE LICENCE W0022-02

ANNUAL ENVIRONMENTAL REPORT

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

1.1 Scope and Purpose of the Annual Environmental Report

Cork Council Council holds E.P.A. Waste Licence W0022-02 to operate waste disposal activities at East Cork Landfill & Civic Amenity Site, Rossmore, Carrigtohill. The Annual Environmental Report provides a review of activities at Rossmore within the last twelve months. The Table of Contents is derived from Schedule C of the Waste Licence.

1.2 Background to the Report

The landfill facility has been in operation at Rossmore since 1986 with waste received in the lined cells since 10th January 1995. The Waste Licence was issued to Cork County Council by the E.P.A. on 27th July 2000.

In accordance with Condition 2.8 of Waste Licence W0022-02 an Annual Environmental Report will issue from the site to the Agency.

This is the tenth A.E.R. for the landfill and covers the period **1st January to 31st December 2010.**

1.3 Site Location

The facility is located 2½ km south of the N25 at Carrigtohill in the townland of Rossmore.

The site address is:

East Cork Landfill,
Rossmore,
Carrigtohill,
Co.Cork.

Tel. (021) 4533934
Fax. (021) 4533880
e-mail: jerome.obrien@corkcoco.ie

1.4 Environmental Policy

Cork County Council is committed to conducting all activities such that they have a minimal effect on the environment.

The main objectives are:

A commitment to comply with the Conditions of the Waste Licence and all relevant environmental legislation.

To ensure that management and all personnel working on the site are familiar with the Conditions of the Waste Licence, the content of the Environmental Management Plan and the Emergency Response Procedures.

2 SITE DESCRIPTION AND ACTIVITIES

2.1 Description of the Site

East Cork Landfill is sited in the Rossmore Peninsula at the midpoint of the northern estuary of Cork Harbour, 12 km from Midleton, 19 km from Cork City and 5 km from the industrial area of Little Island.

The site is the void left by limestone quarrying formerly owned and worked by Cemex Ltd. The total site occupies an area of 38 acres of land. The mining resources are depleted since December 2001

.

The former waste disposal floor area of the site occupies 16.25 acres.

The peninsula has grazing and tillage farming activities almost completely on the perimeter of the landfill. A former oyster farming business, owned by Atlantic Shellfish Ltd., also shares the southeastern end of the region.

Cork Harbour waters almost surround the peninsula and there are extensive mudflats at low tide which provide feeding grounds for aquatic birds. The baseline ecological study indicates a quality of invertebrates, annelids and crustaceans not normally associated with waters adjacent to a landfill.

This region of Cork Harbour is a designated Special Protection Area for wildlife.

There is one groundwater abstraction in the peninsula which is included in the monthly schedule of monitoring. Potable water is supplied to the locality by a Cork County Council main.

The prevailing wind directions over the site are varied but predominantly southwesterly. The change in tides has an effect on wind speed and impacts on site.

The access road from the nearest Local route is in private ownership. It is not possible to place traffic calming, control signage or direction signage along this route as it is ‘not in charge’. The surface is maintained and cleaned by Cork County Council under Condition 4.4.2. Following the construction of an asphalt plant by Irish Asphalt Ltd the road was widened in accordance with planning requirements.

2.2 Reporting Period

The period being reported on is that from 1st January to 31st December 2010.

2.3 Waste Activities now carried out at the Facility

Waste activities at East Cork Landfill are restricted to those outlined in Schedule A of the Waste Licence in accordance with the Waste Management Act: Third Schedule, as outlined below.

2.3 Waste Activities carried out at the Facility (continued)

Class 4: Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.

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.

Class 11: Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.

Class 12: Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.

Class 13: Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule other than temporary storage, pending collection, on the premises where the waste concerned is produced.

2.4 Quantity and Composition of Waste Received and Disposed

The quantity and composition of waste received, disposed of, recovered and recycled during the reporting period is outlined in Table 2.1.

Table 2.1 Quantities of MS Waste Received at Civic Amenity and Disposed of at landfill during the Reporting Period

Month	Quantity of Waste/tonnes	Disposal Destination
January 2010	**138.54**	**Youghal Landfill**
February	**154.18**	**Youghal Landfill**
March	**146.76**	**Youghal Landfill**
April	**281.05**	**Youghal Landfill**
May	**177.15**	**Youghal Landfill**
June	**141.33**	**Youghal Landfill**
July	**178.73**	**Youghal Landfill**
August	**124.38**	**Youghal Landfill**
September	**145.87**	**Youghal Landfill**
October	**90.65**	**Youghal Landfill**
November	**107.12**	**Youghal Landfill**
December	**83.49**	**Youghal Landfill**
Total	**1769.25**	

The software associated with the weighing mechanism is maintained by Precia Molen Ltd. Annual weighbridge calibration is performed by Precia Molen Ltd under new metrology regulations and the calibration certificate is held in the site file.

2.5 Tank Testing and Inspection Reports

Integrity testing of water retaining structures to comply with Condition 4.14.5 of the Waste Licence was carried out in 2010 on both leachate lagoons L1 and L2. Very minor surface damage was reported on and repairs were carried out in Lagoon 1.

The report by Geomembrane Testing Services Ltd is contained in Appendix I.

3 SUMMARY OF MONITORING AND EMISSIONS

3.1 Landfill Gas

The possible migration of landfill gas is monitored daily by site technical staff in excess of the frequencies indicated in Schedule F, Table F.1 (a) and Condition 9 of the Waste Licence. The offsite movement of landfill gas is detected by monitoring the boreholes situated around the perimeter of the site. Constant landfill gas monitoring is taken in the accommodation areas including the site office and weighbridge to detect the accumulation of methane and carbon dioxide. Monitoring is performed on the wells located on the capped landfill.

The landfill gas detection device is a LMSx Multigas Analyzer, calibrated annually by CEMS Ltd.

FTC Drawing No.2000-004-18-10 Rev 'E' is the illustrated layout of the landfill gas monitoring locations agreed with the Agency.

The installation of the Landfill Gas Flare in September 2004 has resulted in constant flaring of emissions. The recorded results were sent to the Agency as part of the monthly monitoring. The average percentage for methane, oxygen and carbon dioxide gas burned on the site is in the region of 28-30%, 1-2% and 20-25% respectively. Gas field balancing is carried out on site when required. The gas is collected from 51 wells in the lined area of the landfill and 9 wells in the unlined area of the landfill. The gas main was extend to incorporate cells 6 to 8b and transducer risers at cells 8b to 9 and also the pump risers at cells 9 and 10 in a bid to reduce odour nuisances in these areas. The results are relayed to a SCADA pc in the main office building.

Average levels for methane, oxygen and carbon dioxide burned at the flare are 28.26, 0.17 and 21.6% respectively with gas field-balancing being done when required.

3.2 Surface Water

Surface water is monitored at the locations described in Schedule F, Table F4.2, of the Waste Licence and FTC Drawing No.2000-004-18-10 Rev 'E' by agreement with the Agency and in accordance with Condition 9. The frequency and composition of analysis is illustrated in Table F4.2 of the Licence. Consultants RPS MCO'S Ltd. sample, analyse and interpret the results of the surface water monitoring on behalf of Cork County Council.

Precipitation falling on the capped landfill is directed by gravity to the surface water lagoon. Some falls to the holding tanks to the rear of Lagoon 2 from where it is pumped to the surface water lagoon at the western end of the site. There, sampling takes place before the inlet and at the outlet for TOC, pH and conductivity.

Installed by Automatic Flare Systems Ltd., the flow is continuously sampled and results compared and trigger levels set. If these levels are exceeded in any of the above an actuated valve closes the outlet pending the dilution of the cause of the exceedence.

3.3 Groundwater

Surface water is monitored at the locations described in Schedule F5 of the Waste Licence and FTC Drawing No.2000-004-18-10 Rev 'E' by agreement with the Agency and in accordance with Condition 9. The frequency and composition of analysis is illustrated in Table F4.2 of the Licence which requires that some parameters are monitored monthly, some quarterly and others annually. Consultants RPS MCO'S Ltd. sample, analyse and interpret the results of Groundwater monitoring on behalf of Cork County Council.

3.4 Leachate

Leachate is monitored at the locations described in Schedule F.6, Table F6.1, of the Waste Licence and FTC Drawing No.2000-004-18-10 Rev 'E' by agreement with the Agency and in accordance with Condition 9. The frequency and composition of analysis is illustrated in Table F4.2 of the Licence.

Leachate levels in the ten waste cells and both lagoons are recorded daily on the instruction of the Agency. pH and temperature readings are recorded as per Table F7.1.

Leachate analysis for ammonia, suspended solids, BOD and COD is conducted weekly at Inniscarra Laboratories and also at the laboratory at Bottlehill landfill, which is now operational, on leachate samples from the lagoon where leachate is removed.

Ammonia levels have shown an overall range is from 73 to 1520mg/l in Lagoon 2 in the monitoring period. pH has shown no major change in comparison to the last reporting period, with ranges from 7.79 to 8.86 in Lagoon 2.

BOD values range from 32 to 102mg/l for Lagoon 2 over the period. COD varies from 660 to 2960mg/l. The ranges vary in relation to the results shown previously. Ammonia, COD and BOD have all shown a reduction a slight increase in pH was evident this year.

3.5 Noise

A noise survey was carried at the landfill in accordance with the requirements of Schedule F.3 and Table F.3, Schedule G1 on the 31st of August 2010, the locations illustrated in FTC Drawing No.2000-004-18-10 Rev 'E' and Condition 9.3. All locations were within the limits as set out in the Waste Licence. The results indicate that the maximum equivalent continuous noise measurement was 58dBA at monitoring locations N4 opposite the site entrance gate is slightly higher than limits given for a noise sensitive location. All recordings were lower than the limit of 55dBA as directed by Schedule G2 of the Waste Licence. Results for 2010 are indicative of the decline in activity and while slightly higher than 2009 still within the Waste Licence Limits. The report by DixonBrosnan Ltd is contained in Attachment F.

3.6 Dust

Three dust surveys were carried in accordance with the requirements of Schedule F.3 and Table F.3, Schedule G2, the locations illustrated in FTC Drawing No.2000-004-18-10 Rev 'E' and Condition 9.5. The dust was collected in Bergerhoff bottles of aperture size from 88mm diameter.

The dust limit in Schedule G2 of 350mg/m^2/day was slightly exceeded in locations D3 and during the three monitoring periods. In the case of D2 this is a result of compacting the residual waste bins at the CA Site using a 360° excavator which results in some amounts of rising dust. The exceedence of the limits at D4 may be as a result of proper procedures not been followed such as washing out the gauges before or during the placement of the sampling gauges. Tampering of all four gauges cannot be ignored. On one occasion in 2008 the Bergerhoff Gauges were removed from the site.

3.7 Dust Survey

Date	Location	Duration	Dust Concentration	Dust Level mg/m^2/day
Jun- 10	Atlantic Shellfish D1	30	8	44.9
	Civic Amenity D2	30	206.9	1160.1
	South Road (pylon) D3	30	42.1	236.1
	Northwestern corner D4	30	84.6	474.4

Date	Location	Duration	Dust Concentration	Dust Level mg/m^2/day
July 10	Atlantic Shellfish D1	31days	3	20.6
	Civic Amenity D2	31days	130.3	707.1
	South Road (pylon) D3	31 days	60.3	327.2
	Northwestern corner D4	31 days	85.2	462.3

Date	Location	Duration	Dust Concentration	Dust Level mg/m^2/day
Sept. 10	Atlantic Shellfish D1	31 days	9.6	52.1
	Civic Amenity D2	31 days	24.8	134.6
	South Road (pylon) D3	31 days	9.3	50.5
	Northwestern corner D4	31 days	65.7	356.5

Table 3.

3.8 Ecology Parameters

In this licence period, the ecology monitoring of the landfill and surrounds was awarded again to Limosa Environmental for consistency and comparison. Dr Lesley Lewis has conducted an extensive ecology report on this site in accordance with the agreed parameters set out by the Agency in Condition 9.14.

The annual ecology survey is enclosed as Attachment G, and includes as required the following:

- *Brief survey of terrestrial component of site to assess changes in habitats and species of flora and fauna since baseline survey of 1998.*

- *Survey of estuarine sediments and shoreline for macro-invertebrates, macro, algae and Spartina distribution.*

- *Analysis of sediments (collected from same sampling points as for fauna/flora) for total nitrogen, total phosphorus, copper, cadmium chromium, zinc, lead and mercury. Organic content of sediment would also be determined. Results to be compared with 1998 data.*

- *Interpretation of water quality data for North Channel area from water quality programme as carried out by Environmental Protection Agency.*

- *Assessment of usage of intertidal flats by feeding wildfowl and waders in vicinity of Rossmore Peninsula and Brick Island. This would be done by systematic observations during low tide periods. Up to six visits would be made during the winter period.*

- *Assessment of relative importance of the North Channel area within the Cork Harbour SPA. This would be done by analysis of data for Cork Harbour from the I-WeBS scheme.*

- *Summary and interpretation of the significance of results of monitoring of shellfish growing areas in the vicinity of the landfill as undertaken by the Department of the Marine and Natural Resources.*

- *Contact with Duchas re any recent surveys or monitoring that might have been carried out in the SPA and the proposed NHA and also to discuss the possible trends in bird population.*

4. SITE DEVELOPMENT WORKS

4.1 Site Development Works during the Reporting Period

A site entry and exit barrier control system and an increased hard standing area were developed in this reporting period.

4.2 Proposed Development Works

Cork County Council proposes the following site development works January-December 2011 pending tendering and appointment of competent contractor/s:

4.3 Site Development Works during the Coming Year

The site development works for the current Waste Licence year will be the collection and discharge within the site perimeter of surface water arising from runoff from the site roads at the bin marshalling area.

4.4 Report on completed development works

In order to control and manage entry and exit into the facility automatic control barriers were installed around a kerbed island with a gate keeper's hut as the central control unit near the main gate. Further concrete kerbing was carried near the front perimeter and a former green area removed to provide a sizeable increase in hard standing. This afforded the movement of containers for some of the major recycling streams to this new location and increased the efficiency for customers by doubling the footprint of the facility.

4.5 Slope Stability

Analysis of slope stability in accordance with Condition 9.20 on a selected area of the restored cells was carried out by Fehily Timoney & Co. The analysis was conducted using the *Reslope* software programme on twelve locations. Factors of safety ranging from 1.25 to 2.23 evolved indicating stable conditions. A full and comprehensive report is included in Appendix A.

4.6 Quantity of indirect emissions to Groundwater

There are no indirect emissions from the site to groundwater. The cell leachate level condition is complied with as much as is possible given volumetric constraints at the waste water treatment plant. Monitoring of surface water does not indicate contamination from leachate.

5 WASTE RECEIVED BY THE FACILITY

5.1 Waste Acceptance

Only domestic MSW from householders and small commercial outlets are accepted at the facility in ro-ro bins for collection, transport, recycling and disposal at Youghal Landfill

The site offers a comprehensive range of vessels for the storage of solid and liquid recyclable materials including;

Cardboard
Newspapers & magazines
Glass bottles
Cooking oil
Engine oil
Plastic bottles
Flat glass
Scrap metal
WEEE
Paint
Automotive Batteries
Ni Cd Batteries
Alkaline Batteries
Flourescent tubes
Green waste
Textiles
Timber

The site generates approximately 5-6 tonnes of WEEE each week.

6.1 Incidents 2010

The following is a table of reportable incidents under Condition 3.1 which occurred this Licence period. It also outlines corrective action, if any required, taken by site management to prevent recurrence.

Site Incidents Log

Date	Nature of Incident	Cause	Corrective Action
13/03/10	LFG flare shut down	Brief interruption in the power supply to the facility	No corrective action possible. Incident likely to be repeated.
27/03/10	LFG flare shut down	Compressor shut down due to power outage, closing main gas valve into the flare stack.	As above
29/03/10	O_2 electronic card in LFG flare out of calibration	Normal wear	Return card to UK for examination & calibration. New card required and placed on order for lengthy delivery
21/04/10	Failure of leachate pump to Cells 3/4	Soil & stones washed down the pump riser causing pump failure.	Introduce cctv camera. Vacuum out approximately 16m column of soil from riser. Repair cable damage.
18/06/10	Failure of Cell 5 leachate level signal transducer	Normal wear	Summon electrician. Order & replace 0-4m range leachate level transducer
22/06/10	LFG flare shut down	High atm pressure/condensate blockage	Investigate cause/s. Balance LFG field. Check KO pots for pump function.
09/07/10	Failure of Cell 7 leachate level signal transducer	Normal wear	Summon electrician. Order & replace 0-4m range leachate level transducer
26/07/10	LFG flare shut down	Field LFG depletion	Balance system
16/08/10	LFG flare shut down	Condensate blockage	Check KO pots for pump function.
26/08/10	SW management signal fault	Cable damage due to water intrusion	Summon electrician. Re-make cable joint
20/10/10	LFG flare shut down	Low LFG flow alarm	Clean flare inlet filters

Date	Nature of Incident	Cause	Corrective Action
26/10/10	LFG flare shut down	Field LFG depletion	Balance system
29/10/10	Cell 9 leachate pump failure	Faulty pneumatic discharge timer	Remove & replace timer
11/11/10	LFG flare shut down	Low LFG flow alarm	Balance LFG field a number of times. Check KO pots for condensate blockages

6.2 Complaints

There were no complaints registered against the site in 2010.

7 ENVIRONMENTAL EMISSIONS

7.1 Volume of Leachate Produced & Transported

The volume of leachate produced is the volume of leachate pumped to the lagoons and transported to the waste water treatment plants at the end of the period 1st January to 31st December 2010.

The total measure is 8,064.17 tonnes or 1,850,727 gallons.

This represents a reduction on 2009 of 4591.54 tonnes.

Month	Leachate tonnes
January	1,522.05
February	1,482.54
March	679.05
April	1,267.75
May	153.63
June	380.85
July	157.77
August	840.78
September	441.69
October	0
November	456.92
December	681.14
Total	8064.17

7.2 Effectiveness of Environmental Nuisance Emission Control

Noise
The degree of noise emissions from the landfill was proportional to the number of plant machinery items operating at any one time. Since closure this has declined to a point where only the vacuum tanker, 360° excavator and customer vehicles are contributory. From observations little airborne sound is evident offsite.

All pumps are electrically or pneumatically powered and have no audible impact on the facility.

Dust
Dust problems on site were attributed to dry weather, fine waste, fine imported soil for development, screening, waste covering, winds, landfill development traffic and works. Other potential sources of wind-blown dust exist in the near locality.

Because the site roads are constructed of hardcore they generate dust on drying and have to be treated to water spraying by vacuum tanker to comply with the Operational Plan and good work practice.

Due to fine weather last summer some dust elevations were found on site.

Odours
Since landfill activity has ceased odours have been completely eliminated.

Landfill Gas
Landfill gas has reached and surpassed its maximum production phase on site. The volume of gas being flared reduced considerably in 2010. Between October and December the field was balanced on over 30 occasions in order to maximize the gas yield. The Estimation of Cumulative and Annual Landfill Gas Emissions is contained in Appendix C.

The installation of the landfill gas flare coincided with the restoration of the landfill to final contour levels. The flare burns landfill gas continuously. Regular field balancing of the well connections to the manifolds yields methane of combustible quality with the elimination of oxygen to minimum quantities. Typically, the field produces about 250-350m^3 per hour, depending on atmospherics and prime operating conditions.

Leachate
The main environmental protection system against emissions from leachate is the HDPE liner. Failure of this system will cause continuing leachate production. The liner is safeguarded in the sense that it is largely located underground with the exception of the lagoons which are fenced off. It is intrinsically safe from damage and the possibility of leakage is removed.

Litter
Litter no longer presents a nuisance either on or offsite.

Vermin
A contract was in place with a pest control firm, PestGuard Ltd., who visit the site fortnightly. Bait is set at six-week intervals by site staff. Experience has shown that less or more frequent baiting is ineffective and not in accordance with bait manufacturers' recommendations. Effective baiting boxes with tipping floor technology are supplied by Ekomille Ltd. Two units are in use at the Civic Amenity. The device contains a unit counter which gives a service requirement indication.

Birds
Birds no longer present a nuisance on the site. The site has an abundance of pheasants and linnets.

7.3 Meteorological Report

Weather
The Vaisala 101 weather station was installed with the commencement of the Waste Licence on the capped landfill and connected to the pc in the landfill manager's office.

The datalogger on the weather station can store up to sixty days' weather information at a time. The read-out is a comprehensive recording of all relevant daily and hourly weather parameters.

Daily weather records for the landfill are enclosed in Appendix D.

Hourly weather records for the landfill are held on the office pc for reference.

Owing to poor station performance this year complete records were not returned. The site found a major difficulty in sourcing a competent national service agent to repair the recording fault. Records are supplemented but not in full detail from Met Éireann stations at Cork Airport and Roche's Point.

Monthly Rainfall Statistics

Month	Rainfall mm
January	152.4
February	50.4
March	100.6
April	48.2
May	17.1
June	48.8
July	160.2
August	18.3
September	86.3
October	102.6
November	74.1
December	108.4

Total rainfall	**967.7 mm**

This represents a considerable reduction of 506mm on 2009 which held record rainfall statistics since recoding began in earnest at the facility in 2001.

8 SCHEDULE OF ENVIRONMENTAL OBJECTIVES AND TARGETS

In accordance with Condition 2.2 of the facility's Waste Licence, specific objectives and targets have been identified, along with a programme for their implementation.

The schedule of objectives and targets for 2010 are outlined in Table 1:

Table 1: Schedule of Objectives & Targets

Objective No.	Objective	Target
1	To monitor and control landfill gas emissions at the facility	Continue efficient control of landfill gas at the facility
2	To promote sustainable energy options and increase the energy efficiency of the facility	Identity at least one feasible sustainable option by December 2010
3	To improve the efficiency of operation and monitoring of the leachate and stormwater management system	Ensure compliance with Condition 4.18 of the waste licence with reference to leachate management
4	To identify possibilities for the after-use of the landfill area following restoration	Identify an after-use plan for the landfill by the end of 2010
5	To maximise the efficiency and continuously improve operations at the civic amenity facility.	To increase the efficiency of the civic amenity and reduce security breaches.
6	Review closure modifications of the Waste Licence following the closure of the landfill facility	Reduce the monitoring requirements and schedules following closure of the landfill
7	Review staffing levels across the organisation to enable a continual service to the public	Ensure minimum staff levels on site to prevent facility closure

Environmental Management Programme

An Environmental Management Programme (EMP) is a programme for achieving the Schedule of Objectives and Targets. This programme defines the principal tasks to be undertaken to achieve the objectives and targets. It identifies those responsible for the carrying out the tasks and the scheduled timeframe for the tasks to be completed.

East Cork Landfill's Environmental Management Programme (EMP) is available in Table 2 below:

Table 2: Environmental Management Programme

Objective No.	Objective	Target	Tasks	Person Responsible	Estimated Completion Date
1	To monitor and control landfill gas emissions at the facility	Continue the efficient control of landfill gas at the facility	Ensure the correct abstraction of landfill gas and operation of the landfill gas flare at the facility.	Jerome O'Brien	January 2010-onwards
			Balance the landfill gas collection system monthly and maintain records	Lisa Collins	Ongoing
			Ensure the correct operation of the remote monitoring and alarm system to control the operation of the flare especially at night-time, at weekends and Bank Holidays.	Jerome O'Brien	January 2009
			Following completion of the capping of the landfill facility conduct a survey to ensure no landfill gas leakage is detected.	Jerome O'Brien	March 2010
			Request expressions of interest from interested parties to establishing a contract to design, build, operate and finance the complete gas collection, utilisation and flaring system at the landfill.	Jerome O'Brien	March 2010
			Explore the market options for utilising the grass growing at the landfill to generate biogas for use as an energy source	Jerome O'Brien	September 2010
2	To promote sustainable energy options and increase the energy efficiency of the facility	Identity at least one feasible sustainable energy option by December 2010	Maintenance and calibration of the stormwater pond control equipment to ensure correct operation of the equipment	Jerome O'Brien	Bi-annual Ongoing
			Carry out a study on the upper and lower limits used to control the actuated valve on the stormwater pond, to ensure correct	Jerome O'Brien	July 2010

Objective No.	Objective	Target	Tasks	Person Responsible	Estimated Completion Date
			operation.		
3	To improve the efficiency of operation and monitoring of the leachate and stormwater management system	Ensure compliance with Condition 4.18 of the waste licence with reference to leachate management	Set up a training manual to contain maintenance, sampling and monitoring procedures for the stormwater pond and ensure all personnel are trained on its operation.	Lisa Collins	April 2010 Training Ongoing
			Test and commission the SCADA control of the leachate recirculation installed. Ensure leachate levels are in compliance with the facilities waste licence	Jerome O'Brien	Ongoing
			Carry out a feasibility study into the possibilities for after use of the landfill area following restoration	Jerome O'Brien	December 2010
			Investigate the possibility of revising the traffic flow layout of the civic amenity facility	Jerome O'Brien	November 2010
			Continue to monitor and control the site security of the facility through the CCTV system.	Jerome O'Brien	Ongoing
4	To identify possibilities for the afteruse of the landfill area following restoration	Identify an after-use plan for the landfill by the end of 2009	Introduce handheld devices to log and record customers using the Civic Amenity Facility and types and tonnages of quantities to be disposed/recycled.	Jerome O'Brien	March 2010

Objective No.	Objective	Target	Tasks	Person Responsible	Estimated Completion Date
5	To maximise the efficiency and continuously improve operations at the civic amenity facility.	To increase the efficiency of the civic amenity	Install traffic control barriers at the entrance and exit of the facility.	Jerome O'Brien	Ongoing
6	Review closure modifications of the Waste Licence following the closure of the landfill facility	Reduce the monitoring requirements following closure of the landfill	Conduct discussions with Agency in relation to monitoring relevance, frequencies etc	Jerome O'Brien	Ongoing
7	Review staffing levels across the organisation to enable a continual service to the public	Ensure minimum staff levels on site to prevent facility closure		Jerome O'Brien	Ongoing

It is a reality that the realisation of each and every one of the above objectives is conditional on the current economic climate and on Cork County Council's ability to provide a budget for payment of the supply of services, materials, maintenance and consultation in view of a 30% reduction in operating revenue for 2010. In light of the County Manager's directive to staff of 28th January 2009 regarding the provision of service, strict guidelines have been laid out to supervisory staff in regard to economics, budgets and expenditure.

Cork County Council will attempt to uphold its statutory and regulatory responsibility in as far as it relates to any historic and conventional areas of compliance but cannot give assurance on the resolution of any unforeseen or any circumstances requiring unbudgeted expenditure.

9 RESOURCE CONSUMPTION

9.1 Energy and Resource Consumption

During the reporting period the following were the recorded energy and resources consumption for the landfill. The totals include those of the plant hire firm as well as Cork County Council usage for plant, offices, weighbridge, leachate pumps, compressor and landfill gas flare.

The reliance on fossil fuels continued the downward trend in 2010 over 2009 by 4,300 litres of gas oil for plant machinery due to the completion of the last capping contract. There was an increase in usage of 30,833 kWh of electricity possibly attributable to the continuous operation of the compressor supplying compressed air to the pneumatic pumps.

Company	Diesel	Electricity
Ted Motherway AgriPlant Ltd	**5,000 litres**	**0 kWh**
Cork County Council	**2,400 litres**	
Cork County Council		**Day 82,858 kWh**
Cork County Council		**Night 51,117 kWh**
Totals	**7,400 litres**	**133,975 kWh**

2010

Table 9.1

10 SUMMARY OF PROCEDURES DEVELOPED

The summary of procedures developed during this period of the Waste Licence, is illustrated as follows:

Operational Health & Safety Plan

Environmental Liabilities Risk Assessment

Landfill Gas Collection System Balancing Interim Report

10.1 Operational Health & Safety Plan

The Operational Health and Safety Plan has been revised to take account of recent changes in legislation, primarily the Safety Health and Welfare at Work Act, Construction Regulations 2006.

10.2 Environmental Liabilities Risk Assessment

The Environmental Liabilities Risk Assessment first submitted by this facility in October 2004 has been re-assessed for submission to the Agency by the third anniversary of the closure of the landfill, 26th February 2010.

This will signal the emergence of the landfill into the aftercare phase on completion of all elements of the landfill restoration as designed and constructed.

11 REPORTS ON FINANCIAL PROVISION

11.1 Financial Provision under the Licence

Cork County Council has made the necessary provision to ensure that there is adequate funding for the management of East Cork Landfill and Civic Amenity Site.

11.2 Management Structure

Details of Operator

Operator Name:	Cork County Council
Operator Address:	County Hall, Carrigrohane Rd., Cork. (021) 4276891
Site Name:	East Cork Landfill & Civic Amenity Site,
Site Address:	Rossmore, Carrigtohill, Co.Cork. (021) 4533934

Management Structure

Cork County Council has overall responsibility for the management and operation of East Cork Landfill and Civic Amenity Site. The Senior Engineer, Environment, South Division is responsible for the management of municipal waste and waste facilities in the Southern Division. The site manager with responsibility for day to day site operations is a Senior Executive Engineer, who is supported by an Environmental Technician in her roles as deputy manager.

Cork County Council continues to contract Fehily Timoney & Company to provide technical and site engineering support and RPS Group Ltd for scheduled environmental monitoring in accordance with the Waste Licence.

Fehily Timoney & Company have been authorised to assist Cork County Council with the following site related activities,
Provision of site engineering assistance and support
Leachate assessment and management
Landfill gas assessment and management
Environmental Liabilities Risk Assessment for the entire landfill
Site management procedures, to incorporate the development of an environmental management system (EMS) and preparation of an annual environmental report (AER); engineering design and document preparation.

RPS Group Ltd are authorised by Cork County Council to assist in environmental monitoring of surface water, groundwater and leachate and interpretation of results.

11.3 PUBLIC CONSULTATION

The programme for public consultation has been outlined on pages 40-42 in the six-month report, dated January 2001. The Public File is located in the Waste Management Section on Floor 4, County Hall, Cork. The Site File is maintained at Rossmore in the event of a request for consultation.

11.4 MANAGEMENT & STAFFING STRUCTURE

	Contact Telephone No.
Senior Engineer: Mr Liam Singleton	(021) 4276891
Landfill & CA Site Manager & *Senior Executive Engineer:* Mr Jerome O'Brien	(021) 4533934
Deputy Landfill Manager & *Executive Engineer:* Mr John Paul O'Neill	(024) 93834
Deputy Landfill Manager & CA Site & *Environmental Technician:* Ms Lisa Collins	(021) 4533934
Deputy CA Site Manager & *Weighbridge Operator* Mr Brian Duggan	(021) 4883936

Rossmore CA Site

Recycling Record
Data Sheet - 2010

Waste Licence W0022-2

	January	February	March	April	May	June	July	August	September	October	November	December	**Cumulative**	
Aerosol Containers	0	0	0	0	0	0	0	0	0	0	0	0	0	Aerosol Containers
Beverage Cans	0.16	0	0	0	0.37	0.2	0.26	0.26	0.2	0.12	0.08	0.14	1.79	Beverage Cans
Cardboard	11.18	7	3.46	9.97	2.9	3.1	5.3	5.66	6.32	0	10.54	4.25	69.68	Cardboard
DIY Waste	0	0	0	0	0	0	13.1	18.36	9.5	9.15	11.7	8.6	70.41	DIY Waste
Farm Plastics	0	0	0	0	0	34.16	0	0	0	0	0	0	34.16	Farm Plastics
Fluorescent Tubes	0	0.08	0	0	0	0	0	0	0	0	0.76	0	0.84	Fluorescent Tubes
Food Tins	0	0	0	0	0	0	0	0	0	0	0	0	0	Food Tins
Glass Bottles	5	0.54	1.54	6.3	2.84	4.17	1.6	4.6	1.97	5.54	0	2.72	36.82	Glass Bottles
Green Waste	0	0	3.6	3.6	0	0	0	5.66	11.86	3.44	7.14	5.6	40.9	Green Waste
Household Batteries	0	0.38	0	0	0.22	0	0	0	0	0	0	0.76	1.36	Household Batteries
Lead Acid Batteries	0	0.6	0.56	1.18	1.14	0	0	0	0.76	0	0	0.64	4.88	Lead Acid Batteries
Light Plastic Pckg.	0	0	0	0	0	0	0	0	0	0	0	0	0	Light Plastic Pckg.
Magazines & Papers	9.55	7.32	6.01	12.36	10.66	7.18	10.02	7.98	6.24	5.58	8.65	10.88	102.43	Magazines & Papers
Paint	1.04	0.62	0.89	1.71	0.94	0.98	1.64	2.36	0.86	1.14	0.92	0	13.1	Paint
Plastic Bottles	1.58	1.36	1.65	2.83	1.47	1.48	1.8	1.58	1.28	1.4	1.63	1.4	19.46	Plastic Bottles
Plate Glass	0	0	0	0	5.8	0	0	0	0	0	0	0	5.8	Plate Glass
Plaster Board	0	0	0	0	0	0	0	0	0	0	0	0	0	Plaster Board
Polystyrene	0	0	0	0	0	0	0	0	0	0	0	0	0	Polystyrene
Scrap Metal	5.68	9.46	9.57	19.01	16.18	0	16.64	15.62	16.05	11.79	9.88	4.54	134.42	Scrap Metal
Textiles	0.26	0.54	0.41	0.87	0.56	0.43	1.02	0.56	0.39	0.58	0.62	0.34	6.58	Textiles
Timber	17.2	21.78	20.22	38.54	32.22	14.28	29.46	27.48	22.58	33.62	23.28	4.57	285.23	Timber
Waste Cooking Oil	0	0	0	0	0	0	0	0	0	0	0	0	0	Waste Cooking Oil
Waste Engine Oil	0	0.78	0	0.87	0	0.58	0.76	0.62	0	1.22	0.48	0	5.31	Waste Engine Oil
WEEE	30.42	26.96	14.57	39.5	27.27	12.88	33.08	26.16	29.86	25.36	27.75	13.04	306.85	WEEE
Totals	82.07	77.42	62.48	136.74	102.57	79.44	114.68	116.9	107.87	98.94	103.43	57.48		
Cumulative Totals	**82.07**	**159.49**	**221.97**	**358.71**	**461.28**	**540.72**	**655.4**	**772.3**	**880.17**	**979.11**	**1082.54**	**1140.02**		**Recyclables**
Bulky Waste Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**32.1**	**107.91**	**75.33**	**65.38**	**32.49**	**313.21**	
Domestic Waste Total	**138.54**	**154.18**	**146.76**	**281.05**	**177.15**	**141.33**	**178.73**	**92.28**	**37.96**	**15.32**	**41.74**	**51**	**1456.04**	
Domestic Waste Monthly Total	138.54	154.18	146.76	281.05	177.15	141.33	178.73	124.38	145.87	90.65	107.12	83.49		
Cumulative Dom. Totals	**138.54**	**292.72**	**439.48**	**720.53**	**897.68**	**1039.01**	**1217.74**	**1342.12**	**1487.99**	**1578.64**	**1685.76**	**1769.25**	**1769.25**	**Dom. Waste**
Total Materials - Mth.	220.61	231.6	209.24	417.79	279.72	220.77	293.41	241.28	253.74	189.59	210.55	140.97		
Cumulative Total Materials	**220.61**	**452.21**	**661.45**	**1079.24**	**1358.96**	**1579.73**	**1873.14**	**2114.42**	**2368.16**	**2557.75**	**2768.3**	**2909.27**		
Total No. of User This Month	**2057**	**2271**	**2413**	**2652**	**2424**	**2491**	**2564**	**2391**	**2115**	**2137**	**1815**	**1501**		
Cumulative Users Year to Date	**2057**	**4328**	**6741**	**9393**	**11817**	**14308**	**16872**	**19263**	**21378**	**23515**	**25330**	**26831**		
Recycling Rate - Mth	**37.20%**	**33.43%**	**29.86%**	**32.73%**	**36.67%**	**35.98%**	**39.09%**	**48.45%**	**42.51%**	**52.19%**	**49.12%**	**40.77%**		
Recycling Rate - Year	**37.20%**	**35.27%**	**33.56%**	**33.24%**	**33.94%**	**34.23%**	**34.99%**	**36.53%**	**37.17%**	**38.28%**	**39.10%**	**39.19%**		

SLOPE STABILITY REPORT

EAST CORK LANDFILL, ROSSMORE, CARRIGTOHILL

WASTE LICENCE REGISTER W0022-01

MARCH 2011

FEHILY TIMONEY & COMPANY

SLOPE STABILITY REPORT

EAST CORK LANDFILL, ROSSMORE, CARRIGTOHILL

WASTE LICENCE REGISTER W0022-01

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	PF/MT	PhC	PK	15-03-11

Client: Cork County Council.

Keywords: Landfill, Capping, Slope Stability, W0022-01.

Abstract: Cork County Council requested FTC to carry out a slope stability analysis of the Rossmore Landfill site side slopes to comply with Condition 9.20 of the Waste Licence.

TABLE OF CONTENTS

PAGE

APPENDICES

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

1. INTRODUCTION

1.1. Purpose

This report presents the results of a slope stability assessment carried out for East Cork Landfill at Rossmore, Carrigtwohill, Co. Cork. This is in accordance with Condition 9.20 of the EPA waste licence issued to the site (reference: W0022-01). Section 9 of the licence relates to Environmental Monitoring.

1.2. Site Description

The landfill site is located at Rossmore, Carrigtohill, Co. Cork, adjacent to Rossmore Bay. The site is a former limestone quarry surrounded by agricultural land and intertidal mud flats.

The southern part of the landfill site consists of lined cells numbered 01-10. The eastern side of the landfill (Cells 1-4) is capped and covered by vegetation. Cells 5-10, located to the west of the site, are lined and recently capped. Waste slopes have been raised in a domed profile above the perimeter access road level (approximately 8 to 9 m AOD), to a maximum height of around 22 m AOD.

1.3. Slope Stability Analysis Method

SLOPE/W software of GEO-SLOPE International Ltd. was used to assess the stability of Rossmore Landfill 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 landfill waste have been estimated based on parameters used by Kolsch (1995) and Thomas *et al (1999)*.

Leachate in landfills may occur in irregular perched bodies as opposed to interconnected liquid bodies. For the purposes of this analysis a waste body leachate level only has been considered in analyses.

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
- Leachate levels within the waste
- Groundwater levels in the supporting soil
- Surcharge.

2. Design Criteria

2.1. Slope Geometry

Using the most recently available topographical survey by Focus Surveys Ltd. presented on Drawing No. 00-023_1 Rev ZM, dated January 2011, typical cross-sections through the waste slopes of the site were taken at the locations shown on Drawings 2005-004-02-008 and 009. The two slopes analysed namely, A – A and C – C were identified as representative of the recently capped slopes located at the western side of the landfill. Slope B - B was analysed as being representative of the already capped slope along the eastern side of the landfill site.

Slope A - A is approximately 11 m high, 40 m long and has a maximum slope of 1:3.0 (vertical : horizontal).

Slope B - B is approximately 11 m high, 30 m long, with a maximum slope of 1:2.0.

Slope C - C is approximately 9 m high, 45 m long, with a maximum slope of 1:3.6.

Sections through the slopes A – A, B – B and C – C are presented in Figures 3.1 to 3.3.

2.2. Geology

The site is underlain by carboniferous deposits of Waulsortian Limestone and Cork Red Marble. The Waulsortian Limestone comprises calcareous mudstone, wackestones and packstones, many of which contain original cavities filled with internal sediments and cements.

The subsoils in the area have been described as Quaternary sandy clays and minor sand and gravel deposits. They range in thickness from 1 m to 3 m in the central part of the peninsula on which the site is located and up to 24 m towards the east of the site. It is understood that the subsoils have been removed from the central part of the site during quarry excavation.

2.3. Waste Parameters

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

Table 2.1: Characteristic Shear Strength Parameters for Landfill 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 if this analysis, the more conservative figures for fresh waste have been used due to the relatively young age of the waste within these recently active cells.

Design values for use in the slope stability analysis have been derived using IS EN-1997-1 Design Approach 3. This design approach is considered to be the most logical approach for slope stability analysis as it includes partial factors for both material properties and variable loads (for example traffic loads). Table 2.2 shows the partial factors have been applied to the characteristic values to give the derived parameters used during the SlopeW analysis as presented in Table 2.3.

Table 2.2: Partial Factors Used to Derive Design Parameters

Set	Partial Factor		Parameter
M2	$\gamma_{c'}$	1.25	Effective cohesion
	$\gamma_{\phi'}$	1.25	Effective angle of friction
	γ_{γ}	1	Soil density
A2	γ_{Q}	1.3	Traffic Loading (variable unfavourable)
R3	$\gamma_{R;e}$	1	Earth resistance

Table 2.3: Design Parameters for Waste materials

Material	Fresh Waste
Cohesion (c')	8 kN/m^2
Effective friction angle (ϕ')	12°
Unit weight γ	9.5 kN/m^3

2.4. Properties of the Supporting Soil and Capping Layer

Table 2.4 below shows the characteristic geotechnical parameters used for the capping and clay liner which have been interpreted from available site data.

Table 2.4: Characteristic Parameters for Typical Supporting Materials

Material	Clay Capping	Clay Liner
Cohesion, c', kN/m^2	4	5
Effective Friction angle, ϕ', °	27	25
Bulk unit weight, γ, kN/m^3	18	16

Table 2.5 shows the design parameters which have been derived using the partial factors given in Table 2.2.

Table 2.5: Design Parameters for Typical Supporting Materials

Material	Clay Capping	Clay Liner
Cohesion, c', kN/m^2	3.2	4
Effective Friction angle, ϕ', °	21.6	20
Bulk unit weight, γ, kN/m^3	18	16

2.5. Leachate Levels within the Waste Material

In practice, the leachate level in the lined cells is maintained at 1 m above the clay liner through pumping from a series of cell pumps. To assess the effects of elevated leachate levels within the waste, analyses was carried out for models simulating the leachate level maintained at 1 m below the toe of the slope as elevation of the clay liner may vary from one section to another.

The leachate levels modelled are shown in Table 2.6:

Table 2.6: Leachate Levels Modelled in Slope Stability Calculation

Slope	Modelled Leachate Level (mAOD)
A – A	8.00
B - B	4.00
C – C	8.50

2.6. Surcharge

A surcharge of 20 kN/m^2 was applied to the slopes during the analyses to simulate vehicular movement. After applying a partial factor of 1.3 as per IS EN 1997-1 Design Approach 3 (variable, unfavourable action), a design load of 26 kN/m^2 has been applied to the models.

3. Results

3.1. Slope Stability Analyses

Models were run for three representative sections to assess the slope stability of the landfill waste embankments. The results of those analyses are summarised in Table 3.1 with factors of safety calculated for Bishop, Janbu and Morgenstern-Price methods. Table 3.1 also gives the slip location of each slope, the material parameters applied, the leachate level simulated, and the length of the relevant slip.

A typical analysis carried out for each of the slopes is presented in Figures 3.1 through 3.3.

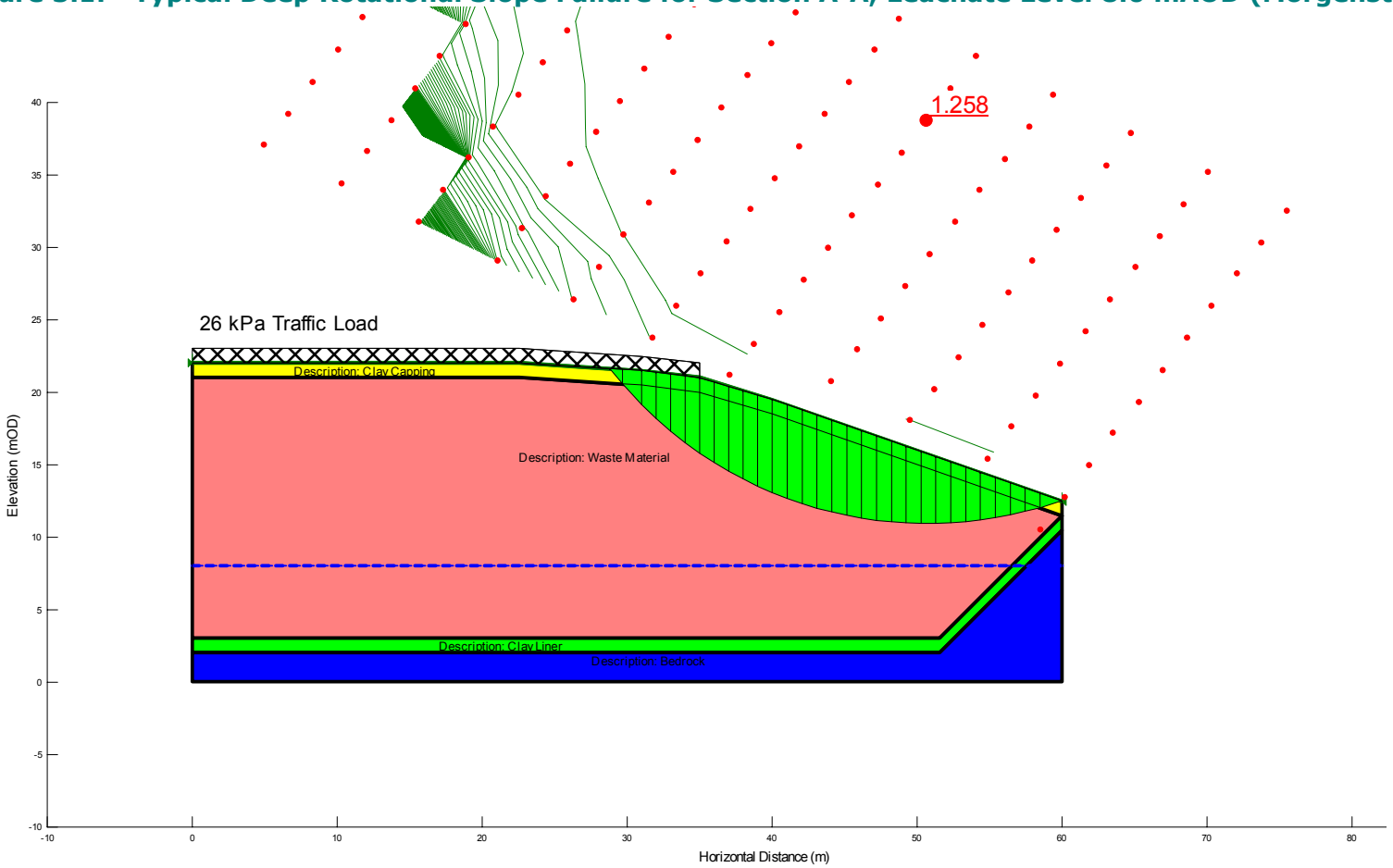
3.2. Factors of Safety

Factors of safety for potential slope failures ranged from 1.14 to 1.58. By adopting the methods of analysis given in IS EN 1997-1, the factor of safety against failure is included in the partial factors applied to the analysis rather than to the end result. Hence, a factor of safety of below 1.0 indicates that the slope has an insufficient factor of safety against failure. A factor of safety of greater than 1.0 indicates that the slope is considered stable.

Table 3.1: Slope Analysis Results

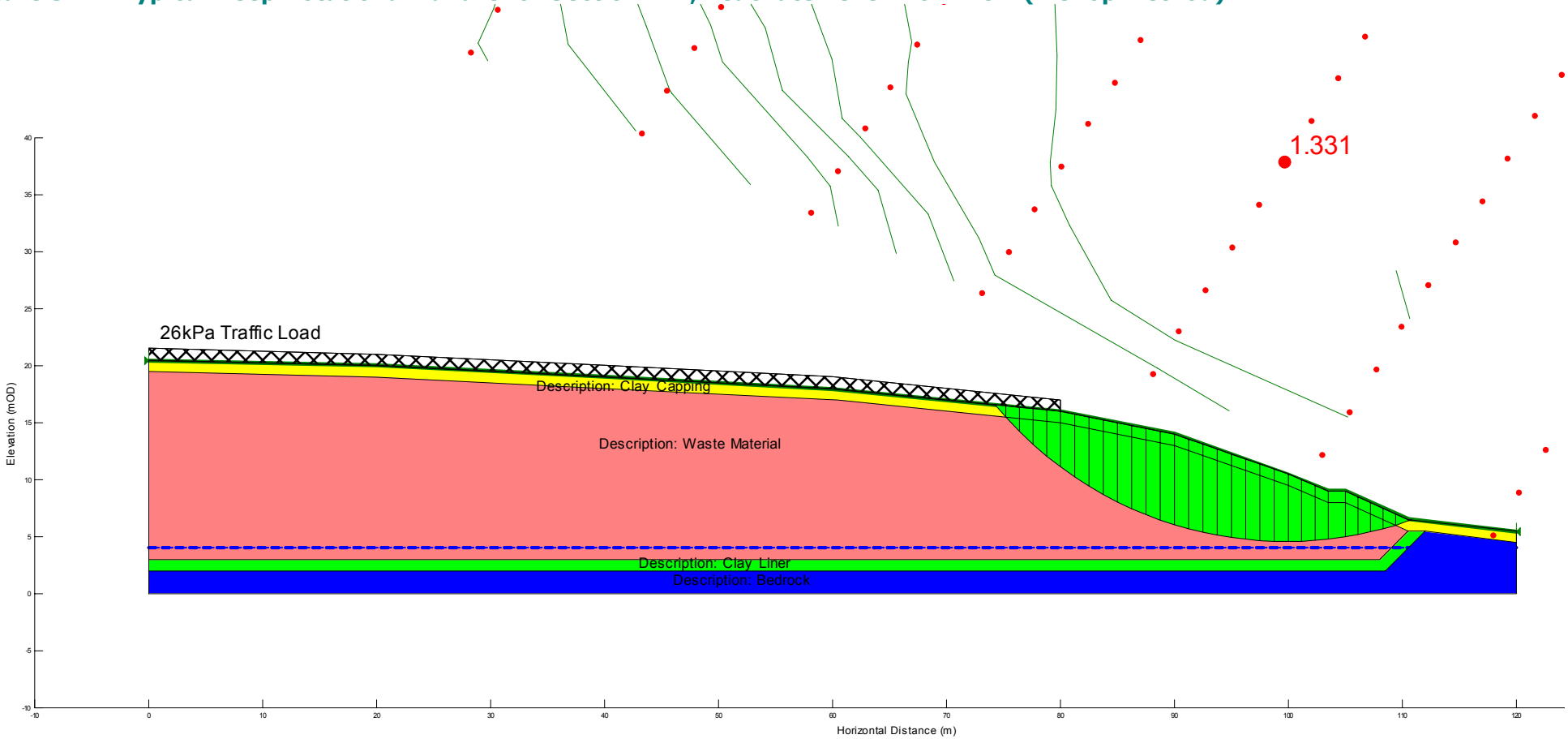
Slope name	Design Waste parameters (C, γ & φ)	Leachate Level (mAOD)	Bishop FoS	Janbu FoS	Morgenstern-Price FoS	Slip Length (m)	Slip location
A-A	8, 9.5, 12	8	1.26	1.14	1.26	32	Deep rotational slip through capping and waste materials
B-B	8, 9.5, 12	4	1.33	1.22	1.33	38	Deep rotational slip through capping and waste materials
C-C	8, 9.5, 12	8.5	1.58	1.43	1.58	61	Deep rotational slip through capping and waste materials

Figure 3.1: Typical Deep Rotational Slope Failure for Section A-A, Leachate Level 8.0 mAOD (Morgenstern Price Method)



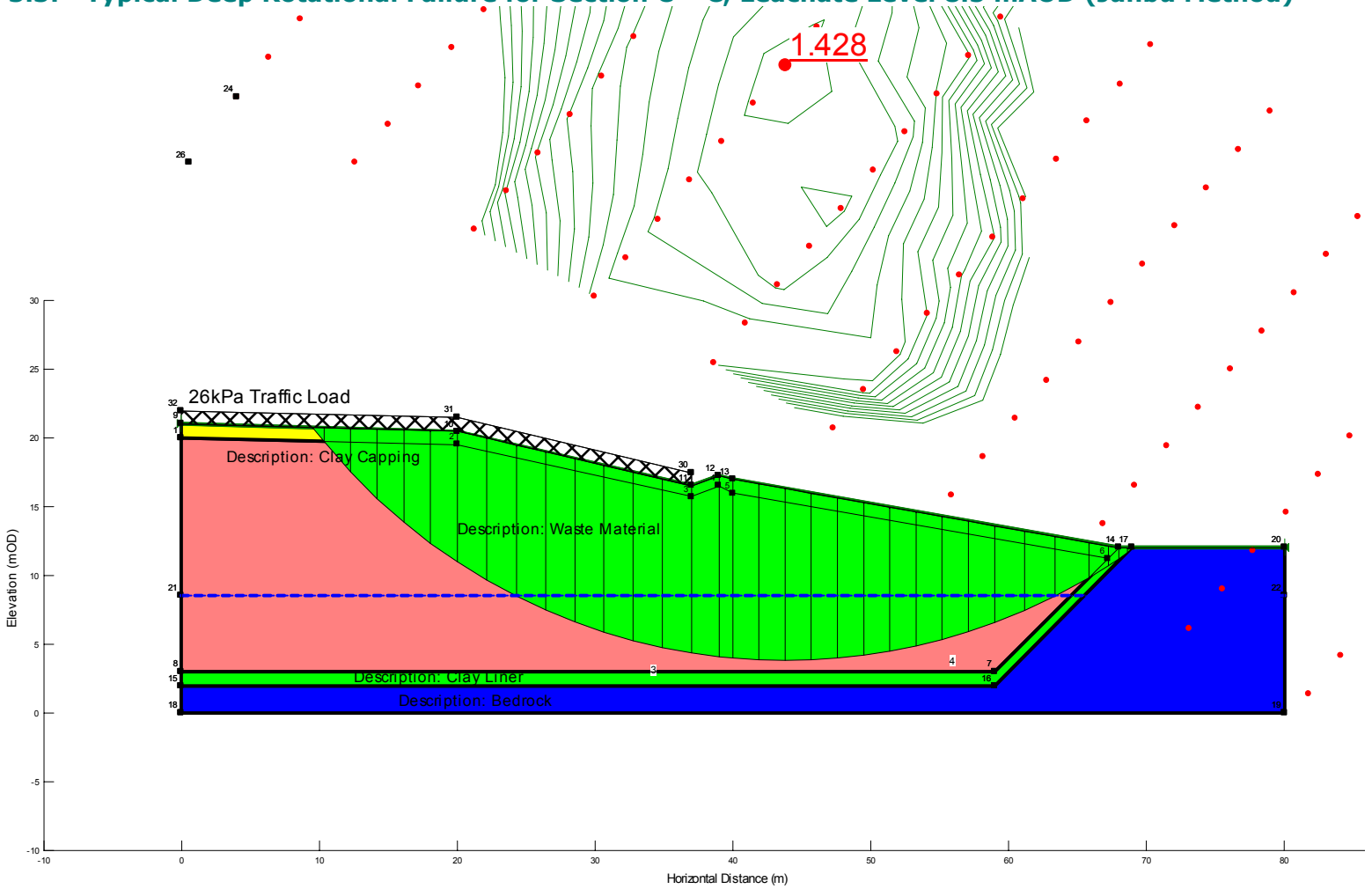
Material #: 1 Description: Waste Material Model: MohrCoulomb Wt: 9.5 Cohesion: 8 Phi: 12 Piezometric Line: 1
Material #: 2 Description: Clay Liner Model: MohrCoulomb Wt: 16 Cohesion: 4 Phi: 20 Piezometric Line: 1
Material #: 3 Description: Clay Capping Model: MohrCoulomb Wt: 18 Cohesion: 3.2 Phi: 21.6 Piezometric Line: 1
Material #: 4 Description: Bedrock Model: Bedrock Piezometric Line: 1

Figure 3.2: Typical Deep Rotational Failure for Section B-B, Leachate Level 4.0 mAOD (Bishop Method)



Material #: 1 Description: Waste Material Model: MohrCoulomb Wt: 9.5 Cohesion: 8 Phi: 12 Piezometric Line: 1
Material #: 2 Description: Clay Liner Model: MohrCoulomb Wt: 16 Cohesion: 4 Phi: 20 Piezometric Line: 1
Material #: 3 Description: Clay Capping Model: MohrCoulomb Wt: 18 Cohesion: 3.2 Phi: 21.6 Piezometric Line: 1
Material #: 4 Description: Bedrock Model: Bedrock Piezometric Line: 1

Figure 3.3: Typical Deep Rotational Failure for Section C – C, Leachate Level 8.5 mAOD (Janbu Method)



Material #: 1 Description: Waste Material Model: MohrCoulomb Wt: 9.5 Cohesion: 8 Phi: 12 Piezometric Line: 1
Material #: 2 Description: Clay Liner Model: MohrCoulomb Wt: 16 Cohesion: 4 Phi: 20 Piezometric Line: 1
Material #: 3 Description: Clay Capping Model: MohrCoulomb Wt: 18 Cohesion: 3.2 Phi: 21.6 Piezometric Line: 1
Material #: 4 Description: Bedrock Model: Bedrock Piezometric Line: 1

4. Discussions and Conclusions

Factors of safety for potential slope failures on the capped slopes ranged from 1.14 to 1.58. All slopes analysed gave factors of safety above the minimum required factor-of-safety of 1.0 in accordance with IS EN 1997-1.

Factors of safety for deep seated and shallow failure through the waste material and supporting strata were investigated and based on the analyses presented, the landfill side slopes are considered stable. It is noted that the waste parameters used in the analysis for are considered to be conservative based on the information available. In particular, the figures used for the waste are for fresh waste (up to 7 years old) and hence the stability of the slope should improve over time.

In order to maintain a long-term factor of safety 1.0 or greater, leachate and groundwater levels must be regularly monitored and pumped down to prevent a build up of levels within the waste body and cause potential instability of the landfill slopes. The stability of the interim slopes on the site should be revisited prior to final capping to ensure that a minimum long term factor of safety of 1.0 can be achieved. It is recommended that for health and safety reasons, temporary active faces are graded back to a minimum slope of 1 in 2.5 to ensure that a minimum interim factor of safety against slope failure of 1.0 is achieved.

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. S Thomas, A Aboura, J P Gourc, P Gotteland, H Billard, T Delineau, T Gisbert, J F Ouvry and M Vuillemin, (1999), An in-situ waste mechanical experimentation on a French Landfill Vol 3, Sardinia Landfill Symposium, pp 445-452.

3. Slope Stability Report (FTC, November 2007). East Cork Landfill, Rossmore, Carrigtohill, County Cork.

4. Survey Drawing No. 00-023_1 Rev ZM provided by Focus Surveys Ltd, Rossmore Landfill Site, updated 07 January 2011.

Appendix A

Drawing 2005-004-02-008 Rev B

Existing Topographic Survey showing Section lines for Slope Stability Analysis

Water Balance Calculation for East Cork Landfill

Month	Rainfall	Potential Evapotran-spiration (P.E.)	Effective Rainfall	Waste Input	Active Cells	Temporarily Capped Cells	Permanently Restored Cells	Active Area	Temporarily Capped Cells	Permanently Restored Cells	Infiltration		
											Active	Temp Capped Cells	Permanently Restored Cells
	(mm)	(mm)	(mm)	(tonnes)				(m^2)	(m^2)	(m^2)	(m^3)	(m^3)	(m^3)
Jan-09	152.40	17.5	134.9	0	-			0	0	66,735	0	0	90
Feb-09	50.40	50.4	0.0	0	-			0	0	66,735	0	0	0
Mar-09	100.60	39.6	61.0	0	-			0	0	66,735	0	0	41
Apr-09	48.20	50.5	0.0	0	-			0	0	66,735	0	0	0
May-09	17.10	70.7	0.0	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	0
Jun-09	48.80	80.3	0.0	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	0
Jul-09	160.20	76.2	84.0	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	56
Aug-09	18.30	80.3	0.0	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	0
Sep-09	86.30	44.4	41.9	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	28
Oct-09	102.60	24.7	77.9	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	52
Nov-09	74.10	9.0	65.1	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	43
Dec-09	108.40	15.2	93.2	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	62
Total	**967**	**559**	**558**	**0**							**0**	**0**	**372**

Infiltration rates (%)	
Active Area	0%
Temp. Covered Area	0%
Permanently Capped Area	100%

† Absorptive Capacity (m^3/tonne) 0.07

Area of leachate lagoons = 1,135 m^2

Month	Liquid Waste	Lagoon Contribution	Absorptive Capacity† of the waste	Leachate			Total Predicted Leachate	Cumulative Predicted Leachate	Leachate Tankered Off-Site		Deficit
				Active Cells	Temporarily Capped Cells	Permanently Restored Cells					
	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(t)	(m^3)	(m^3)
Jan-10	0	153	0	0	0	90	243	243	1,522	1,478	-1,235
Feb-10	0	0	0	0	0	0	0	243	1,483	1,439	-1,439
Mar-10	0	69	0	0	0	41	110	353	679	659	-549
Apr-10	0	0	0	0	0	0	0	353	1,268	1,231	-1,231
May-10	0	0	0	0	0	0	0	353	154	149	-149
Jun-10	0	0	0	0	0	0	0	353	381	370	-370
Jul-10	0	95	0	0	0	56	151	504	158	153	-2
Aug-10	0	0	0	0	0	0	0	504	841	816	-816
Sep-10	0	48	0	0	0	28	76	580	442	429	-353
Oct-10	0	88	0	0	0	52	140	720	0	0	140
Nov-10	0	74	0	0	0	43	117	838	457	444	-326
Dec-10	0	106	0	0	0	62	168	1,006	681	661	-493
Total	**0**	**633**	**0**	**0**	**0**	**372**	**1,006**		**8,064**	**7,829**	**-6,824**

All printouts from s/s or word or other packages to define file name, path and date at a minimum

The purpose of this format is to facilitate compilation of design reports as may be required in the future for submission to RE 's or Clients as may be required

All calculations be they manual or electronic are to follow this format

All manual calculations are to be scanned electronically in PDF format

A Calculation does not have to be a mathematical model. It is a format to describe a work action be it a topographic survey, a methodology for carrying out a bird survey, or a crack width calculation

Calculation numbers that are fixed for all jobs are: structures as follows

Where possible when developing calculations range names are to be used

Where possible colour text blue where inputs are required

Where repetitive calculations are used e.g. Crack width they shall be properly written up, signed of and made available to all FTC staff in the Knowledge base

Calc Set 00	Calculation Register	List of calc sets defining latest revision and links to packages / reports to facilitate updates if required in the future from revisions
Calc Set 01	Design Report	This report will summarise all calculations and works carried out and provide a brief description of the job in relation to calculations produced Upon completion of the job the report will printout the task manager. A task manager export to Excel is available on the Task Manual menu The task manager will summarise inputs in relation to key issues, telephone record, reviews etc An additional title has been inputted to Task manager that of H&S. This is where the H&S file needs to be stored and later inputted to Calc Set 03 H & S
Calc Set 02	Drawings	To minimise drawing corrections and to standardise on notes, notes are to be provided by engineers in s/s format The drawing Calc set will be stored in Q:\Year\Job No\XREFS*.*
Calc Set 03	H & S	The purpose of this calculation is to comply with H & S legislation and to track H&S decisions The Calc Set is designed to lead engineers through the decision making with a minimum of inputs
Calc Set 04	As required	Standard Calcs If drawing table inputs are required they should be developed in the Calc Set copies to the drawing Calc Set in Sheet no referring to drawing no

CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES
Cork : Tel 021-4964133 Fax 021-4964464

DESIGNED: TM **CHECKED:** AR
DATE: 14/01/08 **REVISION:** 1
JOB NUMBER: **2005-004-02**
CALC NUMBER:
FILE C:\OLDCDrive\Documents and Settings\Rossmore\My Doc
SHEET Calc cover

PROJECT: **Regulatory Compliance - Rossmore Landfill**
DESCRIPTION: **Gas Production Calculation for Rossmore Landfill**

431604.5272

Rev	Date	Purpose and Description	Prepared	Checked	Reviewed	Approved
0	04-Oct-07	The purpose of this calculation is to carry out a gas production model for East Cork (Rossmore) Landfill, using Landgem v3.02 from the US EPA, in accordance with the requirements of the waste licence, WL002201. Results of the gas production model will be submitted with the 2007 AER for the site. Site specific parameters were used in the model	TM	AR		
1	14-Jan-08	October to December values entered	TM	AR	JM	JM

Fehily Timoney Co.
Core House
Pouladuff Rd.
Cork

CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES

Cork : Tel 021-4964133 Fax 021-4964464

DESIGNED:	**TM**	**CHECKED:**	**AR**
DATE:	**14/01/08**	**REVISION:**	
JOB NUMBER:		**2005-004-02**	
CALC NUMBER:		**0**	
FILE	C:\OLDCDrive\Documents and Settings\Rossmore\My Documents\Annual Environmental Report 2010\APPENDIX		
SHEET	Check Sheet		

PROJECT: **Regulatory Compliance - Rossmore Landfill**

DESCRIPTION: **Check Sheet**

Description of Calculations **Page 1 of 10**

1.0 GENERAL – Review	See note 1
The design has been reviewed to see if it meets the requirements of the inputs	
A constructability review has been carried out	
Functionality issues have been addressed	
Health and Safety issues have been reviewed	
Planning, Waste License and fire safety issues have been addressed	
2.0 DRAWINGS, REPORTS	
All drawings & reports have been signed, checked and approved	
Drawings & reports have been cross-checked against design information / calculations	
3.0 ELECTRONIC CALCULATIONS ONLY	
The software used is on the list of approved software	
The printout is identified with the software title and version	
Is the input information selected suitable	
Has required output information been suitably assessed	
The output data files are held in the appropriate storage area HARD COPY	
4.0 CALCULATIONS	
Assumptions are realistic	
Calculations comply with the inputs, appropriate codes and standards	
Standards, codes and other regulatory documents are appropriately referenced in the calculations	
Sources of information are referenced and attached where appropriate	
The range of pages in question are identified and marked with the date	
Calculations comply with the project brief/inputs	
The lead page is signed and dated by the designer.	
All tasks associated with this calculation signed off (see Task Manager)	
Calculation review by peer	
All electronic calcs have path, file name on each hard copy sheet	
5.0 OPPORTUNITIES FOR IMPROVEMENT	
The checker must sign here to confirm that any learning points or useful feedback have been entered in the task management database as a “KNOWLEDGE” item.	
The checker must sign here to confirm that, If applicable, the above information has been emailed to the Senior CAD Technician or other relevant personnel to ensure that standard design	

Checked By Date

Note : define whether calc is for

Fehily Timoney Co.
Core House
Pouladuff Rd.
Cork

FEHILY TIMONEY & COMPANY
CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES
Cork : Tel 021-4964133 Fax 021-4964464

DESIGNED: TM **CHECKED:** AR
DATE: 14.1.08 **REVISION:** 1
JOB NUMBER: 2005-004-02
CALC NUMBER: 0
FILE C:\OLDCDrive\Documents and Settings\Rossmore\My Documents\Annual Environmental Report 2010\APPENDIX C Landfill gas model 2010
SHEET Calc Sheet

PROJECT: Regulatory Compliance - Rossmore Landfill

DESCRIPTION: Gas Production Calculation for Rossmore Landfill
431604.53

Ref.		Output

i References

1 LandGEM-v302-guide by US EPA

2 FTC Calculation: CCC-RLC Rossmore Water Balance 2007 (see *Q:\2005\004\02\Calculations\Rossmore Gas Models\2007 Gas Model)*

3 Waste Tonnages January to December 2007 *(see Q:\2005-004-02\Incoming\07 - Jan-Dec'07 Waste Data.xls*

4 Waste Tonnages January to December 2006 *(see Q:\2005-004-02\Calculations\Water Balance\Incoming\Rossmore Waste Deposited Jan 06 - Dec 06.xls)*

5 Waste Tonnages January to December 2005 (see *Q:\2005-004-02\Calculations\Water Balance\Water Balance info from CCC\CCC-RLC_waste tonnages January to December 2005.xls)*

6 2006 Gas Model *(see Q:\2005\004\02\Calculations\Rossmore Gas Models\2006 Gas Model\CCC-RLC gas model rev2.xls)*

7 Gas utilisation report *(see Q:\2006\004\01\Reports\CCC-LGU_Rpt 001_C.doc)*

8 Gas utilisation model calculation *(see Q:\2006\004\01\Calculations\CCC-LGU_Gas Model rev 3.xls)*

ii List of FTC Drawings
2006-004-10-008

iii List of Appendices

App A Outputs Site Specific
App B Outputs Inventory Default

Fehily Timoney Co.,
Core House,
Pouladuff Rd.,
Cork
Tel 021 4964133

i List of References
ii List of Drawings
iii List of Appendices

Contents

Ref. | Output

1.0 Introduction & Purpose

The purpose of this Calc Set is to develop a gas production model using US EPA software package, LandGEM v3.02, to quantify present and future volumes of landfill gas production at Rossmore Landfill Site operated by Cork County Council. The results of the model will be submitted to the EPA as part of the 2007 AER for the site.

2.0 Input Data

Opening Year: 1995
Closure Year: Apr-07

2.1 Waste input data:

2,3,4,5 The waste input data for the site is as shown below. These figures come from communications with Cork County Council, and from previous calculations carried out by FTC.

Year	Input Units (t/year)
1995	28,000
1996	29,801
1997	20,476
1998	37,837
1999	34,763
2000	52,000
2001	63,303
2002	82,679
2003	71,708
2004	55,715
2005	31,527
2006	43,115
2007	4,265

1 **2.2 Model Parameters**

1 **2.2.1 Methane Generation Rate (k)**

The Methane Generation Rate, k, determines the rate of methane generation for the mass of waste in the landfill. The higher the value of k, the faster the methane generation rate increases and then decays over time. The value of k is primarily a function of four factors:

- Moisture content of the waste mass,
- Availability of the nutrients for micro organisms that break down the waste to form methane and carbon dioxide,
- pH of the waste mass, and
- Temperature of the waste mass.

The k value as it is used in the first-order decomposition rate equation, is in units of 1/year, or year^{-1}
There are 5 k values given as options in LandGEM. The default k value is the CAA k value for conventional landfills.

1 **2.2.2 Potential Methane Generation Capacity (Lo)**

The Potential Methane Generation Capacity, Lo, depends only on the type and compositior of waste placed in the landfill. The higher the cellulose content of the waste, the higher the value of Lo. The default Lo values used by LandGEM are representative of MSW. The Lo value, as it is used in the first-order decomposition rate equation, is measured in metric units of cubic meters per megagram to be consistent with the CAA.
The default Lo value is the CAA Lo value for conventional landfills.

1 **2.2.3 Nonmethane Organic Compound Concentration**

The NMOC Concentration in landfill gas is a function of the types of waste in the landfill and the extent of the reactions that produce various compounds from the anaerobic decomposition of waste. NMOC Concentration is measured in units of parts per million by volume (ppmv) and is used by LandGEM only when NMOC emissions are being estimated. The NMOC Concentration for the CAA default is 4,000 ppmv as hexane. The NMOC Concentration for the inventory default is 600 ppmv where co-disposal of hazardous waste has either not occurred or is unknown and 2,400 ppmv where co-disposal of hazardous waste has occurred. The default NMOC Concentration is the CAA value. If you use a site-specific value for NMOC concentration, then you must correct for air infiltration.

Ref.		Output

1 **2.2.4 Methane Content**

For LandGEM, landfill gas is assumed to be 50 percent methane and 50 percent carbon dioxide, with additional, trace constituents of NMOCs and other air pollutants. When using LandGEM for complying with the CAA, Methane Content must remain fixed at 50 percent by volume (the model default value).
You may choose other methane amounts for the Methane Content using the User-specified selection if data exist to support using another concentration. However, using LandGEM at landfills that have methane content outside the range of 40 to 60 percent is not recommended. The first-order decomposition rate equation used by LandGEM to determine emissions may not be valid outside of this range.
The production of methane is determined using the first-order decomposition rate equation and is not affected by the concentration of methane. However, the concentration of methane affects the calculated production of carbon dioxide. The production of carbon dioxide (QCO2) is calculated from the production of methane (QCH4) and the methane content percentage (PCH4) using the equation

$$Q_{CO2} = Q_{CH4} \times \left\{\left[1/(P_{CH4}/100)\right] - 1\right\}$$

This equation is derived as follows:

$$Q_{total} = Q_{CH4} + Q_{CO2}$$
$$Q_{CH4} = Q_{total} \times (P_{CH4}/100)$$
$$Q_{CO2} = Q_{total} - Q_{CH4} = \left[Q_{CH4}/(P_{CH4}/100)\right] - Q_{CH4}$$
$$Q_{CO2} = Q_{CH4} \times \left\{\left[1/(P_{CH4}/100)\right] - 1\right\}$$

where Qtotal is the total production of landfill gas.

2.2.5 CAA & Inventory Parameters

LandGEM contains two sets of default parameters:

CAA Defaults—The CAA defaults are based on requirements for MSW landfills laid out by the US Clean Air Act (CAA), including the NSPS/EG and NESHAP. This set of default parameters yields conservative emission estimates and can be used for determining whether a landfill is subject to the control requirements of the NSPS/EG or NESHAP.

Inventory Defaults—With the exception of wet landfill defaults, the inventory defaults are based on emission factors in the U.S. Environmental Protection Agency's (EPA's) Compilation of Air Pollutant Emission Factors (AP-42). This set of defaults yields average emissions and can be used to generate emission estimates for use in emission inventories and air permits in the absence of site-specific test data.

2.2.6 Site Specific Parameters

Where site specific data is available for the actual quantities of gas produced, the model can be calibrated by varying the parameters to match the predicted volumes to the actual volumes as closely as possible

Fehily Timoney Co.,
Core House,
Pouladuff Rd.,
Cork
Tel 021 4964133

FEHILY TIMONEY & COMPANY
CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES
Cork : Tel 021-4964133 Fax 021-4964464

DESIGNED: TM **CHECKED:** AR
DATE: 14.1.08 **REVISION:** 1
JOB NUMBER: 2005-004-02
CALC NUMBER: 0
FILE C:\OLDCDrive\Documents and Settings\Rossmore\My Documents\Annual Environmental Report 2010\APPENDIX C Landfill gas model 2010
SHEET Calc Sheet

PROJECT: Regulatory Compliance - Rossmore Landfill

DESCRIPTION: Gas Production Calculation for Rossmore Landfill

Ref. | Output

4.0 Calculations

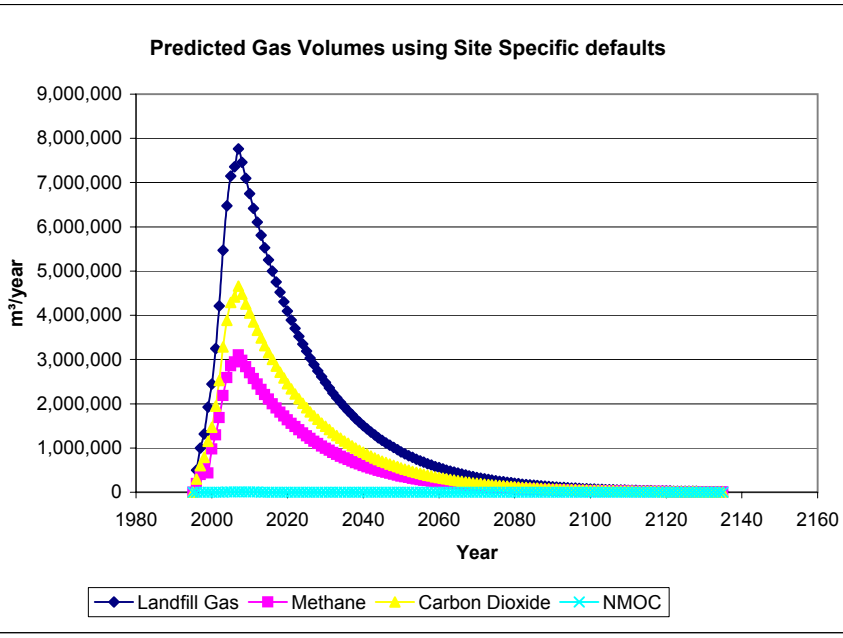
Two calculations were carried out to predict the volumes of gas arising from the landfill.
The first uses site specific parameters, which were derived as outlined in Section 4.3 below, while the second uses LandGEM Inventory Default parameters for comparison.

App A

4.1 "CCC-RLC 2007 Site Specific Defaults LandGEM-v302"

6,7 MODEL PARAMETERS

Methane Generation Rate, k	0.05	$year^{-1}$
Potential Methane Generation Capacity, Lo	145	m^3/Mg
NMOC Concentration	600	ppmv as hexane
Methane Content	40	% by volume



Peak Production Year: 2007

Peak Volumes:

7,761,111 m^3 landfill gas	886	m^3/hr
3,104,444 m^3 methane	354	m^3/hr
4,656,667 m^3 carbon dioxide		
4,657 m^3 NMOC		

These are estimates based on site specific parameters, as outlined in 4.3 below.

Fehily Timoney Co.,
Core House,
Pouladuff Rd.,
Cork
Tel 021 4964133

FEHILY TIMONEY & COMPANY
CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES
Cork : Tel 021-4964133 Fax 021-4964464

DESIGNED: TM **CHECKED:** AR
DATE: 14.1.08 **REVISION:** 1
JOB NUMBER: 2005-004-02
CALC NUMBER: 0
FILE C:\OLDCDrive\Documents and Settings\Rossmore\My Documents\Annual Environmental Report 2010\APPENDIX C Landfill gas model 2010
SHEET Calc Sheet

PROJECT: Regulatory Compliance - Rossmore Landfill

DESCRIPTION: Gas Production Calculation for Rossmore Landfill

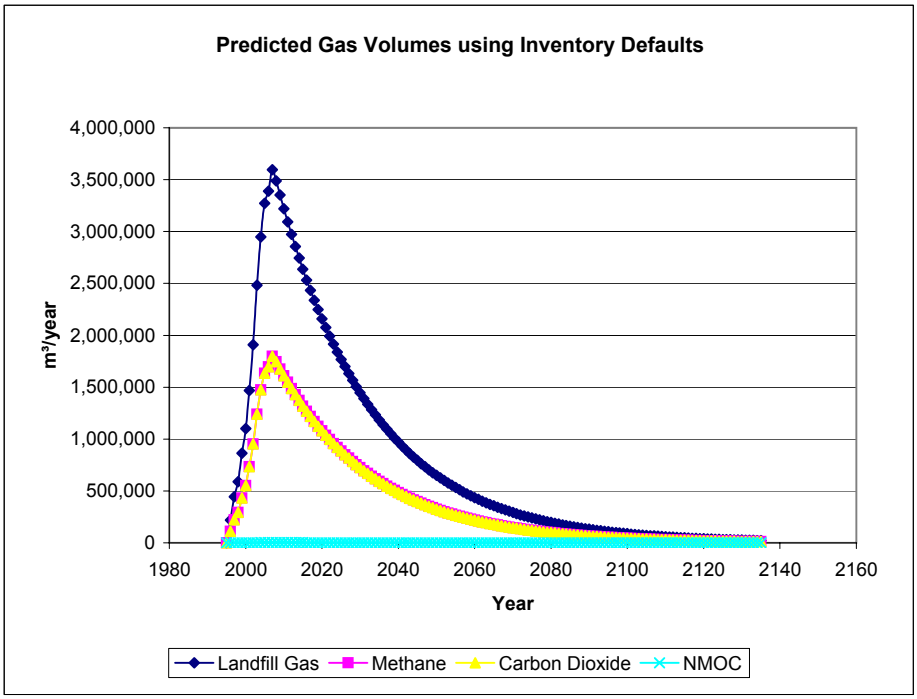
Ref. | Output

4.2 "CCC-RLC 2007 Inventory Defaults LandGEM-v302"

MODEL PARAMETERS

Methane Generation Rate, k	0.04	$year^{-1}$
Potential Methane Generation Capacity, Lo	100	m^3/Mg
NMOC Concentration	600	ppmv as hexane
Methane Content	50	% by volume

App B



Peak Production Year:	**2007**		
Peak Volumes:	3,596,260	m^3 landfill gas	411 m^3/hr
	1,798,130	m^3 methane	205 m^3/hr
	1,798,130	m^3 carbon dioxide	
	2,158	m^3 NMOC	

These figures give an indication of the volumes of gas likely to be produced based on average production values.

Fehily Timoney Co.,
Core House,
Pouladuff Rd.,
Cork
Tel 021 4964133

4.3 Site Specific Parameters

6,7 The site specific parameters used in Section 4.1 above, were developed by FTC in September 2006. The volume of gas burnt at the flare at that time varied between 300 and 400 m^3/hr. This gas volume was being extracted from just Cells 1-4, as the gas collection system did not extend beyond this point at that time. A gas model was prepared for these four Cells, and parameters adjusted so that the predicted output from the model was approximately 350 m^3/hr. The methane content at the flare was known to be approximately 40%, so the CH_4 parameter was also adjusted.

When these parameters are then applied to the entire landfill, the results should give a reasonably accurate prediction as to the volume of gas that will be produced from the entire landfill (Cell 1-10), after capping has been completed and the gas collection system extended over the entire site.

5.0 Discussion

The results obtained using the site specific parameters should reflect the landfill gas available for utilisation at Rossmore, after final capping and the extension of the gas collection system. This volume is predicted to have peaked in 2007, at over 7.5 million m^3 of gas for the year (886 m^3/hr, of which 354 m^3/hr is methane)

The Inventory default parameters predict a much lower production of landfill gas, with a peak in 2007 of just under 3.6 million m^3 of gas (411 m^3/hr, of which 205 m^3/hr is methane). The EPA has previously expressed a preference for the Inventory defaults, however, it is felt that the site specific parameters used here give a better, and more conservative, estimate of the gas production from Rossmore landfill.

Fehily Timoney Co.,
Core House,
Pouladuff Rd.,
Cork
Tel 021 4964133

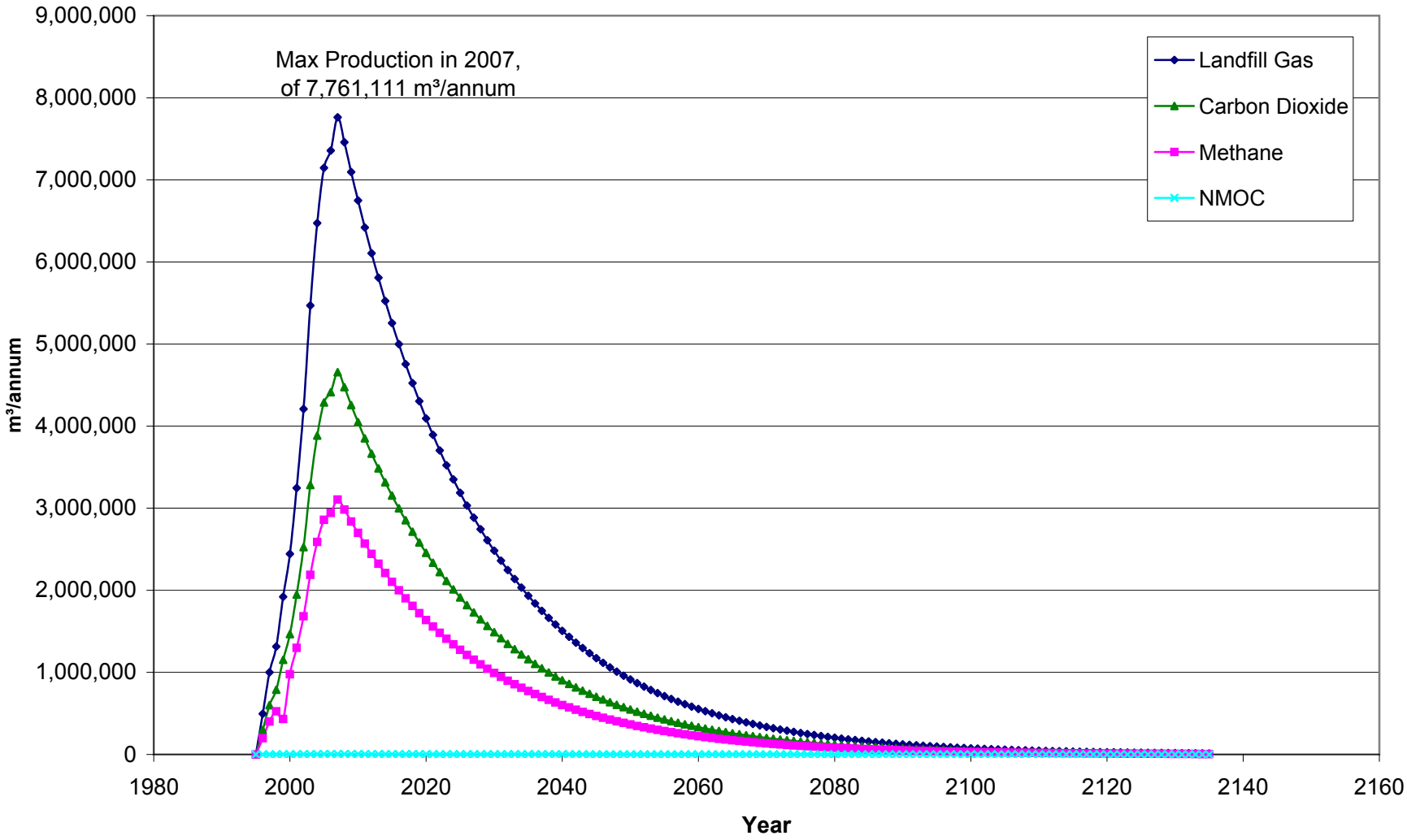
Appendix A - Outputs Site Specific

Year	Landfill Gas	CH_4	CO_2	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	*(m^3/year)*	*(m^3/year)*	*(m^3/year)*	*(m^3/hr)*	*(m^3/hr)*	***tonnes***
1995	0	0	0	0	0	0	0
1996	496,260	198,504	297,756	298	57	23	28,000
1997	1,000,237	400,095	600,142	600	114	46	57,801
1998	1,314,363	525,745	788,618	789	150	60	78,277
1999	1,920,867	431,605	1,152,520	1,153	219	49	116,114
2000	2,443,310	977,324	1,465,986	1,466	279	112	150,877
2001	3,245,774	1,298,310	1,947,464	1,947	371	148	202,877
2002	4,209,431	1,683,772	2,525,658	2,526	481	192	266,180
2003	5,469,501	2,187,800	3,281,701	3,282	624	250	348,859
2004	6,473,672	2,589,469	3,884,203	3,884	739	296	420,567
2005	7,145,416	2,858,166	4,287,250	4,287	816	326	476,282
2006	7,355,701	2,942,280	4,413,421	4,413	840	336	507,809
2007	7,761,111	3,104,444	4,656,667	4,657	886	354	550,924
2008	7,458,200	2,983,280	4,474,920	4,475	851	341	555,190
2009	7,094,459	2,837,784	4,256,676	4,257	810	324	555,190
2010	6,748,458	2,699,383	4,049,075	4,049	770	308	555,190
2011	6,419,332	2,567,733	3,851,599	3,852	733	293	555,190
2012	6,106,258	2,442,503	3,663,755	3,664	697	279	555,190
2013	5,808,452	2,323,381	3,485,071	3,485	663	265	555,190
2014	5,525,170	2,210,068	3,315,102	3,315	631	252	555,190
2015	5,255,705	2,102,282	3,153,423	3,153	600	240	555,190
2016	4,999,381	1,999,752	2,999,629	3,000	571	228	555,190
2017	4,755,558	1,902,223	2,853,335	2,853	543	217	555,190
2018	4,523,627	1,809,451	2,714,176	2,714	516	207	555,190
2019	4,303,007	1,721,203	2,581,804	2,582	491	196	555,190
2020	4,093,147	1,637,259	2,455,888	2,456	467	187	555,190
2021	3,893,522	1,557,409	2,336,113	2,336	444	178	555,190
2022	3,703,632	1,481,453	2,222,179	2,222	423	169	555,190
2023	3,523,004	1,409,202	2,113,803	2,114	402	161	555,190
2024	3,351,185	1,340,474	2,010,711	2,011	383	153	555,190
2025	3,187,746	1,275,098	1,912,648	1,913	364	146	555,190
2026	3,032,278	1,212,911	1,819,367	1,819	346	138	555,190
2027	2,884,392	1,153,757	1,730,635	1,731	329	132	555,190
2028	2,743,718	1,097,487	1,646,231	1,646	313	125	555,190
2029	2,609,906	1,043,962	1,565,943	1,566	298	119	555,190
2030	2,482,619	993,048	1,489,571	1,490	283	113	555,190
2031	2,361,540	944,616	1,416,924	1,417	270	108	555,190
2032	2,246,367	898,547	1,347,820	1,348	256	103	555,190
2033	2,136,810	854,724	1,282,086	1,282	244	98	555,190
2034	2,032,597	813,039	1,219,558	1,220	232	93	555,190
2035	1,933,466	773,386	1,160,079	1,160	221	88	555,190
2036	1,839,169	735,668	1,103,502	1,104	210	84	555,190
2037	1,749,472	699,789	1,049,683	1,050	200	80	555,190
2038	1,664,149	665,660	998,490	998	190	76	555,190
2039	1,582,988	633,195	949,793	950	181	72	555,190
2040	1,505,785	602,314	903,471	903	172	69	555,190
2041	1,432,347	572,939	859,408	859	164	65	555,190
2042	1,362,490	544,996	817,494	817	156	62	555,190
2043	1,296,041	518,416	777,624	778	148	59	555,190
2044	1,232,832	493,133	739,699	740	141	56	555,190
2045	1,172,706	469,082	703,624	704	134	54	555,190

Year	Landfill Gas	CH_4	CO_2	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	***(m^3/year)***	***(m^3/year)***	***(m^3/year)***	***(m^3/hr)***	***(m^3/hr)***	***tonnes***
2046	1,115,513	446,205	669,308	669	127	51	555,190
2047	1,061,108	424,443	636,665	637	121	48	555,190
2048	1,009,358	403,743	605,615	606	115	46	555,190
2049	960,131	384,052	576,078	576	110	44	555,190
2050	913,305	365,322	547,983	548	104	42	555,190
2051	868,762	347,505	521,257	521	99	40	555,190
2052	826,392	330,557	495,835	496	94	38	555,190
2053	786,088	314,435	471,653	472	90	36	555,190
2054	747,750	299,100	448,650	449	85	34	555,190
2055	711,282	284,513	426,769	427	81	32	555,190
2056	676,593	270,637	405,956	406	77	31	555,190
2057	643,595	257,438	386,157	386	73	29	555,190
2058	612,206	244,883	367,324	367	70	28	555,190
2059	582,349	232,939	349,409	349	66	27	555,190
2060	553,947	221,579	332,368	332	63	25	555,190
2061	526,931	210,772	316,159	316	60	24	555,190
2062	501,232	200,493	300,739	301	57	23	555,190
2063	476,787	190,715	286,072	286	54	22	555,190
2064	453,534	181,413	272,120	272	52	21	555,190
2065	431,415	172,566	258,849	259	49	20	555,190
2066	410,374	164,150	246,225	246	47	19	555,190
2067	390,360	156,144	234,216	234	45	18	555,190
2068	371,322	148,529	222,793	223	42	17	555,190
2069	353,212	141,285	211,927	212	40	16	555,190
2070	335,986	134,394	201,592	202	38	15	555,190
2071	319,600	127,840	191,760	192	36	15	555,190
2072	304,013	121,605	182,408	182	35	14	555,190
2073	289,186	115,674	173,511	174	33	13	555,190
2074	275,082	110,033	165,049	165	31	13	555,190
2075	261,666	104,666	157,000	157	30	12	555,190
2076	248,905	99,562	149,343	149	28	11	555,190
2077	236,765	94,706	142,059	142	27	11	555,190
2078	225,218	90,087	135,131	135	26	10	555,190
2079	214,234	85,694	128,540	129	24	10	555,190
2080	203,786	81,514	122,271	122	23	9	555,190
2081	193,847	77,539	116,308	116	22	9	555,190
2082	184,393	73,757	110,636	111	21	8	555,190
2083	175,400	70,160	105,240	105	20	8	555,190
2084	166,846	66,738	100,107	100	19	8	555,190
2085	158,709	63,483	95,225	95	18	7	555,190
2086	150,968	60,387	90,581	91	17	7	555,190
2087	143,605	57,442	86,163	86	16	7	555,190
2088	136,602	54,641	81,961	82	16	6	555,190
2089	129,940	51,976	77,964	78	15	6	555,190
2090	123,602	49,441	74,161	74	14	6	555,190
2091	117,574	47,030	70,545	71	13	5	555,190
2092	111,840	44,736	67,104	67	13	5	555,190
2093	106,386	42,554	63,831	64	12	5	555,190
2094	101,197	40,479	60,718	61	12	5	555,190
2095	96,262	38,505	57,757	58	11	4	555,190
2096	91,567	36,627	54,940	55	10	4	555,190
2097	87,101	34,840	52,261	52	10	4	555,190
2098	82,853	33,141	49,712	50	9	4	555,190
2099	78,812	31,525	47,287	47	9	4	555,190

Year	Landfill Gas	CH_4	CO_2	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	***(m^3/year)***	***(m^3/year)***	***(m^3/year)***	***(m^3/hr)***	***(m^3/hr)***	***tonnes***
2100	74,969	29,987	44,981	45	9	3	555,190
2101	71,312	28,525	42,787	43	8	3	555,190
2102	67,834	27,134	40,701	41	8	3	555,190
2103	64,526	25,810	38,716	39	7	3	555,190
2104	61,379	24,552	36,827	37	7	3	555,190
2105	58,386	23,354	35,031	35	7	3	555,190
2106	55,538	22,215	33,323	33	6	3	555,190
2107	52,829	21,132	31,698	32	6	2	555,190
2108	50,253	20,101	30,152	30	6	2	555,190
2109	47,802	19,121	28,681	29	5	2	555,190
2110	45,471	18,188	27,282	27	5	2	555,190
2111	43,253	17,301	25,952	26	5	2	555,190
2112	41,144	16,457	24,686	25	5	2	555,190
2113	39,137	15,655	23,482	23	4	2	555,190
2114	37,228	14,891	22,337	22	4	2	555,190
2115	35,413	14,165	21,248	21	4	2	555,190
2116	33,686	13,474	20,211	20	4	2	555,190
2117	32,043	12,817	19,226	19	4	1	555,190
2118	30,480	12,192	18,288	18	3	1	555,190
2119	28,993	11,597	17,396	17	3	1	555,190
2120	27,579	11,032	16,548	17	3	1	555,190
2121	26,234	10,494	15,741	16	3	1	555,190
2122	24,955	9,982	14,973	15	3	1	555,190
2123	23,738	9,495	14,243	14	3	1	555,190
2124	22,580	9,032	13,548	14	3	1	555,190
2125	21,479	8,592	12,887	13	2	1	555,190
2126	20,431	8,173	12,259	12	2	1	555,190
2127	19,435	7,774	11,661	12	2	1	555,190
2128	18,487	7,395	11,092	11	2	1	555,190
2129	17,585	7,034	10,551	11	2	1	555,190
2130	16,728	6,691	10,037	10	2	1	555,190
2131	15,912	6,365	9,547	10	2	1	555,190
2132	15,136	6,054	9,082	9	2	1	555,190
2133	14,398	5,759	8,639	9	2	1	555,190
2134	13,696	5,478	8,217	8	2	1	555,190
2135	13,028	5,211	7,817	8	1	1	555,190

Rossmore Landfill - Gas Model Outputs
Site Specific Parameters



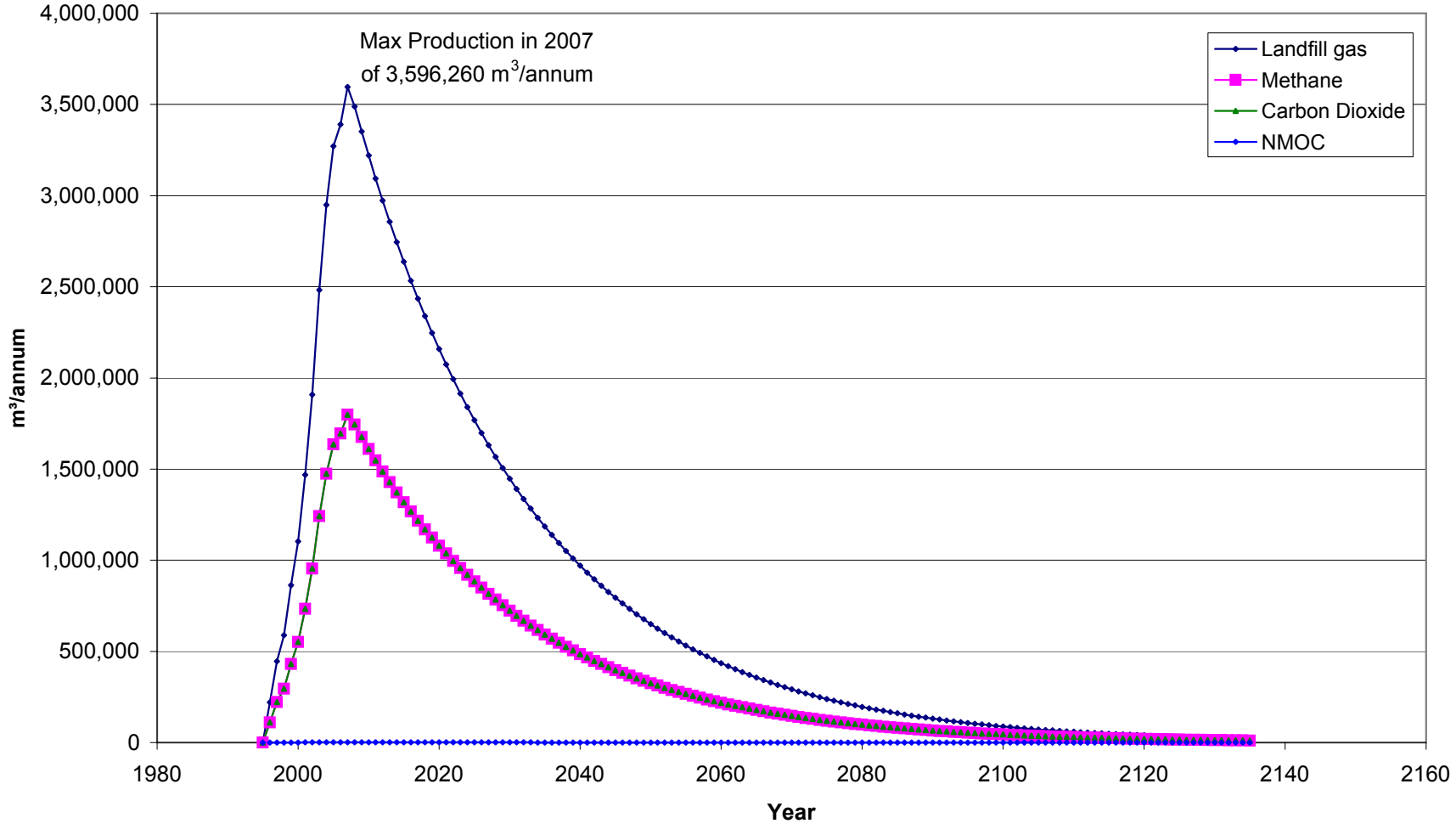
Appendix B - Gas Generation Model Outputs using LandGEM Inventory Default Settings

Year	Landfill Gas	Methane	Carbon Dioxide	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	*(m^3/year)*	*(m^3/year)*	*(m^3/year)*	*(m^3/hr)*	*(m^3/hr)*	*tonnes*
1995	0	0	0	0	0	0	0
1996	220,019	110,009	110,009	132	25	13	28,000
1997	445,562	222,781	222,781	267	51	25	57,801
1998	588,988	294,494	294,494	353	67	34	78,277
1999	863,209	431,605	431,605	518	99	49	116,114
2000	1,102,523	551,262	551,262	662	126	63	150,877
2001	1,467,898	733,949	733,949	881	168	84	202,877
2002	1,907,764	953,882	953,882	1,145	218	109	266,180
2003	2,482,635	1,241,318	1,241,318	1,490	283	142	348,859
2004	2,948,757	1,474,379	1,474,379	1,769	337	168	420,567
2005	3,270,933	1,635,466	1,635,466	1,963	373	187	476,282
2006	3,390,411	1,695,205	1,695,205	2,034	387	194	507,809
2007	3,596,260	1,798,130	1,798,130	2,158	411	205	550,924
2008	3,488,766	1,744,383	1,744,383	2,093	398	199	555,189
2009	3,351,970	1,675,985	1,675,985	2,011	383	191	555,189
2010	3,220,537	1,610,268	1,610,268	1,932	368	184	555,189
2011	3,094,258	1,547,129	1,547,129	1,857	353	177	555,189
2012	2,972,930	1,486,465	1,486,465	1,784	339	170	555,189
2013	2,856,360	1,428,180	1,428,180	1,714	326	163	555,189
2014	2,744,361	1,372,180	1,372,180	1,647	313	157	555,189
2015	2,636,753	1,318,376	1,318,376	1,582	301	150	555,189
2016	2,533,364	1,266,682	1,266,682	1,520	289	145	555,189
2017	2,434,029	1,217,015	1,217,015	1,460	278	139	555,189
2018	2,338,590	1,169,295	1,169,295	1,403	267	133	555,189
2019	2,246,892	1,123,446	1,123,446	1,348	256	128	555,189
2020	2,158,790	1,079,395	1,079,395	1,295	246	123	555,189
2021	2,074,143	1,037,072	1,037,072	1,244	237	118	555,189
2022	1,992,815	996,407	996,407	1,196	227	114	555,189
2023	1,914,675	957,338	957,338	1,149	219	109	555,189
2024	1,839,600	919,800	919,800	1,104	210	105	555,189
2025	1,767,468	883,734	883,734	1,060	202	101	555,189
2026	1,698,165	849,082	849,082	1,019	194	97	555,189
2027	1,631,579	815,789	815,789	979	186	93	555,189
2028	1,567,604	783,802	783,802	941	179	89	555,189
2029	1,506,137	753,069	753,069	904	172	86	555,189
2030	1,447,081	723,540	723,540	868	165	83	555,189
2031	1,390,340	695,170	695,170	834	159	79	555,189
2032	1,335,824	667,912	667,912	801	152	76	555,189
2033	1,283,445	641,723	641,723	770	147	73	555,189
2034	1,233,121	616,560	616,560	740	141	70	555,189
2035	1,184,769	592,385	592,385	711	135	68	555,189
2036	1,138,314	569,157	569,157	683	130	65	555,189
2037	1,093,680	546,840	546,840	656	125	62	555,189
2038	1,050,796	525,398	525,398	630	120	60	555,189
2039	1,009,594	504,797	504,797	606	115	58	555,189
2040	970,007	485,004	485,004	582	111	55	555,189
2041	931,973	465,986	465,986	559	106	53	555,189
2042	895,429	447,715	447,715	537	102	51	555,189
2043	860,319	430,160	430,160	516	98	49	555,189
2044	826,586	413,293	413,293	496	94	47	555,189
2045	794,175	397,087	397,087	477	91	45	555,189
2046	763,035	381,517	381,517	458	87	44	555,189
2047	733,116	366,558	366,558	440	84	42	555,189
2048	704,370	352,185	352,185	423	80	40	555,189
2049	676,751	338,375	338,375	406	77	39	555,189
2050	650,215	325,108	325,108	390	74	37	555,189
2051	624,720	312,360	312,360	375	71	36	555,189
2052	600,224	300,112	300,112	360	69	34	555,189
2053	576,689	288,345	288,345	346	66	33	555,189
2054	554,077	277,038	277,038	332	63	32	555,189
2055	532,351	266,176	266,176	319	61	30	555,189
2056	511,477	255,739	255,739	307	58	29	555,189
2057	491,422	245,711	245,711	295	56	28	555,189

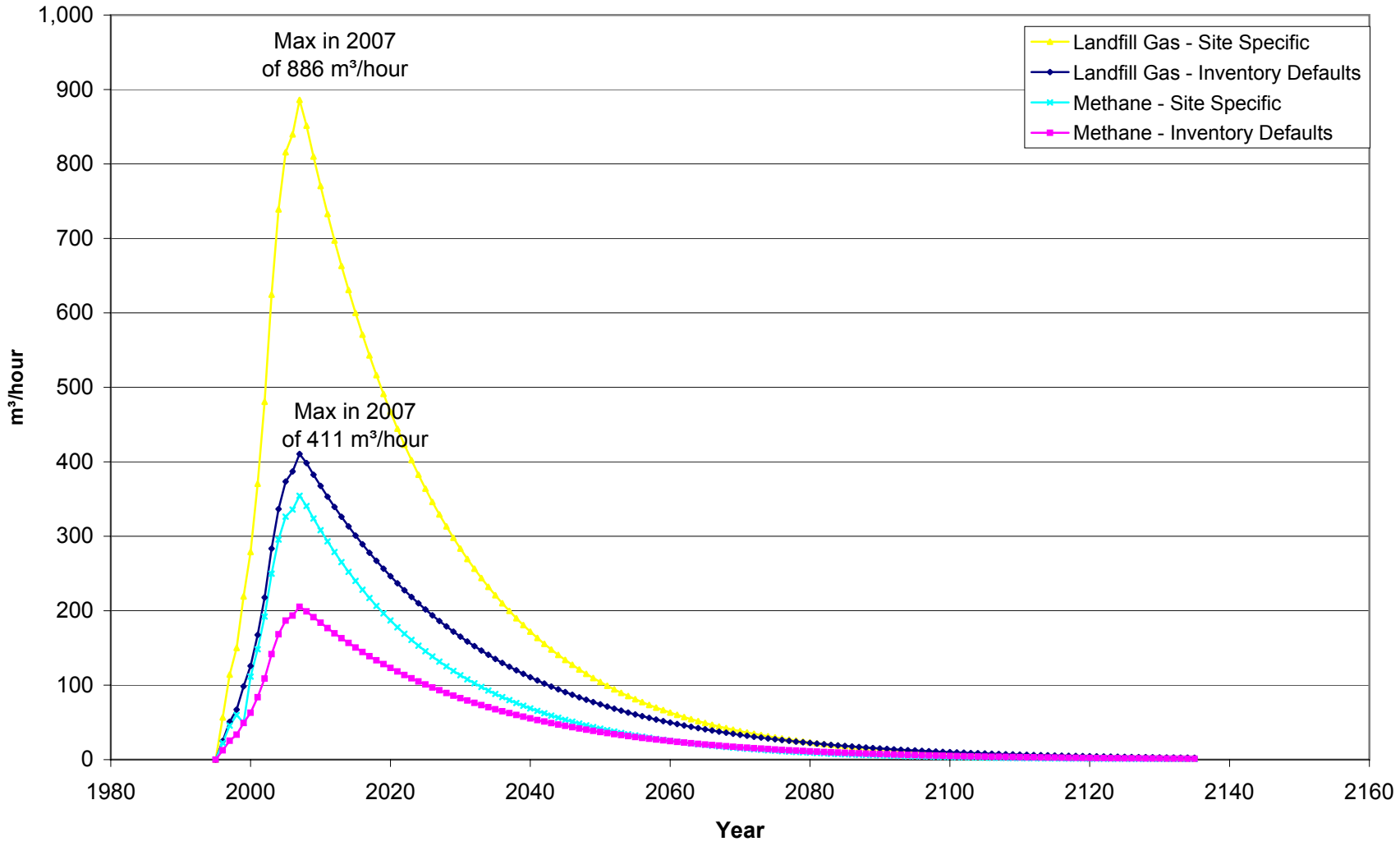
Year	Landfill Gas	Methane	Carbon Dioxide	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	*(m^3/year)*	*(m^3/year)*	*(m^3/year)*	*(m^3/hr)*	*(m^3/hr)*	***tonnes***
2058	472,153	236,077	236,077	283	54	27	555,189
2059	453,640	226,820	226,820	272	52	26	555,189
2060	435,852	217,926	217,926	262	50	25	555,189
2061	418,762	209,381	209,381	251	48	24	555,189
2062	402,342	201,171	201,171	241	46	23	555,189
2063	386,566	193,283	193,283	232	44	22	555,189
2064	371,409	185,704	185,704	223	42	21	555,189
2065	356,846	178,423	178,423	214	41	20	555,189
2066	342,854	171,427	171,427	206	39	20	555,189
2067	329,410	164,705	164,705	198	38	19	555,189
2068	316,494	158,247	158,247	190	36	18	555,189
2069	304,084	152,042	152,042	182	35	17	555,189
2070	292,161	146,080	146,080	175	33	17	555,189
2071	280,705	140,352	140,352	168	32	16	555,189
2072	269,698	134,849	134,849	162	31	15	555,189
2073	259,123	129,562	129,562	155	30	15	555,189
2074	248,963	124,481	124,481	149	28	14	555,189
2075	239,201	119,600	119,600	144	27	14	555,189
2076	229,822	114,911	114,911	138	26	13	555,189
2077	220,810	110,405	110,405	132	25	13	555,189
2078	212,152	106,076	106,076	127	24	12	555,189
2079	203,833	101,917	101,917	122	23	12	555,189
2080	195,841	97,921	97,921	118	22	11	555,189
2081	188,162	94,081	94,081	113	21	11	555,189
2082	180,784	90,392	90,392	108	21	10	555,189
2083	173,695	86,848	86,848	104	20	10	555,189
2084	166,885	83,442	83,442	100	19	10	555,189
2085	160,341	80,171	80,171	96	18	9	555,189
2086	154,054	77,027	77,027	92	18	9	555,189
2087	148,013	74,007	74,007	89	17	8	555,189
2088	142,210	71,105	71,105	85	16	8	555,189
2089	136,634	68,317	68,317	82	16	8	555,189
2090	131,276	65,638	65,638	79	15	7	555,189
2091	126,129	63,064	63,064	76	14	7	555,189
2092	121,183	60,592	60,592	73	14	7	555,189
2093	116,432	58,216	58,216	70	13	7	555,189
2094	111,866	55,933	55,933	67	13	6	555,189
2095	107,480	53,740	53,740	64	12	6	555,189
2096	103,266	51,633	51,633	62	12	6	555,189
2097	99,216	49,608	49,608	60	11	6	555,189
2098	95,326	47,663	47,663	57	11	5	555,189
2099	91,588	45,794	45,794	55	10	5	555,189
2100	87,997	43,999	43,999	53	10	5	555,189
2101	84,547	42,273	42,273	51	10	5	555,189
2102	81,232	40,616	40,616	49	9	5	555,189
2103	78,046	39,023	39,023	47	9	4	555,189
2104	74,986	37,493	37,493	45	9	4	555,189
2105	72,046	36,023	36,023	43	8	4	555,189
2106	69,221	34,610	34,610	42	8	4	555,189
2107	66,507	33,253	33,253	40	8	4	555,189
2108	63,899	31,949	31,949	38	7	4	555,189
2109	61,393	30,697	30,697	37	7	4	555,189
2110	58,986	29,493	29,493	35	7	3	555,189
2111	56,673	28,337	28,337	34	6	3	555,189
2112	54,451	27,226	27,226	33	6	3	555,189
2113	52,316	26,158	26,158	31	6	3	555,189
2114	50,265	25,132	25,132	30	6	3	555,189
2115	48,294	24,147	24,147	29	6	3	555,189
2116	46,400	23,200	23,200	28	5	3	555,189
2117	44,581	22,290	22,290	27	5	3	555,189
2118	42,833	21,416	21,416	26	5	2	555,189
2119	41,153	20,577	20,577	25	5	2	555,189
2120	39,540	19,770	19,770	24	5	2	555,189
2121	37,989	18,995	18,995	23	4	2	555,189
2122	36,500	18,250	18,250	22	4	2	555,189
2123	35,069	17,534	17,534	21	4	2	555,189

Year	Landfill Gas	Methane	Carbon Dioxide	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	***(m^3/year)***	***(m^3/year)***	***(m^3/year)***	***(m^3/hr)***	***(m^3/hr)***	***tonnes***
2124	33,693	16,847	16,847	20	4	2	555,189
2125	32,372	16,186	16,186	19	4	2	555,189
2126	31,103	15,551	15,551	19	4	2	555,189
2127	29,883	14,942	14,942	18	3	2	555,189
2128	28,712	14,356	14,356	17	3	2	555,189
2129	27,586	13,793	13,793	17	3	2	555,189
2130	26,504	13,252	13,252	16	3	2	555,189
2131	25,465	12,732	12,732	15	3	1	555,189
2132	24,466	12,233	12,233	15	3	1	555,189
2133	23,507	11,754	11,754	14	3	1	555,189
2134	22,585	11,293	11,293	14	3	1	555,189
2135	21,700	10,850	10,850	13	2	1	555,189

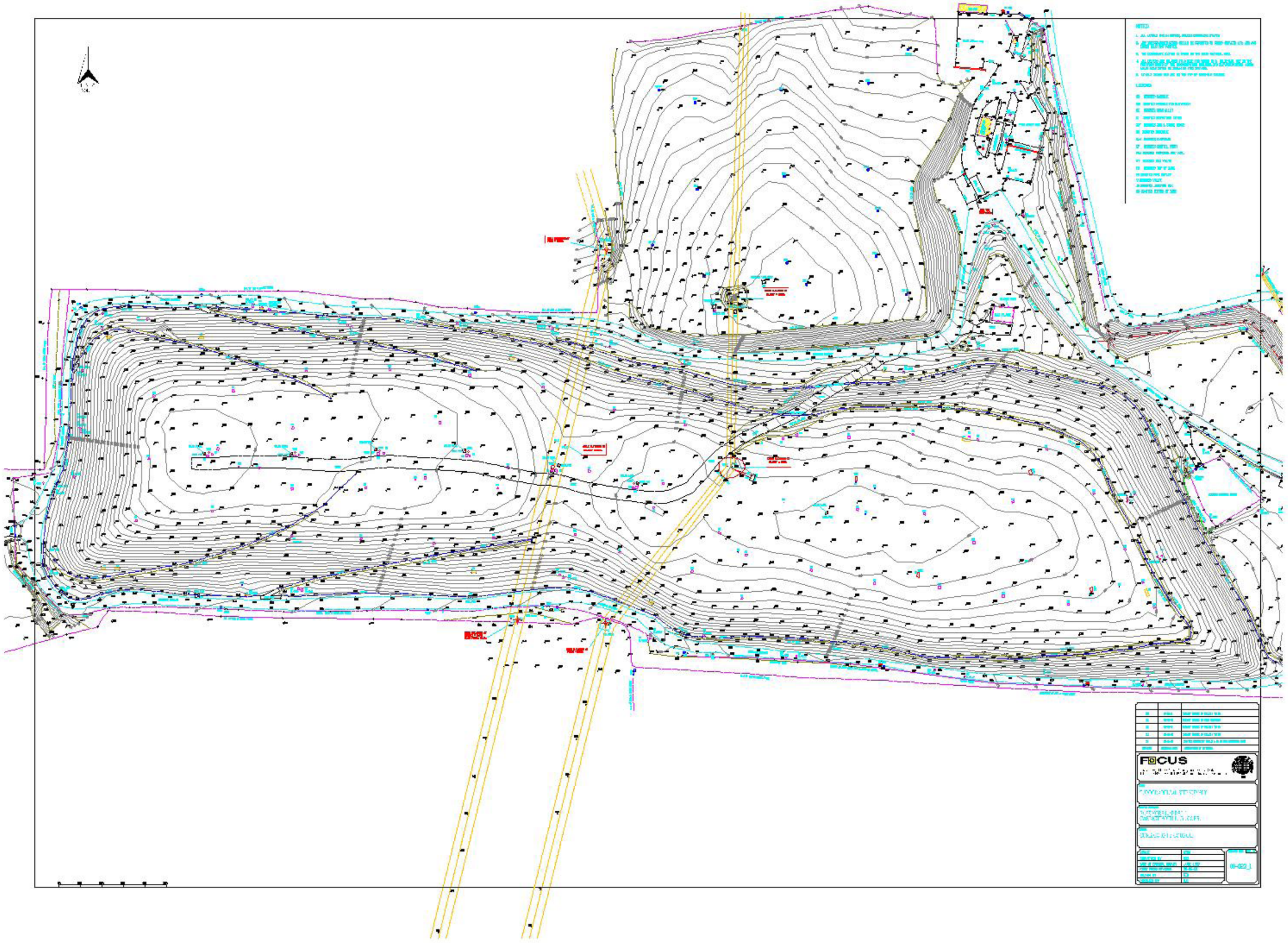
Rossmore Landfill - Gas Model Outputs
using LandGEM Inventory Default Settings



Rossmore Landfill - Gas Model Outputs
Comparison of Results - Hourly Production



time	EvapCalcDaily evap	PR_Sum24h PR_Sum24h	TA_24h Max	TA_24h Min	RH_24h Avg	PA_24h Avg	WD_24h Avg	WS_24h Avg
Tue Nov 1 23:59:07 2010	0.4	1.8	13.7	6.8	92.3	1011.7	215	12.8
Wed Nov 2 23:59:07 2010	0.4	0.2	14.3	11.0	85.3	1006.5	235	18.3
Thu Nov 3 23:59:07 2010	0.4	0.9	16.6	9.8	90.8	1010.0	235	14.8
Fri Nov 4 23:59:07 2010	0.3	1.3	15.1	13.8	94.3	1014.8	230	20.3
Sat Nov 5 23:59:07 2010	0.4	2.7	13.8	9.4	89.6	1019.5	250	5.8
Sun Nov 6 23:59:07 2010	0.4	1.2	10.8	5.5	92.0	1019.1	285	10.8
Mon Nov 7 23:59:07 2010	0.3	13.6	10.8	5.2	84.1	1005.8	300	16.8
Tue Nov 8 23:59:08 2010	0.6	5.8	12.1	6.1	89.0	967.2	275	10.8
Wed Nov 9 23:59:08 2010	0.7	0	10.4	5.8	79.9	984.3	355	15.9
Thu Nov 10 23:59:08 2010	0.1	2.5	10.7	2.9	83.0	1000.2	235	11.6
Fri Nov 11 23:59:08 2010	0.6	3.6	13.2	8.7	80.8	985.2	255	24.8
Sat Nov 12 23:59:08 2010	0.3	1	10.5	6.3	85.2	992.9	245	12.8
Sun Nov 13 23:59:07 2010	0.2	2.8	9.3	3.8	85.4	990.9	245	8.6
Mon Nov 14 23:59:07 2010	0.1	0.2	10.1	1.1	88.3	996.3	340	4.2
Tue Nov 15 23:59:08 2010	0.2	1.2	9.6	2.9	87.5	1012.3	330	4.7
Wed Nov 16 23:59:08 2010	0.3	22.4	10.9	6.1	85.3	1008.8	150	19.6
Thu Nov 17 23:59:08 2010	0.3	3.4	10.5	8.4	84.9	991.9	200	18.6
Fri Nov 18 23:59:08 2010	0.2	0	11.0	6.3	83.9	998.8	245	12.1
Sat Nov 19 23:59:08 2010	0.3	4.6	11.8	6.4	89.2	1006.2	90	5.3
Sun Nov 20 23:59:07 2010	0.2	2.9	10.9	6.2	91.0	1011.9	45	9.4
Mon Nov 21 23:59:07 2010	0.2	0	7.3	3.3	84.7	1016.0	10	11.7
Tue Nov 22 23:59:08 2010	0.2	0	5.8	2.7	87.4	1014.3	340	11.2
Wed Nov 23 23:59:08 2010	0.1	0	7.0	2.9	91.5	1016.7	330	9.7
Thu Nov 24 23:59:08 2010	0.1	0.1	7.1	1.9	90.0	1015.2	325	9.4
Fri Nov 25 23:59:08 2010	0.1	0	5.6	2.0	81.9	1017.3	335	14.8
Sat Nov 26 23:59:08 2010	0.0	0	5.9	1.9	84.1	1011.9	330	16.3
Sun Nov 27 23:59:07 2010	0.5	0	3.2	-0.5	82.5	1008.8	340	12.5
Mon Nov 28 23:59:07 2010	0.2	0	1.9	-1.8	80.7	1006.7	5	9.6
Tue Nov 29 23:59:08 2010	0.7	0	3.1	-0.9	73.5	1012.2	45	11.0
Tue Nov 30 00:00:05 2010	0.2	1.9	2.0	-1.2	88.5	1015.7	10	11.6
Totals	9.0	74.1						


NOTES:
LEGEND:
FOCUS

DixonBrosnan

environmental consultants

dixonbrosnan.com

Project

2010 annual environmental noise survey at
East Cork Landfill, Rossmore, Carrigtohill, Co. Cork

Client

Cork County Council

Project no	No pages	Client reference	©DixonBrosnan 2010
09135	9	W0022-01	v150610

DixonBrosnan Shronagreehy Kealkil Bantry Co Cork
Tel 086 813 1195 | damian@dixonbrosnan.com | www.dixonbrosnan.com

Report no	Date	Edit	Prepared by	Chkd
09135.1.1	16.09.10	Release 1	Damian Brosnan	CD

1 Introduction

1.1 DixonBrosnan Environmental Consultants were instructed by Cork County Council to carry out the 2010 annual environmental noise survey at their East Cork Landfill (ECL) facility at Rossmore, Carrigtohill, Co. Cork. The facility is regulated by the Environmental Protection Agency (EPA) through waste licence W0022-01. Several noise conditions attached to the licence are presented in **appendix 1**.

1.2 The noise survey was undertaken on Tuesday 31.08.10. Monitoring was conducted at five boundary stations and one offsite station as specified in the licence, and as shown in **appendix 2**. Survey methodology, equipment specifications and weather conditions are outlined in **appendix 3**. Recorded noise data are presented in **appendix 4**, and frequency spectra in **appendix 5**. As the facility operates during daytime hours only, a night-time noise survey was not undertaken.

1.3 The ECL facility was open to users throughout the survey. Noise emissions arose from user waste disposal activities at the civic amenity area near the site entrance, and from vehicle movements through the facility gate. Emissions also arose occasionally from waste management operations undertaken in the vicinity of the civic amenity area. Apart from continuous low emissions arising from the onsite gas flare plant, there were no noise sources deeper within the facility.

2 Results & analysis

2.1 At five of the six measurement stations, including the only offsite noise sensitive location N1, no emissions were audible from the ECL facility. Background noise levels (as $L_{AF90\ 30\ min}$) were 44 dB or less at these stations. It follows that ECL emissions were significantly lower than the 55 dB daytime limit specified in licence W0022-01, particularly at N1 which is the only station to which this limit applies.

2.2 The proximity of station N4 to the ECL entrance and civic amenity area resulted in an $L_{Aeq\ 30\ min}$ level of 58 dB, arising chiefly from vehicle movements through the facility gate. There are no noise sensitive locations in the vicinity of the site entrance, and the daytime noise limit does not apply here.

2.3 No audible tones were noted at any of the stations. Third octave band frequency analysis detected a tone in the 80 Hz band at N4, attributable to use of a wheeled excavator in the civic amenity area. The tone was not of audible significance, and was not detected offsite at the sensitive location N1. Site operations did not give rise to impulsive emissions.

3 Conclusions

3.1 ECL noise emissions were not audible at five of the six measurement stations, including the offsite sensitive location N1. It follows that at N1, the only station to which the limit applies, landfill emissions were significantly lower than the 55 dB daytime noise limit set out in the licence.

3.2 Vehicle movements through the site entrance gave rise to an $L_{Aeq\ 30\ min}$ level of 58 dB at the nearby station N4. Noise limits included in the site waste licence do not apply to this station.

3.3 No audible tones or impulses were noted in site emissions. Third octave band frequency analysis detected a tone at N4. This station is not a noise sensitive location. Overall, measured noise levels were satisfactory.

9.3. The licensee shall carry out a noise survey of the site operations annually. A survey programme(including the timing, nature and extent of the survey) shall be submitted to the Agency in writing at least two months month before the survey is to be carried out. A record of the survey results shall be available for inspection by any authorised persons of the Agency, at all reasonable times.

9.4. The licensee shall within six months of the grant of this licence, submit to the Agency for its agreement noise monitoring proposals for the nearest noise sensitive locations. Such proposals shall address the establishment of noise levels (day time and night time) at the proposed monitoring locations as a result of the operations on site during and outside of normal operations at the facility.

F.3 Noise

Noise monitoring locations shall be those as set out in Table F.3.1 and at the additional locations agreed in advance with the Agency locations

Table F.3.1 Noise Monitoring Locations

STATION	EASTING	NORTHING
N3	182689	70390
N4	182574	70515
N5	182374	70519
GG1	182261	70385
GG4	182273	70242

(Refer to Drawing J/1Rev.B (July 1998) of information submitted 30 November 1998

Noise Sensitive Locations:

N1(Grid Reference 182776 E 70115 N) and nearest noise sensitive locations to be agreed in advance with the Agency.

Grid references to be provided to the Agency within six months of the date of licence.

The frequency of sampling and analysis is listed in Table F.3:

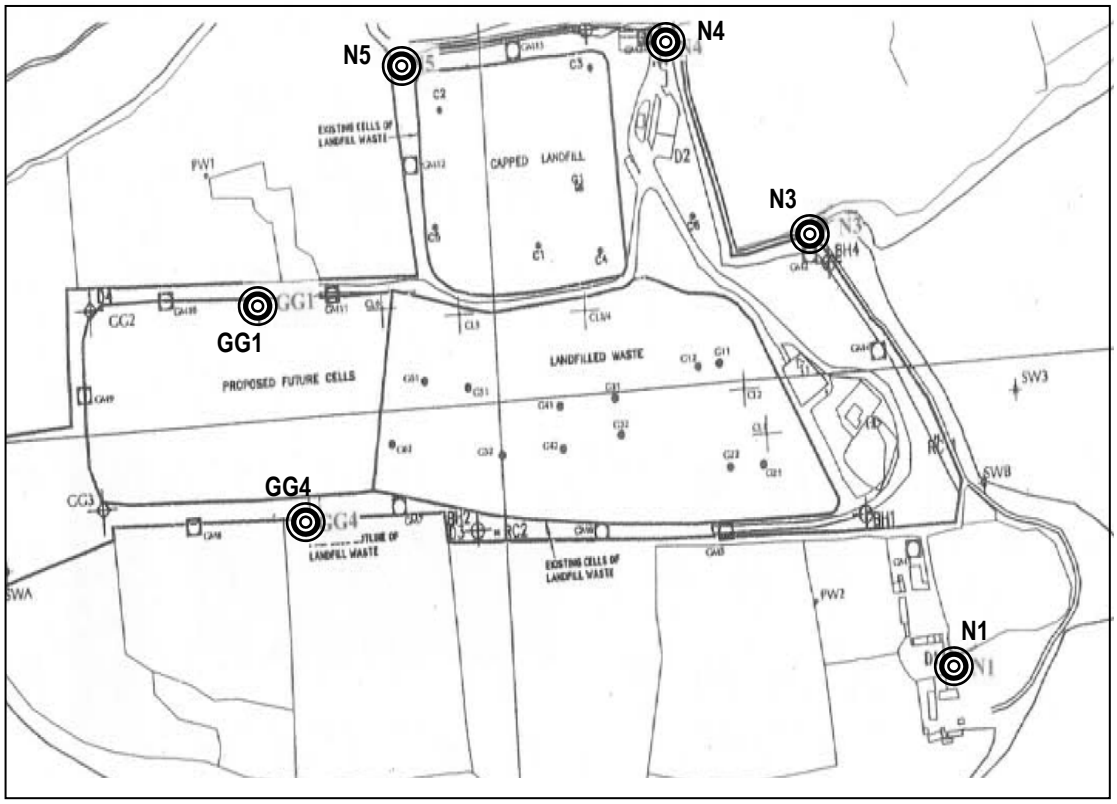
Table F.3 Noise Monitoring

Parameter	Monitoring Frequency	Analysis Method/Technique
$L(A)_{EQ}$ [30 minutes]	Annual	Standard[Note 1]
$L(A)_{10}$ [30 minutes]	Annual	Standard[Note1]
$L(A)_{90}$ [30 minutes]	Annual	Standard[Note 1]
Frequency Analysis(1/3 Octave band analysis)	Annual	Standard[Note1]

Note 1:"International Standards Organisation. ISO 1996. Acoustics - description and Measurement of Environmental noise. Parts 1, 2 and 3."

G.1 Noise Emissions At Noise Sensitive Locations (4 No.) to be agreed in advance with the Agency.

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


N5
N4
N3
GG1
GG4
N1
EXISTING CELLS OF LANDFILL WASTE
CAPPED LANDFILL
PW1
D2
BH4
CG2
PROPOSED FUTURE CELLS
LANDFILLED WASTE
SW3
SW8
CG3
BH2
BH1
RC2
EXISTING CELLS OF LANDFILL WASTE
PW2
SWA

Appendix 3: Survey details

Survey	Project ref.	09135
	Purpose	2010 annual waste licence compliance survey
	Locations	Rossmore landfill N1 N3 N4 N5 GG1 GG4
	Comment	Civic amenity area open
Event	Date	31.08.10
	Day	Tuesday
	Time	Morning
Operator	On behalf of DixonBrosnan	Damian Brosnan
Conditions	Cloud cover	Varying 20-100 %
	Precipitation	0 mm
	Temperature	11 ^{0}C rising to 15 ^{0}C
Wind	Direction	SE
	Speed	0-3 m/s
	Measurement	Anemo anemometer 2 m above ground level
Sound level meter	Instrument	Bruel & Kjaer Type 2250
	Instrument serial no.	2506594
	Microphone serial no.	2529531
	Application	BZ7224 Version 2.5
	Bandwidth	Broadband
	Max input level	141.16 dB
	Broadband weightings	Time: Fast Frequency: AC
	Spectrum weightings	Time: Fast Frequency: Z
	Windscreen correction	UA-1650
	Sound Field correction	Free-field
	UKAS calibration	09.12.09
	UKAS calibration certificate	Available on request
Onsite calibration	Time	31/08/2010 08:39:46
	Calibration type	External
	Sensitivity	48.74 mV/Pa
	Post measurement check	93.9 dB
Onsite calibrator	Instrument	Bruel & Kjaer Type 4231
	Instrument serial no.	1723667
	UKAS calibration	14.09.09
	UKAS calibration certificate	Available on request
Monitoring methodology	Standard	ISO 1996 Acoustics: Description and measurement of environmental noise - Part 1 (2003) & Part 2 (2007)
	Exceptions	-
	Intervals	30 min

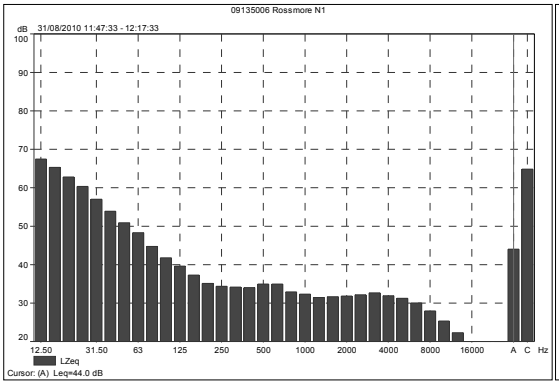
Appendix 4: Noise data

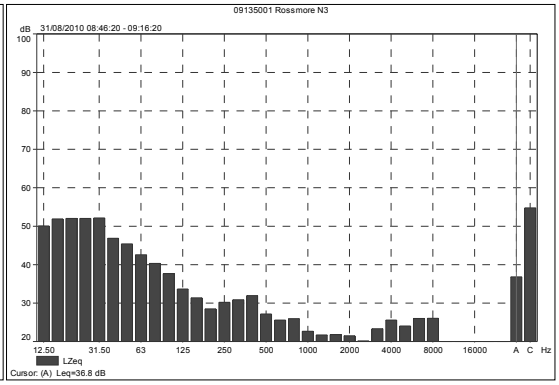
Survey date: 31.08.10.

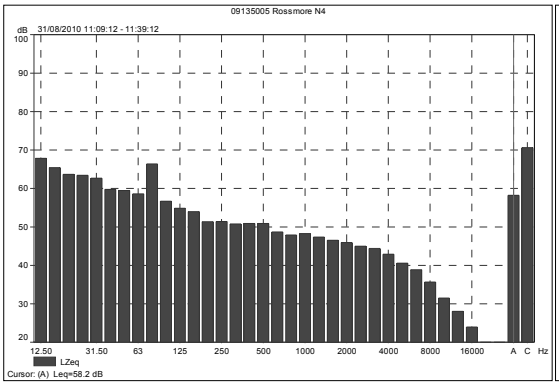
Station	Time	$L_{Aeq\ 30\ min}$ dB	$L_{AF10\ 30\ min}$ dB	$L_{AF90\ 30\ min}$ dB	Specific level* dB	Noise audible
N1	1147-1217	44	47	38	<38	No emissions from landfill or adjacent quarry audible. Bird song/calls, rustling vegetation and aircraft audible. Occasionally firing bird scarer device audible offsite to NE in distance.
N3	0846-0916	37	38	31	<31	No landfill emissions audible. Processing plant emissions at nearby quarry continuously audible at low level. Intermittent truck movements slightly audible on access road serving landfill facility & quarry. Bird song/calls significant. Aircraft. Occasionally firing bird scarer device audible offsite to NE in distance.
N4	1109-1139	58	60	46	58	Intermittent vehicle movements through landfill facility entrance dominant. No other emissions audible from facility apart from waste disposal activities around CA area, including wheeled excavator used in waste management, with tone at 80 Hz. Rustling vegetation. Processing plant emissions at nearby quarry facility continuously audible at low level. Bird song/calls.
N5	1029-1059	48	51	44	<44	No emissions audible from landfill facility. Continuous processing plant emissions clearly audible from quarry to N. Truck movements on access road serving landfill & quarry also audible. Rustling leaves in nearby stand of trees almost continuously audible. Bird song/calls & aircraft. Occasionally firing bird scarer device audible offsite to NE in distance.
GG1	0955-1025	36	39	31	<31	No emissions audible from landfill. Processing & mobile plant continuously audible at low level from quarry facility to N. Bird song/calls & aircraft. Occasionally firing bird scarer device audible offsite to NE in distance.
GG4	0921-0951	31	31	25	<25	No emissions audible from landfill facility. Few extraneous sources audible, chiefly bird song/calls. Aircraft & distant intermittent rooster crowing to S also audible. Occasionally firing bird scarer device audible offsite to NE in distance.

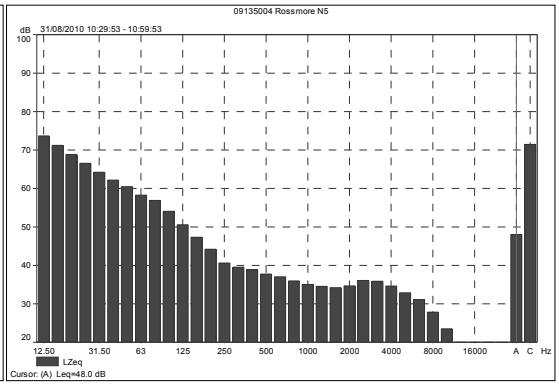
*Specific level: Sound pressure level contribution considered attributable to facility, determined using real time assessment, field notes, time history profiles, statistical analysis, frequency spectra, near field correction if applicable, and other parameters.

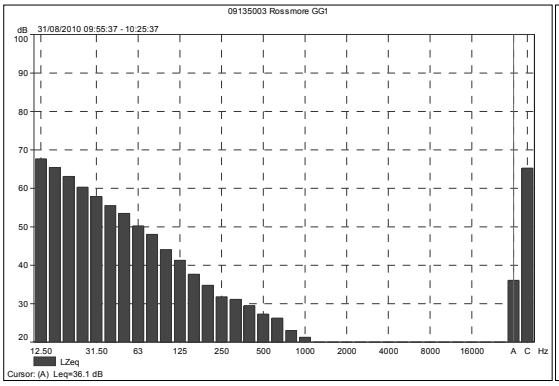
Appendix 5: Frequency spectra

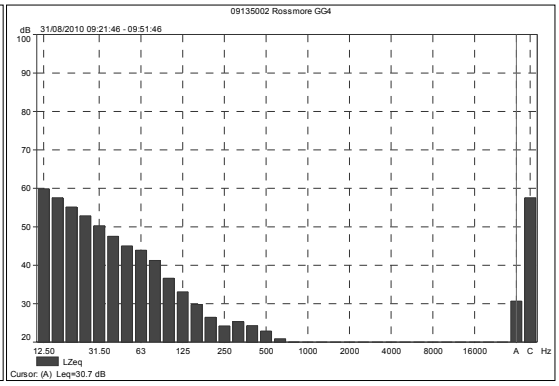












Appendix 6: Glossary

Ambient	Total noise environment at a location, including all sounds present.
A-weighting	Weighting or adjustment applied to sound level to approximate non-linear frequency response of human ear. Denoted by suffix A in parameters such as $L_{Aeq\ T}$, $L_{AF10\ T}$, etc.
Background level	$L_{AF90\ T}$. A-weighted sound pressure level of residual noise exceeded for 90 % of time interval T.
Decibel	Shortened to dB. Unit of noise measurement scale. Based on logarithmic scale so cannot be simply added or subtracted. 3 dB difference is smallest change perceptible to human ear. 10 dB difference is perceived as doubling or halving of sound level. **Throughout this report noise levels are presented as decibels relative to 20 µPa**. Examples of decibel levels are as follows: 20 dB: very quiet room; 30-35 dB: night-time rural environment; 55-65 dB: conversation; 80 dB: busy pub; 100 dB: nightclub.
Fast response	0.125 seconds response time of sound level meter to changing noise levels. Denoted by suffix F in parameters such as $L_{AF10\ T}$, $L_{AF90\ T}$, etc.
Free field	Noise environment away from all surfaces other than ground ie. outside near field.
Frequency	Number of cycles per second of a sound or vibration wave. Low frequency noise may be perceived as hum, while whine represents higher frequency. Range of human hearing approaches 20-20,000 Hertz.
Hertz	Shortened to Hz. Unit of frequency measurement.
Impulse	Noise which is of short duration, typically less than one second, sound pressure level of which is significantly higher than background.
Interval	Time period T over which noise monitoring is conducted. Denoted by T in $L_{Aeq\ T}$, $L_{AF90\ T}$, etc.
$L_{Aeq\ T}$	Equivalent continuous sound level during interval T, effectively representing average A-weighted noise level.
L_{AF}	Sound pressure level averaged over one second, and changing each second in fluctuating noise environment.
$L_{AF10\ T}$	Sound pressure level exceeded for 10% of interval T, usually used to quantify traffic noise.
$L_{AF90\ T}$	Sound pressure level exceeded for 90% of interval T, usually used to quantify background noise. May also be used to describe noise level from continuous steady or almost-steady source, particularly where local noise environment fluctuates.
$L_{Req\ T}$	Rating noise level, derived from $L_{Aeq\ T}$ plus specified adjustments for tonal and impulsive characteristics.
Near field	Noise levels recorded near walls or other surfaces, artificially increased due to reflections. Levels near walls may be increased by up to 3 dB, and up to 6 dB near corners. Free field conditions may be achieved by maintaining separation distance of at least 3.5 m from walls.
Noise sensitive location	Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires absence of noise at nuisance levels.
1/3 octave band	Frequency spectrum may be divided into octave bands. Upper limit of each octave is twice lower limit. Each octave may be subdivided into thirds, allowing greater analysis of tones.
Residual level	Noise level remaining when specific source is absent or does not contribute to ambient.
Specific level	Sound pressure level contribution arising from specific noise source, measured directly or by estimation or calculation.
Tone	Character of noise caused by dominance of one or more frequencies which may result in increased noise nuisance.
Z-weighting	Standard weighting applied by sound level meters to represent linear scale.

LIMOSA ENVIRONMENTAL
ECOLOGICAL AND ENVIRONMENTAL CONSULTANCY

Ecological Monitoring of East Cork Landfill

Report for

Cork County Council

December 2010

Report Reference:	RP10-GW007-04-A
Draft	Draft Report
Prepared by:	L J Lewis
Checked by:	L JrdLewis
Report Date:	23 December 2010
Sign-off date:	
Signature:	

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report presents the results of the 2010 ecological surveys and monitoring undertaken across East Cork Landfill and surrounding area, in fulfilment of the requirements of the East Cork Landfill Waste Licence.

Annual ecological surveys include terrestrial habitats, flora and fauna, intertidal habitats, and waterbird communities of the surrounding harbour area. The scope of work also includes a review of shellfish monitoring and water quality data obtained from the Marine Institute and Environmental Protection Agency, respectively..

Habitat types within the landfill boundaries have changed little during the period in which annual surveys have taken place. The main difference across time is the location and extent of certain habitat types; largely spoil and bare ground (ED2) and recolonising bare ground (ED3) which have varied across the years due to the active nature of the landfill site and associated earth-moving works, and more recently, due to the capping, re-profiling and re-vegetation processes.

Habitats within the study area but outside of the landfill boundary have remained stable across time. These habitats continue to support a diversity of flora and fauna and no obvious differences in the extent or quality of these habitats was noted this year. The scarce plant Yellow-wort continues to occur within the exposed calcareous rock (ER2) habitat on the south-east of the peninsula.

The intertidal survey (benthic flora and fauna) recorded communities consistent with previous annual surveys. The long-term dataset shows that the macroinvertebrate species that characterise the sampling area have continued to be present and abundant across the monitoring period. The overall trend since 2002 has been for increasing species diversity. Over time there appears to have been an increase in the isolated smaller stands of the invasive intertidal grass *Spartina anglica*, but there have been no significant increases in the main (larger) stands and no expansion of the plant across the entire inner bay of Rossmore Bay. This contrasts to other areas close to the site e.g. Belvelly, where *Spartina* now extends over vast areas. Overall results of the 2010 intertidal survey and assessment suggest that that there has been no deterioration in the intertidal habitats across the survey area.

Sediment metal analysis revealed that levels of Chromium, Copper, Lead, Nickel and Zinc were below the lower level threshold of national dredging guidance and the majority below the more stringent Canadian guidance (CCME, 1999). All concentrations of Cadmium were above the lower level thresholds but none were above the upper levels of the national dredging guidance. Arsenic levels were lower in 2010 than in 2009, but there is a pattern for increased levels since 2007. In 2009, one site (SS3) reported the highest levels of Kjeldahl Nitrogen, Organic Carbon and 6 metals. This sample was taken close to the landfill site. In 2010, no such pattern exists and results from this site are in line with other sites. One site in 2010 reported the highest levels of Kjeldahl Nitrogen, Cadmium, Chromium, Lead, Nickel and Zinc - this site is located on the north-western shore of Rossmore Bay i.e. across the other side of the bay from the landfill site.

Waterbird numbers within Rossmore Bay and Brick Island Embayment have shown great variation across the years but the overall trend is for largely stable numbers of the species occurring within these sites. Numbers of Black-tailed Godwits have increased within both areas. The use of a population indexing method helped to reveal that within Rossmore Bay numbers of Shelduck and Oystercatcher have declined over the past five years. Within Brick Island Embayment, numbers of Oystercatcher and Redshank have increased. Curlews show no trend for lower numbers within these two sites, but were present in relatively fewer numbers during the surveys around a wider area of Rossmore Peninsula. This observation is in line with the trends for decline in both the wider Cork Harbour area and nationally. Rossmore Bay and Brick Island Embayment can, on occasion, support numbers of national importance and both sites are important and integral parts of the overall wetland of Cork Harbour.

Based on an information review, we have found no evidence of deterioration in the shellfish quality or shellfish water quality of the North Channel in recent years.

In terms of estuarine water quality, the most recent trophic status assessment of the North Channel undertaken by the EPA shows an overall classification of 'potentially eutrophic'. Winter levels of Dissolved Inorganic Nitrogen (DIN) and levels of Dissolved Oxygen failed to meet required standards. All other measured parameters met their respective standard thresholds, although as a more detailed examination of 2009 data showed that some individual samples within the overall dataset exceeded threshold values. Overall, results from the EPA monitoring programme suggest an improvement in the estuarine water quality of Cork Harbour in recent years.

1.0 INTRODUCTION

1.1 Background

Limosa Environmental was commissioned by Cork County Council to undertake ecological surveys for East Cork Landfill during 2010 in fulfilment of the requirements of the East Cork Landfill Waste Licence (Environmental Protection Agency Reg. No. 22-1, Condition 9.14) as follows:

Condition 9.14 Ecological Monitoring (9.14.1) *''The licensee shall submit to the Agency for its agreement within six months of the date of grant of this licence, proposals for the ongoing monitoring and assessment of the site and the adjoining habitats (including methods) with particular reference to the intertidal habitats (shoreline and mudflats). The scope of these proposals shall take into account the findings of the investigations required by Condition 9.13 and shall include as a minimum, monitoring of the following:*

(i) habitat quality within the Special Protection Area and proposed NHA including the usage of the intertidal areas by estuarine birds and an assessment of the relative importance of the area within the Cork Harbour SPA;

(ii) estuarine water quality and chemical analysis of estuarine sediments;

(iii) flora including macroalgae; and

(iv) macroinvertebrate fauna (including bivalves) of sediments and shoreline (hard substrate).

In addition to the above, a summary and interpretation of the significance of the results of monitoring of the shellfish growing areas in the vicinity of the landfill undertaken by the Department of the Marine and Natural Resources/Marine Institute shall be submitted to the Agency along with the Annual Ecological Report required to be submitted in accordance with schedule D: Recording and Reporting to the Agency."

1.2 Study Area

East Cork Landfill is situated 2.5km south of Carrigtohill, Co Cork and lies on the Rossmore Peninsula; a small peninsula overlooking the North Channel of Cork Harbour (Figure 1). The landfill covers approximately one third of the total land area of the peninsula, some 14.54 hectares. The remaining land on the peninsula is largely agricultural in nature, quarrying is a feature nearby. The nearest residential property is approximately 50m from the landfill boundary and is associated with the premises of Atlantic Shellfish Limited which is currently not in operation.

A landfill has been present at the site since 1986 but developed since 1994 for the acceptance of non-hazardous waste (EPA Inspector's Report: InsRegWLRegNo22-1). The landfill closed for waste acceptance in February 2007 but an area of built surfaces in the north of the site is still operational as a civic amenity centre.

1.3 Areas of ecological importance in the vicinity of East Cork Landfill

From an early period in the planning and licensing stage for the landfill, it was recognised that there were 'ecologically valuable habitats' in the vicinity. Coastal and intertidal habitats that surround Rossmore Peninsula are considered of high ecological value for the following reasons:

- The North Channel (Great Island Channel) lies to the south of the landfill site and stretches from Little Island to Midleton and is bordered by mainland to the north and east, Great Island to the south and Fota Island to the west. Receiving its main freshwater from the Owennacurra and Dungourney Rivers (NPWS, 2001), the North Channel is an integral part of Cork Harbour and is linked to inner Lough Mahon by the Belvelly Channel and to the outer harbour by the Ballynacorra River Channel.

  The North Channel forms part of the **Great Island Channel Special Area of Conservation** (SAC 1058) (EU Habitats Directive 92/43/EEC) and contains several habitats that are listed on Annex I of the directive including 'mudflats and sandflats not covered by seawater at low tide' and 'Atlantic saltmeadows' (*Glauco-Puccinellietalia maritimae*).

  The North Channel in the vicinity of the landfill is known to support the Annex II species Otter *Lutra lutra.*

  The SAC site synopsis (National Parks and Wildlife Service NPWS) is given in Appendix 1.1.

- The North Channel forms an integral part of the **Cork Harbour Special Protection Area** (SPA) (Site Code 4030) designated under Directive 2009/147/EC on the conservation of wild birds (formerly Directive 79/409/EEC) and transposed under Statutory Instrument No. 237 of 2010.

  The SPA site synopsis (NPWS) is given in Appendix 1.1.

- A similar area to the Cork Harbour SPA is also designated as a Ramsar Site (Site Code 835) (Ramsar Convention Bureau, 1984).

1.4 Scope of works

In fulfilment of the waste licence conditions, and following the tender brief issued by Cork County Council, the scope of works for the 2010 surveys was as follows:

- Phase 1 habitat survey of terrestrial components of the site following the 'Habitat classification of Ireland' (Fossitt, 2000). Assessment of changes in habitats and species of flora and fauna since the baseline survey undertaken in 1998.
- Intertidal survey to include estuarine sediments and shoreline; macroalgae and *Spartina* sp. distribution.
- Waterbird surveys of the intertidal mudflats surrounding Rossmore Peninsula. Assessment of the waterbird data and the relative importance of the North Channel within Cork Harbour SPA.
- Chemical analysis of estuarine sediments at pre-determined sampling points and following strict criteria as set out in the tender brief.
- Collection, collation and interpretation of EPA water quality data for the North Channel.
- Collection, collation and interpretation of shellfish monitoring data as collected by the Department of Communications, Marine & Natural Resources - **Note** the regulatory body has now changed and data is obtained from the Marine Institute.
- Consultation with the National Parks & Wildlife Service with regards any recent surveys or monitoring within the study area and to discuss recent trends in waterbird populations.

1.5 Report format

This report is presented in sections that correspond to the different ecological surveys or assessments undertaken. Section 2 presents the results of the terrestrial habitat survey with notes on terrestrial birds and invertebrates that were recorded within the study area throughout the year. Section 3 reports on the intertidal survey and includes macroinvertebrates and sediment analysis. Section 4 provides an assessment of the wintering waterbird community of Rossmore Bay, the North Channel and Brick Island embayment. Finally Section 5 reviews shellfish and water quality data for the study area and Section 6 reviews EPA water quality data for the North Channel.

Figure 1. Aerial photograph of Rossmore Peninsula (Google Earth™). The red arrow points to East Cork Landfill.

Appendix 1.1

SITE SYNOPSIS: GREAT ISLAND CHANNEL SAC & NHA (SITE CODE 01058)

The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour which contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed. Within the site is the estuary of the Owennacurra and Dungourney Rivers. These rivers, which flow through Midleton, provide the main source of freshwater to the North Channel.

The main habitats of conservation interest are the sheltered tidal sand and mudflats and Atlantic salt meadows, both habitats listed on Annex I of the EU Habitats Directive. Owing to the sheltered conditions, the intertidal flats are composed mainly of soft muds. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algal species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially at Rossleague and Belvelly. The salt marshes are scattered through the site and are all of the estuarine type on mud substrate. Species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Greater Sea-spurry (*Spergularia media*), Sea Lavender (*Limonium humile*), Sea Arrowgrass (*Triglochin maritimum*), Mayweed (*Matricaria maritima*) and Red Fescue (*Festuca rubra*).

The site is extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North Channel, Harper's Island and Belvelly-Marino Point. Shelduck are the most frequent duck species with 800-1000 birds centred on the Fota/Marino Point area. There are also large flocks of Teal and Wigeon, especially at the eastern end. Waders occur in the greatest density north of Rosslare, with Dunlin, Godwit, Curlew and Golden Plover the commonest species. A population of about 80 Grey Plover is a notable feature of the area. All the mudflats support feeding birds; the main roost sites are at Weir Island and Brown Island and to the north of Fota at Killacloyne and Harper's Island. Ahanesk supports a roost also but is subject to disturbance. The numbers of Grey Plover and Shelduck, as given above, are of national importance.

The site is an integral part of Cork Harbour which is a wetland of international importance for the birds it supports. Overall, Cork Harbour regularly holds over 20,000 waterfowl and contains internationally important numbers of Black-Tailed Godwit (1,181) and Redshank (1,896) along with nationally important numbers of nineteen other species. Furthermore, it contains the large Dunlin (12,019) and Lapwing (12,528) flocks. All counts are average peaks, 1994/95 - 1996/97. Much of the site forms part of Cork Harbour Special Protection Area, an important bird area designated under the EU Birds Directive.

While the main land use within the site is aquaculture (Oyster farming), the greatest threats to its conservation significance come from road works, infilling, sewage outflows and possible marina developments.

The site is of major importance for the two habitats listed on the EU Habitats Directive that it contains, as well as for its important numbers of wintering waders and wildfowl. It also supports a good invertebrate fauna.

SITE SYNOPSIS: CORK HARBOUR SPA (SITE CODE 4030)

Cork Harbour is a large, sheltered bay system, with several river estuaries - principally those of the Rivers Lee, Douglas, Owenboy and Owenacurra. The SPA site comprises the main intertidal areas of Cork Harbour, including all of the North Channel, the Douglas Estuary, inner Lough Mahon, Monkstown Creek, Lough Beg, the Owenboy Estuary, Whitegate Bay and the Rostellan inlet.

Owing to the sheltered conditions, the intertidal flats are often muddy in character. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algae species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* sp.) has colonised the intertidal flats in places, especially where good shelter exists, such as at Rossleague and Belvelly in the North Channel. Salt marshes are scattered through the site and these provide high tide roosts for the birds. Salt marsh species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Lax-flowered Sea-lavender (*Limonium humile*) and Sea Arrowgrass (*Triglochin maritima*). Some shallow bay water is included in the site. Cork Harbour is adjacent to a major urban centre and a major industrial centre. Rostellan Lake is a small brackish lake that is used by swans throughout the winter. The site also includes some marginal wet grassland areas used by feeding and roosting birds.

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. The five-year average annual core count for the entire harbour complex was 34,661 for the period 1996/97-2000/01. Of particular note is that the site supports an internationally important population of Redshank (1,614) - all figures given are average winter means for the 5 winters 1995/96-1999/00. A further 15 species have populations of national importance, as follows: Great Crested Grebe (218), Cormorant (620), Shelduck (1,426), Wigeon (1,750), Gadwall (15), Teal (807), Pintail (84), Shoveler (135), Red-Breasted Merganser (90), Oystercatcher (791), Lapwing (3,614), Dunlin (4,936), Black-Tailed Godwit (412), Curlew (1,345) and Greenshank (36). The Shelduck population is the largest

in the country (9.6% of national total), while those of Shoveler (4.5% of total) and Pintail (4.2% of total) are also very substantial. The site has regionally or locally important populations of a range of other species, including Whooper Swan (10), Pochard (145), Golden Plover (805), Grey Plover (66) and Turnstone (99). Other species using the site include Bat-tailed Godwit (45), Mallard (456), Tufted Duck (97), Goldeneye (15), Coot (77), Mute Swan (39), Ringed Plover (51), Knot (31), Little Grebe (68) and Grey Heron (47). Cork Harbour is an important site for gulls in winter and autumn, especially Common Gull (2,630) and Lesser Black-Backed Gull (261); Black-Headed Gull (948) also occurs.

A range of passage waders occur regularly in autumn, including Ruff (5-10), Spotted Redshank (1-5) and Green Sandpiper (1-5). Numbers vary between years and usually a few of each of these species over-winter.

The wintering birds in Cork Harbour have been monitored since the 1970s and are counted annually as part of the I-WeBS scheme.

Cork Harbour has a nationally important breeding colony of Common Tern (3-year mean of 69 pairs for the period 1998-2000, with a maximum of 102 pairs in 1995). The birds have nested in Cork Harbour since about 1970, and since 1983 on various artificial structures, notably derelict steel barges and the roof of a Martello Tower. The birds are monitored annually and the chicks are ringed.

Extensive areas of estuarine habitat have been reclaimed since about the 1950s for industrial, port-related and road projects, and further reclamation remains a threat. As Cork Harbour is adjacent to a major urban centre and a major industrial centre, water quality is variable, with the estuary of the River Lee and parts of the Inner Harbour being somewhat eutrophic. However, the polluted conditions may not be having significant impacts on the bird populations. Oil pollution from shipping in Cork Harbour is a general threat. Recreational activities are high in some areas of the harbour, including jet skiing which causes disturbance to roosting birds.

Cork Harbour has is of major ornithological significance, being of international importance both for the total numbers of wintering birds (i.e. > 20,000) and also for its population of Redshank. In addition, there are at least 15 wintering species that have populations of national importance, as well as a nationally important breeding colony of Common Tern. Several of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover, Bar-Tailed Godwit, Ruff and Common Tern. The site provides both feeding and roosting sites for the various bird species that use it.

2.0 TERRESTRIAL HABITAT SURVEY OF EAST CORK LANDFILL AND ENVIRONS

2.1 Habitat Survey Methods

The habitat survey was conducted on 20th July 2010. The survey area comprised the landfill site and immediate surrounding terrestrial and coastal habitats of Rossmore Peninsula. This area was walked and each habitat encountered was mapped onto a field map. Habitats were classified using habitat descriptions and codes set out in the Heritage Council's "*A Guide to Habitats in Ireland*" (Fossitt, 2000). A plant species list was compiled for both habitats recorded within the landfill site and those in the surrounding study area. Target notes were made for habitats encountered, including a note as to the dominant plant species within each habitat type together with an assessment of changes in the habitat since the 2009 and previous surveys.

2.2 Results

Throughout the text, common names are used for plant species. A list of vascular plants is presented in Appendix 2.1, with species Latin names and plant frequency of occurrence within Ireland (after Webb et al. 1996). This table also lists the habitat(s) within which each plant species were recorded. A habitat map was produced and is shown in Figure 2.

Terrestrial habitats are separated into those occurring within the landfill boundaries and those occurring within the surrounding environment. Saltmarsh habitats are included here as they form the transition between land and sea. Intertidal habitats are considered in Section 3.

Landfill Habitats

In 2020 the landfill site comprised four main habitats: buildings and artificial surfaces (BL3), spoil and bare ground (ED2), recolonising bare ground (ED3), and unimproved/semi-natural grassland (GS).

Dry meadows and grassy verges (GS2), amenity grassland (GA2), scrub (WS1), artificial ponds (FL8), hedgerows (WL1) and treelines (WL2) were also present either within the site or on the site boundaries.

Buildings and artificial surfaces (BL3)

This habitat refers to areas of built land (buildings) or any areas where artificial surfaces have been used e.g. tarmac, concrete, paving stones. It occurred exclusively in the north of the site at the landfill entrance where buildings and concreted areas form the landfill management office and the civic amenity area. There is a further small area of BL3 mapped just south of the main area (Figure 2) which relates to the landfill gas flare.

Buildings and artificial surfaces (BL3), spoil and bare ground (ED2) (landfill track) and scrub (WS1) habitats

Spoil and bare ground (ED2)

This habitat refers to areas of bare ground or piles of spoil and rubble but also includes areas with unpaved surfaces kept clear of vegetation through regular use or being regularly driven over (i.e. unpaved tracks or paths). In 2010 there was relatively little of this habitat present and it occurred mainly in the form of the landfill track which runs from the built area southwards before dividing into east and western routes which extend around the perimeter of the landfill site.

There was a further small area of ED2 just to the south-east of the built area used for the positioning of containers and a further area around two small leachate lagoons just to the south.

Spoil and bare ground has vegetation present but a characterising feature is that this habitat should have less than 50% cover. The majority of this habitat was sparsely covered; ED2 occurring close to the leachate lagoons was notable in supporting Ox-eye Daisy, in flower at the time of survey.

The edge of the landfill track supported a greater diversity of plant species as the ED2 habitat merged with the recolonising bare ground (ED3) beyond. In this location there were occasional tall stands of Teasel, swaths of Bird's-foot Trefoil and patches of Ragwort or Yarrow.

Spoil and bare ground (ED2) in the form of the landfill track

Recolonising bare ground (ED3)

Recolonising bare ground is the habitat name used to describe areas where bare or disturbed ground has been recolonised by vegetation to such an extent that vegetation cover is greater than 50%. In terms of species diversity, this habitat can be interesting as a mix of plants can be present, all competing for space and resources, before dominant species 'take over' and species richness declines as a result.

In the landfill site, ED3 is the most interesting habitat in terms of botanical diversity and particularly that in association with the artificial lagoon in the west of the site. Here there was a mixture of plants from those that are good colonisers of bare spaces (e.g. Prickly Sow Thistle, Red Bartsia and Ox-eye Daisy), to species that have naturally spread from the coastal environment (e.g. Sea Campion) to scarcer species that have found 'space' to grow and thrive (e.g. Common Poppy, Bristly Oxtongue).

The largest mapped area of ED3 is the western-most capped landfill cell. Although nearly covered in 100% vegetation, the habitat does not fit neatly into the standard classification. As it occurred as a dense mixture of species and not dominated by grassland, it is best described as ED3. Parts of this area are becoming dominated by one or a few species such as the banks where thistles, docks or Ragwort dominate. Other patches have relatively sparse vegetation and scarcer annuals such as Bristly Ox-tongue were found.

ED3 in the north-east of the site (close to the two leachate lagoons) has developed from bare ground and has most likely grown from a seed mixture. Here a large proportion of the vegetation was White Clover.

Docks dominating the banks of the landfill capped area (unimproved grassland GS habitat)

Amenity grassland (GA2)

Alongside the built area just inside the landfill entrance is a small patch of **amenity grassland (GA2)** with a sward kept short by regular mowing. Grass species dominate although a variety of herbs were also recorded such as Daisy, Dandelion and Ribwort Plantain.

Unimproved/Semi-natural grassland (GS)

Two capped landfill cells (north and south) have been classified as Unimproved/Semi-natural grassland (GS). These habitats have resulted from seeding and are dominated by grass species although Common Nettle, docks or Wild Cabbage can dominate in small patches throughout. Grass species include Yorkshire Fog, Cocksfoot and Rye Grass. The area in the north of the site is older, that in the south having developed since landfill cap re-profiling in recent previous years. Both areas were observed to be used as a breeding habitat by Meadow Pipits and Pheasants.

Scrub (WS1)

Scrub is a broad habitat category referring to areas covered by over 50% in shrubs, small trees or brambles. It occurred in small patches around the landfill boundary in association with hedgerows (WL1) or treelines (WL2) (unmapped). The largest patch of scrub occurred to the west of the built surfaces in the north of the site, and forms a border between the built area and the northern-most capped landfill cell, which is now dominated by unimproved/semi-natural grassland (GS). A large stand of the alien, invasive species Japanese Knotweed occurs here.

Scrub (WS1) separates the landfill track (ED2) from the capped area (unimproved grassland GS) to the south

Artificial lakes and ponds (FL8)

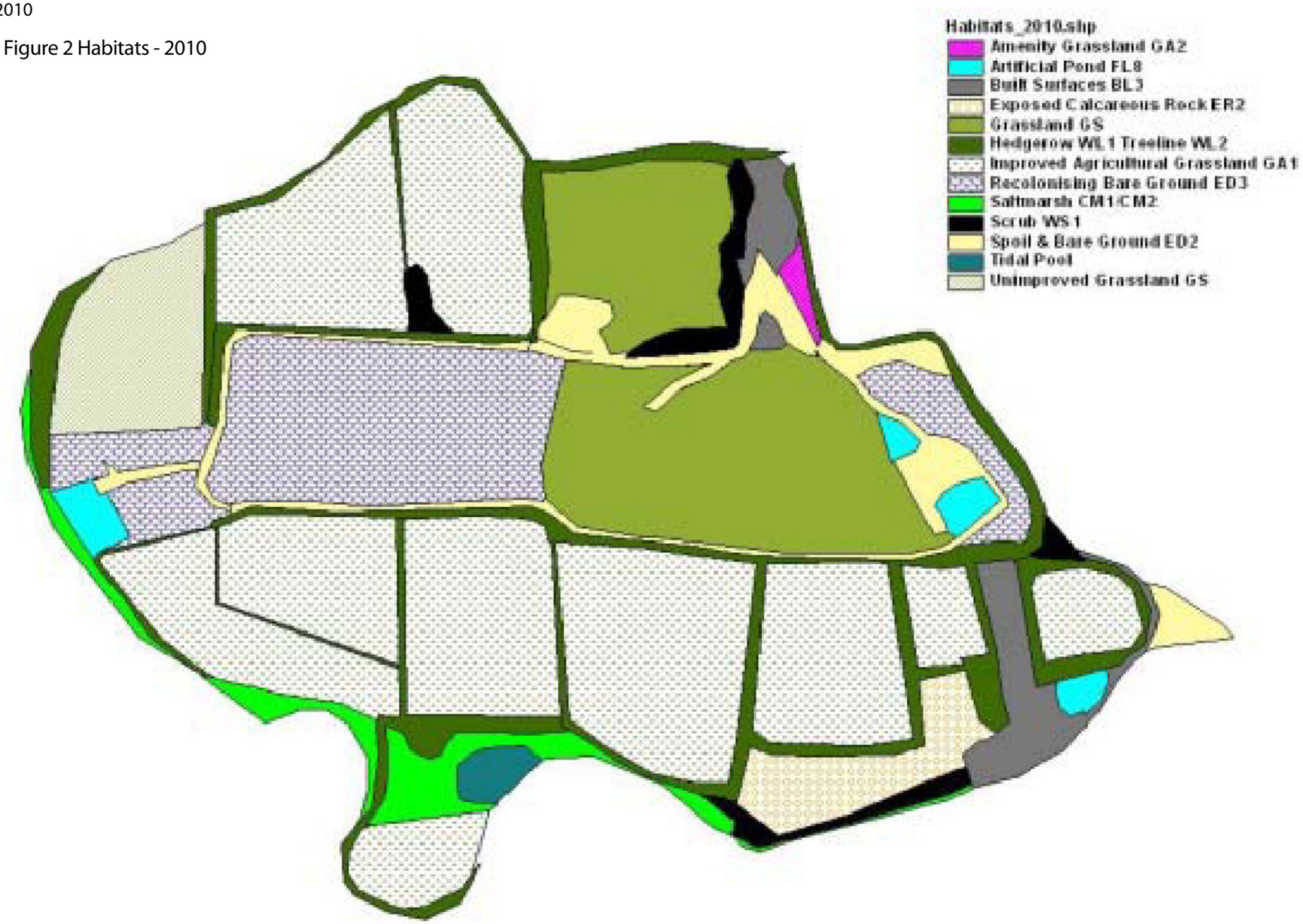
This habitat is used to describe the artificial ponds/leachate lagoons present within the site. They are man-made and support no natural vegetation.

Hedgerows (WL1) and Treelines (WL2)

These habitats were present along the site boundaries and remain largely unchanged from previous years. Species include Hawthorn and Sycamore with associated scrub habitat dominated by Bramble and Nettle. As noted in previous years, a stand of the alien, invasive species Japanese Knotweed
occurs along the southern boundary although it was not recorded on the adjacent landfill cap this year.

Figure 2. Habitat Map 2010

Figure 2 Habitats - 2010



Habitats outside the landfill boundaries

Habitats in the surrounding environment can be divided into terrestrial habitats that occur immediately beyond the site boundaries and coastal habitats that occur around the coastline of Rossmore Peninsula

Terrestrial habitats: Improved Agricultural Grassland (GA1), Semi-natural grassland (GS), Hedgerows (WL1), Treelines (WL2), Scrub (WS1), Exposed calcareous rock (ER2), Built surfaces (BL3).

Coastal Habitats: Lower Saltmarsh (CM1), Upper Saltmarsh (CM2), Mixed Substrata Shore (LR4), Shingle and gravel banks (CB1).

Habitats surrounding the landfill site have changed little in recent years; changes observed on the habitat map are due largely to improvements in mapping.

The dominant habitats in the immediate vicinity of the landfill site are agricultural which cover the remaining terrestrial element of Rossmore Peninsula. Grassland fields are classified as either **improved agricultural grassland (GA1)** or **semi-natural grassland (GS)**, the latter being a broader classification used for areas of unmanaged grassland.

Agricultural fields are mostly bordered by **hedgerows (WL1)** with occasional **treelines (WL2). Scrub (WS1)** often occurs in association with the hedgerows and bramble and gorse scrub often dominates the boundary between the agricultural habitats and the shoreline.

Buildings and artificial surfaces (BL3) occurs on the south-eastern corner of Rossmore peninsula and comprise domestic dwellings, farm buildings, buildings associated with a former shellfish plant and domestic gardens. A man-made pond (artificial pond FL8) also occurs here.

To the south-east is an area of bare, exposed rock, bordered by scrub (predominantly gorse). The habitat is classified as **exposed calcareous rock (ER2)** and provides an interesting diversity of plants that favour limestone/calcareous habitats including Yellow-wort, a species that has a localised distribution within Ireland (Preston *et al.,* 2002). Wood Sage is also found here.

Saltmarsh habitat forms the transition between the terrestrial and intertidal (littoral) habitats that surround Rossmore peninsula; divided into **lower saltmarsh (CM1) and upper saltmarsh (CM2)** depending on their vertical location.

Saltmarsh habitat is present to varying degrees all around Rossmore Peninsula. The largest expanses occur in the inner parts of Rossmore Bay and inner sections of Brick Island Embayment (Figure 2). Lower saltmarsh in Rossmore Bay is dominated by Common Cord-grass (*Spartina* sp.) with Glasswort and Lax-flowered Sea-lavender. Lower saltmarsh within Brick Island Embayment is dominated by Sea Purslane with occasional strands of Common Cord-grass. A clear zonation of saltmarsh plants from lower to upper shore can be observed: Glasswort ► Lax-flowered Sea-lavender ► Sea Beet ► Common Salt-marsh Grass.

Lower and upper saltmarsh also occurs in varying degrees at the top of the shoreline around Rossmore Peninsula. Often only small patches of Glasswort are seen, in other places there are quite dense stands of Lax-flowered Sea-lavender.

Saltmarsh occurs at its most extensive habitat around a tidal pool on the southern point of Rossmore Peninsula (Figure 2). The pool is connected to the sea via an inlet and its surrounding vegetation is dominated by Glasswort sp, Annual Sea-blite, Common Orache and Sea Beet.

Where saltmarsh is not present, the upper shoreline is classified as **shingle and gravel shores (LS1).** Below the strandline the shingle and gravel community gives way to a **mixed substrata shore** (LR4) (described further in Section 3).

2.3 Discussion and Conclusions

2.3.1 Habitat changes across time

Habitat types within the landfill boundaries have changed little during the period in which annual surveys have taken place. The main difference across time is the location and extent of certain habitat types; largely spoil and bare ground (ED2) and recolonising bare ground (ED3) which have varied across the years due to the active nature of the landfill site and associated earth-moving works, and more recently, due to the capping, re-profiling and re-vegetation processes.

Very few 'new' plant species were recorded this year and the majority of previously-recorded species remain to the present day, including scarcer species such as Bristly Ox-tongue. The geology of the area (limestone/calcareous) and the coastal and marine influence lead to an interesting and diverse species list both within and outside the landfill site.

Recolonising vegetation within the landfill site was shown to attract a range of wildlife from mammals (rabbits) to butterflies and birds. However in some places some nuisance plants (e.g. Wild Cabbage) were observed. Some patches of the landfill cap are becoming dominated by docks or bramble - these will quickly expand to form scrub habitat if unchecked.

As noted in previous annual surveys, the alien, invasive species Japanese Knotweed is present within the landfill boundaries and most dominant on the bank just west of the built area in the north of the site. As an aggressively competitive alien, the species' potential to spread into the surrounding coastal habitats of high conservation importance is of concern. However control of this plant should not be undertaken without knowledge of correct means of its removal. Useful guidelines can be found at http://www.invasivespeciesireland.com.

Habitats within the study area outside of the landfill boundary have remained stable across time. The habitats continue to support a diversity of flora and fauna and no obvious differences in the extent or quality of these habitats was noted this year, compared to recent previous annual surveys. The scarce plant Yellow-wort continues to occur within the exposed calcareous rock (ER2) habitat on the south-east of the peninsula.

2.3.2 Common Cord-grass (*Spartina anglica*)

Common Cord-grass first appeared on the south coast of England in the 1890's. Its history is interesting. In the early 19th century the American cord grass *S. alterniflora* was accidentally introduced into England. This plant hybridised with the native *S. maritime* to form *S. townsendii* (Townsend's grass) which was a sterile hybrid. Through subsequent chromosome doubling, Townsend's grass formed the fertile hybrid known as Common Cord-grass (*S. anglica*) (McCorry et al. 2003).

Common Cord-grass was more vigorous than its parents and rapidly colonised coastal areas and stabilised mudflats. This property of stabilising was recognised as a potential tool to reclaim mudflats and the grass was therefore planted on many sites around the coasts of Britain, Ireland and Northern Europe during the 1920's. In Ireland, Common Cord-grass was first planted in 1925 in Cork Harbour (Cummins, 1930).

There has been much debate as to the potential impacts of *Spartina* on the ecology and conservation of the intertidal mudflats and salt marshes it invades. Particular concerns include its impact on eel grass (*Zostera*) communities, Salicornia beds, *Puccinellia maritima* species and general colonisation of salt marshes and mudflats. These impacts include knock-on effects on wintering wildfowl and waders as a result of the loss of feeding grounds and roosting areas. In relation to intertidal macroinvertebrates, it remains inconclusive whether Common Cord-grass decreases or changes diversity which may also impact on bird populations. In terms of positive effects, the grass has been seen to provide shelter and roosting areas for some bird species (e.g. Redshank, Snipe) which is evident within inner Rossmore Bay.

Certainly some studies and observations suggest that negative impacts may not be as serious as previously predicted (McCorry *et al.,* 2003). At some sites the plant has shown a trend for natural' die back' and

although it is not known why, potential reasons include intolerance of anaerobic sediment which was created by the plant itself over time. Certainly the spread of the species and subsequent effects appear to vary on a site by site basis.

Within the study area, Common Cord-grass has been recorded for many years and occurs at two locations - inner Rossmore Bay and inner Brick Island Embayment.

Figure 3 shows a mapped estimation of the extent of the plant within inner Rossmore Bay. The estimated distribution in 2005 was mapped using an aerial photograph (obtained at www.npws.ie). This should be viewed as a best estimation only because of the lack of clarity in the photograph. The 2010 estimated distribution is based on a hand mapping exercise carried out in November 2010. Differences between the 2005 and 2010 distribution are evident with a greater cover during 2010 but given the obvious errors associated with the mapping exercise, the two distributions are relatively similar. Over time there appears to have been an increase in the isolated smaller stands of the plant but there have been no significant increases in the main (larger) stands and no expansion of the plant across the entire inner bay area. This contrasts to some areas close to the site e.g. Belvelly, where Spartina now extends over vast areas completely covering entire areas of the inner estuary.

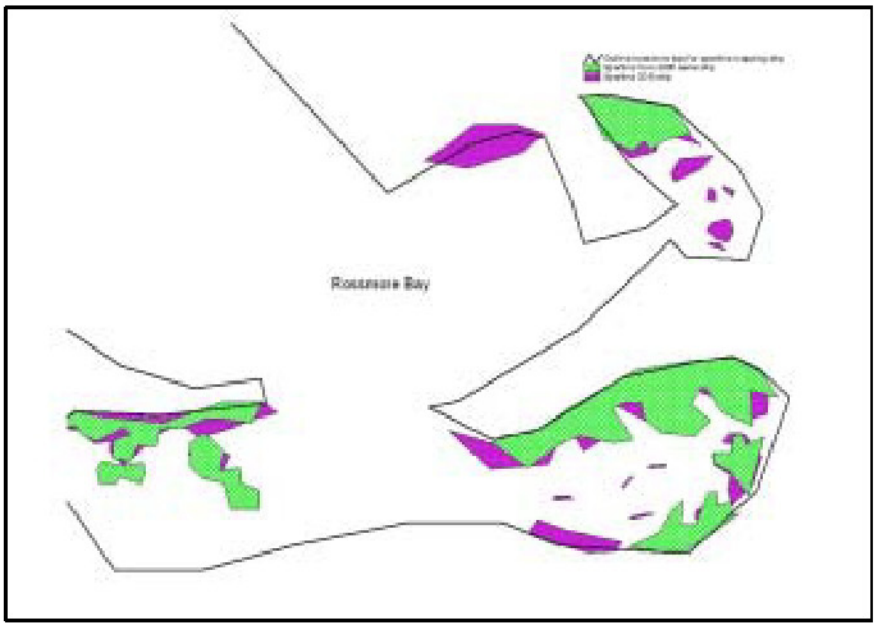


Figure 3 Mapped estimation of extent of *Spartina anglica* within inner Rossmore Bay 2005 and 2010

Spartina anglica within inner Rossmore Bay, November 2010.

2.4 Fauna within the study area

Terrestrial Birds - species within the landfill boundaries

21 bird species were recorded within the landfill site during the 2010 surveys (Appendix 2.2). The majority of these birds were recorded within hedgerow and/or scrub habitats that occur along the site boundaries and particularly those in the south-east of the site.

As in 2009, Meadow Pipits were observed to be breeding within the site. Apparent breeding (observed in the form of territorial flight dives) was evidenced for both the northern capped area (unimproved grassland) and that in the south-east. The latter area also appears to support breeding Pheasants.

Given the likelihood of breeding Meadow Pipits and Pheasants within the site, both ground-nesting birds, we recommend that vegetation management of the landfill caps (e.g. mowing) be undertaken outside the bird breeding season in future years in order to avoid destruction of nests.

Terrestrial Birds - species within the surrounding environment

31 bird species were recorded in the habitats surrounding East Cork landfill site during the 2010 surveys (Appendix 2.2). (Note that waterbird species are considered separately within Section 4 of this report.

Butterflies

Butterfly species recorded during 2010 fieldwork:

- **Small Blue** (*Cupido minimus*) - this is a relatively scarce and localised species. It has been recorded before in the locality most likely due to the species' preference for calcareous land land.
- **Meadow Brown** (*Maniola jurtina*) - widespread and common in meadows and grassy places.
- **Painted Lady** (*Vanessa cardui*) - a large, migrant species recorded in the summer months. This butterfly was observed upon a Buddleja bush along the southern boundary of the landfill site.
- **Large White** (*Pieris brassicae*) - observed inside the landfill site within recolonising bare ground habitat.
- **Small White** (*Pieris rapae*) **-** a very common and widespread species.

Mammals

Signs of terrestrial mammals were recorded during the habitat and waterbird surveys plus during some other dedicated site walkovers undertaken during the year. Mammal presence was identified through visible signs such as tracks and footprints, hair caught in wire fences, feeding signs or remains, burrows/dens and droppings etc.

Mammal species recorded during 2010 fieldwork:

- Rabbit *(Oryctolagus cuniculus)* - signs of rabbits occur widely inside the landfill and it is relatively easy to spot individuals while walking around the site. There are particularly well-used latrine areas upon the southern landfill capped areas. Rabbit burrows occur along landfill boundaries. The species is also widespread within habitats surrounding the landfill site.
- Fox *(Vulpes vulpes)* - tracks and signs observed mainly along the perimeter of the landfill site and at several locations around Rossmore peninsula.

- Brown Rat *(Rattus norvegicus)* - likely to be present within the landfill site but no visible signs were observed during the 2010 surveys, likely due to the on-going programme of vermin control. They are present outside the landfill boundaries and abundant within the hedgerows along the eastern and northern boundaries of the landfill site.

The otter seat (otter resting area) found during the 2006 survey has been eroded further (due to natural coastal erosion) and no direct evidence of otter usage was recorded in 2010 current survey. However, based on previous evidence of otters using the area it is likely that they still do at times.

Appendix 2.1

Latin and common names of plants are given for all species recorded within or adjacent to the landfill site during the 2009 habitat survey. Species names and nomenclature follow Stace (1997) (*i.e*. that used in *Flora Atlas* (Preston *et al*. 2000), and frequency of occurrence in Ireland follows Webb *et al*. (1996).

Habitats: FL8 (artificial pond); GA1 (improved agricultural grassland); GA2 (amenity grassland); GS (unimproved/semi- natural grassland); WL1 (hedgerows); WL2 (treelines); WS1 (scrub); ER2 (exposed calcareous rock); ED2 (spoil & bare ground); ED3 (recolonising bare ground); CM1 (lower saltmarsh); CM2 (Upper saltmarsh).

Latin Name	Common Name	Frequency of occurrence in Ireland	Habitat where recorded
Acer pseudoplatanus	Sycamore	Abundant	WL1, WL2
Achillea millefolium	Yarrow	Abundant	GA2, CM2
Agrostis stolonifera	Creeping Bent	Abundant	GA2, CM2,
Anagallis arvensis	Scarlet Pimpernel	Occasional to frequent	ED3, ED2,
Anthyllis vulneraria	Kidney Vetch	Frequent near coast	CM2
Armeria maritima	Thrift	Frequent	CM2, CM1
Arrhenatherum elatius	False Oat-grass	Abundant	GA2, WS1, GS2, GS,
Aster tripolium	Sea Aster	Very frequent	CM2
Atriplex portulacoides	Sea Purslane	Locally abundant E & S, rare W & N	CM1
Atriplex patula	Common Orache	Frequent	CM2
Bellis perennis	Daisy	Abundant	GA2
Beta vulgaris subsp. *maritima*	Sea Beet	Widespread but occasional	CM1, CM2
Blackstonia perfoliata	Yellow-wort	locally frequent in centre, rare in south-west.	ER2
Brassica oleracea	Wild Cabbage	-	ED3, ED2
Buddleja davidii	Butterfly-bush	Frequent in Cork, non-native	WL1, WL1, WS, ER2
Calystegia sepium	Hedge Bindweed	Frequent	ED3, WL1,
Calystegia soldanella	Sea Bindweed	Rare in S & E	CM2
Capsella bursa-pastoris	Shepherd's-purse	Abundant	ED3
Carex species	Sedge species	-	CM2
Centaura nigra	Common Knapweed	Abundant	ED3
Centaurium erythraea	Common Centaury	Very frequent near the sea	ER2, CM2
Cerastium fontanum	Common Mouse-ear	Abundant	ED3
Cirsium vulgare	Spear Thistle	Abundant	WL1,
Chamaerion angustifolium	Rosebay Willowherb	Locally frequent	ED3, WL1
Cirsium arvense	Creeping Thistle	Abundant	ED3
Cirsium vulgare	Spear Thistle	Abundant	ED3, WL1
Cochleria officinale	Common Scurvey-grass	Frequent	CM2
Crataegus monogyna	Hawthorn	Locally frequent	WL1, WL2
Dactylis glomerata	Cock's-foot	Abundant	GS2, GS
Digitalis purpurea	Foxglove	Very frequent	ED3
Elytrigia repens	Common Couch	Abundant	GS2, GS
Epilobium hirsutum	Great Willowherb	Very frequent	WL1
Fallopia japonica	Japanese Knotweed	Frequent, increasing	ED3, WL1,
Festuca rubra	Red Fescue	Abundant	CM2
Fraxinus excelsior	Ash	Frequent	WL1, WL2
Fumaria officinalis	Common Fumitory	Frequent near the east coast, rarer elsewhere	ED3
Geranium dissectum	Cut-leaved Crane's-bill	Very frequent	ED3
Geranium robertianum	Herb Robert	Abundant	ED3
Geum urbanum	Wood Avens	Frequent	WL
Hedera helix	Ivy	Widespread and abundant	WL
Heracleum sphondylium	Hogweed	Abundant	WS1, WL1
Hieracium sp. Holcus	Hawkweed sp.	Frequent	ED3
lanatus	Yorkshire Fog	Abundant	GA2, ED3, GS

Lactuca serriola	Prickly Lettuce	-	ED3, CM2
Leontodon autumnalis	Autumn Hawkbit	Frequent	ED3, GA2
Leucanthemum vulgare	Oxeye daisy	Abundant	ED3
Limonium humile	Lax-flowered Sea-lavender	Abundant	CM1, CM2
Lolium perenne	Perennial Rye-grass	Abundant	GS
Lonicera periclymenum	Honeysuckle	Frequent and widespread	WL1
Lotus corniculatus	Bird's-foot Trefoil	Abundant	ED3, WL1, CM2
Malva sylvestris	Common Mallow	Frequent in south	ED3
Matricaria discoidea	Pineappleweed	abundant	ED3
Odontites vernus	Red Bartsia	Frequent in south-west	ED3
Papaver rhoeas	Common Poppy	Occasional/frequent	ED2 ED3
Petasites hybridus	Butterbur	Frequent but local	WS1, ED3, ED2
Picris echioides	Bristly Oxtongue	Very rare (introduced)	ED3
Plantago coronopus	Buck's-horn Plantain	Very frequent	CM2
Plantago lanceolata	Ribwort Plantain	Abundant	GA2, ED3, GS
Plantago major	Greater Plantain	Abundant	ED2
Plantago maritima	Sea Plantain	Very frequent	CM2, CM1
Poa annua	Annual Meadow-grass	Abundant	ED3, CM2
Polygonum aviculare agg	Knotgrass	Abundant	ED2, ED3,
Poplus sp.	Popular sp.	-	WL2
Potentilla anserina	Silverweed	Abundant	ED3
Potentilla erecta	Tormentil	Abundant	GS2, ED2, ED3,
Potentilla reptans	Creeping Cinquefoil	Frequent in south and centre, rarer in north	CM2
Prunella vulgaris	Self Heal	Abundant	CM2
Pteridium aquilinum	Bracken	abundant	WL1
Puccinella maritima	Common Saltmarsh-grass	Very frequent	CM1, CM2
Ranunculus repens	Creeping Buttercup	Abundant	GA2, ED3,
Reseda luteola	Weld	Frequent	ED2, ED3
Rosa canina	Dog Rose	Very frequent	WL1
Rubus fruticosus agg.	Bramble	Abundant	WS1, ED3,
Rumex acetosa	Common Sorrel	Abundant	ED3, GS2,
Rumex obtusifolius	Broad-leaved Dock	Abundant	WS1, ED3,
Sagina maritima	Sea Pearlwort	Occasional	CM2
Sambucus nigra	Elder	Frequent	WL1, WL2
Salicornia species	Glasswort species	Frequent	CM1
Salix sp.	Willow	Frequent	WL1, WL2
Scrophularia nodosa	Common Figwort	Very frequent	ED3,
Senecio jacobaea	Common Ragwort	Abundant	GA2, GS2, WS1, ED3, WL1, ER2
Senecio vulgaris	Groundsel	Very frequent	ED3,
Silene uniflora	Sea Campion	Very frequent	ED3, CM2
Sinapis arvensis	Charlock	Frequent	ED3
Sonchus oleraceus	Smooth Sow-thistle	Frequent	GS2
Sonchus asper	Prickly Sow-thistle	Very frequent	ED3
Spartina anglica	Common Cord-grass	Locally abundant	CM1
Spergularia marina	Lesser Sea-spurrey	Very frequent	CM1, CM2
Stachys sylvatica	Hedge Woundwort	Very frequent	ED3
Stellaria media	Common Chickweed	Abundant	ED2
Suaeda maritima	Annual Sea-blite	Frequent	CM1
Taraxacum officinale	Dandelion	Abundant	GA2
Trifolium pratense	Red Clover	Abundant	WL1
Trifolium repens	White Clover	Abundant	CM2
Triglochin maritimum	Sea Arrowgrass	Very frequent	CM2, CM1
Tripleurospermum inodorum	Scentless Mayweed	Disturbed ground, occasional	ED3
Tripleurospermum maritimum	Sea Mayweed	Very frequent	CM2
Ulex europaeus	Gorse	Abundant	WS1, WL1, ER2
Urtica dioica	Common Nettle	Abundant	ED3, WS1, WL1,
Verbascum thapsus	Great Mullein	Locally frequent in south	WL1
Veronica persica	Common Field-speedwell	Abundant	ED3
Vicia cracca	Tufted Vetch	Abundant	WL1

Appendix 2.2

Terrestrial bird species recorded inside East Cork Landfill and within the surrounding environment.

Birds of conservation concern are listed as per Lynas et al. (2007):- Criteria: SPEC = European conservation status.

Bird Species	Observed inside landfill boundaries	Observed outside landfill boundaries	Listed on Birds Of Conservation Concern (Lynas *et al.,* 2007))
Blackbird *Turdus merula*	*	*	
Blue Tit *Parus caeruleus*	*	*	
Bullfinch *Pyrrhula pyrrhula*		*	
Chaffinch *Fringilla coelebs*	*	*	
Chiffchaff *Phylloscopus collybita*	*	*	
Coal Tit *Parus ater*		*	
Dunnock *Prunella modularis*	*	*	
Goldcrest *Regulus regulus*		*	
Goldfinch *Carduelis carduelis*		*	
Great Tit *Parus major*	*	*	
Greenfinch *Carduelis chloris*	*	*	
Grey Wagtail	*	*	
Hooded Crow *Corvus corone cornix*		*	
Jackdaw *Corvus monedula*		*	
Kestrel *Falco tinnunculus*	*	*	Amber-list (SPEC)
Linnet *Carduelis cannabina*	*	*	Amber-list (SPEC)
Magpie *Pica pica*	*	*	
Meadow Pipit *Anthus pratensis*	*	*	
Peregrine Falcon *Falco peregrinus*		*	
Pheasant *Phasianus colchicus*	*	*	
Pied Wagtail *Motacilla alba*		*	
Robin *Erithacus rubecula*	*	*	
Rook *Corvus frugilegus*	*	*	
Sand Martin *Riparia riparia*	*	*	Amber-list (SPEC)
Song Thrush *Turdus philomelos*	*	*	
Starling *Sturnus vulgaris*	*	*	Amber-list (SPEC)
Stonechat *Saxicola torquata*		*	
Swallow *Hirundo rustica*	*	*	Amber-list (SPEC)
Willow Warbler *Phylloscopus trochilus*		*	
Wood Pigeon *Columba palumbus*	*	*	
Wren *Troglodytes troglodytes*	*	*	

3.0 INTERTIDAL SURVEY OF ROSSMORE BAY AND PENINSULA

3.1 Introduction

The survey includes the following components:

- An assessment of the fauna and flora of the hard shore and intertidal mudflats of Rossmore Bay, Rossmore Peninsula (North Channel) and the Brick Island Embayment (core sampling and quadrat survey).
- Sediment chemical analysis.
- Sediment particle size analysis (granulometry).

3.2 Methodology

The intertidal survey was undertaken on 13th August and 27th August 2010.
The 22 sampling sites are located around Rossmore Peninsula, Rossmore Bay and Brick Island Embayment (Figure 3).

Figure 3 Rossmore Bay and position of intertidal sampling sites. Macrofaunal sampling sites are numbered M1 to M22; sediment sampling sites for chemical analysis are numbered SS1 to SS9 (figure reproduced from Cork County Council).

3.2.1 Core sampling

Core-samples were taken at 22 sites (Sites M1 - M22, Figure 3). Each site location was located via the use of a hand-held GPS (Global Positioning System) (Note - the grid reference was taken on the hard shore directly above the mudflat where the cores were taken). This year however, in some cases we found it difficult to re-locate GPS grid references recorded during 2009, possibly due to the natural errors associated with a hand-held GPS or poor satellite coverage during the survey period. Therefore we re-recorded grid references where necessary.

Firstly, a qualitative assessment was made of each core sampling location. This included recording physical features such as: sediment type (i.e. mud, sandy mud, muddy sand or sand), presence and depth of the

anoxic layer, proximity of the river channel and/or drainage channels/creeks, presence of standing water and visible signs of fauna on the sediment surface.

In line with methodology adopted previously, a single core sample was taken from each site. Core sampling was carried out, following standard methodology, each sample being taken with a 10.0cm Ø cylindrical core (area = 0.01m)^{2}to a depth of 15cm (Dalkin & Barnett, 2001). The samples were sieved within low-tide channels on site using a 0.5-mm mesh stainless steel sieve and placed into labelled, watertight plastic bags for transport.

Laboratory processing began with each sample being washed over a 0.5mm-mesh sieve with tap water to clean the sample. Each sample was placed into a white plastic tray for sorting (visual screening of the tray). Macroinvertebrate species detected by eye were placed into labelled sample storage containers with 70% Ethanol.

Sample identification proceeded with the use of a dissecting microscope (Brunel BZM x10 - x20 zoom stereomicroscope). Identification keys (e.g. Hayward & Ryland, 1995) were consulted where necessary. All invertebrates were subsequently counted and their relative abundance determined.

3.2.2 Rocky shore/upper littoral survey

Sampling of the rocky or upper intertidal habitat was undertaken at the 22 sampling sites used for core sampling (Figure 3). Three replicate quadrats (measuring 0.5m x 0.5m = area 0.25m^2) were positioned randomly within the mid-shore zone. Within each quadrat, algal cover was recorded as % cover. Fauna were either counted directly (in the case of larger individuals) or recorded as % cover (in the case of barnacles).

The % cover of flora within quadrats is presented as an average within the three quadrats. Similarly, the abundance of barnacles is also presented as average % cover. In the case of other fauna, the peak abundance within any of the three quadrats was determined, this then extrapolated to numbers/m^2 and the result presented as per the SACFOR Scale (following the Marine Nature Conservation Review SACFOR Abundance Scale, Connor *et al.,* 2004): S (Superabundant); A (Abundant); C (Common); F (Frequent); O (Occasional); R (Rare).

Marine biotope codes were assigned to sampling sites (soft sediment and hard shore habitats) as per the Marine Biotope Classification of Britain and Ireland (Connor *et al.,* 2004). A biotope is defined as the 'physical habitat together with its characteristic community of plants and/or animals' (Connor *et al.,* 1997).

3.2.3 Sediment chemical and physical analysis

Sediment samples were taken at 9 No. sampling sites (Figure 3) on 18th October 2010. A single control sample was also taken; sample 10 being a duplicate of sample site 2. Sample site locations were the same as used in previous years; sample locations located using a hand-held GPS (Table 3.1).

Table 3.1 Location of sediment sampling sites as recorded with a hand-held GPS.

Sampling Site	Easting (m)	Northing (m)
1	182966	070163
2	182828	070433
3	182339	070565
4	182500	070650
5	182352	070794
6	181915	070880
7	182186	069992
8	182000	070221
9	181996	070458
10	182352	070794

At each site, small scoops of sediment (to a depth no greater than 10cm) were taken for organic carbon and granulometry analysis. A small sample of surface sediment was taken with a plastic scoop and packaged separately for metals analysis.

All samples were put into clean, sterile, plastic bags and labelled. Samples for chemical analysis were placed into a cool box for transport (via courier) to City Analysts, Dublin. Samples for granulometry analysis were placed into a container and delivered to Aquatic Services Unit (UCC) in Cork.

Laboratory analyses are described in Table 3.2.

Table 3.2 Sediment Chemical and Physical Analyses

PARAMETER	METHOD OF ANALYSIS	UNITS
Granulometry	Sieving	% Coarse Sand (2mm - 710µm) % Medium Sand (710 µm - 250 µm), % Fine Sand (250 µm - 63 µm), % Silt/Clay (< 63 µm)
Organic Carbon	Loss on Ignition (LOI)	%
Kjeldahl Nitrogen	Kjeldahl digestion and automated ammonia analysis	mg/g
Arsenic	Atomic adsorption spectrometry (AAS)	mg/kg
Cadmium	Atomic adsorption spectrometry (AAS)	mg/kg
Chromium	Atomic adsorption spectrometry (AAS)	mg/kg
Copper	Atomic adsorption spectrometry (AAS)	mg/kg
Lead	Atomic adsorption spectrometry (AAS)	mg/kg
Nickel	Atomic adsorption spectrometry (AAS)	mg/kg
Zinc	Atomic adsorption spectrometry (AAS)	mg/kg
Mercury	Atomic adsorption spectrometry (AAS)	mg/kg

3.3 Results & Discussion

3.3.1 Intertidal flora and fauna

Fauna and flora of the 'hard' shore line - Mixed Substrata Shore

The sampling sites are characterised by an intertidal zone consisting of an upper shore of cobbles/pebbles which extends vertically downwards to a mudflat. A zonation in particle size from the upper to lower hard shore can be observed at the majority of sites, with the upper shore comprising of boulders, larger cobbles and pebbles which become progressively smaller down shore to where pebbles and finer gravels dominate the zone just above the mudflat. In many cases there is no clear division between the hard (rock) littoral habitat and the soft (sediment) littoral habitat, as gravels and pebbles merge into the mudflat (e.g. Site M15, M17). Sites M10 and M11 have no upper 'hard' shore as saltmarsh lies above the mudflat.

According to Fossitt (2000) the best classification to use for the 'hard shore' is 'mixed substrata shore' (LR4) which is used to classify locations where the shoreline comprises a mixture of rock and sediment and in sheltered situations may support fucoid communities similar to sheltered rocky shores (i.e. *Ascophyllum nodosum* & fucoids). In some cases however, the shoreline may best be suited to a 'mixed sediment shore' (LS5) where there is limited actual underlying rock but cobbles, pebbles and gravel on sediment. Fossitt (2000) and the Marine Habitat Classification for Britain and Ireland (2004) are slightly at variance because the latter considers fucoid shores on mixed substrata as littoral rock as opposed to littoral sediment.

Flora and faunal species recorded during the quadrat survey are presented in Table 3.3. Descriptions for each sampling site are given in Appendix 3.1.

A common feature of mixed substrata shorelines is the presence of a fucoid (algal) zone. Within the survey area a fucoid zone was observed at 20 out of the 22 sampling sites (M10 and M11 the exceptions). The brown alga Egg Wrack (*Ascophyllum nodosum*) dominated most sites, with varying amounts of Bladder Wrack (*Fucus vesiculosis*) and to a lesser extent Channelled Wrack (*Pelvetia canaliculata*), the latter usually present as a very narrow band at the upper extent of the fucoid zone.

The green alga *Ulva* (formerly *Enteromorpha*) was recorded at six sites upon the hard shore (the same as in 2009), although its presence was predominantly due to being washed up with the tide. Algal mats of Ulva species occurred upon the mudflat, particularly prevalent along the northern shore of Rossmore Bay.

Faunal species observed during the quadrat survey of the hard shore included barnacles *Semibalanus balanoides* and *Elminius modestus,* the latter generally being the dominant species*,* Shore crabs (*Carcinus maenas*), Littorinid periwinkles, amphipod crustaceans (Talitridae (Sandhoppers) and Gammaridae).

The marine biotopes assigned to the mixed substrata shoreline (hard shore) are the same as those assigned in previous years, as follows:

- *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock' (LR.LLR.FVS.AscVS) - this biotope describes the dominant macroalgal species recorded but also the faunal community associated with it that includes winkles (*Littorina littorea, L. obtusata*), Barnacles (*Semibalanus balanoides* and *Elminius modestus*), occasional Mussels (*Mytilus edulis)* and Shore Crabs (*Carcinus maenas*).
- Ephemeral green and red seaweeds on variable salinity and/or disturbed mixed substrata (LR.FLR.Eph.EphX) - describes areas where green macroalgae (e.g. Ulva) is present in a layer overlying pebbles and cobbles and/or mud/gravel.
- *Fucus vesiculosis* on mid-eulittoral variable salinity boulders and stable mixed substrata (LR.LLR.Fves.VS) - describes areas where a distinct zone of Bladder Wrack occurred.

Other biotopes present include:

- Saltmarsh (LS.LMp.Sm) - describes the saltmarsh community on the upper shore.
- Strandline (LS.Lsa.St) - a line of decomposing seaweed (wrack) left behind by a falling tide.
- Shingle (pebble) and gravel shores (LS.LCS.Sh) - a higher biotope code that could be used for areas with no further distinguishing characteristics/species.
- *Pelvetia canaliculata* on sheltered, variable salinity littoral fringe rock (LR.LLR.FVS.PelVS) - narrow band of Channel Wrack (*Pelvetia canaliculata*) found occasionally above the macroalgal zone.
- Yellow and grey lichens on supralittoral rock (LR.FLR.Lic.YG) - lichens growing on upper shore (supralittoral) rocks.
- *Verrucaria maura* on littoral fringe rock (LR.FLR.LIV.Ver) - characteristic black lichen growing on supralittoral rock.

Table 3.3 Fauna of the hard shoreline of sampling sites M1 - M22.
Flora and Barnacles are presented as average % cover (average cover within 3 replicate quadrats). The red alga *Polysiphonia lanosa* is recorded as present/absent (X). Lugworm (*Arenicola marina*) casts are recorded as present/absent (X). Peak numbers of fauna (within a single quadrat) were presented as per the SACFOR Scale (see Section 3.2.2). Sites M10 and M11 lack a hard shore and no visible epifauna was recorded.

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Flora																						
(average % cover)																						
Ascophyllum nodosum	100	90	70	67	100	11	77	40	79			84	73	68	79	72	15	20	22	93 *Fucus*		
vesiculosis	18	13	12	62	12	<2	8	8	15			8	12	52	14	8						
Ulva sp (formerly *Enteromorpha* sp)						5	8							25			<2			<2	4	
Presence/Absence																						
Polysiphonia lanosa									X			X					X	X			X	X
Fauna																						
Barnacles (% cover)	<2	<2	3	3	<2		<2					4					4	3	<2	<2	14	
Other fauna (SACFOR Scale)																						
Amphipods	F	F	F	F	F	F	F	O				F	F		F		F		F			F
Carcinus maenas		A	C	C		C																
Littorina spp.	F	C	F	F	F	A		F				A			A	F		F	F *Arenicola marina* (Casts)			
	X	X	X	X	X	X		X				X			X	X						

Flora and fauna of the mudflats

The mudflat habitat varies from 'mud shore' (LS4) to 'muddy sand shore' (LS3). Inner and more sheltered areas such as Rossmore Bay and Brick Island embayment are characterised by soft sediment (silt/clay) as a result of the low energy environment leading to deposition of fine silt/clay particles. These inner areas are also characterised by the presence of Common Cord Grass *Spartina* sp. (See Section 2). More exposed areas, such as the outer Rossmore Peninsula are characterised by coarser, sandier particles.

Macroinvertebrates recorded within core samples are shown in Table 3.4. Descriptions for each sampling site are given in Appendix 3.1.

A total 14 invertebrate taxa were found within the samples. Species richness, (a measure of the total number of species or taxa per sample) varied from one to eight across all sampling stations. As reported in previous annual surveys, species richness was highest within Rossmore Bay sites (e.g. M3, M4, M6 and M8) and lower at sites along the southern shore of Rossmore Peninsula (North Channel).

The large polychaete *Nepthys* sp. was the most frequently recorded invertebrate, recorded from 12 of the sampling stations. The polychaete *Hediste diversicolor* was the second most frequent species, recorded at 11 sampling sites. Oligochaete worms were recorded at one site this year; this contrasts greatly with the results from 2009 when they were the most-frequently observed taxa.

Of note this year, was the abundance of the amphipod *Corophium volutator* at several sites, notably M9 where the mudflat was observed to be 'teeming' with these small crustaceans. As with previous annual surveys, this species' distribution appears to be clustered around sites M9 to M14, with relatively few individuals elsewhere.

The mud snail *Hydrobia ulvae* was less abundant this year than in previous annual surveys. It was recorded at only two sites (M5 and M8) in contrast to eight sites in 2009.

The marine biotopes assigned to the mudflat sampling sites are similar to those assigned in previous years. Very often the community recorded (based on one core sample) does not easily fit into a biotope code, so the best-fit is used, or where necessary, an upper biotope code to describe the general community. Biotopes assigned in 2010 are as follows (and see Appendix 3.1):

- LS.Lmu.MEst Polychaete/bivalve dominated mid estuarine mud shores - an upper biotope code used to describe mid estuarine shores of silt clay or silty mud sediment with rich communities of polychaetes, bivalves & oligochaetes. Used for the majority of sampling sites as the species assemblage recorded did not fit neatly into a lower biotope code.
- LS.LSa.MuSa Polychaete/bivalve dominated muddy sand shores - an upper biotope code used to cover a range of biotopes that could occur.
- LS.LMu.MEst.Hed.Mac.Scr *Hediste diversicolor, Macoma balthica and Scrobicularia plana* in littoral sandy mud shores.

Table 3.4 Benthic macrofauna within core samples (2010). Abundance per core (numbers/0.01m ^{2})

Taxa	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22
Phylum Annelida																						
Class Polychaeta																						
Hediste diversicolor	1		1	2	3	1	6	2	3	1		3							1			
Nepthys sp.		2	1	2				2	1				1	1		1		1	2	1	1	
Nepthys hombergi															1							
Nepthys caecea					1																	
Spionid indent.			3	1		1	1					8							2	1		
Phyllodocidae indent						1																
Arenicola marina		4	2			1		1				1	1									3
Ampharete acutifrons			2	1		3																
Class Oligochaeta																						
Oligochaetes																					3	
Phylum Mollusca																						
Class Gastropoda																						
Hydrobia ulvae					5			6														
Class Bivalvia																						
Cerastoderma edule								1														
Scrobicularia plana							1	1													1	
Macoma balthica						1		1													1	1
Phylum Crustacea																						
Order Amphipoda																						
Corophium volutator				1	1			55	132	3	27	41	17	45				4				6
Order Decapoda																						
Crangon crangon																			1			
Total No. Individuals	1	6	9	7	10	8	8	69	136	4	27	53	19	46	1	1	0	5	6	2	6	10
Total No. Species/taxa	1	2	5	5	4	6	3	8	3	2	1	4	3	2	1	1	0	2	4	2	4	3

Shoreline in the region of sampling site M18 (SS7)

Shoreline in the region of sampling site M16

Shoreline in the region of sampling site M15

Brick Island Embayment

Intertidal flora and fauna - Discussion

- Hard Shore flora and fauna

The fauna and flora of the mixed substrata shoreline recorded in 2010 were remarkably similar to that recorded in previous annual surveys. The macroalgal community was dominated by Egg Wrack (*Ascophyllum nodosum*) with variable amounts of Bladder Wrack (*Fucus vesiculosis*). The green macroalga *Ulva* (formerly *Enteromorpha* sp.) was present in varying amounts but as in previous years, appeared as an 'algal mat' along the northern shore of Rossmore Bay.

The algal species recorded are widespread around Ireland and although generally resistant to many forms of environmental impact, can be slow to re-establish following severe damage. Within the survey area, the macroalgal community appears to have changed little over time. The long-term dataset shows a trend for a more dense community of Egg Wrack (*Ascophyllum nodosum*) at sites along the northern and southern shores of Rossmore Bay with a more variable cover at sampling sites around Rossmore Peninsula. This pattern is as expected given that Egg Wrack (*Ascophyllum nodosum*) is characteristic of more sheltered shores.

The faunal species recorded upon the mixed substrata shore shows little change over recent years. Abundances appeared a little lower in 2010 but this is likely due to sampling on a large spring tide which led to the shoreline being very dried out; mobile species e.g. amphipods *Talitrus saltator* or Shore Crabs (*Carcinus maenas*) having likely burrowed or moved in order to gain shelter in wetter areas.

Overall the results suggest that there has been little change in the flora and fauna of the mixed substrata shore over time.

- Intertidal (soft sediment) macroinvertebrates

Species diversity in 2010 was in line with recent annual surveys, although slightly lower than recorded during 2009. The overall trend since 2002 has been for increasing species diversity (Figure 4). A pattern exists in the long-term dataset for sampling sites within Rossmore Bay (M1-M9) to be more diverse than sites along the southern shore of Rossmore Peninsula (North Channel).

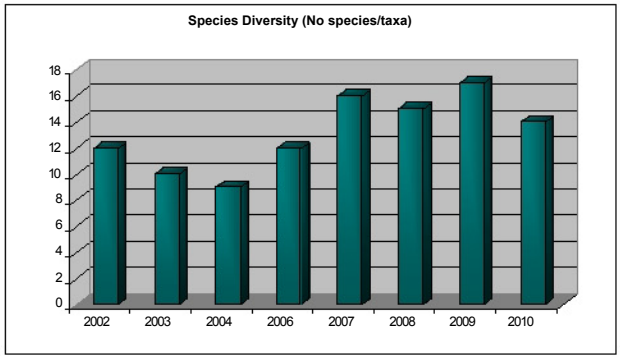


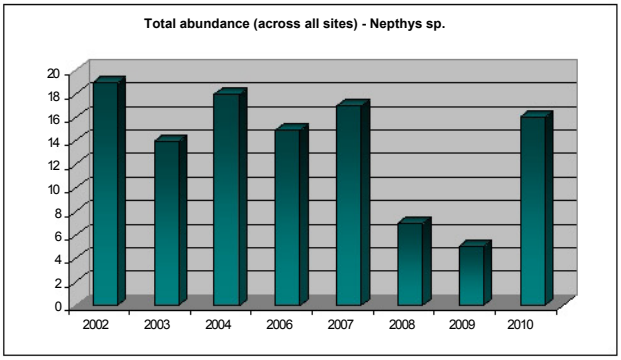
Figure 4 Total number of macroinvertebrate species/taxa recorded 2002-2010.

Proliferations of oligochaete worms can be linked to organic enrichment or pollution. Oligochaete worms have been recorded with varying abundance and distribution across the years that the landfill monitoring has been undertaken. In 2009, Oligochaetes occurred more frequently than in previous annual surveys although not at a level that would be considered an unusual proliferation. The species was recorded at only one site during 2010 and in very low numbers.

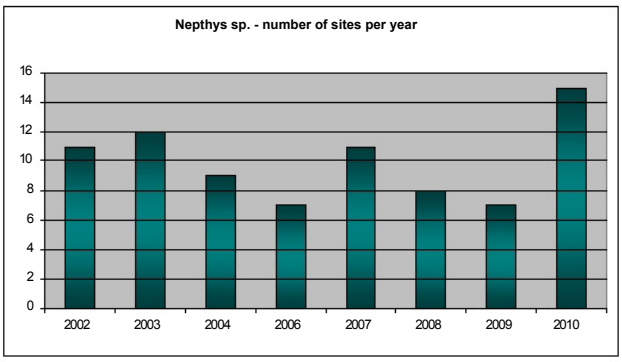
The large polychaete worm *Nepthys* sp. is a characterising species of the North Channel mudflat community (NPWS, 2001). Apart from lower abundances in 2008 and 2009, the species has been relatively stable across time in terms of total abundance (Figure 5a). The species has been recorded at between 7 and 15 sites across the years 2002 - 2010; the pattern across time shows no trend for decline and the species was recorded in the greatest number of sampling sites during 2010 (Figure 5b).

Figure 5

(a) Total number of *Nepthys sp*. recorded 2002-2010.



(b) Number of sites *Nepthys sp*. was recorded (2002-2010).



Corophium volutator is also an important characterising species of mudflat communities. This burrowing amphipod was recorded in relatively low numbers in 2008 and 2009 but total numbers in 2010 were the highest across the entire dataset. This species occurs mainly at sampling sites M9 - M12, associated with the soft silt sediment of inner Rossmore Bay.

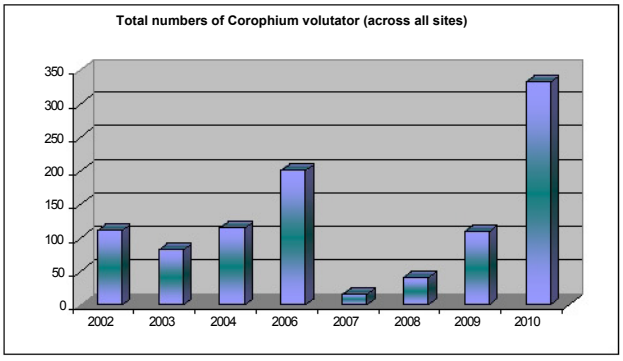


Figure 6 Total number of *Corophium volutator* (across all sites) 2002-2010.

The long-term dataset shows that the macroinvertebrate species that characterise the sampling area have continued to be present and abundant across the monitoring period. There is evidence that species richness (number of species/taxa) has increased over the years although this trend is tentative given that sampling methodology differed a little in earlier years (e.g. a 1mm mesh sieve used as opposed to a 0.5mm mesh sieve in recent years).

The species recorded are characteristic infaunal species of a mid-estuarine shore which is subject to variable salinity but does not undergo the extreme changes in salinity which occurs at the head of an estuary where there is a large freshwater input.

The intertidal sampling sites cover two broad habitat types, that of 'hard shore' classified as a 'mixed substrata shore' and littoral sediment (mudflat), classified as a 'mud shore' under Fossitt (2000). This combination results in an increase in the diversity of species, communities and biotopes across the sampling area. These habitats provide important foraging habitat for wildfowl and wading birds plus a range of other fauna species. In conclusion, the 2010 intertidal survey and assessment of results in light of previous annual surveys, suggests that that there has been no deterioration in the intertidal habitats across the survey area.

3.3.2 Intertidal sediment analysis - results & discussion

Granulometry

Results of granulometry (sediment particle size) analysis are shown in Table 3.6.

Eight out of ten samples taken during 2009 comprised silt-clay sediment (mud). One sample (SS8) reported sandy silt and one sample (SS9) reported gravel-influenced silt.

As found in previous annual surveys, Sites SS1 and SS2 in Brick Island Embayment had the greatest proportion of fine particles (i.e. particles < 63 µm in size), along with SS3 (inner Rossmore Bay).

Sites SS7 and SS8 had the greatest proportion of fine sand; these sites also reported this trend in 2009.

The results for SS2 and SS10 compare favourably, Site SS10 being a control replicate of SS2.

Table 3.6 Granulometry Results 2010

Site	% Gravel >2mm	%Coarse Sand 2mm-710µm	% Med Sand 710-250 µm	% Fine Sand 250-63 µm	% Silt/Clay < 63 µm	
SS1	0.1	0	0.2	2.6	97.1	Silt Clay (Mud)
SS2	1.2	0.8	0.4	5.9	91.7	Silt Clay (Mud)
SS3	0.4	0.6	1.3	0.7	97.0	Silt Clay (Mud)
SS4	0.2	0.2	0.7	5.6	93.3	Silt Clay (Mud)
SS5	5.3	1.3	0.7	8.2	84.5	Silt Clay (Mud)
SS6	2.5	0.5	0.3	16.7	80.0	Silt Clay (Mud)
SS7	0	0.7	0.6	21.7	77.0	Silt Clay (Mud)
SS8	0.3	0.2	2.4	46.2	50.9	Sandy Silt (Sandy Mud)
SS9	27.1	1.4	1.2	9.5	60.8	Gravelly Silt
SS10	0.6	0.1	0.4	5.3	93.6	Silt Clay (Mud)

Sediment chemical analysis

Results of the sediment chemical analyses are shown in Table 3.7. The highest result of any parameter is highlighted blue. Note that SS10 is a control (duplicate) of SS2.

Table 3.7 Sediment Chemical Analysis (2010)

Parameter	Units	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10
Organic Carbon	%	0.7	1.0	0.83	0.97	1.1	0.99	0.75	0.32	1.3	0.87
Kjeldahl Nitrogen	mg/g N	0.74	0.65	0.77	0.61	0.83	0.83	0.78	0.38	<5	0.03
Arsenic	mg/kg	5.0	6.0	7.2	5.8	5.4	5.6	10.00	6.2	6.9	5.4
Cadmium	mg/kg	<1	1.1	1.6	1.5	1.5	2.1	1.3	1.3	1.7	1.6
Chromium	mg/kg	13	16	19	16	17	24	16	15	21	18
Copper	mg/kg	9 13	13	21	19	19	12	11	17	13 Lead	
	mg/kg	14.89	19.75	24.97	21.5	18.04	25.36	17.0	16.6	21.1	20
Nickel	mg/kg	10.5	12.5	13.7	12.1	12.4	18.4	11.5	12.1	14.5	13.4
Zinc	mg/kg	55.1	65.2	61.7	64.2	62.1	86.6	56.4	58.9	74.3	63
Mercury	mg/kg	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35

- *% Organic Carbon*

Carbon is a basic constituent of all organic compounds and the carbon in plant and animal tissue eventually breaks down to become organic matter. Organic content of sediment is closely correlated with sediment particle size; higher organic matter contents being found in muddy sediments.

Organic carbon values within the ten sediment samples for 2010 were relatively low (range 0.32 - 1.3) and well within the 5% threshold that generally indicates a level of organic enrichment (e.g. Hansen & Kristensen, 1997).

- *Kjeldahl Nitrogen*

Kjeldahl Nitrogen is a measure of ammonia plus organic nitrogen. The un-ionised ammonium ion (NH^3) is regarded as the most toxic form of ammonia and generally increases in aquatic environments with lower levels of dissolved oxygen and reduced salinity. The source of ammonia to tidal waters is linked to sewage treatment plants, agricultural run-off and industrial effluents.

Levels of Kjeldahl Nitrogen found within sediment samples for 2010 ranged from 0.03 mg/g N (SS10) to 0.83 mg/g N (SS3). The levels recorded are well within the considered normal range for an estuary that is subject to a variety of anthropogenic influences. As noted in 2009, results in recent years have been significantly lower than in previously reported years (Table 3.8).

Table 3.8 Kjeldahl Nitrogen (mg/g N) - current and previous results.

	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9
2010	0.74	0.65	0.77	0.61	0.83	0.83	0.78	0.38	<5
2009	0.235	0.210	0.970	0.165	0.195	0.058	0.403	0.235	0.045
2008	1.00	1.00	1.60	1.40	1.30	1.30	2.80	2.40	3.40
2007	1.87	2.28	2.729	2.563	2.008	0.967	2.822	1.531	1.047
2006	1.04	0.98	1.10	0.98	0.98	0.49	1.06	0.66	0.99
2004	1.80	1.25	2.18	2.38	1.70	1.57	2.13	1.50	1.45
2002	1.80	1.25	2.18	2.38	1.70	1.57	2.13	1.50	1.45

Metals

Metals occur naturally within marine sediments but also arise from anthropogenic sources. There are five main sources of heavy metals to aquatic and sedimentary systems (after Wittmann & Förstner, 1980):-

- Erosion of geological sources;
- Industrial processing of ores and metals;
- The use of metals and metal compounds in industry;
- the burning of fossil fuels;
- leaching from refuse dumps.

Of particular significance is the fact that the decay of organic matter, a normal and important process within estuaries, can enhance the harmful potential of heavy metals because reducing conditions help mobilise the metals. As noted above, the sampling area is not characterised by high levels of organic matter, indeed the sampling area is classified as a mid-estuary (Section 3.1.1). although reducing conditions are apparent in certain areas such as the inner reaches of Rossmore Bay and Brick Island Embayment.

Assessing the levels of metals within the marine sediments of the sampling area has therefore been an important part of the landfill monitoring programme.

The results of the 2010 sediment metal analyses were compared against the Marine Institute Dredging Guidelines (Marine Institute, 2006). The MI Lower level defines a threshold of contamination, below which biological effects would not be anticipated. Results were also compared against thresholds drawn up by Canada (CCME, 1999) (Thresholds are given in Appendix 3.2).

- Arsenic

Arsenic is a metalloid that is considered nonessential to living organisms. The most stringent threshold applied to this metal is 7.24 mg/kg (CCME, 1999).

Results for 2010 show that all samples are below the most stringent threshold with the exception of SS7 (10.0 mg/kg) which is above both the Marine Institute (2006) and Canadian CCME (1999) guidance values.

Results from samples SS3, SS8 and SS9, the closest sampling sites to the landfill site, are significantly lower than that reported in 2009 (Table 3.9).

Table 3.9 Arsenic levels (mg/kg) - current and previous results.

	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9
2010	5.0	6.0	7.2	5.8	5.4	5.6	10.0	6.2	6.9
2009	6.70	7.70	9.20	5.10	7.10	7.30	6.50	8.20	9.80
2008	4.60	7.20	<1.00	6.30	5.00	9.50	7.30	4.90	6.00
2007	0.313	0.328	0.48	0.237	0.434	0.37	0.113	0.175	0.303
2006	2.21	2.32	1.04	2.68	1.70	2.42	1.90	2.80	2.70
2004	1.88	2.15	3.04	1.67	1.23	0.93	1.17	2.67	0.86

- Cadmium

All samples contained levels of Cadmium above the lower levels (0.7mg/kg) of the national dredging guidance (MI, 2006) and CCME (2006). The levels however were lower than the upper level (4.2 mg/kg) of the national standard guidance (MI, 2006). SS6 recorded the highest level (2.2 mg/kg)

- Chromium

All samples contained levels of Chromium below the lower levels of the national dredging guidance (MI, 2006) and below the more stringent threshold of CCME (2006).

- Copper

All samples contained levels of Copper below the lower levels of the national dredging guidance (MI, 2006). Three samples (SS4, SS5 & SS6) had levels above the more stringent threshold of CCME (2006).

- Lead

All samples contained levels of Lead below the lower levels of the national dredging guidance (MI, 2006) and below the more stringent threshold of CCME (2006).

- Nickel

All samples contained levels of Nickel below the lower levels of the national dredging guidance (MI, 2006) (no threshold being given by CCME, 1999).

- Zinc

All samples contained levels of Zinc below the lower levels of the national dredging guidance (MI, 2006) and below the more stringent threshold of CCME (2006).

- Mercury

All sediment samples contained levels below 0.35 mg/kg but analysis is not sensitive enough to ascertain lower levels and hence compare with the most stringent sediment quality criteria.

General discussion

Levels of Chromium, Copper, Lead, Nickel and Zinc were found to be generally low, all below the lower levels threshold of national dredging guidance and the majority below the more stringent Canadian guidance (CCME, 1999) (Table 3.10). All concentrations of Cadmium were above the lower level thresholds but none were above the upper levels of the national dredging guidance (MI, 2006).

Arsenic levels were lower in 2010 than in 2009, but there is a pattern for increased levels since 2007 (Table 3.9).

In 2009, one site (SS3) reported the highest levels of Kjeldahl Nitrogen, Organic Carbon and 6 metals. This sample is taken close to the landfill site. In 2010, no such pattern exists, results from SS3 being in line with other sites.

In 2010, SS6 reported the highest levels of Kjeldahl Nitrogen, Cadmium, Chromium, Lead, Nickel and Zinc. This sampling site is located on the north-western shore of Rossmore Bay. No other pattern exists in the dataset.

Table 3.10 Summary - Sediment Chemical Analysis (2010)

Parameter mg/kg	(1) MI (2006) Lower Level	(2) CCME (1992)	Number of samples exceeding (1)	Number of samples exceeding (2)
Arsenic	9	7.24	1 (SS7)	1 (SS7)
Cadmium	0.7	0.7	10 (all)	10 (all)
Chromium	120	52.3	0	0
Copper	40	18.7	0	3 (SS4, SS5, SS6)
Lead	60	30.2	0	0
Nickel	21	-	0	0
Zinc	160	124	0	0
Mercury	0.2	0.13	-	-

Appendix 3.1

Physical and biological characteristics of intertidal sampling sites (M1 - M22). Marine biotopes are assigned to the sampling sites as per the Marine Habitat Classification of Britain and Ireland (version 04.05) (Connor *et al.,* 2004). For the mudflat habitat, a biotope is assigned to the site based on the qualitative assessment and the fauna recorded within the benthic core samples. For the 'hard shore' habitat a biotope is assigned based on the qualitative assessment and the results of the quadrat sampling.

Note: GPS grid references were taken on the mid-shore (hard shore) and therefore above the mudflat sampling location. Note: Macroalgal cover may exceed 100% within a quadrat as one species of macroalgae may overlay another.

Station Number	Grid Ref	Location	Mudflat habitat	Hard shore habitat	Biotope assigned
M1	181823 070891	Northern shore of Rossmore Bay.	Soft silt sediment. An algal mat (*Ulva*) extends out to about 30m. Dense juvenile Lugworms (*Arenicola marina*) casts.	Below zone of barren stones/cobbles (c15m) is a narrow (*c* 1m) zone of Channel Wrack (*Pelvetia caniculata*) followed by a 10m fucoid zone dominated by Egg Wrack (*Ascophyllum nodosum*).	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M2	181912 070885	Northern shore of Rossmore Bay. As M1.	Similar to M1. Algal mat also present.	As M1.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M3	182041 070886	Northern shore of Rossmore Bay. Upper shore being colonised by vascular plants.	Fine silt/clay overlies muddy sand sediment. Lugworm casts 'Abundant.' *Hydrobia ulvae* also observed on sediment surface.	Wider zone of barren boulders and cobbles at top of intertidal. Zone (*c* 8m) of Egg Wrack (*Ascophyllum nodosum*). Smaller % of Bladder Wrack (*Fucus vesiculosis*) present.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M4	182091 070864	Northern shore of Rossmore Bay. Upper shore bordered by hedgerow & treeline of quarry site.	Fine silt/clay overlies muddy sand sediment. Abundant worm holes; *Hydrobia ulvae* observed on sediment surface.	Similar to M3.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst).
M5	182172 070841	Northern shore of Rossmore Bay.	Muddy sand. Patchy algal mat. Occasional Lugworm casts. Occasional *Hydrobia ulvae.*	Upper zone (*c* 25m) of barren cobbles merges into narrow (6m) fucoid zone dominated of Egg Wrack (*Ascophyllum nodosum*).	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M6	182352 070793	Northern shore of Rossmore Bay.	Sandy mud. Patchy algal mat. Superabundant Lugworm (*Arenicola marina*) casts. *Corophium volutator and Hydrobia ulvae* present on sediment surface. Worm holes.	Quarry track on upper shore then a 10m zone of barren cobbles/ pebbles. Below is a 10m fucoid zone dominated by Egg Wrack (*Ascophyllum nodosum*) but Bladder Wrack (*Fucus vesiculosis*) and *Ulvae* sp are also	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)

				present.	
M7	1820415 070714	Northern shore of Rossmore Bay.	Sandy clay sediment. Visible worm holes on sediment surface.	Similar to M6 but fucoid zone is very patchy.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** *Hediste diversicolor, Macoma balthica and Scrobicularia plana* in littoral sandy mud shores (LS.LMu.MEst.Hed.Mac.Scr)
M8	82528 70672	North-eastern shore of Rossmore Bay, directly south quarry.	Firm silt/clay sediment.	Quarry road above. Mixed substrata shore. Patch fucoid zone. Egg Wrack (*Ascophyllum nodosum*) and Bladder Wrack (*Fucus vesiculosis*).	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock of (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst).
M9	182478 070601	The inner eastern shoreline of Rossmore Bay.	Soft mud (silt/clay) with gravels. sediment. Visible worm holes.	Upper zone of saltmarsh dominated by Sea Purslane. Below this is a zone of *Enteromorpha* that grades into a stony, hard shore that merges into gravely mud. *Egg Wrack* (*Ascophyllum nodosum*) overlies the stony mud substratum; limited Bladder wrack.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) Ephemeral green and red seaweeds on variable salinity and/or disturbed mixed substrata (LR.FLR.Eph.EphX) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M10	182534 070609	The inner eastern shoreline of Rossmore Bay.	Soft mud. Common Cord-grass (*Spartina* sp.) consolidates the mud.	No hard shore - saltmarsh habitat upon upper shore Sea Purslane grades into a lower zone of *Spartina* sp.	**Saltmarsh** (LS.LMp.Sm) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore
M11	182339 070562	Sheltered inner area of Rossmore Bay surrounded by lower saltmarsh of Common Cord Grass *Spartina.*	Soft silt/ clay. Mudflat surface literally 'crawling' with *Corophium volutator*.	No hard shore - Narrow zone of upper saltmarsh (dominated by Sea Purslane) followed by narrow zone of barren cobbles which extends into mudflat of soft silt/clay. No flora/fauna present.	**Saltmarsh** (LS.LMp.Sm) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst).
M12	182292 070616	Southern shore of Rossmore Bay.	Soft silt/ clay	10m upper shore saltmarsh with Sea Purslane and Lax-flowered Sea-lavender. A 20m fucoid zone of Egg Wrack (*Ascophyllum nodosum*). *Fucus vesiculosis* also recorded. (LR.FLR.Eph.EphX)	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS). Ephemeral green and red seaweeds on variable salinity and/or disturbed mixed substrata **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst) **Saltmarsh**: (LS.LMp.Sm)
M13	182828 070433	Along northern shore of Brick Island embayment.	Silt clay sediment. Lugworm (*Arenicola marina*) casts abundance on sediment surface.	Well-developed saltmarsh on upper shore, scrub behind. Lax-flowered Sea Lavender and Sea Purslane extend into hard shore. A 10m zone	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore

				of barren cobbles is followed by 8m zone of Egg Wrack which is mud covered.	(LS.LMu.MEst)
M14	182966 070163	Along southern shore of Brick Island embayment.	Soft silt/clay. Visible worm holes. Lugworm casts abundant.	Saltmarsh upon upper shore dominated by Sea Purslane and Lax-flowered Sea Lavender. Then a very narrow zone of cobbles which extend into mudflat. Bladder Wrack (*Fucus vesiculosis*) dominates. *Ulvae* also present.	**Hard Shore:** Ephemeral green and red seaweeds on variable salinity and/or disturbed mixed substrata (LR.FLR.Eph.EphX) *Fucus vesiculosis* on mid-eulittoral variable salinity boulders and stable mixed substrata (LR.LLR.Fves.VS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M15	182954 070543	South-east of Rossmore peninsula; northern shore of the North Channel. mid-	Mud covered cobbles on upper mudflat with abundant Lugworm casts; not present where the core samples are taken.	Upper shore boulders & cobbles with saltmarsh above. Then an algal zone dominated by Bladder Wrack (*Fucus vesiculosis*).	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) *Fucus vesiculosis* on eulittoral variable salinity boulders and stable mixed substrata (LR.LLR.Fves.VS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)
M16	182428 070041	Southern shore of Rossmore peninsula.	Sandy mud. Visible Lugworm (*Arenicola marina*) casts. No algal mat.	Has a typically observed zonation: saltmarsh - mixed substrata shore - algal zone - mudflat.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated muddy sand shores (LS.LSa.MuSa)
M17	182188 69889	Southern shore of Rossmore peninsula.	Soft silt sediment. No worm holes/casts.	Mixed substrata shore (boulders, cobbles & pebbles. Lugworm (*Arenicola marina*) casts present amongst the stones.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** No core invertebrates recorded.
M18	182200 069986	Southern shore of Rossmore peninsula.	Sandy mud sediment.	Mixed substrata shore (boulders, cobbles & pebbles), occasional Channel Wrack on upper shore. Brown algae zone dominated by Egg Wrack.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS)2006 **Mudflat:** Polychaete/bivalve dominated muddy sand shores (LS.LSa.MuSa)
M19	182119 070089	South-western shore of Rossmore peninsula.	Pebbles and gravel intergrades with mudflat. Fine silt/clay with sandy mud beneath. Rippled surface with standing water. No Lugworm casts or visible worm holes. Channel approx. 100m offshore.	Wide strip of saltmarsh above a 30-40m algal zone. Mid shore of pebbles/gravel substratum. Fucoid algae are sparse and dried out.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) Ephemeral green and red seaweeds on variable salinity and/or disturbed mixed substrata (LR.FLR.Eph.EphX) **Mudflat:** Polychaete/bivalve dominated muddy sand shores (LS.LSa.MuSa)
M20	182000 070225	South-western shore of Rossmore	Sandy mud sediment. Channel occurs *c* 15m offshore.	Upper zone of saltmarsh; zone of cobbles and pebbles then a zone of	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable

		peninsula.		Egg Wrack (*Ascophyllum nodosum*).	salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated muddy sand shores (LS.LSa.MuSa)
M21	181996 070458	Western shore of Rossmore peninsula.	Narrow area of mudflat as a channel occurs just offshore (15m). Gravely and sandy mud. Lugworm casts abundant. Polychaete/bivalve	Mixed substrata shore - larger cobbles give way to smaller pebbles/gravel down shore.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** dominated muddy sand shores (LS.LSa.MuSa)
M22	182165 070536	Southern shore of Rossmore Bay	Clay sediment. Lugworm casts abundant on upper mudflat but more occasional where core samples are taken. Site *approx.* 15 m from a low-tide channel.	Narrow upper band of saltmarsh. Mixed substrata shore (boulders, cobbles & pebbles). Larger cobbles on upper shore. Sparse algal zone.	**Hard Shore:** *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) **Mudflat:** Polychaete/bivalve dominated mid estuarine shore (LS.LMu.MEst)

Appendix 3.2

Sediment Quality Guidance Criteria

Marine Institute Dredging Guidelines

The Marine Institute (MI) has developed guidelines for the assessment of dredge material for disposal in Irish waters (Marine Institute 2006). They include guidel ine values for a suite of metals, organic compounds and organotin compounds which have been shown to have a negative impact on marine flora and fauna at elevated concentrations. The interpretation of the par ameters content uses a sy stem of assigning action levels to the sediment to each of the parameters. The action levels are defined as:

- MI Lower Level: defines a concentration (i.e. guidance value) of a contaminant in sediment below which biological effects would not be anticipated.
- MI Upper Level: defines a contaminant concentration above which biological effects are anticipated to occur.

Irish SQG's for dredged sediment (Marine Institute, 2006)

	Units	Lower level	Upper Level
Arsenic	mg/kg-1	9	70
Cadmium	mg/kg-1 -	0.7	4.2
Chromium		120	370 110
Copper	1	40	218 0.7
Lead		60	
Mercury	mg/kg-1	0.2	
	mg/kg-1		
	mg/kg-1		
	mg/kg-1		
Nickel	mg/kg-1	21	60
Zinc	mg/kg	160	410

Canadian Sediment Quality Guidelines for the Protection of Aquatic Life

The Canadian Council of Ministers of the Environment (CCME) developed Sediment Quality Guidelines for the Protection of Aquatic Life (CCME 1999) to assist in evaluating sediment quality. Screening levels have been established, based on toxicology data, to determine the potential effect of chemicals in sediment on aquatic organisms.

	Units	Canadian CCME (1992)
Arsenic	mg/kg-1	7.24
Cadmium	mg/kg-1	0.7
Chromium	mg/kg-1	52.3 18.7 30.2
Copper	mg/kg-1	0.13
Lead	mg/kg-1	-
Mercury	mg/kg-1	124
Nickel	mg/kg-1	
Zinc	mg/kg-1	

4.0 WATERBIRD SURVEY AND ASSESSMENT

4.1 Overview of study area

Cork Harbour is the largest estuarine habitat on the south coast of Ireland. It is a highly complex coastal wetland site and stretches from the two main estuaries of the River Lee in the west and the Owennacurra River, near Midleton in the east, southwards to where it meets the sea at Roche's Point (Crowe, 2005). The variety of habitats provided by the different basins and enrichment from the river inputs have made Cork Harbour one of the prime sites for waterbirds within Ireland, and one of few which regularly support greater than 20,000 individuals during winter (Sheppard, 1993).

The large expanses of intertidal mudflats and associated wetland habitats of Cork Harbour provide important feeding and roosting areas for migratory wintering wading birds and wildfowl (Smiddy *et al.,* 1995). Consequently the main intertidal areas of Cork Harbour are designated as a Special Protection Area (SPA) under Directive 2009/147/EC (Birds Directive) on the conservation of wild birds (the codified version of Council Directive 79/409/EEC as amended). There have been various proposals to designate Cork Harbour SPA over the past decade but the site remained a proposed SPA (pSPA) site until rela tively recently. Cork Harbour SPA (Site Code 4030) is now legally designated under S. I. No. 237 of 2010 (4th June 2010).

Cork Harbour qualifies for designation because it fulfils several criteria for international importance under established criteria of the Ramsar Convention Bureau (1984). The following is an extract from the Site Synopsis (NPWS); the full document is shown in Appendix 1.1.

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. The five-year average annual core count for the entire harbour complex was 34,661 for the period 1996/97-2000/01. Of particular note is that the site supports an internationally important population of Redshank (1,614) - all figures given are average winter means for the 5 winters 1995/96-1999/00. A further 15 species have populations of national importance, as follows: Great Crested Grebe (218), Cormorant (620), Shelduck (1,426), Wigeon (1,750), Gadwall (15), Teal (807), Pintail (84), Shoveler (135), Red-Breasted Merganser (90), Oystercatcher (791), Lapwing (3,614), Dunlin (4,936), Black-Tailed Godwit (412), Curlew (1,345) and Greenshank (36). The Shelduck population is the largest in the country (9.6% of national total), while those of Shoveler (4.5% of total) and Pintail (4.2% of total) are also very substantial. The site has regionally or locally important populations of a range of other species, including Whooper Swan (10), Pochard (145), Golden Plover (805), Grey Plover (66) and Turnstone (99). Other species using the site include Bat-tailed Godwit (45), Mallard (456), Tufted Duck (97), Goldeneye (15), Coot (77), Mute Swan (39), Ringed Plover (51), Knot (31), Little Grebe (68) and Grey Heron (47). Cork Harbour is an important site for gulls in winter and autumn, especially Common Gull (2,630) and Lesser Black-Backed Gull (261); Black-Headed Gull (948) also occurs.

Currently, Cork Harbour is ranked as the sixth most important wetland site in the country and supported an average 28,462 wintering waterbirds during the period 2003/04 to 2007/08 (Boland et al., 2009). Cork Harbour supports wintering populations of Golden Plover, Bar-tailed Godwit and Little Egret, species listed on Annex I of the EU Birds Directive, together with Little Egret and Common Terns during the breeding season (Wilson *et al.,* 2000).

Wintering waterbirds are monitored annually at major wetland sites around Ireland by the Irish Wetland Bird Survey (I-WeBS). This programme was initiated in the Republic of Ireland in 1994/95. The primary objective of this and its UK counterpart (WeBS) is to monitor the numbers and distribution of non-breeding waterbirds populations across Britain and Ireland. All major wetland sites are covered and the surveys, undertaken by volunteers, comprise monthly counts of sites between the months of September and March each year.

Cork Harbour has been counted as part of I-WeBS since the beginning (winter 1994/95). As a large complex site, it is subdivided into a number of smaller count sections, of which the North Channel is one. The North Channel is then further subdivided into five smaller count sub-sites:

- North Channel - Ballintubbrid (W 810 702) - the largest sub-site and running directly south of Rossmore peninsula.
- Weir Island (W 810 710) • Brick Island (W820 700)

- Ballintubbrid (W840 702)
- Rathcoursey & Ahanesk (W870 700)

4.2 Methodology

Waterbird Surveys of Rossmore Bay & Brick Island Embayment

Throughout the time period that the East Cork Landfill monitoring programme has been undertaken, waterbird surveys have been carried out within two standardised survey zones:

- Zone A includes Rossmore Bay from its innermost reaches westwards to its 'junction' with the North Channel
- Zone B covers the mudflats partially enclosed by the Brick Island Peninsula (Brick Island Embayment) (Figure 7).

In 2010, surveys were undertaken on 6th October, 21st October, 24th November and 21st December. On each visit, six hours of waterbird observations were made, alternating between Zone A and Zone B. Each 30-minute observation time was split into 20 minutes for counting waterbirds and 10 minutes for walking between vantage points of the two zones. All surveys were undertaken within a period extending from 3 hours before low tide to three hours after the time of low tide.

Waterbird surveys were carried out using a telescope (20-60 x zoom lens) and binoculars (x 50) and in (almost all cases) calm and clear weather conditions.

Waterbird Surveys of Rossmore Peninsula including Brick Island Embayment

On two occasions (13/11/10 and 26/11/10) waterbird surveys were undertaken within four survey zones A-D, as shown in Figure 7. In addition to Rossmore Bay and Brick Island Embayment, this survey also includes the section of the North Channel that lies to the south of Rossmore Peninsula. This survey aims to record the full range of waterbird species that may be present in the estuarine habitat surrounding the landfill site.

Review of Data from the Irish Wetland Bird Survey

The assessment included a review of data from the Irish Wetland Bird Survey (I-WeBS) for count areas (sub-sites of Cork Harbour) that are located close to Rossmore Peninsula.

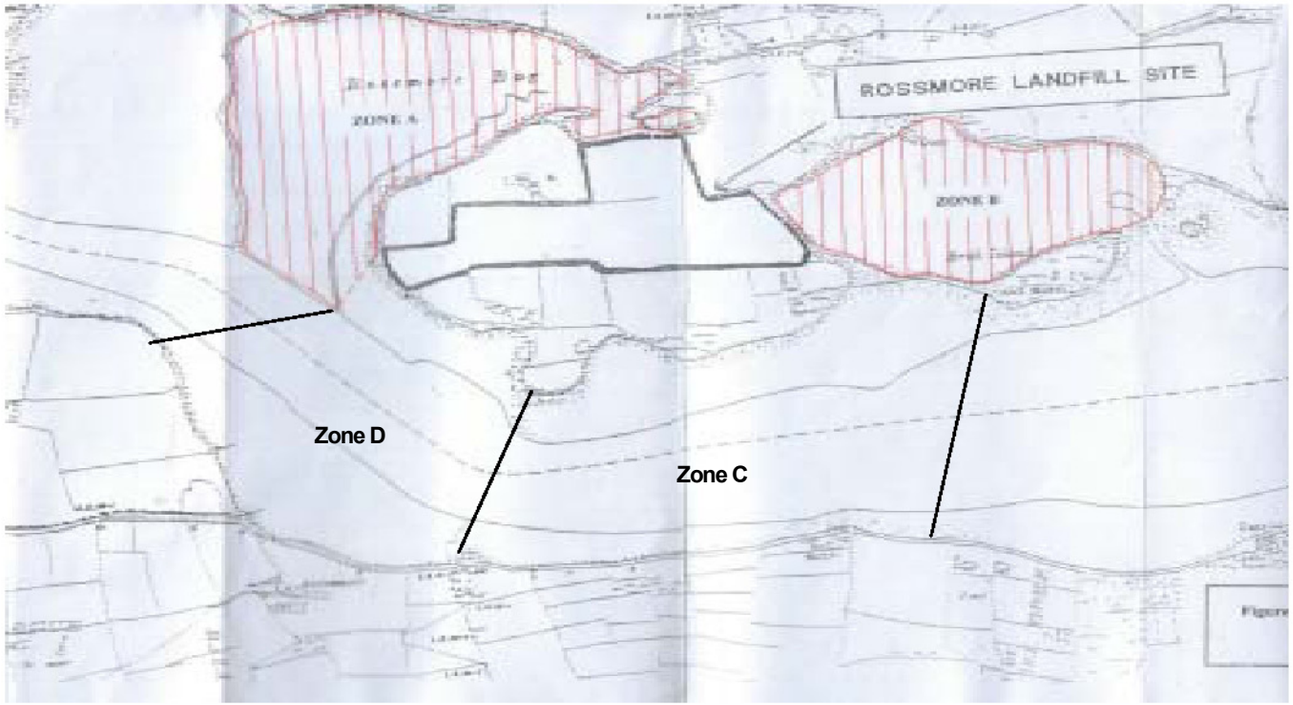


Figure 7 Estuarine Bird Survey Zones A-D

4.3 Data assessment and presentation

Throughout the text, common names are used for bird species. A list of all bird species recorded during the waterbird surveys is shown in Appendix 4.1.

- Data analysis & presentation

Waterbirds were counted and recorded according to the zone (count area) within which they were observed.

The time of the tidal cycle is important in assessing waterbird presence and distribution. This year we ensured that all surveys were undertaken within a period extending from 3 hours before low tide to three hours after the time of low tide. To allow comparison of 2010 data with previous datasets we compiled data collected since 2006 and assigned 'tidal stages' to each survey undertaken (see below). Thereafter when analysing the longer dataset we only used data that was collected within tidal stage 2 or tidal stage 3 i.e. the six-hour period extending before and after the point of low tide. In practice, most surveys were undertaken within this period. This analysis differs somewhat to those carried out in previous years but it is considered appropriate in 2010 to analyse the dataset as correctly as possible given that five years data have now been collected in a standardised manner. Waterbird data collected prior to 2006 was collected at differing times of the tidal cycle (e.g. 2005 +/- HT) or with different count methodologies (e.g. estimate counts such as 300+) so this data could not be included in current analyses.

Tidal Stages

Tide 1: Initial tidal ebb (3 hours after HT);
Tide 2: tidal ebb approaching and including low water (3 hours prior LT);
Tide 3: initial tidal inflow (3 hours after LT);
Tide 4: tidal inflow approaching high water (3 hours prior HT).

A variety of data analyses were undertaken. For the repeat surveys of Zone A and B we calculated mean (average) numbers for selected species. These are shown together with peak numbers observed. Averaging across a season is slightly erroneous as the species concerned are migratory and numbers may increase from the start of the season. Therefore we show average numbers by way of representing the 'typical' numbers observed within the count zone and we present the range (min-max).

In the majority of cases, trends in species numbers were assessed by 'eye-balling' the data.
When using I-WeBS data to examine trends, we were able to employ an indexing and trend analysis for selected waterbird species for two subsites (Brick Island and Weir Island). This method could not be used for the North Channel - Ballintubbrid subsite because there has been changes in the subsite boundary and related dataset during the time period for which we hold data. Similarly, this analysis was not undertaken for the entire Cork Harbour dataset because of incomplete coverage in some years (Appendix 4.3). Trend analysis methodology is described below.

Trend Analysis

As part of the annual landfill monitoring, count data has been obtained from the I-WeBS office on an annual basis. We compiled this data to obtain a dataset that spans the period 1998/99 - 2007/08, the latter being the most up-to- date data available as these subsites were not counted in the winter of 2008/09.

Using the ten-year dataset, we undertook trend analysis for selected waterbird species. Firstly, the raw count data (annual peak data) were converted into index numbers. An index number can be defined as a measure of population size in one year expressed in relation to the size of the population in another selected year (Leech et al., 2002). Index numbers therefore increase as the number of individuals, relative to the number recorded in the base year, increases. Trends were then examined further by fitting a trend line (line-of-best-fit) to the data points. The equation of that straight line was then obtained ($y = mx + c$). The gradient (slope) gives a measure of the annual percentage change in index numbers.

- International and national thresholds of waterbird population size

Waterbird populations at various spatial scales can be assessed with reference to national and international threshold levels. A waterbird species that occurs in numbers that correspond to 1% or more of the individuals in the all-Ireland population of the species is said to occur in 'nationally important numbers'. A waterbird species that occurs in numbers that correspond to 1% or more of the individuals in the biogeographic population of the species or subspecies is said to occur in 'internationally important numbers.' Current population threshold values are published in Crowe et al. (2008) and Wetlands International (2006) (all-Ireland and international respectively).

- Legislation and conservation status

In terms of waterbird species conservation importance, the species recorded during the 2010 surveys were assessed in light of national and international legislation and with reference to 'Birds of Conservation Concern in Ireland' (Lynas et al., 2007):

Legislation concerning birds:

Council Directive 2009/147/EC (Birds Directive) on the conservation of wild birds (the codified version of Council Directive 79/409/EEC as amended) - this directive relates to the conservation of all species of naturally occurring birds in the wild. The directive lays down protection, management and control of these species and lays down rules for their exploitation. The directive applies to the birds, their eggs, nests and habitats.

This legislation is behind the designation of Special Protection Areas (SPAs).
This directive also lists particularly vulnerable bird species on Annex I for whom protection must be given via protection of their habitats.

Wildlife Act, 1976 and Wildlife Amendment Act (2000):- Principal national legislation which protects all bird species, their nests and eggs.

Red Data Lists:

Birds of conservation concern in Ireland 2008 - 2013 (Lynas *et al.*, 2007).

The assessment covers all current Irish birds. Several criteria were used to determine population status: global conservation status, European conservation status, decline in population, decline in breeding range, decline in population during non-breeding season, historical decline in breeding population, breeding rarity, localised breeding and non-breeding species and international importance during breeding and non-breeding season.

4.4 Survey Results & Discussion

4.4.1 Waterbird species diversity

A list of all waterbird species recorded during the surveys is shown in Appendix 4.1. Thirty waterbird species were recorded in total. This list included three species listed on Annex I of the EU Birds Directive (Little Egret, Golden Plover & Bar-Tailed Godwit).

A diversity of species was recorded representing several waterbird families: Podicipedidae (grebes), Anatidae (swans, geese and ducks), *Ciconiiformes* (Herons), Haematopodidae (oystercatchers), Charadriidae (plovers and lapwings), Scolopacidae (sandpipers and allies) and Laridae (gulls and terns). Although Cormorants (*Phalacrocoracidae*) are not strictly waterbirds, it is standard convention to include them within the waterbird grouping.

4.4.2 Waterbird surveys around Rossmore Peninsula (Zones A-D)

Data from the two bird surveys covering the four zones (Zones A, B, C & D) are given in Table 4.1. The first count (13th November 2010) was taken around the period of high tide and initial tidal ebb. The second count (26th November 2010) was undertaken on an ebbing tide towards low tide.

Species diversity (total number of species) was remarkably similar within zones when comparing the two surveys. However the constituent species differed in their presence and abundance between the two surveys most likely due to the state of the tide. For instance, Red-breasted Mergansers, sea ducks which feed on fish, were more widely distributed and more abundant during the high tide survey. The same was the case for Cormorants and Great Crested Grebes which are also piscivores. In contrast Dunlin and Black-tailed Godwits, wading birds that forage across tidal flats, were only observed during the low tide survey, suggesting that at high tide they are roosting elsewhere.

Zone A (Rossmore Bay) recorded the greatest number of waterbirds on both survey occasions with notably more Redshank and Oystercatchers within this zone than any other.

Of note was the relatively low number of Curlew present within the surveys in comparison with previous annual surveys. Although the species was recorded in the other surveys undertaken, their numbers do appear to be lower than in previous years. While Curlews have a variety of foraging options (e.g. terrestrial grassland) and could perhaps be distributed elsewhere, the noted trend is perhaps related to the overall national and International decline of this species (Wetlands International, 2006; Crowe et al. 2008).

Table 4.1 Data from the North Channel bird surveys (4 zones as per Figure 7).

	13th November 2010				26th November 2010			
	Zone A	**Zone B**	**Zone C**	**Zone D**	**Zone A**	**Zone B**	**Zone C**	**Zone D**
Time	11.40	10.30	10.50	11.15	12.50	11.40	11.55	12.25
Tide Time	HT+2	HT+1	HT+2	HT+2	LT-2	LT-3	LT-3	LT-2
Tidal State	1	1	1	1	2	2	2	2
Conditions	100% cloud, occasional heavy showers. Light breeze. Good visibility.				30% cloud, dry, bright, sunny. Light breeze. Bright sun led to some visibility problems across North Channel.			
Mute Swan				2				
Shelduck	5	10					17	10
Wigeon		20				2		
Teal	4	20		16		6		
Mallard	2		1	6			19	31
Red-breasted Merganser		6	3	2			15	
Little Grebe		7	10					
Great Crested Grebe		21	2	16	Cormorant		6	3 4 5 1
Little Egret		1		1		2		
Grey Heron		1		1				
Oystercatcher	18	1	54	40	7	5	9	5
Ringed Plover					8			
Lapwing			10					1
Dunlin					79			
Black-tailed Godwit		59	9		93	15	Curlew 1	1
		1	5		3	2		
Greenshank	13	1	3	3	Redshank	48	32	482 60 7 13 Turnstone
	99	**87**	**237**	**114**	**189**	**107**		

4.4.3 Waterbird surveys of Zones A and B

Count data from the repeat surveys of Zone A (Rossmore Bay) and Zone B (Brick Island Embayment) are shown in Appendix 4.2.

Across all surveys, a total 27 waterbird species were recorded within Zone A and 23 waterbird species within Zone B.

The highest number of waterbirds recorded within Zone A during any one count was 840 on 21st October 2010 (Table 4.2). Over half of these birds were Black-tailed Godwits that, with a count of 437 were present in numbers of all-Ireland importance. The highest number of waterbirds recorded within Zone B during any one count was 631 on 21.12.10 when good numbers (100+) of Teal, Dunlin and Redshank were present. Species diversity (peak number of species) was relatively consistent within both survey zones throughout the study period (Table 4.2).

Table 4.2 Peak total waterbird numbers and peak number of species within any one survey of Zone A and Zone B 2010.

Zone	Peak Numbers	Peak no. species	Peak Numbers	Peak no. species
	Zone A	Zone A	Zone B	Zone B
06.10.10	363	14	224	14
21.10.10	840	13	244	13
24.11.10	350	10	417	11
21.12.10	594	14	631	14

Table 4.3 shows summary data for selected species recorded within Zone A and Zone B during the low tide period (tidal stages 2 and 3). This dataset highlights the variability amongst waterbird counts in terms of the large standard deviations about the mean. Because of this, analysis of waterbird numbers and trends generally use peak count data (e.g. I-WeBS dataset).

Table 4.3 Mean numbers of selected waterbird species (± SD standard deviation) within **Zone A** and **Zone B** across the low tide period (tidal stages 2 and 3) plus the range (minimum-maximum) (n = 24, Zone A; n = 23, Zone B).

Species	Zone A		Zone B	
	Mean ± S. D 2010	Range (min-max)	Mean ± S. D 2010	Range (min-max)
Shelduck	7±9	1 - 36	5 ± 13	1 - 52
Wigeon	- - 10 ± 17	2 - 77 Teal	-	- 25 ±
44	2 - 168 Oystercatcher	18 ± 12	2 - 39	16 ± 15
	1 - 54			
Ringed Plover	3±4 2 - 13	--Dunlin	59 ± 91	5 - 420
	19 ± 48	2 - 176 Black-tailed Godwit		93 ±
142	3 - 437	22 ± 24	1 - 97 Curlew	20 ± 13
	1 - 46	16 ± 7	3 - 34 Greenshank	-- 1±1
	1-4			
Redshank	95 ± 49	15 - 199	57 ± 30	21 - 126
Black-headed Gull	5±7	1 - 21	3±3	1 - 12

To examine the data further and to compare across years we compiled a dataset containing the peak numbers for each species that were recorded during the low tide period (tidal stages 2 or 3 - see Section 4.3 data analysis for more details). Within this standardised format, data is available for the five-year period 2006 - 2010 inclusive.

Table 4.4 shows peak waterbird numbers within Zone A. The dataset shows great variability for species between years despite using peak (rather than average) data. The following species appear to have variable but stable numbers: Teal, Dunlin and Redshank. Limosa Environmental (2009) also reported apparent stable trends for Dunlin and Redshank within this site. In contrast, numbers of Black-tailed Godwits appear to have increased within this site across the five-year period although prior to the addition of 2010 data appeared to be declining (Limosa Environmental, 2009). Numbers of Curlew appear to have increased and certainly in the past two years. No obvious trends are evident for Wigeon, Oystercatcher or Ringed Plover.

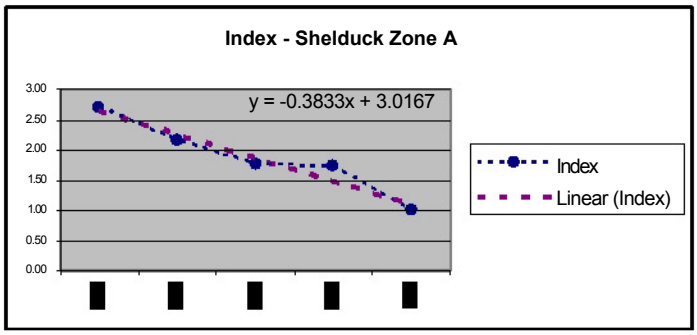
Table 4.4 Peak numbers of selected waterbird species during the low tide period within **Zone A** 2006 - 2010.

	2010	2009	2008	2007	2006
Shelduck	36	62	63	78	97
Wigeon	0	43	15	62	50
Teal	43	0	21	0	45
Oystercatcher	42	28	46	53	80
Ringed Plover	13	33	9 1	0Dunlin	420
	381	1300	470	200	
Black-tailed Godwit	437	0	35	80	60
Curlew	44	24	9 17	14 Redshank	
	199	112	108	97	139

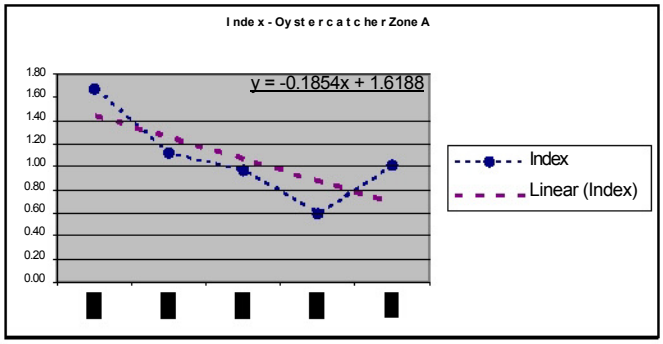
Of note was the peak count of Dunlin within Zone A in 2008. 1,300 individuals surpasses the threshold for national importance, highlighting the importance of this subsite within Cork Harbour for this species. Similarly, numbers of Black-tailed Godwit in 2010 (max 437) also passes the threshold for national importance.

Further investigation of the dataset for selected species was carried out using the population indexing method (See Section 4.3 for details).

Shelduck - indexing of peak numbers reveals a steady decline across the five-year period.



Oystercatcher - indexing of peak numbers reveals a steady decline across the five-year period although numbers recorded during 2010 where on par with those recorded in 2007 and 2008.



Black-tailed Godwit - although the trend is now for increase this is largely driven by a high count during 2010. A longer dataset would be needed to investigate the trend further.

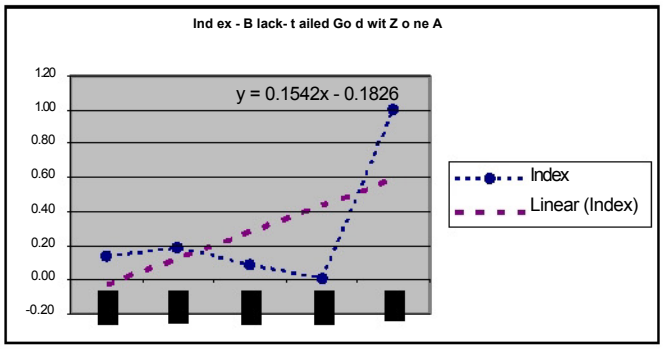
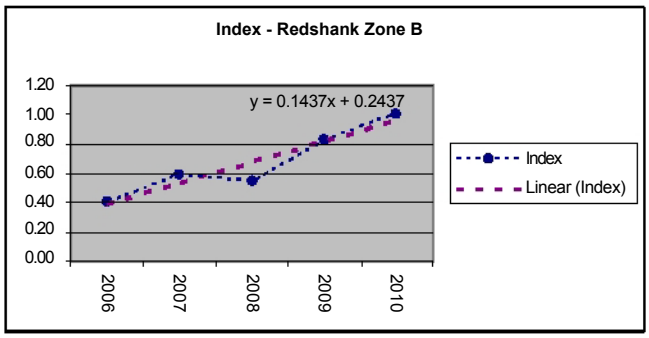


Table 4.5 shows peak waterbird numbers within Zone B across the five-year period 2006 to 2010. For the majority of species no obvious trend is evident from simple eye-balling of the data although Curlews appear stable and Oystercatchers and Redshanks have increased in numbers within this zone (see plots below), the increase for Redshank was also suggested in Limosa Environmental (2009).



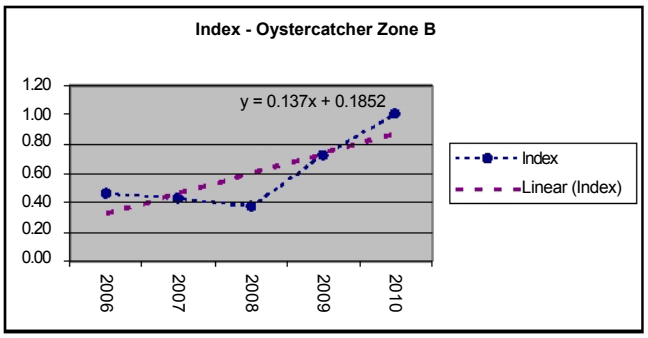


Table 4.5 Peak numbers of selected waterbird species during the low tide period within **Zone B** 2006 - 2010.

	2010	2009	2008	2007	2006
Shelduck	15	4	13	8	12
Wigeon	77	14	21	2	43
Teal	168	0	10	3	37
Oystercatcher	54	39	20	23	25 Dunlin
	176	108	824	0	620
Black-tailed Godwit	97	18	15	32	74
Curlew	34	22	12	23	18
Greenshank	4	4	2	2	2
Redshank	126	105	69	74	51

4.4.4 Review of data from the Irish Wetland Bird Survey (I-WeBS)

I-WeBS count sub-sites that are closest to East Cork Landfill are Brick Island (directly east), Ballintubbrid (south) and Weir Island (to the west). The most recent I-WeBS data for these sites (2003/04 - 2007/08) is shown in Appendix 4.3 together with data for the entire Cork Harbour site.

Sub-site: North Channel - Ballintubbrid

This is the largest sub-site in the North Channel, extending from Ballintubbrid in the east, to Fota Island in the west. During the period 2004/05 to 2008/09, this sub-site supported 22 regularly-occurring waterbird species including Annex I species Little Egret, Bar-tailed Godwit and Golden Plover.
Current data (averaged across the period 2004/05 - 2008/09) shows that Shelduck occurred in nationally-important numbers. Average numbers of Red-breasted Mergansers and Black-tailed Godwit were close to the national threshold.

A comparison of data for Shelduck at this subsite with data for the entire site of Cork Harbour reveals that this subsite can support up to 35% of the total numbers recorded across the harbour as a whole.

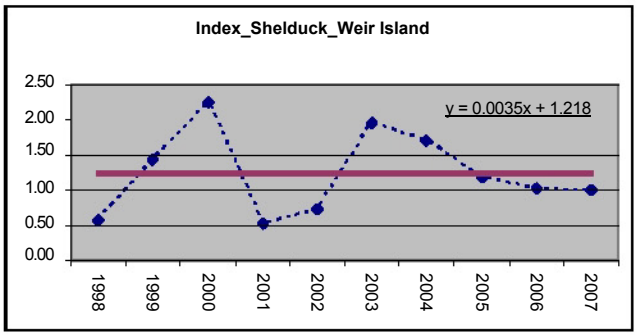
Previous annual monitoring reports found that four species had occurred in nationally-important numbers during the period 2002/03 - 2006/07. However with the change in I-WeBS subsite boundary and its related data, we can no longer compare data across a longer time period than that shown in Appendix 4.3 (2004/05 to 2008/09).

Sub-site: Weir Island

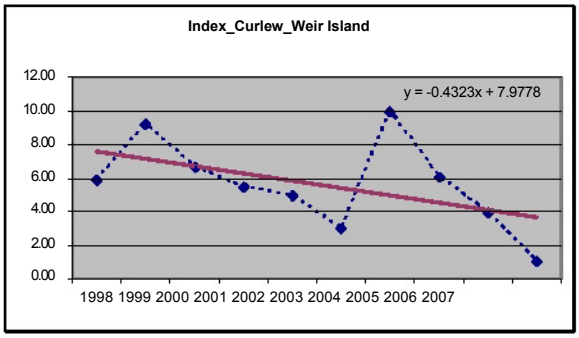
Weir Island supported 15 regularly-occurring waterbird species during the period 2004/05 to 2008/09. This subsite is particularly important for Shelduck whose 5-yr mean peak of 110 individuals was close to the threshold for national importance. The subsite is also an important area for Redshank (5-yr mean peak of 254 individuals).
*Note that the 5-year mean peak number quoted is actually a four-year average calculated across the five-year period because data was not collected for the winter 2008/09.

Lapwings have declined at this subsite in recent years. This wader species was present in every year from 1998/99 to 2005/06 but have not been recorded since.

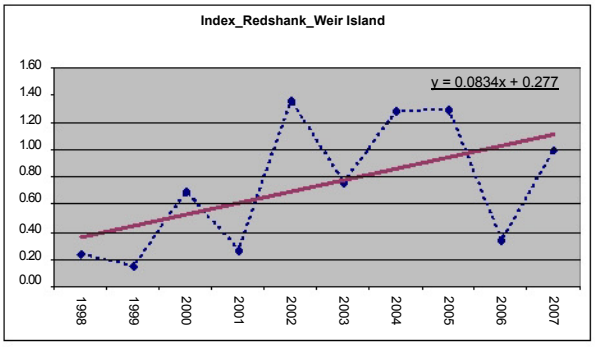
The annual population index for Shelduck at Weir Island shows great variation between years. The plot to the right shows that the species was recorded in relatively low numbers in the winters of 2001 and 2002 but thereafter rose to a relatively stable level. The slope of the fitted trend line (line of best fit) indicates an annual % change in numbers of + 0.4%).



Curlew numbers recorded at the Weir Island subsite have declined steadily since 1998. Examination of the I-WeBS dataset for Cork Harbour (entire site) suggest the species has declined overall; as noted in Section 4.4.2, this decline is in line with the overall national and International decline of this species (Wetlands International, 2006; Crowe et al. 2008).



In contrast, numbers of Redshank within the Weir Island subsite have increased across the data period.

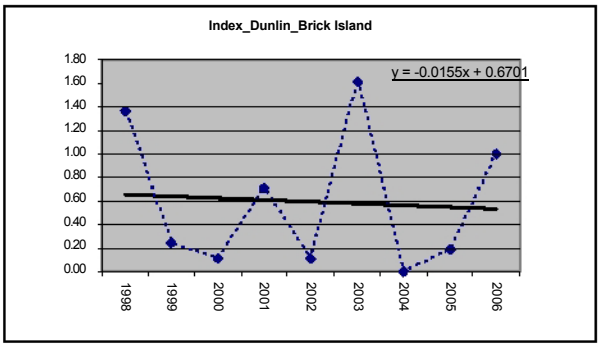


Sub-site: Brick Island

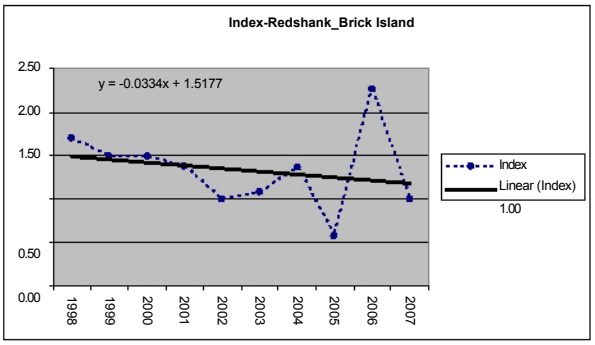
Brick Island is known to be an important area for intertidal feeding and supports an important roost site along its shoreline. As the embayment drains and floods slowly due to the narrow tidal entrance, the mudflat remains uncovered for longer when tide floods in. This provides intertidal feeding opportunities to waterbirds that otherwise may not have found exposed flats. Similarly, as the tide retreats more slowly, waterbirds that prefer to feed at the tide edge can avail of this activity for longer.

This relatively small sub-site has recorded an overall 29 waterbird species during the I-WeBS programme (compiled dataset 1998/99 - 2007/08. Of these 16 species are considered regularly-occurring (recorded within five or more years during the time period).

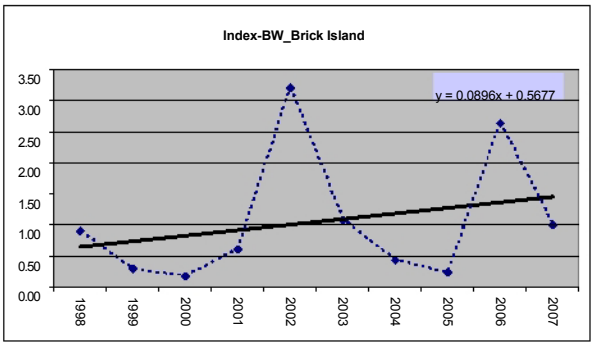
Dunlin numbers are variable at this subsite; this species was recorded in every year from 1998/99 to 2003/04 but has since been recorded in only two years since. The lack of Dunlin presence in two years is surprising, especially considering that the dataset represents not one, but a series of monthly counts each year. Furthermore, this subsite supported good numbers previously and that the species is known to be highly site-faithful to roost sites.
The graphed index numbers (see right) highlight the variability in annual numbers but also suggest a trend for decline in Dunlin at this subsite.



Brick Island has always been known for good numbers of Redshank. Index numbers (1998/99 to 2007/08) suggest a decline in numbers at this subsite.



Numbers of Black-tailed Godwits at the subsite have increased across the years. This increase is in line with the national trend for this species (Crowe et al. 2008).



Entire Count Unit: Cork Harbour

I-WeBS data for the entire site of Cork Harbour is presented in Appendix 4.3. The data period is 2004/05 to 2008/09.

- Waterbirds that occur in internationally important numbers

Current data (2004/05 to 2008/09) shows that Cork Harbour currently only supports one species (Black-tailed Godwit) in numbers of international importance. Redshank, who occurred in numbers of international importance during the baseline period used for SPA selection, no longer pass the international threshold (5-year mean peak of 1,610 individuals).

- Waterbirds that occur in nationally important numbers.

Current data shows that Cork Harbour supports 19 species in nationally important numbers: Shelduck, Wigeon, Teal, Mallard, Shoveler, Red-breasted Merganser, Little Grebe, Great Crested Grebe, Cormorant, Grey Heron, Moorhen, Oystercatcher, Golden Plover, Lapwing, Dunlin, Curlew, Greenshank, Redshank and Turnstone.

4.5 Final conclusions of the waterbird surveys and assessment

Waterbird numbers within Zones A and B (Rossmore Bay and Brick Island Embayment) show great variation across the years but the overall trend is for largely stable numbers within these sites. Numbers of Black-tailed Godwits have increased within both zones. The use of a population indexing method helps to reveal that within Zone A (Rossmore Bay) numbers of Shelduck and Oystercatcher have declined over the past five years. Within Zone B (Brick Island) numbers of Oystercatcher and Redshank have increased. In contrast analysis of I-WeBS data suggests a decline in the numbers of Redshank at Brick Island but the difference is likely due to the fact that I-WeBS is primarily a high tide roost count and our surveys were conducted during the low tide period when birds were feeding.

Curlews show no trend for lower numbers within Zones A and B but were present in relatively fewer numbers during the surveys around Rossmore Peninsula. This observation is in line with the trends for decline in both the wider Cork Harbour are and nationally (Crowe et al. 2008).

Zones A and B can, on occasion, support numbers considered of national importance and both sites are important and integral parts of the overall wetland of Cork Harbour.

Appendix 4.1

Waterbird species recorded during waterbird counts 2010

Birds of Conservation Concern - Criteria: IUCN (Global conservation status), SPEC (European conservation status); BDp, BDMp (decline in population); BDr, BDMr (decline in breeding range); WDp, WDMp (decline in population during non-breeding season); HD (historical decline in breeding population); BR (breeding rarity); BL (localised breeding); WL (non-breeding species); BI (international importance during breeding season); WI (international importance during non- breeding season).

Bird Species	Listed on Birds Of Conservation Concern (Lynas *et al.,* 2007)	Listed on Annex I of EU Birds Directive
Bar-tailed Godwit *Limosa lapponica*	Red-list (BDp, BDr)	*
Black-Headed Gull *Larus ridibundus*	Red-list (BDp, BDr)	
Black-tailed Godwit *Limosa limosa*	Amber-list (SPEC, WL)	
Common Gull *Larus canus*	Amber-list (SPEC, BDMr, BL)	
Cormorant *Phalacrocorax carbo*	Amber-list (BL)	
Curlew *Numenius arquata*		
Dunlin *Calidris alpina*	Amber-list (SPEC, WL)	
Golden Plover *Pluvialis apricaria*	Red-list (BDp)	*
Great Black-backed gull *Larus marinus*	Amber-list (BDMp)	
Great Crested Grebe *Podiceps cristatus*	Amber-list (WL)	
Grey Heron *Ardea cinerea*		
Greenshank *Tringa nebularia*	Amber-list (BR, WI)	
Green Sandpiper *Tringa ochropus*	-	
Herring Gull *Larus argentatus*	Red-list (BDp)	
Lapwing *Vanellus vanellus*	Red-list (BDp)	
Lesser Black-backed gull *Larus fuscus*	Amber-list (BL)	
Little Egret *Egretta garzetta*		*
Knot *Calidris canutus*	Red-list (WDp, WDMp, SPEC)	
Mallard *Anas platyrhynchos*		
Mute Swan *Cygnus olor*		
Oystercatcher *Haematopus ostralegus*	Amber-list (WL)	
Red-breasted Merganser *Mergus serrator*		
Redshank *Tringa totanus*	Red-list (HD, SPEC, WL)	
Ringed Plover *Charadrius hiaticula*	Amber-list (WI)	
Shelduck *Tadorna tadorna*	Amber-list (WL)	
Snipe *Gallinago gallinago*	Amber-list (SPEC)	
Teal *Anas crecca*	Amber-list (BDMr)	
Turnstone *Arenaria interpres*		
Whimbrel *Numenius phaeopus*		
Wigeon *Anas penelope*	Amber-list (WL)	

Waterbird Survey Data

6th October 2010

Replicate Zones A & B	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**
Count Time	09:10	10:10	11:10	12:10	13:10	14:10	09:40	10:40	11:40	12:40	13:40	14:40
Time of Low Tide (Cobh)	11:07	11:07	11:07	11:07	11:07	11:07	11:07	11:07	11:07	11:07	11:07	11:07
Tidal state at count	Falling	Falling	Low	Rising	Rising	Rising	Falling	Falling	Low	Rising	Rising	Rising
Shelduck	1	1	1			2	3					
Teal									15			
									4	Red-breasted Merganser		1
Cormorant				1								
Little Egret	7	1	2	3	3	2	2	2	1	2	Grey Heron	1
	1	1	1	1	Oystercatcher	39	25	18	21	25	2	15
	32	31	37	54	24							
Ringed Plover	3	3										
Golden Plover	2	Dunlin	48	11	37	32	18	7	Black-tailed Godwit		25	6	3
	7	8	3	1	1	1	1	1	24	Bar-tailed Godwit		1
	1	Curlew	39	32	30	44	26	13	16	3	6	18	26
	18											
Whimbrel	1	1										
Green Sandpiper	1											
Greenshank	3	1	1	1	21	23	3	Redshank		169	15	15	85
	113	135	21	42	40	44	64	126				
Turnstone					2							
Black-headed Gull	21	18	14	16	18	11	4	4	84	12	10	Great
Black-backed Gull	5	22	1	1	**Number species**	**14**	**12**	**8**	**11**	**98**	**88**	**67**
	8	**14**	**Total waterbirds**	**363**	**116**	**85**	**217**	**228**	**185**	**64**	**86**	**101**
	108	**162**	**224**									

21st October 2010

Replicate Zones A & B	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	
Count Time	10:35	11:35	12:35	13:35	14:35	15:35	11:05	12:05	13:05	14:05	15:05	16:05	
Time of Low Tide (Cobh)	11:34	11:34	11:34	11:34	11:34	11:34	11:34	11:34	11:34	11:34	11:34	11:34	
Tidal state at count	Falling	Low	Rising	Rising	Rising	Rising	Falling	Low	Rising	Rising	Rising	Rising	
Shelduck	8	8	2	4							1		
Teal									2		8	3	
Cormorant	7	2											
Little Egret		1	3	1	1	2	1	1	1	Grey Heron	1	1	
		1	1	1	1	1	1						
Great Crested Grebe						1							
Oystercatcher	41	37	48	17	3	14	6	3	12	31	41	5	
Ringed Plover	11	11	11	3									
Golden Plover	21												
Knot	22	36	38	36									
Dunlin	111	87	46	32	10	Black-tailed Godwit		437	356	355	352	296	3 1
	13	Greenshank	1	1	11	1	3	4	3				
Turnstone		1	2	16									
Black-headed Gull	5	7	4	4	2	3	4	3	2	6	8	6	
Common Gull	1	1	1	1			1						
Lesser Black-backed Gull											1	1	
Great Black-backed Gull	1	**Number species**	**13**	**13**	**13**	**12**	**7**	**8**	**8**	**7**	**8**	**8**	**13** **10 Tota**

24th November 2010.

Replicate Zones A & B	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**
Count Time	11:05	12:05	13:05	14:05	15:05	16:05	11:35	12:35	13:35	14:35	15:35	16:35
Time of Low Tide (Cobh)	13:07	13:07	13:07	13:07	13:07	13:07	13:07	13:07	13:07	13:07	13:07	13:07
Tidal state at count	Falling	Falling	Low	Rising	Rising	Rising	Falling	Falling	Low	Rising	Rising	Rising
Shelduck	36	12	7		8	3						26
Wigeon						2	22	7	2	12		77
Teal						4	8	32				
Cormorant	9	3	5									
Little Egret										1	2	1
Grey Heron	2	2										
Oystercatcher	10	12	13	6	14	2	1	5	4	2	16	12
Ringed Plover	13	5	7	8	8							
Grey Plover				1								
Lapwing				1								
Dunlin	55	22	171	14	7	5	28	Black-tailed Godwit		86	58	42
	18	14	37	12	10	9	10	15	97	Curlew 23	17	21
	14	10	1	812	13	18	17	34	Redshank	115	79	74
	100	76	37	36	39	38	41	61	108	Greenshank	1	11
	1	Black-headed Gull	1	11	1	1	1					
Common Gull	1				1							
Number species	**10**	**98**	**98**	**77**	**76**	**9**	**6**	**11**	**Total waterbirds**		**350**	**210**
	340	**163**	**138**	**87**	**81**	**78**	**67**	**94**	**112**	**417**		

21st December 2010

Replicate Zones A & B	**A**	**A**	**A**	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**
Count Time	09:35	10:35	11:35	12:35	13:35	14:35	10:05	11:05	12:05	13:05	14:05	15:05
Time of Low Tide (Cobh)	11:36	11:36	11:36	11:36	11:36	11:36	11:36	11:36	11:36	11:36	11:36	15:05
Tidal state at count	Falling	Falling	Low	Rising	Rising	Rising	Falling	Falling	Low	Rising	Rising	Rising
Shelduck	17	15	13	26	11	2		1	1	1	34	52
Wigeon		8	29	21	10	14	32 Tea	5	14	30	40	43
		16	58	79	58	121	168					
Mallard				1					2			
Cormorant		4										
Little Egret	1	1	Grey Heron	1	1	1	1	Oystercatcher	22	13	13	
	14	8	12	7	4	4	7	5	7			
Ringed Plover	2				1	2						
Grey Plover	12	Lapwing 1	1	4	7	8	6	4	3	Dunlin 175	420	38 42 44 2
Bar-tailed Godwit	1											
Curlew	918	21	16	4	4	21	14	11	22	17	27	Redshank
	111	102	115	122	88	39	37	44	58	58	95	106
Greenshank	11	1										
Turnstone	8				9	9		2	2			
Black-headed Gull	1	3	1	1	1		2	1	1	2		1
Common Gull	1				1	1						
No. species	**12**	**10**	**710**	**12**	**14**	**9**	**12**	**12**	**11**	**13**	**14**	**Total**
waterbirds	**373**	**594**	**195**	**263**	**223**	**205**	**139**	**208**	**258**	**210**	**497**	**631**

Appendix 4.3

Data from the Irish Wetland Bird Survey (I-WeBS) (provided by BirdWatch Ireland)

I-WeBS

Cork Harbour

Species	1% National	1% International	2004/05	2005/06	2006/07	2007/08	2008/09	Mean	Peak
Mute Swan	110		71	54	73	68	39	61	73
Whooper Swan	130	210	7			3	1	2	7
Black Swan					2			0	2
Pink-footed Goose		2,250				2		0	2
Greylag Goose	50	870	1	3	1	6		2	6
Canada Goose			23	11	13	22	5	15	23
Light-bellied Brent Goose		260	16	26	11	17	6	15	26
Feral/hybrid Goose			2			5		1	5
Shelduck	150	3,000	1,391	1,350	916	823	849	1,066	1,391
Wigeon	820	15,000	2,043	2,332	1,492	1,269	665	1,559	2,332
Gadwall	20	600	13	13	7		6	8	13
Teal	450	5,000	1,169	1,302	667	644	690	934	1,302
Mallard	380	20,000	628	405	423	484	305	449	628
Pintail	20	600	20	14	2		22	12	22
Shoveler	25	400	24	45	62	51	18	40	62
Pochard	380	3,500	7	7	2	3	2	4	7
Tufted Duck	370	12,000	14	14	19	16	22	17	22
Scaup	45	3,100		2			1	1	2
Eider	30	12,630		15	1			3	15
Common Scoter	230	16,000	3	7		1	1	2	7
Velvet Scoter						3		1	3
Goldeneye	95	11,500	7	10	5	14	17	11	17
Red-breasted Merganser	35	1,700	85	80	68	72	51	71	85
Red-throated Diver	20	3,000		1	1			0	1
Black-throated Diver		3,750					1	0	1
Great Northern Diver		50			4	3	2	2	4
Little Grebe	25	4,000	80	69	58	65	43	63	80
Great Crested Grebe	55	3,900	105	137	63	106	78	98	137
Slavonian Grebe		55	1	2				1	2
Cormorant	140	1,200	370	308	163	285	144	254	370
Shag			2		2	6	3	3	6
Little Egret		1,300	166	126	143	151	69	131	166
Cattle Egret							3	1	3
Grey Heron	30	2,700	135	76	84	72	75	88	135
Spoonbill						1		0	1
Water Rail			2	2	2	2	1	2	2
Moorhen	20		24	33	55	25	25	32	55
Coot	330	17,500	23	16	19	7	2	13	23
Oystercatcher	880	10,200	1,857	2,076	1,951	1,550	886	1,466	2,076
Ringed Plover	150	730	25	67	17	27	38	35	67
Golden Plover	1,700	9,300	6,200	3,002	3,266	5,232		3,540	6,200
Grey Plover	65	2,500	4	24	12	39	6	17	39
Lapwing	2,100	20,000	4,133	4,096	3,321	3,321	1,155	3,205	4,133
Knot	190	4,500	85	117	124	111	32	94	124
Sanderling	65	1,200		33				7	33
Curlew Sandpiper			3	4	1			2	4
Dunlin	880	13,300	4,325	3,874	4,496	3,579	5,091	4,265	5,091
Ruff		12,500		1		3		1	3
Snipe		20,000	14	49	32	75	7	35	75
Black-tailed Godwit	140	470	2,937	3,337	1,403	2,623	2,050	2,510	3,337
Bar-tailed Godwit	160	1,200	298	218	383	257	19	235	383
Whimbrel		2,000	1	4	1	1	1	2	4
Curlew	550	8,500	2,317	1,809	1,363	1,607	694	1,558	2,317
Common Sandpiper			2	2	1	4	3	2	4
Green Sandpiper			1	1				0	1
Spotted Redshank		900	2	1	1	1		1	2

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species.

I-WeBS

Greenshank	20	2,300	83	68	72	71	44	68	83
Redshank	310	3,900	2,295	1,543	1,459	1,725	1,027	1,610	2,295
Turnstone	120	1,500	161	136	129	214	67	141	214
Mediterranean Gull			13	15	24	48	65	33	65
Bonaparte's Gull					1			0	1
Black-headed Gull		20,000	2,170	2,627	2,010	2,103	513	1,885	2,627
Ring-billed Gull			1					0	1
Common Gull		16,000	250	188	214	207	71	194	250
Lesser Black-backed Gull		4,500	496	31	630	72	57	257	630
Herring Gull		13,000	36	40	123	51	41	58	123
Iceland Gull							1	0	1
Glaucous Gull						1		0	1
Great Black-backed Gull		4,800	385	157	137	98	43	164	385
Sandwich Tern			2	225	2	67	1	49	225
Common Tern				1	1	1		1	1
Arctic Tern						1		0	1
Kingfisher			3	3	1	2	1	2	3

Corh Harbour coverage:

Subsite	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	
Rostellan Lake	7	7	6	6	6		
Rathcoursey & Ahareek	6	5	7	7	6		
Lough Beg	5	5		1			
Owenboy Estuary	6	3		6	1		
Ringaskiddy - Luc Strand	4	1		1			
Weir Island	7	7	7	7		7	
Harpers Island					3		
Ballintubbrid	7	7	7	7		7	
Ballynacorra	6	5	6	7	6		
Cuskinny	6	4	5	5	5	5	
Dunkettle	5	1	4	6		4	
Brick Island	7	7	7	7		7	
Douglas Estuary	6	6	5	7			
Glounthane Estuary/ Slatty Water	6	5	6	5	3	7	
Aghada	7	7	6	6	6		
Whitegate Bay	7	7	6	6	6		
North Channel - Ballintubbrid	6	4	5	5	5	6	
Belvelly - Marino Point	6	4	5	1	5		
Monkstown Creek	5	5		1			
Saleen	7	7	6	6	6		
East Lough Mahon				6			
Carrigaenan Pools				4			
Belvelly Tower				6			
Belvelly Bridge - Railway				6			
Carrigenan - Great Island & Railway				6			

Weir Island

Species	1% National	1% International	2004/05	2005/06	2006/07	2007/08	2008/09	Mean	Peak
Mute Swan	110					2		1	2
Shelduck	150	3,000	151	106	92	89		110	151
Wigeon	820	15,000	87	42	38	50		54	87
Teal	450	5,000	27	34	8	2		18	34
Mallard	360	20,000		3	2	2		2	3
Little Grebe	25	4,000			3			1	3
Great Crested Grebe	55	3,600	1					0	1
Cormorant	140	1,200	1	6	1			2	6
Little Egret		1,300	5	2	2	8		4	8
Grey Heron	30	2,700	1	1	1	1		1	1
Oystercatcher	680	10,200	156	243	153	83		159	243
Ringed Plover	150	730				2		1	2
Golden Plover	1,700	9,300	1,224					306	1,224
Lapwing	2,100	20,000	32	210				61	210
Knot	190	4,500		60	6			17	60
Curlew Sandpiper			1					0	1
Dunlin	880	13,300	243	314	132			172	314
Snipe		20,000		1	2	4		2	4
Black-tailed Godwit	140	470	62	68	6	16		38	68
Curlew	550	8,500	120	73	47	12		63	120
Greenshank	20	2,300	6	1	1			2	6
Redshank	310	3,900	334	335	87	259		254	335
Turnstone	120	1,500	22	27	43	78		43	78

Brick Island

Species	1% National	1% International	2004/05	2005/06	2006/07	2007/08	2008/09	Mean	Peak
Shelduck	150	3,000	3	37	81	21		36	81
Wigeon	820	15,000	25	6	18	33		21	33
Teal	450	5,000	12	42	4	11		17	42
Mallard	360	20,000	2	18		2		6	18
Red-breasted Merganser	35	1,700		2	2			1	2
Great Crested Grebe	55	3,600		1	1			1	1
Cormorant	140	1,200	1	1		1		1	1
Little Egret		1,300	1	1	2	6		3	6
Grey Heron	30	2,700	1			1		1	1
Oystercatcher	680	10,200	7	9	14	14		11	14
Lapwing	2,100	20,000	24	36	70			33	70
Dunlin	880	13,300		70	367			109	367
Snipe		20,000		16		6		6	16
Black-tailed Godwit	140	470	14	8	87	33		36	87
Curlew	550	8,500	10	9	6	10		9	10
Greenshank	20	2,300	3	2	6	2		3	6
Redshank	310	3,900	64	27	106	47		61	106
Turnstone	120	1,500	38	36		1		19	38
Kingfisher				1				0	1

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species.

5.0 REVIEW OF SHELLFISH DATA

5.1 Introduction

One requirement of the ecological monitoring of East Cork Landfill is to review shellfish monitoring data for shellfish growing areas in the vicinity of the landfill.

The review is in three parts. Firstly, we assess data on trace metal concentrations in shellfish. Up until 2006 these data were published annually as a Marine Institute Publication '*Trace metal concentrations in shellfish from Irish waters,* Marine Environment and Health Series.' Since then, data for this section of the annual report for East Cork Landfill has been obtained directly from the Marine Institute. Secondly, we review the current classification for Cork Harbour North Channel in relation to shellfish microbiological standards. Finally we review the current status of the North Channel is relation to shellfish biotoxins.

There is an expanse of EU and Irish legislation concerning the production and sale of shellfish. Two major pieces of legislation are discussed below. Note that further information in regards to legislation concerning shellfish production and food safety can be reviewed at www.sfpa.ie.

- **The Shellfish Waters Directive 2006/113/EC**

This Directive is implemented in Ireland by the European Communities (Quality of Shellfish Waters) Regulations 2006 (SI No 268 of 2006).

The aim of the Shellfish Waters Directive is to protect or improve shellfish waters in order to support shellfish life and growth. It is designed to protect the aquatic habitat of bivalve and gastropod molluscs, which include oysters, mussels, cockles, scallops and clams. The Directive requires Member States to designate waters that need protection in order to support shellfish life and growth. The Directive also sets physical, chemical and microbiological requirements that designated shellfish waters must either comply with or endeavour to improve (Appendix 5.1). Furthermore, it provides for the establishment of pollution reduction programmes for the designated waters.

Responsibility for the Shellfish Waters Directive in Ireland transferred from the Department of Agriculture, Fisheries and Food to the Department of the Environment, Heritage and Local Government on 5 November 2008.

In February 2009 the **European Communities (Quality of Shellfish Waters) (Amendment) Regulation 2009, (SI 55 of 2009),** provided for an additional 49 designated shellfish growing areas. Under the 2009 Regulations, Cork Harbour's Great Island North Channel is now legally designated as a shellfish growing area and is required to meet the monitoring requirement set out in S.I. No. 268 of 2006. Although Cork Harbour had not been legally designated prior to this, regular monitoring of the waters has been undertaken by the Marine Institute for a number of years.

- **EC Hygiene Regulations 'laying down specific rules for food of animal origin' (Nos. 852/853/854 of 2004)**

The Sea Fisheries Protection Authority (SFPA) implements EU Directives on the quality of shellfish waters. European Regulations Nos. 852/2004, 853/2004 and 854/2004 have surpassed EU Directive 91/492/EEC in laying down the conditions for the production and public sale of live bivalve molluscs. In addition shellfish harvesting areas are required to be classified according to the shellfish microbiological standards: Class A (no restrictions; can be collected for direct human consumption); Class B (depurated, heat treated or relayed to meet Class A standards), Class C (relay in a clean area for at least 2 months prior to sale), Class D (harvesting prohibited).

5.2 Data review for Cork Harbour North Channel

5.2.1 Trace metal contaminants in shellfish and shellfish waters

Trace metals are naturally occurring elements required by all living organisms for growth and development. However, many metals are introduced into the aquatic environment through anthropogenic activities such as mining, industry and agriculture (Boyle et al. 2006).

Shellfish can accumulate chemical contaminants, including trace metals, in their tissues. The level of contaminants within shellfish tissue is a good indicator of levels present within the water column, therefore providing valuable information as to the quality of the shellfish and the waters in which they were grown (Boyle *et al.,* 2006).

Strictest limits for the levels of mercury, lead and cadmium within shellfish flesh are provided in Commission Regulation 466/2001/EEC (as amended by Regulation 221/2002/EC and Regulation 208/2005/EC) which came into effect on 5th April 2002. Apart from these three metals, there are no European standards for trace metals in shellfish although guide values are given in S. I. No. 268 (2006). Because of this, this review uses strictest limits as per Boyle et al. 2006.

Contaminant	Values and Units (wet weight)
Cadmium	1.0 mg kg^{-1}
Copper	20 mg kg^{-1} (60 mg kg^{-1} for oysters)
Lead	1.5 mg kg^{-1}
Mercury	0.5 mg kg^{-1}
p,p' DDT & metabolites	500 µg kg^{-1}
HCB	50 µg kg^{-1}
A and β HCH	50 µg kg^{-1}
Lindane (gamma HCH)	100 µg kg^{-1}
PCB 28	80 µg kg^{-1}
PCB 52	80 µg kg^{-1}
PCB 101	80 µg kg^{-1}
PCB 138	100 µg kg^{-1}
PCP 153	100 µg kg^{-1}
PCB 180	80 µg kg^{-1}

Table 5.1 Synopsis of the strictest guidance and standard values applied by various OSPAR countries for contaminants in shellfish (Data source: Boyle *et al.,* 2006). Note that levels for mercury, lead and cadmium are provided by European legislation (see text).

The data received for the North Channel (2008/2009 data) is provided in Appendix 5.2. A review of these recorded levels of trace metals and other compounds show that all data are within the accepted guidance limits.

5.2.2 Microbiological quality of shellfish waters - Shellfish Production Areas

The Shellfish Production Area currently operating within the Cork Habour North Channel (Area CK-CH- NC), is licensed to produce Pacific Oyster (*Crassostrea gigas*) and Native Oyster (*Ostrea edulis*) (source www.fsaI.ie). The Sea Fisheries Protection Authority (SFPA) has recently reclassified Shellfish Production Areas in Ireland. The classification for the North Channel is presented below (Table 5.2).

Table 5.2 Classified Bivalve Mollusc Production Area in Ireland (15th June 2010) (www.sfpa.ie)

	Between 8°16.4' W and 8° 15.6' W.	North Channel West	Oysters	Class B
Cork Harbour	Between 8°14.6'W and 8°13.2'W.	North Channel East	Oysters	Class B

The classification as a Class B Shellfish Production Area requires that oysters harvested from the area are depurated, heat treated or relayed before going for human consumption (see Table 5.3).

Table 5.3 Criteria for the classification of bivalve mollusc harvesting areas under Regulation (EC) No 854/2004, Regulation (EC) 853/2004 and Regulation (EC) 2073/2005.

Category	***Microbiological***	***Standard Treatment Required***
A*	<230 *E. coli* per 100g flesh and intra-valvular liquid.	May go direct for human consumption.
B	<4,600 *E. coli* per 100g flesh and intra-valvular liquid.	Must be depurated, heat treated or relayed to meet class A requirements.
C	<46,000 *E. coli* per 100g of flesh and intra-valvular liquid.	Relay for two months to meet class A or Brequirements - may also be heat treated.
D	>46,000 *E. coli* per 100g of flesh and intra-valvular liquid.	Harvesting prohibited

5.2.3 National Marine Biotoxin Monitoring Programme

Under Council Directive 853/2004, Ireland is required to monitor shellfish harvesting areas for the presence of toxins produced by some species of phytoplankton. The Programme covers the toxins, Diarrhetic Shellfish Poisoning (DSP), Azaspiracid poisoning (AZP), Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP). Other toxins are also tested for on an ongoing basis. Under the Council Directive live bivalve molluscs, echinoderms, tunicates and marine gastropods (e.g. whelks and periwinkles) must be tested for biotoxins, this includes both commercially farmed and wild species.

Samples of shellfish are analysed routinely for the presence of these toxin groups using both biological and chemical test methods. Water samples are also collected from shellfish sites and the number of known toxin producing phytoplankton species and harmful/nuisance phytoplanktonic species is determined. The sampling frequency is currently monthly and is undertaken by the Marine Institute.

Figure 5.1
Cork Harbour Production Area CK-CH.
Sample Points**:** CK-CH-NC North Channel (*Crassostrea gigas*, *Ostrea edulis, Mytilus edulis*). Longitude -8.25917, Latitude 51.88056 (Marine Institute, 2010).

Based on the results of the sampling, shellfish production areas are deemed either 'open' or 'closed.'
Two Biotoxin-free samples, taken at least 48 hours apart, are required to re-open an area that has been closed.

Shellfish toxicity summaries are provided by the Marine Institute (www.marine.ie) and up-to-date information on the open or closed status of shellfish production areas. Summary data (5th September - 23rd October) shows the North Channel to have an open status. The phytoplankton count summary for the same time period does not show any harmful blooms within the North Channel or wider Cork Harbour.

Concluding statement

Based on the information review, we have found no evidence of deterioration in the shellfish quality or shellfish water quality of the North Channel in recent years.

Appendix 5.1

SHELLFISH WATERS MANDATORY VALUES - FROM DIRECTIVE 2006/113/EC

Parameter	*Unit of Measurement*	*Standard/Value*	*Reference Method of analysis or inspection*	*Frequency of sampling*
pH	pH unit	Not less than 7 nor greater than 9	Electrometry	Quarterly Measured in situ at the time of sampling.
Temperature	Degrees Celsius		Thermometry	Quarterly Measured in situ at the time of sampling.
Coloration (After Filtration)	Milligrams per litre	A discharge affecting shellfish waters must not cause the colour of the waters after filtration to deviate by more than 10 milligrams per litre from the colour of waters not so affected.	Filter through a 0.45 micrometre membrane. Photometric method, using the platinum/cobalt scale.	Quarterly
Suspended solids	Milligrams per litre	A discharge affecting shellfish waters must not cause the suspended solids content of the waters to exceed by more than 30 per cent the suspended solids content of waters not so affected.	Filtration through a 0.45 micrometre membrane, drying at 105 degrees Celsius and weighing. Centrifuging (for at least 5 minutes, with mean acceleration 2,800 to 3,200g), drying at 105 degrees Celsius and weighing.	Quarterly
Salinity	Practical salinity units	(a) less that 40 practical salinity units, and (b) discharges affecting shellfish waters must not cause the salinity of the waters to exceed by more than 10 per cent the salinity of waters not so affected.	Conductimetry	Monthly
Dissolved oxygen	Saturation per cent	(a) equal to or greater than 70 per cent (average value) (b) no individual measurement to indicate a value less than 60 per cent unless it can be established that there are no harmful consequences for the development of shellfish colonies. minimum Should an individual measurement indicate a value less than 70 per cent, measurements must be repeated.	Winkler's method or electrochemical method	Monthly, with a minimum of one sample representative of low oxygen conditions on the day of sampling. However, where major daily variations are suspected, a of two samples in one day must be taken.
Petroleum hydrocarbons		Hydrocarbons must not be present in the shellfish waters in such quantities as will— (a) produce a visible film on the surface of the water or a deposit on the shellfish, or both, or (b) have harmful effects on the shellfish.	Visual examination	Quarterly

Organohalo-genated substances Polychlorinated biphenyls	µg.litre-1_{-1} (seawater)	0.30	Gas chromatography after extraction with suitable solvents and purification.	Half-yearly
Polychlorinated Biphenyls: Sum of ICES 7CBs	µg.kilogram-1_{-1} wet weight @ 1 per cent lipid (shellfish flesh)	300.00 The concentration of each substance in the shellfish water or in the shellfish flesh must not reach or exceed a level, which has harmful effects on the shellfish and their larvae.		
Metals (Dissolved): Arsenic Cadmium Chromium Copper Lead Mercury Nickel Silver Zinc	µg.litre-1 (seawater)	40.00 5.00 30.00 10.00 20.00 0.40 50.00 10.00 200.00 The concentration of each substance in the shellfish water must not exceed a level that gives rise to harmful effects on the shellfish and their larvae. The synergic effects of these metals must be taken into consideration.	Spectrometry of atomic absorption preceded, when appropriate, by concentration or extraction, or both.	Half-yearly
Faecal coliforms	Number of faecal coliforms per 100 millilitres		Method of dilution with fermentation in liquid substrates in at least three tubes in three dilutions. Subculturing of the positive tubes on a confirmation medium. Count according to MPN (most probable number). Incubation temperature 44°C ± 0.5°C.	Quarterly
Substances affecting the taste of shellfish		The concentrations of such substances in shellfish waters or in shellfish flesh must be limited so that the taste of shellfish is not impaired.	Examination of the shellfish by tasting.	If the presence of any of these substances is presumed.

SCHEDULE 4

SHELLFISH WATERS GUIDE VALUES (FROM S. I. NO, 268 OF 2006)

Parameter	*Unit of Measurement*	*Standard/Value*
pH	pH unit	
Temperature	Degrees Celsius	A discharge affecting shellfish must not cause the temperature of the waters to exceed by more than 2 degrees Celsius the temperatures of waters not so affected.
Coloration (after filtration)	Milligrams per litre	
Suspended solids	Milligrams per litre	
Salinity	Practical salinity units	12 to 38 practical salinity units.
Dissolved oxygen	Saturation per cent	Equal to or greater than 80 per cent (average value)
Petroleum hydrocarbons		
Organohalogenated substances:		
Polychlorinated biphenyls: Sum of ICES 7CBs	∝g.kilogram$_{-1}$ wet weight @ 1 per cent lipid (shellfish flesh)	100.00
Metals:	Milligrams/ kilogram-1$_{-1}$ dry weight (shellfish flesh)	The concentration of each substance in the shellfish flesh must be so limited that it contributes to the high quality of shellfish products.
Arsenic		30.00
Cadmium		5.00 6.00
Chromium		400.00
Copper		7.50 1.00
Lead		5.00
Mercury		15.00
Nickel		4000.00
Silver		The concentration of each substance in the shellfish flesh must be so limited that it contributes to the high quality of shellfish products.
Zinc		Equal to or less than 300 in the shellfish flesh and inter-valvular liquid
Faecal coliforms	Number of faecal coliforms per 100 millilitres	
Substances affecting the taste of shellfish		

Shellfish Data - Contaminants in shellfish - data supplied by the Marine Institute September 2010.

Sample Site	Cork Harbour - North Channel	Cork Harbour - North Channel	Cork Harbour - North Channel	Cork Harbour - North Channel	Cork Harbour - North Channel	Cork Harbour - North Channel
M.I. Reference No.	ENV/08/083	ENV/08/0146	ENV/09/054	ENV/09/069	SWD/09/4023	SWD/09/4024
Sampling Date	29/10/08	10/12/08	04/08/09	11/08/09	18/11/09	18/11/09
Latitude	51° 52.86	51° 52.98	51° 52.57	51° 53.09	51° 53.02	51° 53.02
Longitude	8° 15.56	8° 14.64	8° 15.50	8° 14.53	8° 16.02	8° 16.02
Species sampled	*M. edulis*	*C. gigas*	*M. edulis*	*M. edulis*	*C. gigas*	*M. edulis*
Number individuals	46	25	50	50	25	50
Method of cultivation	bed	trestle	intertidal		trestle	intertidal
Water Parameters						
Temperature (°C)	8.53					
Salinity	27					
pH	7.74					
Suspended Solids (mg L_{-1})						
Shellfish						
Shell length range (mm)	42 - 58	79 - 147	41.5 - 58	41 - 60	75.5 - 148	41 - 59.5
Shell mean length (mm)	50.8	113	51.6	50.2	107	48.6
Shell length std dev (mm)	3.35	18.5	4.40	6.00	20.8	4.50
Meat water content (%)	72.5	81.2	73.4	74.5	82.6	80.8
Metals mg kg_{-1} (ppm) wet wt.						
Arsenic	2.09	2.03	2.4	1.55	2	1.6
Cadmium	0.1	0.19	0.13	0.05	0.09	0.07
Chromium	0.09	0.1	0.17	0.15	0.07	0.18
Copper	1.9	19.8	2	1.37	5.59	1.31
Lead	0.39	0.27		0.46	0.23	0.34

Mercury	0.03	0.03	0.03	0.02	0.02	0.02
Zinc	16	291	13.7	11.4	138	12.9
Nickel	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13
Silver	<0.01	0.59	0.04	0.02	0.22	<0.01
PCB's g kg.$_1$ (ppb) wet wt.						
CB Congener 18						0.02
CB Congener 28		0.19	0.04	<0.08	0.07	0.11
CB Congener 31		0.63			nd (<0.01)	0.23
CB Congener 44						nd (<0.008)
CB Congener 52		0.25	<0.33	<0.87	0.16	0.36
CB Congener 101		1.3	0.13	0.2	0.24	<0.42
CB Congener 105		nd (<0.02)	<0.12	nd (<0.04)	0.16	0.04
CB Congener 118		0.61	0.22	nd (<0.17)	0.31	0.5
CB Congener 138		1.03	0.29	0.3	0.37	0.43
CB Congener 153		1.03	0.25	0.51	0.85	0.88
CB Congener 156		<0.11	0.04	0.05	0.02	0.04
CB Congener 170			nd (<0.001)		<0.006	0.01
CB Congener 180		0.05	0.04	0.04	<0.06	<0.09
CB Congener 194			nd (<0.001)		nd (<0.003)	nd (<0.003)
CB Congener 209			nd (<0.13)			
Organochlorines g kg.$_1$ (ppb) wet wt.						
DDT-pp'		0.23	<0.12	0.08	<0.19	nd (<0.003)
DDE-pp'		0.92	0.43	0.5	0.65	0.74
DDT-op'		0.05	nd (<0.001)	0.03	nd (<0.01)	<0.12
DDE-op'			0.01			nd (<0.003)
TDE-op'			nd (<0.001)	nd (<0.008)	nd (<0.003)	nd (<0.003)
TDE-pp'		0.54		0.19	0.25	0.25
Dieldrin		0.24	0.32		0.25	0.78
Hexachlorobenzene		<0.11	0.1	0.02	<0.01	0.05
alpha-HCH		nd (<0.0008)	0.05	0.04	0.01	0.03

beta-HCH		nd (<0.004)	0.02	nd (<0.008)	nd (<0.003)	<0.004
gamma-HCH		0.07	0.03	0.09	0.06	<0.008
delta-HCH						
trans-Nonachlordane		0.13	0.01	0.02	0.04	0.03
trans-Chlordane		nd (<0.09)	0.08		0.11	0.13
cis-Chlordane		0.06	0.02	0.03	0.11	0.15
Endrin			nd (<0.006)	nd (<0.008)	0.04	nd (<0.003)
Aldrin		0.07	<0.006	nd (<0.008)	nd (<0.003)	nd (<0.003)
Oxychlordane		0.02	0.01	0.02	nd (<0.003)	nd (<0.003)
Endosulfan sulfate		nd (<0.09)		nd (<0.008)	<0.008	nd (<0.003)
Mirex						
alpha-endosulfan		nd (<0.0008)	nd (<0.001)	nd (<0.008)		
beta-endosulfan			nd (<0.001)	nd (<0.008)	nd (<0.003)	nd (<0.003)
trans-heptachloroepoxide			0.02	nd (<0.008)	0.03	<0.04
Heptachlor		0.03	<0.006	nd (<0.008)	0.03	0.04
Lipid (%)		1.45	1.10	1.38	2.24	2.45

6.0 REVIEW OF EPA WATER QUALITY DATA

6.1 Introduction

This section presents the findings of a review of data from the Environmental Protection Agency (EPA) Estuarine and Coastal Water Quality Monitoring Programme. This monitoring programme is carried out in conjunction with local authorities and the Marine Institute, a major objective being to assess the eutrophic status of the coastal waters.

6.2 Review of water quality data for Cork Harbour North Channel

Trophic Status Assessment

The water quality of estuarine and coastal waters is assessed by the EPA under their Trophic Status Assessment Scheme (TSAS). The scheme, which was designed to detect the occurrence of eutrophication in estuarine and nearshore waters, is based on relevant measures of water quality; methodology is detailed in Toner et al. (2005).

In brief, the scheme works by assessing the level of compliance of a range of parameters and their associated assessment levels that are considered to be indicative of good environmental quality. Both dissolved inorganic nitrogen (DIN) and ortho-phosphate (MRP) levels are assessed in summer and winter, chlorophyll data are assessed using a median and 90 percentile approach and oxygen conditions are assessed both in respect of deoxygenation and supersaturation. A further element of the TSAS system includes a qualitative approach to observing the distribution of opportunistic macroalgae *Ulva* species (Clabby et al. 2007). The parameters and criteria used are shown in Appendix 6.1 (after Toner et al. 2005).

In previous assessments, trophic status of the North Channel has varied from 'eutrophic' to the improved classification of 'intermediate.' The most recent assessment (2006 - 2008) classifies the North Channel as 'potentially eutrophic' (Lucey, 2009). The Owenacurra Estuary (main river flowing into the North Channel) has an improved classification of 'potentially eutrophic. Of the nine sampling sites within Cork Harbour, none were classified as 'eutrophic' during this assessment period. These results therefore suggest an overall improvement of water quality of Cork Harbour's estuarine waters in recent years.

The most recent water quality data for the North Channel covers the period 2007 - 2009 and was kindly provided by Shane O'Boyle, Environmental Protection Agency in December 2010. The full dataset is given in Appendix 6.2. Summary data for the North Channel is shown in Table 6.1 along with the results of the most recent trophic status assessment. These data show that the winter levels of Dissolved Inorganic Nitrogen (DIN) exceeded the standard of 0.825 mg/l for intermediate waters at salinity 26.97 psu (North Channel DIN - median 1.4 mg/l N and maximum 2.1 mg/l N). The other criteria that failed to meet standards was Dissolved Oxygen (D.O % sat) which had a minimum recorded level of 59.2, below the standard of 78 % for water with salinity 31psu.

Table 6.1 Summary water quality data for Cork Harbour North Channel 2007 - 2009 (data kindly provided by the EPA).

(a) Summary data

		Salinity	Temp (°C)	pH	Secchi (m)	DO sat. (%)	DO (mg/l)	BOD (mg/l)	TON (mg/l)	NH_3 (mg/l)	DIN (mg/l)	MRP (µg/l)	Chl. a (µg/l)
Winter	MINIMUM	13.67	5.46	7.8	0.8	90.2	8.6	<1	0.84	0.04	0.942	33	0.2
	MEDIAN	26.96	9.24	7.9	1.5	92.7	8.9	<1	1.32	0.07	**1.410**	36	0.5
	MAXIMUM	29.64	9.40	8.1	1.8	99.5	11.0	1.5	1.99	0.16	**2.139**	54	2.9
	No. samples	*21*	*21*	*21*	*9*	*21*	*21*	*10*	*21*	*21*	*21*	*21*	*21*
Summer	MINIMUM	0.44	13.20	7.5	1.0	**59.2**	4.7	<1	< 0.01	< 0.02	0.015	<5	1.6
	MEDIAN	31.82	15.65	8.2	1.9	102.5	8.2	2.2	0.11	0.03	0.225	5	6.9
	MAXIMUM	33.39	19.18	8.4	3.8	129.0	10.2	4.0	2.61	0.38	2.933	107	28.8
	No. samples	*95*	*95*	*95*	*34*	*95*	*95*	*57*	*95*	*95*	*95*	*95*	*87*

(b) TSAS Assessment

TSAS criteria	Threshold	Value	Potentially Eutrophic
Winter DIN	0.825	1.410	Fail
Winter MRP	50	36	Pass
DIN-	0.506	0.225	Pass
MRP-	44	5	Pass
Chloro. Median	11.1	6.9	Pass
Chloro 90 percentile	22.2	19.3	Pass
Opportunistic algae	0.6		
DO%sat 5 percentile	78	91.7	Pass
DO%sat 95 percentile	122	122.7	Fail
BOD	4	3.8	Pass

Biological Status

Various parameters are used to assess the ecological status of transitional and coastal waters for Water Framework Directive (WFD) purposes. The biological quality elements (BQEs) used for WFD status assessment are phytoplankton (biomass and bloom frequency), aquatic flora (rocky shore seaweed biodiversity and opportunistic macroalgal abundance) and fish (structure of the fish community) (Lucey, 2009). The most recent assessment (2006 - 2008) classifies the North Channel as having 'good' biological status (Lucey, 2009); several sampling sites within Cork Harbour are classified as 'poor' in relation to fish community structure, including the Owenacurra Estuary.

The most recent EPA trophic status assessment of estuarine waters of the North Channel (2006 - 2009) shows that the samples taken met standards required for the criteria of 'accelerated growth' (Chlorophyll *a*) (Table 6.1). Winter values ranged from a minimum 0.2 to a maximum 3 ∝g/l; Summer values ranged from 1.6 to 28.8 ∝g/l and the median values were within the accepted threshold.

Examination of 2009 data (Appendix 6.2) shows that some samples exceeded their respective thresholds based on salinity levels:-

Station	Date	Salinity	Chlorophyll *a* Threshold Median ∝g/l	Sample Chlorophyll a ∝g/l
LE420	02/07/09	31.12	11.1	14.3
LE420	02/07/09	31.12	11.1	14.3
LE410	02/07/09	28.59	11.9	19.7

Nitrates in estuarine waters

Excessive levels of nutrients in estuarine and coastal waters can result in eutrophication. While phosphorus can limit plant growth in freshwater and estuarine systems, nitrogen is considered to be the limiting nutrient in open coastal waters not influenced significantly by freshwater run-off.

The concentration of nitrogen as Dissolved Inorganic Nitrogen (DIN) is monitored by the EPA in winter when levels are expected to be at their seasonal maximum due to the absence of any significant plant or algal growth (Lucey, 2009). During the EPA assessment period 2006 - 2008, Cork Harbour was found to exceed the assessment criteria on a large number of occasions. The Owenacurra Estuary in particular, recorded high levels (e.g. 4.2 mg N/l) and had one of the highest levels of 'exceedances' (greater than 100%) (Lucey, 2009).

In addition to TSAS criteria, the following salinity-related standards for Dissolved Inorganic Nitrogen (DIN) are given for coastal waters (at a salinity of 34.5) (under Regulations (S.I. No. 272 of 2009), to give effect to the standards required to meet environmental objectives of the Water Framework Directive:-

- High Status ≤0.17 mg N/l;
- Good Status ≤0.25 mg N/l (median, summer or winter).

The most recent EPA trophic status assessment of estuarine waters of the North Channel (2006 - 2009) shows that winter levels of Dissolved Inorganic Nitrogen (DIN) exceeded the standard of 0.825 mg/l for intermediate waters at salinity 26 psu (North Channel DIN - median 1.4 mg/l N and maximum 2.1 mg/l N) (Table 6.1).

Examination of 2009 data (Appendix 6.2) shows that three samples taken in January 2009 exceed threshold levels for their respective salinities:

Station	Salinity	DIN Threshold Mg/l	Sample DIN mg/l
LE410	13.67	1.68	2.14
LE430	25.02	0.889	1.24
LE550	26.96	0.825	0.94

Phosphates in estuarine waters

The concentration of phosphorus as Molybdate Reactive Phosphate (MRP) is monitored by the EPA in winter when levels are expected to be high in the absence of any significant biological uptake by plants and algae. Levels are also monitored in summer to record possible effects of seasonal changes in river flow on MRP concentration (Lucey, 2009).

An environmental quality standard (EQS) based on MRP and equivalent to that used in TSAS has been established for estuarine (transitional) waters. Good status is achieved if the median (summer or winter) MRP concentration is ≤0.060 (at salinity 0.0 - 17.0) and ≤0.040 (at salinity 35.0) (units mg/l P) (S.I. No. 272 of 2009).

During the EPA assessment period 2006 - 2008, all Cork Harbour sampling sites, except one, recorded levels of 20-40∝gP/l (equivalent to 0.02 - 0.04 mg/l P) indicating good status.

The most recent EPA trophic status assessment of estuarine waters of the North Channel (2006 - 2009) shows that the summer level of MRP (Median 5 ∝gP/l) is within the threshold (44 ∝gP/l). Examination of 2009 data more closely (Appendix 6.2) shows that one sample taken on 21st January 2009 (winter sample at Station LE550) exceeded the standard threshold as follows:-

Station	Salinity	MRP Threshold ∝g/l	Sample MRP ∝g/l
LE550	26.96	50	51

Discussion & Conclusions

The most recent trophic status assessment of the North Channel undertaken by the EPA shows an overall classification of 'potentially eutrophic'. Winter levels of Dissolved Inorganic Nitrogen (DIN) exceeded the standard of 0.825 mg/l for intermediate waters at salinity 26.97 psu (North Channel DIN - median 1.4 mg/l N and maximum 2.1 mg/l N). The other criteria that failed to meet standards was Dissolved Oxygen (D.O % sat) which had a minimum recorded level of 59.2 which is below the standard of 78 % for water with salinity 31psu. All other parameters considered met their respective standard thresholds (based on median values recorded) although as examination of 2009 data more closely showed, some individual samples exceeded threshold values.

Appendix 6.1

	NUMERIC CRITERION	STATISTIC	PERIOD
Category A (Nutrient Enrichment)			
Dissolved Inorganic Nitrogen (DIN) mg/l			
Tidal Fresh Waters [I]	>2.6	Median	Winter or Summer Winter
Intermediate Waters	>1.4	Median	or Summer Winter or
Full salinity Water	>0.25	Median	Summer
Ortho-phosphate (MRP) ∝g/l			
Tidal Fresh Waters [I]	>60	Median	Winter or Summer Winter
Intermediate Waters	>60	Median	or Summer Winter or
Full salinity Water	>40	Median	Summer
Category B (Accelerated growth)			
Chlorophyll (µg/l)			
Tidal Fresh Waters	>15	Median	Summer
	or >30	90%ile	Summer
Intermediate Waters[I]	>15	Median	Summer
	or >30	90%ile	Summer
Full salinity Water	>10	Median	Summer
	or >20	90%ile	Summer
Category C (Undesirable disturbance)			
Dissolved Oxygen (D.O %Sat)			
Tidal Fresh Waters	<70	5 percentile	Summer
	or >130	95 percentile	Summer
Intermediate Waters[I]	<70	5 percentile	Summer
	or >130	95 percentile	Summer
Full salinity Water	<80	5 percentile	Summer
	or >120	95 percentile	Summer

[I] at median salinity 17 psu (see Toner et al. 2005).

Appendix 6.2

Water quality data for Cork Harbour North Channel 2007 - 2009 (data kindly provided by the EPA) - WINTER samples. Levels that exceed accepted guidelines during 2009 are in bold.

Station No	Survey Date	Salinity S ‰	Temp S °C	pH	DO S % Sat	B.O.D. mg/l O2	TON mg/l N	NH3 mg/l N	PO4 µg/l P	Chlorophyll a mg/m	DIN mg/l N	Free NH3 mg/l N	DO mg/l
LE420	27-Feb-07	24.48	9.29	8.09	92.8	1.5	1.40	0.064	49	0.5	1.46	0.0016	9.1
LE420	27-Feb-07	25.47	9.05	8.09	91.5	1.5	1.40	0.064	49	0.5	1.46	0.0016	9.0
LE430	27-Feb-07	24.3	9.25	8.1	92.7		1.30	0.110	36	0.5	1.41	0.0029	9.1
LE430	27-Feb-07	24.3	9.3	8.1	92.7		1.30	0.110	36	0.5	1.41	0.0029	9.1
LE450	27-Feb-07	26.3	9.27	8.11	92.3		1.08	0.134	54	0.5	1.21	0.0036	8.9
LE450	27-Feb-07	29.59	9.06	8.11	93.3		1.08	0.134	54	0.5	1.21	0.0035	8.9
LE550	27-Feb-07	26.71	9.4	8.12	90.2	1	1.08	0.074	53	0.5	1.15	0.0021	8.7
LE550	27-Feb-07	27.82	9.24	8.12	92.0	1	1.08	0.074	53	1.0	1.15	0.0020	8.8
LE420	29-Jan-08	25.39	9.13	7.89	92.2	0.499	1.45	0.079	35	1.8	1.53	0.0013	9.0
LE420	29-Jan-08	26.91	9.13	7.89	92.3	0.499	1.45	0.079	35	1.8	1.53	0.0013	8.9
LE430	29-Jan-08	27.04	9.13	7.91	91.6	0.499	1.32	0.054	34	0.2	1.37	0.0009	8.9
LE430	29-Jan-08	28.21	9.19	7.91	92.3	0.499	1.32	0.054	34	0.2	1.37	0.0009	8.9
LE450	29-Jan-08	27.88	9.23	7.93	93.0		1.44	0.049	34	0.2	1.49	0.0009	8.9
LE450	29-Jan-08	29.64	9.3	7.93	92.7		1.44	0.049	34	0.2	1.49	0.0009	8.8
LE540	29-Jan-08	29.04	9.26	7.92	93.5		0.90	0.042	33	2.3	0.94	0.0007	8.9
LE540	29-Jan-08	29.59	9.31	7.92	93.3		0.90	0.042	33	2.3	0.94	0.0007	8.8
LE550	29-Jan-08	28.76	9.27	7.92	90.6	0.499	1.99	0.057	33	0.2	2.05	0.0010	8.6
LE550	29-Jan-08	29.24	9.3	7.92	94.1	0.499	1.99	0.057	33	0.2	2.05	0.0010	8.9
LE410	21-Jan-09	13.67	5.46	7.78	95.2		1.98	0.159	38	2.9	**2.14**	0.0015	11.0
LE430	21-Jan-09	25.02	5.72	7.9	99.5		1.11	0.133	49	1.5	**1.24**	0.0017	10.6
LE550	21-Jan-09	26.96	6.57	7.89	97.0		0.84	0.104	**51**	2.0	**0.94**	0.0014	10.0

Water quality data for Cork Harbour North Channel 2007 - 2009 (data kindly provided by the EPA) - SUMMER samples. Levels that exceed accepted guidelines are in bold.

Station No	Survey Date	Salinity S ‰	Temp S °C	pH	DO S % Sat	B.O.D. mg/l O2	TON mg/l N	NH3 mg/l N	PO4 µg/l P	Chlorophyll a mg/m	DIN mg/l N	Free NH3 mg/l N
LE550	12-Jun-07	33.39	17.66	8.22	105.9		0.05	0.010	4.99		0.07	0.0013
LE540	12-Jun-07	33.36	17.96	8.2	103.7		0.05	0.010	4.99		0.07	0.0012
LE450	12-Jun-07	33.33	17.87	8.21	104.4		0.05	0.010	4.99		0.07	0.0013
LE440	12-Jun-07	33.30	17.89	8.21	102.7		0.06	0.010	10		0.08	0.0013
LE430	12-Jun-07	33.00	18.58	8.2	98.9		0.10	0.020	13		0.12	0.0013
LE420	12-Jun-07	32.62	19.44	8.17	83.6	1.6	0.09	0.069	27		0.157	0.0045
LE450	10-Jul-07	32.64	13.79	8.23	119.1	2.1	0.67	0.010	4.99	6.9	0.6899	0.0010
LE550	10-Jul-07	32.59	14.11	8.23	121.3	1.9	0.06	0.010	4.99	1.6	0.0799	0.0010
LE540	10-Jul-07	32.38	14.17	8.2	120		0.07	0.010	4.99	1.7	0.0899	0.0010
LE550	10-Jul-07	32.21	14.39	8.23	121.7	1.9	0.06	0.010	4.99	1.6	0.0799	0.0010
LE450	10-Jul-07	32.15	14.22	8.23	116.9	2.1	0.67	0.010	4.99	6.9	0.6899	0.0010
LE540	10-Jul-07	32.00	14.78	8.2	123		0.07	0.010	4.99	1.7	0.0899	0.0011
LE440	10-Jul-07	31.96	14.34	8.25	116.2	1.7	0.11	0.010	4.99	6.6	0.1299	0.0011
LE440	10-Jul-07	31.83	14.49	8.3	116	1.7	0.11	0.010	4.99	6.6	0.1299	0.0011
LE430	10-Jul-07	31.19	14.69	8.3	118		0.11	0.010	4.99	3.7	0.1299	0.0013
LE430	10-Jul-07	30.63	14.91	8.3	121		0.11	0.010	4.99	3.7	0.1299	0.0013
LE420	10-Jul-07	30.50	14.95	8.31	110.9	3.1	0.06	0.010	4.99	4.8	0.0799	0.0013
LE420	10-Jul-07	30.38	14.92	8.31	112.9	3.1	0.06	0.010	4.99	4.8	0.0799	0.0013
LE450	21-Aug-07	32.83	14.72	8.1	98.5	2.9	0.26	0.010	4.99	4.6	0.28	0.0008
LE550	21-Aug-07	32.79	14.68	8.09	98.4		0.22	0.032	4.99		0.25	0.0012
LE550	21-Aug-07	32.49	14.81	8.09	103.3		0.22	0.032	4.99		0.25	0.0012
LE540	21-Aug-07	32.45	14.83	8.11	104.3	3.1	0.25	0.010	4.99	2.1	0.2719	0.0008
LE540	21-Aug-07	31.94	15.03	8.11	107	3.1	0.25	0.010	4.99	2.1	0.2719	0.0008
LE450	21-Aug-07	31.40	15.07	8.1	102.2	2.9	0.26	0.010	4.99	4.6	0.2769	0.0008
LE440	21-Aug-07	31.35	15.16	8.15	98.8		0.36	0.010	4.99	6	0.3749	0.0009
LE440	21-Aug-07	30.85	14.98	8.15	106.7		0.36	0.010	4.99	6	0.3749	0.0009

LE430	21-Aug-07	30.84	15.28	8.2	106.1		0.39	0.066	4.99	10.3	0.46	0.0034
LE420	21-Aug-07	30.45	15.40	8.19	102.1	40.21	0.045	4.99	8.8	0.251	0.0023 LE420	21-Aug-
07	30.44	15.40	8.19	102.7	4	0.21	0.045	4.99	8.8	0.251	0.0023 LE430	21-Aug-
07	30.23	15.09	8.2	108.1	0.39	0.066	4.99	10.3	0.46	0.0034 LE550	10-Jun-08	33.03
	15.94	8.33	116.4	2.4	0.00	0.010	4.99	8.5	0.01	0.0007 LE550	10-Jun-08	33.03
	15.82	8.33	118.7	2.4	0.00	0.010	4.99	8.5	0.01	0.0007 LE540	10-Jun-08	32.94
	16.59	8.31	122.1	0.00	0.046	4.99	11.5	0.05	0.0033 LE540	10-Jun-08	32.94	15.66
	8.31	114.6	0.00	0.046	4.99	11.5	0.05	0.0031 LE450	10-Jun-08	32.65	16.94	8.33
	126.3	2.7	0.01	0.010	4.99	13.1	0.02	0.0008 LE450	10-Jun-08	32.65	16.94	8.33
	126.3	2.7	0.01	0.010	4.99	13.1	0.02	0.0008 LE430	10-Jun-08	32.45	17.32	8.38
	124.6	0.00	0.315	4.99	19.1	0.3199	0.0277 LE430	10-Jun-08	32.45	16.49	8.38	116.9
	0.00	0.315	4.99	19.1	0.3199	0.0262 LE440	10-Jun-08	32.45	17.59	8.37	129	0.00
	0.010	4.99	16.4	0.0148	0.0009 LE440	10-Jun-08	32.45	16.22	8.37	116.9	0.00	0.010
	4.99	16.4	0.0148	0.0008 LE420		10-Jun-08	32.16	18.34	8.4	122.5	3.7	0.00
	0.115	4.99	20.4	0.12	0.0113 LE420	10-Jun-08	32.16	17.42	8.4	120.5	3.7	0.00
	0.115	4.99	20.4	0.12	0.0106 LE450	29-Jul-08	32.66	16.73	8.23	104.4	1.7	0.06
	0.030	6	5.8	0.09	0.0018 LE540	29-Jul-08	32.61	16.81	8.24	101.2	10.06	0.024
	6	3.5	0.081	0.0015 LE550		29-Jul-08	32.56	16.83	8.25	101.8	1.3	0.07
	0.023	5	6.2	0.089	0.0015 LE540	29-Jul-08	32.48	16.88	8.24	102.6	10.06	0.024
	6	3.5	0.081	0.0015 LE440		29-Jul-08	32.45	16.88	8.23	103.3	0.499	0.06
	0.027	7	5.5	0.089	0.0017 LE550	29-Jul-08	32.33	16.91	8.25	102.5	1.3	0.07
	0.023	5	6.2	0.089	0.0015 LE450	29-Jul-08	32.31	17.00	8.23	103.3	1.7	0.06
	0.030	6	5.8	0.092	0.0019 LE440	29-Jul-08	32.18	17.10	8.23	103.6	0.499	0.06
	0.027	7	5.5	0.089	0.0017 LE430	29-Jul-08	31.81	17.42	8.23	101.2	1.5	0.09
	0.036	9	9.1	0.121	0.0023 LE430	29-Jul-08	31.70	17.48	8.23	102	1.5	0.09
	0.036	9	9.1	0.121	0.0023 LE420	29-Jul-08	30.86	18.08	8.24	101.2	1.3	0.08
	0.040	11	12.7	0.119	0.0027 LE420	29-Jul-08	30.68	18.14	8.24	100.8	1.3	0.08
	0.040	11	12.7	0.119	0.0028 LE550	13-Aug-08	30.73	15.12	8.15	102	2.4	0.20
	0.023	2.49	18.6	0.225	0.0010 LE450	13-Aug-08	30.66	15.90	8.14	101.9	0.36	0.029
	2.49	17.4	0.385	0.0014								

LE550	13-Aug-08	30.46	15.30	8.15	104.7	2.4	0.20	0.023	2.49	18.6	0.225	0.0011
LE540	13-Aug-08	30.16	15.34	8.13	98.9	0.23	0.041	2.49	17.2	0.27	0.0018 LE540	13-Aug-
08	29.69	15.42	8.16	104.8	0.26	0.025	2.49	25.2	0.289	0.0012 LE440	13-Aug-08	29.30
	15.56	8.15	101.5	3.3	0.34	0.029	7	23.3	0.372	0.0014 LE450	13-Aug-08	29.22
	15.38	8.14	105.1	0.36	0.029	2.49	17.4	0.385	0.0013 LE430	13-Aug-08	29.08	15.61
	8.15	103.3	0.29	0.032	2.49	23.6	0.317	0.0015 LE430	13-Aug-08	28.91	15.62	8.15
	104.9	0.29	0.032	2.49	23.6	0.317	0.0015 LE440	13-Aug-08	28.34	15.65	8.15	108.4
	3.3	0.34	0.029	7	23.3	0.372	0.0014 LE420	13-Aug-08	27.41	15.69	8.09	96.3
	2.2	0.35	0.089	11	14.1	0.435	0.0037 LE420	13-Aug-08	27.34	15.67	8.09	97.7
	2.2	0.35	0.089	11	14.1	0.435	0.0037 LE410	13-Aug-08	0.44	13.20	7.89	97
	4	2.61	0.323	21	28.8	2.933	0.0071 LE410	02-Jul-09	19.18	8.18	106.5	3.6
	0.30	0.099	26	9.6	0.40	0.0064 LE550	02-Jul-09	33.35	17.79	8.1	94.5	1.7
	0.09	0.070	13	7.7	0.16	0.0035 LE540	02-Jul-09	33.30	17.96	8.09	96.8	0.11
	0.061	16	3.6	0.17	0.0030 LE450	02-Jul-09	33.20	17.86	8.09	96.3	0.11	0.053
	13	6.6	0.16	0.0026 LE540		02-Jul-09	32.95	18.09	8.09	98.7	0.11	0.061
	16	3.6	0.17	0.0030 LE450		02-Jul-09	32.94	18.01	8.09	97.0	0.11	0.053
	13	6.6	0.16	0.0026 LE550		02-Jul-09	32.91	18.07	8.1	98.5	1.7	0.09
	0.070	13	7.7	0.16	0.0035 LE440	02-Jul-09	32.47	18.70	8.09	94.7	2.5	0.17
	0.086	15	3.8	0.251	0.0044 LE440	02-Jul-09	32.30	18.22	8.09	96.8	2.5	0.17
	0.086	15	3.8	0.251	0.0043 LE430	02-Jul-09	31.68	18.40	8.08	94.7	0.23	0.132
	14	6.9	0.359	0.0065 LE430		02-Jul-09	31.54	18.46	8.08	94	0.23	0.132
	14	6.9	0.359	0.0066 LE420		02-Jul-09	31.12	19.09	8.19	99.5	3.7	0.11
	0.046	17	**14.3**	0.159	0.0030 LE420	02-Jul-09	31.12	19.10	8.19	99.7	3.7	0.11
	0.046	17	**14.3**	0.159	0.0030 LE410	02-Jul-09	28.59	18.43	7.73	**59.2**	3.4	0.39
	0.272	**107**	**19.7**	0.658	0.0062 LE550	16-Sep-09	31.58	15.01	8.04	99.3	1.2	0.25
	0.127	11	4.2	0.377	0.0045 LE550	16-Sep-09	31.30	15.09	8.04	94.2	1.2	0.25
	0.127	11	4.2	0.377	0.0045 LE450	16-Sep-09	31.24	15.00	8.02	96.3	1.4	0.32
	0.102	14	5.6	0.426	0.0035 LE540	16-Sep-09	31.11	15.05	8.01	96.2	0.32	0.122
	12	5.9	0.444	0.0041 LE450		16-Sep-09	31.06	14.99	8.02	93.2	1.4	0.32
	0.102	14	5.6	0.426	0.0035							

LE540	16-Sep-09	30.84	15.06	8.01	92.5		0.32	0.122	12	5.9	0.444	0.0041
LE440	16-Sep-09	30.14	14.88	7.71	93.6	1.7	0.44	0.162	15	6.9	0.598	0.0027
LE440	16-Sep-09	29.93	14.92	7.71	90.8	1.7	0.44	0.162	15	6.9	0.598	0.0027
LE430	16-Sep-09	28.02	15.19	8.06	96.5	0.64	0.120	10	9.9	0.763	0.0045 LE430	16-Sep-
09	27.96	15.25	8.06	98.7	0.64	0.120	10	9.9	0.763	0.0045 LE420	16-Sep-09	27.07
	14.96	8.07	92.1	2.4	0.62	0.133	19	10.8	0.749	0.0050 LE420	16-Sep-09	27.02
	14.83	8.07	90.8	2.4	0.62	0.133	19	10.8	0.749	0.0050 LE410	16-Sep-09	24.89
	15.08	7.83	93.7	0.73	0.263	39	3.7	0.992	0.0058 LE410	16-Sep-09	21.13	13.82
	7.48	80.5	2.6	1.33	**0.382**	47	3.9	**1.712**	0.0035			

REFERENCES

ANZECC/ARMCANZ (2000) *Australian and New Zealand guidelines for fresh and marine water quality.* Australian and New Zealand Environment and Conservation Council/Agriculture and resource management Council of Australia and New Zealand.

ASU (Aquatic Services Unit) (2004) *East Cork Landfill Ecological Monitoring Report.* Aquatic Services Unit. Prepared for Cork County Council. September 2004.

Bang, P. & Dahlstrøm, P. (2003) *Animal tracks and signs.* Oxford University Press, Oxford.

Biosphere Environmental Services (1998) *Rossmore Landfill Facility Ecological Study*. *Environmental Impact Statement.* Prepared for M. C. O'Sullivan & Co Ltd. February 1998.

Boland, H., Crowe, O. & Walsh, A. (2009) Irish Wetland Bird Survey: Results of waterbird monitoring in Ireland in 2007/08. *Irish Birds* 8, 521-532.

Boyle, B., Tyrrell, L., McHugh, B., Joyce, E., Costello, J., Glynn, D. & McGovern, E. (2006) *Trace metal concentrations in shellfish from Irish waters,* 2003. Marine Environment and Health Series No 25, 2006.

CCME (Canadian Council of Ministers of the Environment) (1992) *Canadian Water Quality Guidelines.* Prepared by a Task Force on water quality guidelines of the Canadian Council of Ministers of the Environment, Eco-Health Branch, Ottowa, Canada.

Chapman, D. (Editor) (1996) *Water Quality Assessments. A guide to the use of biota, sediments and water in environmental monitoring.* UNESCO/WHO/UNEP. E & FN Spon, (Chapman & Hall), UK. 625pp.

Clabby, K.J., Bradley, C., Craig, M., Daly, D., Lucey, J., McGarrigle, M., O'Boyle, S., Tierney, D. and Bowman, J. (2007) *Water Quality in Ireland 2004 - 2006.* Environmental Protection Agency.

Connor, D. W., Brazier, D. P., Hill, T. O. & Northern, K. O. (1997) *Marine Nature Conservation Review: Marine biotope classification for Britain and Ireland.* Volume 1. Littoral biotopes. Version 97.06. Joint Nature Conservation Committee Report No. 229, Peterborough, UK.

Connor, D. W., Allen, J. H., Golding, N., Howell, K. L., Lieberknecht, L. M., Northern, K. O. and Reker, J. B. (2004) *The Marine habitat classification for Britain and Ireland*. Version 04.05. JNCC, Peterborough, UK. www.jncc.gov.uk/MarineHabitatClassification.

Cork County Council (2008) *Draft local Biodiversity Action Plan 2008. Consultation Draft.* Cork County Council.

Cronin, M., McGovern, E., McMahon, T. & Boelens, R. (2006) *Guidelines for the assessment of dredge material for disposal in Irish waters.* Marine Institute and Department of Communications, Marine and Natural Resources. Marine Environment and Health Series No 24, 2006.

Crowe, O. (2005) *Ireland's Wetlands and their waterbirds:* Status and Distribution. BirdWatch Ireland. Newcastle, Co Wicklow.

Crowe, O., Austin, G, E., Colhoun, K., Cranswick, P., Kershaw, M. & Musgrove, A. J. (2008) Estimates and trends of waterbird numbers wintering in Ireland, 1994/95-2003/04. *Bird Study* 55, 66-77.

Cummins, H. A. (1930) Experiments on the establishment of rice grass (*Spartina townsendii*) in the estuary of the Lee. *Economic Proceedings (Royal Dublin Society)* 2, 419-422.

Dalkin M. & Barnett, B. (2001) Procedural guideline No. 3-6. Quantitative sampling of intertidal sediment species using cores. In: *Marine Monitoring Handbook.* (eds: J. Davies; J. Baxter; M. Bradley; D. Connor; J. Khan; E. Murray; W. Sanderson; C. Turnbull & M. Vincent). Joint Nature Conservation Committee, Peterborough, UK. pp 253-258.

Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson; C. Turnbull & M. Vincent) *Marine Monitoring Handbook.* Joint Nature Conservation Committee, UK Marine SACs Programme.

DNFC (2004) *A guide to the butterflies of Ireland.* Dublin Naturalists Field Club. Revised 2004.

Durrell, S. E. A le Vit., McGrorty, S., West, A. D., Clarke, R. T., Goss-Custard, J. D. & Stillman, R. A. (2005) A strategy for baseline monitoring of estuary Special Protection Areas. *Biological Conservation* 121, 289- 301.

Fairley, J.S. (2001) *A Basket of Weasels*. Privately Published, Belfast.

Fossitt, J.A. (2000) *A Guide to the Habitats of Ireland*. The Heritage Council, Ireland.

Glynn, D., Tyrrell, L, McHugh, B., Monaghan, E., Costello, J. & McGovern, E. (2004) *Trace metal and chlorinated hydrocarbon concentrations in shellfish from Irish waters, 2002.* Marine Environment and Health series, No. 16. Marine Institute.

Harris, S. & Yalden, D. W. (2008) *Mammals of the British Isles : Handbook, 4th Edition*. The Mammal Society

Hayden, T. & Harrington, R (2001) *Exploring Irish Mammals*. Dúchas The Heritage Service, Town House Publishing, Dublin.

Hayward, P. J. & Ryland, J. S. (eds) (1995) *Handbook of the Marine Fauna of North-West Europe*. Oxford University Press, Oxford, UK.

Heritage Council (2002) Habitat Survey Guidelines: a standard methodology for habitat survey and mapping in Ireland (Draft). The Heritage Council, Kilkenny, Ireland.

JNCC (2003) *Handbook for Phase 1 habitat survey: a technique for environmental audit*. Joint Nature Conservation Committee, Peterborough.

Leech, D. I., Rehfisch, M. M. & Atkinson, P. W. (2002) *A Guide to BTO Alerts.* BTO Research Report No 281.

Limosa Environmental (2006) *East Cork Landfill, Ecological Monitoring. Report on Waste Licence No. 22-1 Condition 9.14.* Prepared for Cork County Council. December 2006.

Limosa Environmental (2007) *East Cork Landfill, Ecological Monitoring. Report on Waste Licence No. 22-1 Condition 9.14.* Prepared for Cork County Council. December 2007.

Limosa Environmental (2008) *East Cork Landfill, Ecological Monitoring. Report on Waste Licence No. 22-1 Condition 9.14.* Prepared for Cork County Council. December 2008.

Limosa Environmental (2009) *East Cork Landfill, Ecological Monitoring. Report on Waste Licence No. 22-1 Condition 9.14.* Prepared for Cork County Council. December 2009.

Lucey, J. (2009) *Water Quality in Ireland 2007-2008: Key Indicators of the Aquatic Environment*. Environmental Protection Agency.

Lynas, P., Newton, S. F. & Robinson, J. (2007) The status of birds in Ireland: an analysis of conservation concern 2008-2013. *Irish Birds* 8, 149-166.

Marine Institute (2010) *Molluscan Shellfish Production Areas, Sample Points and Co-ordinates for Biotoxin and Phytoplankton Samples. June 2010.* Accessed 29.10.2010 - www.marine.ie

McCorry, M. L., Curtis, T. G. & Otte, M. L. *Spartina* in Ireland. In: *Wetlands of Ireland: distribution, ecology, uses and economic value.* (Ed M. L. Otte. University College Dublin Press.

McGarrigle, M. L., Bowman, J. J., Clabby, K. J., Lucey, J., Cunningham, P., MacCárthaigh, M., Keegan, M., Cantrell, B., Lehane, M., Clenaghan, C. & Toner, P. F. (2002) *Water Quality in Ireland 1998-2000.* Environmental Protection Agency, Wexford.

NPWS (2001) *Site Synopsis for Great Island Channel SAC and NHA, Site Code 1058*. National Parks & Wildlife Service.

Preston, Pearman & Dines (2002) *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.

Ramsar Convention Bureau (1984) Convention on wetlands of international importance especially as waterfowl habitat*. Proceedings of the 2nd conference of Parties: Groningen, Netherlands, 7-12th May, 1984*. Ramsar Convention Bureau, Gland, Switzerland.

Sheppard, R (1993) *Ireland's Wetland Wealth. The report of the Winter Wetlands Survey 1984/85 to 1986/87.* Irish Wildbird Conservancy.

Smiddy, P., O'Halloran, J., Coveney, J. A., Leonard, P. G. & Shorten, M. (1995) Winter wildfowl populations of Cork Harbour: an update. *Irish Birds* 5, 285-294.

Stace, C. A. (1997) *New Flora of the British Isles.* 2nd Edition. Cambridge University Press, UK.

Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarringle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCárthaigh, M., Craig, M. & Quinn, R. (2005) *Water Quality in Ireland 2001-2003.* Environmental Protection Agency, Wexford.

Webb, D. A., Parnell, J. & Doogue, D. (1996) *An Irish Flora.* Dundalgan Press Ltd, Dundalk, Ireland.

Watson, D. & Hack, V. (2000) *Wildlife management and habitat creation on landfill sites.* Ecoscope Applied Ecologists, UK.

Wernham, C. V., Toms, M. P., Marchant, J. H., Clark, J. A., Siriwardena, G. M. & Baillie, S. R. (eds) *The Migration Atlas.* T & A D Poyser, UK.

Wetlands International (2006) Waterfowl Population Estimates - Fourth Edition. Wetlands International, Wageningen, The Netherlands.

Whilde, A. (1993) *Threatened Mammals, Birds, Amphibians and Fish in Ireland. Irish Red Data Book 2: Vertebrates*. HMSO, Belfast.

Wilson, J., O'Mahony, B. & Smiddy, P. (2000) Common Terns *Sterna hirundo* nesting in Cork Harbour. *Irish Birds* 6, 597-599.

Wittmann, G. T. W. & Förstner, U. (1980) Metal enrichment of sediments in inland waters. Water SA 1, 76-82.

Wyn, G. & Brazier, P. (2001) Procedural Guideline No. 3-1. *In situ* intertidal biotope recording. In: *Marine Monitoring Handbook.* (eds: J. Davies; J. Baxter; M. Bradley; D. Connor; J. Khan; E. Murray; W. Sanderson; C. Turnbull & M. Vincent). Joint Nature Conservation Committee, Peterborough, UK. pp 223- 227.

ODOUR & ENVIRONMENTAL ENGINEERING CONSULTANTS

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

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

TITLE: AIR EMISSION TESTING OF ONE LANDFILL FLARE LOCATED IN EAST CORK LANDFILL, ROSSMORE, CARRIGTOHILL, CO. CORK.

PREFORMED BY ODOUR MONITORING IRELAND ON BEHALF OR CORK COUNTY COUNCIL

PREPARED BY:	Dr. John Casey
ATTENTION:	Mr. Jerome O Brien
LICENCE NUMBER:	WL0022-01
LICENCE HOLDER:	Cork County Council
FACILITY NAME:	East Cork Landfill Facility
DATE OF MONITORING VISIT:	16th Jul. 2010
NAME AND ADDRESS OF CLIENT ORGANISATION:	East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork
NAME AND ADDRESS OF MONITORING ORGANISATION:	Odour Monitoring Ireland, Unit 32 DeGranville Court, Dublin Road, Trim, Co. Meath
DATE OF REPORTING:	25th Jan 2011
NAME AND THE FUNCTION OF THE PERSON APPROVING THE REPORT:	Dr. Brian Sheridan, Managing Partner, Odour Monitoring Ireland
REPORT NUMBER:	2011A36(1)
REVIEWERS:	

TABLE OF CONTENTS

Document Amendment Record

Client: ***Cork County Council***

Project: Air emission testing of one Landfill flare located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork

Project Number: 2011A36(1)			**Document Reference:** Air emission testing of one Landfill flare located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork		
2011A36(1)	Document for review	J.W.C	J.W.C	B.A.S	25/01/2011
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**
ODOUR monitoring IRELAND					

Signing sheet

Brian Sheridan Ph.D Eng

For and on behalf of Odour Monitoring Ireland

Part 1 - Executive Summary

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

- CO, NO_x as NO_2, and TOC emissions from the flare were within the emission limit values as per WL0022-01.

1.1 Monitoring Objectives

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 1 No. Enclosed ground flare at East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork. The monitoring was carried out at this facility as part of compliance monitoring with the requirements of Waste licence W0022-01. The emissions testing was carried out by Odour Monitoring Ireland on behalf of Cork County Council.

1.2 Special Monitoring Requirements

There were no special monitoring requirements for this campaign.

1.3 The substances to be monitored at each emission point

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

Table 1.1. Monitored parameters and techniques for East Cork Landfill

Sample location	Parameter	Analytical method
1 Landfill Flare outlet	Volumetric airflow rate & Temperature (^{0}C)	Pitot in accordance with EN13284-1 where possible. MGO coated K type thermocouple and PT100 Volumetric airflow rate theoretical calculated for Landfill flare.
1 Landfill Flare outlet	Oxides of nitrogen (NO_X as NO_2), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), and Oxygen (O_2)	Flue gas analyser, Testo 350/454 MXL
1 Landfill Flare outlet	Total Volatile Organic Carbon	Portable Signal 3030PM FID calibrated with Propane in accordance with EN12619:1999.

This report presents details of this monitoring programme. This environmental monitoring was carried out Dr. John Casey, Managing Partner, Odour Monitoring Ireland on the 16th July 2010. Methods, Results, Discussion and Conclusions are presented herein.

2. Monitoring Results

This section will present the results of the monitoring exercise.

2.1 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load
Flare 1	16/07/2010	Landfill flare	Continuous	Landfill Gas	N/A	None	Landfill Gas

2.2 Monitoring Result Reference Conditions

Emission Point Reference	Temperature (K)	Pressure	Moisture Correction	Oxygen Correction (%)
Flare 1	K	101.3	Yes	3

2.3. Sampling Location Summary

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

Note: Temperature and airflow rate traverse measurements were performed across the stack in one plane only. Only one plane was possible due to access port issues.

2.4. Sampling time runs on the 16th July 2010 for monitoring of landfill flare.

Parameter	Approx. Sampling period for 1 landfill flare
Inlet CH_4	45 minutes
Inlet O_2	45 minutes
Volumetric air flow rate	Theoretically calculated
SO_2	45 minutes
NO_x	45 minutes
CO	45 minutes
O_2	45 minutes
CO_2	45 minutes
Stack gas temp	45 minutes
TOC	45 minutes

2.5. Characteristics of raw inlet gas to one enclosed Landfill flare gas burner

Inlet compound identity	Compound loading Landfill flare	Unit values
CH_4	22.5	%
CO_2	30.1	%
O_2	3	%
Total Landfill gas volumetric airflow rate	335	m^3/hr

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

Parameter	Enclosed flare
Total Volumetric methane loading (m^3/hr)	75
Total Volumetric Oxygen loading (m^3/hr)	10.05
Ratio to complete combustion of methane assuming no excess Oxygen	9.57
Oxygen concentration level in flue gas (%)	7.27
Flue gas temperature (Kelvin)[2]	1,292
Theoretical calculated Volumetric exhaust airflow rate (m^3/h)	1,604
Normalised average exhaust airflow rate ($Nm^3\ h^{-1}$)[3]	339

Notes:
[1] denotes data from 16th July 2010.
[2] denoted converted from degrees Celsius to Kelvin (^{0}C + 273.15);
[3] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 2.4. Emission value results for one landfill gas flare.

Landfill Flare No. 1	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission conc for flare to 3% (mgN/m^3)[1]	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
TOC	3.48	mgC/m^3	5.57	7.31	10.37	<20 mg/Nm^3	As Normal
Temperature	1019	degrees	1292K	-	-	>1273 K	As Normal
CO	4	ppm	5	6.57	16.47	<50 mg/Nm^3	As Normal
O_2	7.27	%	-	-	-	-	
Total NO_X as NO_2	16	ppm	32.86	43.15	7.63	<200 mg/Nm^3	As Normal
SO_2	41	ppm	117	153.84	-	-	As Normal
CO_2	9.57	%	-	-	-	-	As Normal
Volumetric airflow rate (Nm^3/hr)	339	-	-	258	-	<3,000	As Normal
Inlet methane concentration	54	Kg/hr	-	-	-	--	As Normal
Methane destruction Eff	>99	%	-	-	-	--	As Normal

3. Discussion of results

Tables 2.1 to *2.4* present the results of the emission monitoring carried out on the landfill flare stack burner located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. 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% oxygen was performed. Due to possible inaccuracies in airflow rate measurement, it was not possible to determine the oxygen intake of the flare through the louver system using measurement. Since the volume of intake air required for complete combustion was known and the oxygen concentration in the exhaust flue gas was known, the volume of intake excess fuel air could be theoretically calculated through numerous iterations using the Solver program (i.e. Microsoft Excel). This allows for the calculation of the volume of intake excess air through the louver landfill flare intake system. These calculations were validated through use of the published Environment Agency equation (see *Eqn 8.3.1*) (Environment Agency, 2002).

4. Conclusion

The following conclusions can be drawn from this study:

1. A theoretically exhaust flue gas volume was calculated for the landfill flare.
2. NO_x as NO_2, SO_2, CO, O_2, and TOC monitoring and analysis was carried out in accordance with specified requirements;
3. All data was standardised to 273.15 Kelvin, 101.3 kPa;
4. All data is presented as Oxygen corrected to 3% (v/v) using the appropriate equations;
5. CO, NO_x as NO_2, and TOC emissions from the flare were within the emission limit values as per WL0022-01.

5. References

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

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

6. *Appendix I*-Sampling, analysis

6.1.1 Location of Sampling
East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork

6.1.2 Date & Time of Sampling
16th July 2010

6.1.3 Personnel Present During Sampling
Dr. John Casey, Odour Monitoring Ireland, Trim, Co. Meath.
MCERTS level 1: MM0674

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

TITLE: AIR EMISSION TESTING OF ONE LANDFILL FLARE LOCATED IN EAST CORK LANDFILL, ROSSMORE, CARRIGTOHILL, CO. CORK.

PREFORMED BY ODOUR MONITORING IRELAND ON BEHALF OR CORK COUNTY COUNCIL

PREPARED BY:	Dr. John Casey
ATTENTION:	Mr. Jerome O Brien
LICENCE NUMBER:	WL0022-01
LICENCE HOLDER:	Cork County Council
FACILITY NAME:	East Cork Landfill Facility
DATE OF MONITORING VISIT:	17th Nov. 2010
NAME AND ADDRESS OF CLIENT ORGANISATION:	East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork
NAME AND ADDRESS OF MONITORING ORGANISATION:	Odour Monitoring Ireland, Unit 32 DeGranville Court, Dublin Road, Trim, Co. Meath
DATE OF REPORTING:	25th Jan 2011
NAME AND THE FUNCTION OF THE PERSON APPROVING THE REPORT:	Dr. Brian Sheridan, Managing Partner, Odour Monitoring Ireland
REPORT NUMBER:	2011A37(1)
REVIEWERS:	

TABLE OF CONTENTS

Document Amendment Record

Client: ***Cork County Council***

Project: Air emission testing of one Landfill flare located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork

Project Number: 2011A37(1)			**Document Reference:** Air emission testing of one Landfill flare located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork		
2011A37(1)	Document for review	J.W.C	J.W.C	B.A.S	25/01/2011
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**
ODOUR monitoring IRELAND					

Signing sheet

Brian Sheridan Ph.D Eng

For and on behalf of Odour Monitoring Ireland

Part 1 - Executive Summary

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

- CO and NO_x as NO_2, emissions from the flare were within the emission limit values as per WL0022-01.

1.1 Monitoring Objectives

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 1 No. Enclosed ground flare at East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork. The monitoring was carried out at this facility as part of compliance monitoring with the requirements of Waste licence W0022-01. The emissions testing was carried out by Odour Monitoring Ireland on behalf of Cork County Council.

1.2 Special Monitoring Requirements

There were no special monitoring requirements for this campaign.

1.3 The substances to be monitored at each emission point

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

Table 1.1. Monitored parameters and techniques for East Cork Landfill

Sample location	Parameter	Analytical method
1 Landfill Flare outlet	Volumetric airflow rate & Temperature (^{0}C)	Pitot in accordance with EN13284-1 where possible. MGO coated K type thermocouple and PT100 Volumetric airflow rate theoretical calculated for Landfill flare.
1 Landfill Flare outlet	Oxides of nitrogen (NO_X as NO_2), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), and Oxygen (O_2)	Flue gas analyser, Testo 350/454 MXL

This report presents details of this monitoring programme. This environmental monitoring was carried out Dr. John Casey, Managing Partner, Odour Monitoring Ireland on the 17th November 2010. Methods, Results, Discussion and Conclusions are presented herein.

2. Monitoring Results

This section will present the results of the monitoring exercise.

2.1 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load
Flare 1	17/11/2010	Landfill flare	Continuous	Landfill Gas	N/A	None	Landfill Gas

2.2 Monitoring Result Reference Conditions

Emission Point Reference	Temperature (K)	Pressure	Moisture Correction	Oxygen Correction (%)
Flare 1	K	101.3	Yes	3

2.3. Sampling Location Summary

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

Note: Temperature and airflow rate traverse measurements were performed across the stack in one plane only. Only one plane was possible due to access port issues.

2.4. Sampling time runs on the 17th November 2010 for monitoring of landfill flare.

Parameter	Approx. Sampling period for 1 landfill flare
Inlet CH_4	45 minutes
Inlet O_2	45 minutes
Volumetric air flow rate	Theoretically calculated
SO_2	45 minutes
NO_x	45 minutes
CO	45 minutes
O_2	45 minutes
CO_2	45 minutes
Stack gas temp	45 minutes

2.5. Characteristics of raw inlet gas to one enclosed Landfill flare gas burner

Inlet compound identity	Compound loading Landfill flare	Unit values
CH_4	20.2	%
CO_2	29.12	%
O_2	5	%
Total Landfill gas volumetric airflow rate	410	m^3/hr

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

Parameter	Enclosed flare
Total Volumetric methane loading (m^3/hr)	82.82
Total Volumetric Oxygen loading (m^3/hr)	20.5
Ratio to complete combustion of methane assuming no excess Oxygen	9.57
Oxygen concentration level in flue gas (%)	3.65
Flue gas temperature (Kelvin)[2]	1,282
Theoretical calculated Volumetric exhaust airflow rate (m^3/h)	1,432
Normalised average exhaust airflow rate ($Nm^3\ h^{-1}$)[3]	304

Notes:
[1] denotes data from 17th Nov. 2010.
[2] denoted converted from degrees Celsius to Kelvin (^{0}C + 273.15);
[3] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 2.4. Emission value results for one landfill gas flare.

Landfill Flare No. 1	Conc.	Units	Adjusted units (mg/m^3)	Oxygen corrected emission conc for flare to 3% (mgN/m^3)[1]	Expanded uncertainty as percentage of limit value (%)	Emission limit Values	Operating Status
Temperature	1009	degrees	1282K	-	-	>1273 K	As Normal
CO	1	ppm	1.25	1.30	12.79	<50 mg/Nm^3	As Normal
O_2	3.65	%	-	-	-	-	
Total NO_X as NO_2	23	ppm	47.23	49.01	6.6	<200 mg/Nm^3	As Normal
SO_2	74	ppm	211.43	219.4	-	-	As Normal
CO_2	12.39	%	-	-	-	-	As Normal
Volumetric airflow rate (Nm^3/hr)	305	-	-	293	-	<3,000	As Normal

3. Discussion of results

Tables 2.1 to *2.4* present the results of the emission monitoring carried out on the landfill flare stack burner located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. 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% oxygen was performed. Due to possible inaccuracies in airflow rate measurement, it was not possible to determine the oxygen intake of the flare through the louver system using measurement. Since the volume of intake air required for complete combustion was known and the oxygen concentration in the exhaust flue gas was known, the volume of intake excess fuel air could be theoretically calculated through numerous iterations using the Solver program (i.e. Microsoft Excel). This allows for the calculation of the volume of intake excess air through the louver landfill flare intake system. These calculations were validated through use of the published Environment Agency equation (see *Eqn 8.3.1*) (Environment Agency, 2002).

4. Conclusion

The following conclusions can be drawn from this study:

6. A theoretically exhaust flue gas volume was calculated for the landfill flare.
7. NO_x as NO_2, SO_2, CO and O_2, monitoring and analysis was carried out in accordance with specified requirements;
8. All data was standardised to 273.15 Kelvin, 101.3 kPa;
9. All data is presented as Oxygen corrected to 3% (v/v) using the appropriate equations;
10. CO and NO_x as NO_2, emissions from the flare were within the emission limit values as per WL0022-01.

5. References

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

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

6. *Appendix I*-Sampling, analysis

6.1.1 Location of Sampling
East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork

6.1.2 Date & Time of Sampling
17th November 2010

6.1.3 Personnel Present During Sampling
Dr. John Casey, Odour Monitoring Ireland, Trim, Co. Meath.
MCERTS level 1: MM0674

6.1.4 Instrumentation check list
Testo 350 MXL/454 in stack analyser;
Federal Method 2 S type pitot and MGO coated thermocouple;
L type pitot tube
Testo 400 handheld and appropriate probes.
Ceramic and Inconel 625 sampling probes.

European PRTR Table Raffeen Landfill flare only.

Table 1. Table for European-PRTR requirements for Landfill flare only.

Raffeen Combustion plant	**Carbon Monoxide (CO) (kg/yr)**	**Carbon dioxide (CO_2) (kg/yr)**	**Nitrogen Oxides (NO_x as NO_2) (kg/yr)**	**TNMVOC's (kg/yr)**	**Sulphur dioxid (SO_2) (kg/yr)**
Flare No. 1	12	174,200	41	2	9
Total Emissions[1, 2]	12	174,200	41	2	9
Emission Limits	500,000	100 million	100,000	100,000	150,000
Compliance	Yes	Yes	Yes	Yes	Yes

Notes: [1] denotes that this is total emissions for 1 No. enclosed landfill flare only.
[2] denotes that the total values reported are based on 24 hr per day 365 days per year operation and for enclosed No. 1 landfill flare only. If the hours of operation are known through site records then the total actual amount can be calculated by calculating the yearly total to an hourly figure and then multiply by the number of hours operation (e.g. Emissions (kg/yr) / 8760 hrs = kg/hr × hours operation = Total emission in kg/yr).

Environmental Protection Agency

Guidance to completing the PRTR workbook

AER Returns Workbook

Version 1.1.11

NCE YEAR	2010

1. FACILITY IDENTIFICATION

Parent Company Name	Cork County Council
Facility Name	East Cork Landfill Site
PRTR Identification Number	W0022
Licence Number	W0022-01

Waste or IPPC Classes of Activity

No.	class_name
3.5	Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment.
3.1	Deposit on, in or under land (including landfill).
3.11	Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.12	Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.13	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.
3.4	Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.
3.7	#######
4.10	The treatment of any waste on land with a consequential benefit for an agricultural activity or ecological system.
4.11	Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.
4.13	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.
4.2	Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).
4.3	Recycling or reclamation of metals and metal compounds.
4.4	Recycling or reclamation of other inorganic materials.
4.9	Use of any waste principally as a fuel or other means to generate energy.

Address 1	Rossmore
Address 2	Carrigtohill
Address 3	County Cork
Address 4	
Country	Ireland
Coordinates of Location	-8.25588 51.8851
River Basin District	IESW
NACE Code	3821
Main Economic Activity	Treatment and disposal of non-hazardous waste
AER Returns Contact Name	Jerome O'Brien (W0022)
AER Returns Contact Email Address	Jerome.OBrien@CorkCoCo.ie
AER Returns Contact Position	Senior Executive Engineer, South Cork Division
AER Returns Contact Telephone Number	021 4533934
AER Returns Contact Mobile Phone Number	086 8355143
AER Returns Contact Fax Number	021 4533880
Production Volume	0.0
Production Volume Units	
Number of Installations	1
Number of Operating Hours in Year	2314
Number of Employees	5
User Feedback/Comments	Reliance on a gas model to calculate or predict the quantity of LFG generated in accordance with the age and tonnage of waste is misleading, in our opinion. We have a figure in excess of 500,000 cu.m of LFG released which is 20% of gas produced. If the quantity was this large on site you are assured that the physical signs would be immediately visible with deprived growth. Gas models are unreliable. In the past the model underestimated the gas yield and we actually had more passing through the flare than the model predicted. Our model is GasSim. We have also used LandGem. I entered zero against edible oils but the document looks for a destination. The zero should be linked to the distination
Web Address	www.corkcoco.ie

2. PRTR CLASS ACTIVITIES

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

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

Is it applicable?	No
Have you been granted an exemption ?	No
If applicable which activity class applies (as per Schedule 2 of the regulations) ?	
Is the reduction scheme compliance route being used ?	

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD				QUANTITY		
			Method Used		Landfill			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
01	Methane (CH4)	M	MAB	Estimated LFG production 2010 (LandGem) less total LFG flow measured through flare 2010. Multiply result by the average monthly Methane content over the year. Convert cu.m to kg by multiplying by conversion factor 0.717 kg/cu.m	0.0	106125.0	0.0	106125.0
03	Carbon dioxide (CO2)	M	MAB	Estimated LFG production 2010 (LandGem) less total LFG flow measured through flare 2010. Multiply result by the average monthly Carbon Dioxide content over the year. Convert cu.m to kg by multiplying by conversion factor 1.977 kg/cu.m	0.0	224522.0	0.0	224522.0
02	Carbon monoxide (CO)	M	MAB	Measured through analysis of flare flue gas emissions monitoring	0.0	15.0	0.0	15.0
08	Nitrogen oxides (NOx/NO2)	M	MAB	Measured through analysis of flare flue gas emissions monitoring	0.0	98.0	0.0	98.0
07	Non-methane volatile organic compounds (NMVOC)	M	MAB	Measured through analysis of flare flue gas emissions monitoring	0.0	0.0	0.0	0.0
11	**Sulphur oxides (SOx/SO2)**	M	MAB	Measured through analysis of flare flue gas emissions monitoring	0.0	348.0	0.0	348.0
					0.0	0.0	0.0	0.0

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

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD				QUANTITY		
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0
					0.0	0.0	0.0	0.0
					0.0	0.0	0.0	0.0

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

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

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

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

Additional Data Requested from Landfill operators

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

Landfill: East Cork Landfill Site

Please enter summary data on the quantities of methane flared and / or utilised

	T (Total) kg/Year	M/C/E	Method Used: Method Code	Method Used: Designation or Description	Facility Total Capacity m3 per hour	
Total estimated methane generation (as per site model)	652790.0	C	Method Code	Calculation of total LFG generation using GasSim model and waste inputs per annum over time	N/A	
Methane flared	546705.0	M	Method Code	LFG flare measured through fl	0.0	(Total Flaring Capacity)
Methane utilised in engine/s	0.0				0.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	106125.0	C	Method Code	Arithmetic difference between	N/A	

4.2 RELEASES TO WATERS

SECTION A : SECTOR SPECIFIC PRTR POLLUT

PO
No. Annex II

SECTION B : REMAINING PRTR POLLUTANTS

PO
No. Annex II

SECTION C : REMAINING POLLUTANT EMISSIO

PO
Pollutant No.

Link to previous years emissions data | PRTR# : W0022 | Facility Name : Ea

ANTS Data on ambient monitoring of stor

RELEASES TO WATERS		
LLUTANT		
Name	M/C/E	Method Code

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

RELEASES TO WATERS		
LLUTANT		
Name	M/C/E	Method Code

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

NS (as required in your Licence)

RELEASES TO WATERS		
LLUTANT		
Name	M/C/E	Method Code

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

ʻm/surface water or groundwater, conducted as part of your licence requirements, should NOT be submit

	Please enter all quantities in this section in KGs	
Method Used		
Designation or Description	Emission Point 1	T (Total) KG/Year
	0.0	0.0

	Please enter all quantities in this section in KGs	
Method Used		
Designation or Description	Emission Point 1	T (Total) KG/Year
	0.0	0.0

	Please enter all quantities in this section in KGs	
Method Used		
Designation or Description	Emission Point 1	T (Total) KG/Year
	0.0	0.0

ted under AER / PRTR Reporting as this only concerns Releases from your facility

QUANTITY	
A (Accidental) KG/Year	F (Fugitive) KG/Year
0.0	0.0

QUANTITY	
A (Accidental) KG/Year	F (Fugitive) KG/Year
0.0	0.0

QUANTITY	
A (Accidental) KG/Year	F (Fugitive) KG/Year
0.0	0.0

4.4 RELEASES TO LAND

SECTION A : PRTR POLLUTANTS

	PO
No. Annex II	

SECTION B : REMAINING POLLUTANT EMISSIO

	PO
Pollutant No.	

Link to previous years emissions data | PRTR# : W0022 | Facility Name : East Cork Lan

RELEASES TO LAND		
LLUTANT		METHOI
Name	M/C/E	Meth Method Code

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

NS (as required in your Licence)

RELEASES TO LAND		
LLUTANT		METHOI
Name	M/C/E	Meth Method Code

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

	Please enter all quantities in this section in KGs	
D		
ıod Used		
Designation or Description	Emission Point 1	T (Total) KG/Year
	0.0	0.0

	Please enter all quantities in this section in KGs	
D		
ıod Used		
Designation or Description	Emission Point 1	T (Total) KG/Year
	0.0	0.0

QUANTITY
A (Accidental) KG/Year
0.0

QUANTITY
A (Accidental) KG/Year
0.0

Please enter all quantities on this sheet in Tonnes

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste : Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facilit y Non Haz Waste : Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
Within the Country	20 03 01	No	1769.25	mixed municipal waste	D1	M	Weighed	Onsite in Ireland	Youghal Landfill,W0068-03	Foxhole,N/A,Youghal,N/A,Ireland		
Within the Country	15 01 01	No	69.68	paper and cardboard packaging	R3	M	Weighed	Onsite in Ireland	greenstar Ltd,W173-01	Forge Hill,,Cork,,Ireland		
Within the Country	20 01 01	No	102.43	paper and cardboard	R3	M	Weighed	Onsite in Ireland	greenstar Ltd,W136-02	Sarsfield Court Industrial Estate,Glanmire,Cork,,Ireland		
Within the Country	15 01 07	No	36.82	glass packaging	R5	M	Weighed	Onsite in Ireland	Mr Binman,W0061-01	Luddenmore,Grange,Kilmallock,Co Limerick,Ireland		
Within the Country	20 01 02	No	5.8	glass	R5	M	Weighed	Onsite in Ireland	MSM Recycling Ltd,W0079-01	41-42 Cookstown Industrial Estate,Tallaght,Dublin,D24,Ireland		
Within the Country	20 01 40	No	134.42	metals	R4	M	Weighed	Onsite in Ireland	Pouladuff Dismantlers Ltd,CK/0584/01	Pouladuff Rd,Togher,Cork,,Ireland		
Within the Country	15 01 02	No	19.46	plastic packaging	R5	M	Weighed	Onsite in Ireland	Green Dragon Recycling Ltd,CK/09/0629/01	Corbally North,Glanmire,Cork,,Ireland		
Within the Country	20 01 11	No	6.58	textiles	R5	M	Weighed	Onsite in Ireland	Textile Recylling Ltd,WCP-DC 08-1225-01	Glen Abbey Business Park,Tallaght,Dublin,D24,Ireland		
Within the Country	20 01 38	No	285.23	wood other than that mentioned in 20 01 37	R13	M	Weighed	Onsite in Ireland	CTO Environmental Solutions Ltd,CK/09/0018/02	Rostellan,,,<Midleton,Co Cork,Ireland		
Within the Country	16 06 01	Yes	4.88	lead batteries	R6	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland
Within the Country	16 06 02	Yes	1.36	Ni-Cd batteries	R13	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland
Within the Country	13 02 08	Yes	5.31	other engine, gear and lubricating oils	R9	M	Weighed	Onsite in Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,Portlaoise,Co Laois,,Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,Portlaoise,Co Laois,,Ireland
Within the Country	20 01 25	No	0.0	edible oil and fat	R9	M	Weighed	Onsite in Ireland	N/A,N/A	N/A,N/A,N/A,N/A,N/A,N/A		
Within the Country	20 01 28	No	13.1	paint, inks, adhesives and resins other than those mentioned in 20 01 27	R1	M	Weighed	Onsite in Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,Portlaoise,Co Laois,,Ireland		
Within the Country	20 03 03	No	0.9	street-cleaning residues	D5	M	Weighed	Onsite in Ireland	Youghal Landfill,W0068-03	Foxhole,N/A,Youghal,N/A,Ireland		
Within the Country	20 01 23	Yes	28.026	discarded equipment containing chlorofluorocarbons	R4	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland	M Baker Recycling Ltd,".",Baring House,6 Baring Crescent,Exeter,EX1 1TL,United Kingdom	".",".",".",".",".",United Kingdom
Within the Country	20 01 36	No	79.353	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland		
Within the Country	20 01 36	No	56.378	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighed	Onsite in Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,Portlaoise,Co Laois,".",Ireland		
Within the Country	20 01 36	No	148.85	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W00133-03	Cappincur Industrial Estate,Tullamore,Co Offaly,,Ireland		
Within the Country	19 07 03	No	8064.17	landfill leachate other than those mentioned in 19 07 02	D8	M	Weighed	Onsite in Ireland	Cork County Council,"."	Carrigtohill Waste Water Treatment Plant,Tullagreen,Carrigtohill,".",Ireland		

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

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

GTS

Geomembrane Testing Services Limited

Client: Cork County Council

REPORT ON:

EAST CORK LANDFILL DEVELOPMENT
CARRIGTWOHILL, CO CORK

MOBILE ELECTRICAL LEAK LOCATION SURVEY
of
LEACHATE LAGOON NO. 1

Inspection Date: November 2010

Prepared by:
Geomembrane Testing Services Limited
Thornback Road, Troyswood, Co Kilkenny, Ireland
Tel/Fax: (056) 7770953 Mobile: (086 8323113)
Email: gts@o2.ie

Section 1:

Mobile Electrical Leak Location Survey Introduction

GTS

Geomembrane Testing Services Limited

Thornback Road, Troyswood, Co Kilkenny, Ireland
Tel/Fax: (056) 7770953 Mobile: (086 8323113)
Email: gts@o2.ie

INDEX

GTS

Geomembrane Testing Services Limited

Thornback Road, Troyswood, Co Kilkenny, Ireland
Tel/Fax: (056) 7770953 Mobile: (086 8323113)
Email: gts@o2.ie

INTRODUCTION:

Geomembrane Testing Services Limited carried out, on behalf of Cork County Council, a geophysical survey of Leachate Lagoon No. 1 at East Cork Landfill Development, Carrigtwohill, Co Cork.
The objective of this survey was to determine the presence of any defects within the lined containment area.

SITE DESCRIPTION:

The area surveyed was Leachate Lagoon No. 1 which is 27 metres long x 14 metres wide with a vertical depth of 2.0 metres. This lagoon consisted of a 2mm thick High-Density Polyethylene membrane (HDPE). Engineered clay formed the subgrade. Due to the vertical depth of this lagoon, the survey was carried out in two (2) stages.

In order to achieve maximum contact between the High-Density Polyethylene membrane and the engineered clay subgrade, liquid levels within the lagoon had to be increased between each survey. (Refer to attached drawing).

Stage 1: .400 metres maximum liquid depth.

Stage 2: 1.100 metres maximum liquid depth.

…/2

TEST SURVEY:

Prior to data acquisition a simulated test leak (3.5mm∅) was conducted. In this case the simulated test leak assembly cylinder was lowered to the bottom of the lagoon. This cylinder was then connected to the grounded electrode. A source electrode was excited to 340V. The test results demonstrated an electrical radial decay of 1.285 metres. This test survey determined the grid pattern to be used in this case. Data was acquired on a 1 metre x .8 metre grid.

MAIN SURVEY:

Data was acquired on survey lines spaced at 1m x .8m. These survey lines were oriented approximately north-south and east-west. Two independent measuring probes were used simultaneously to acquire data. For each measurement the two probes were placed in the liquid and data recorded.

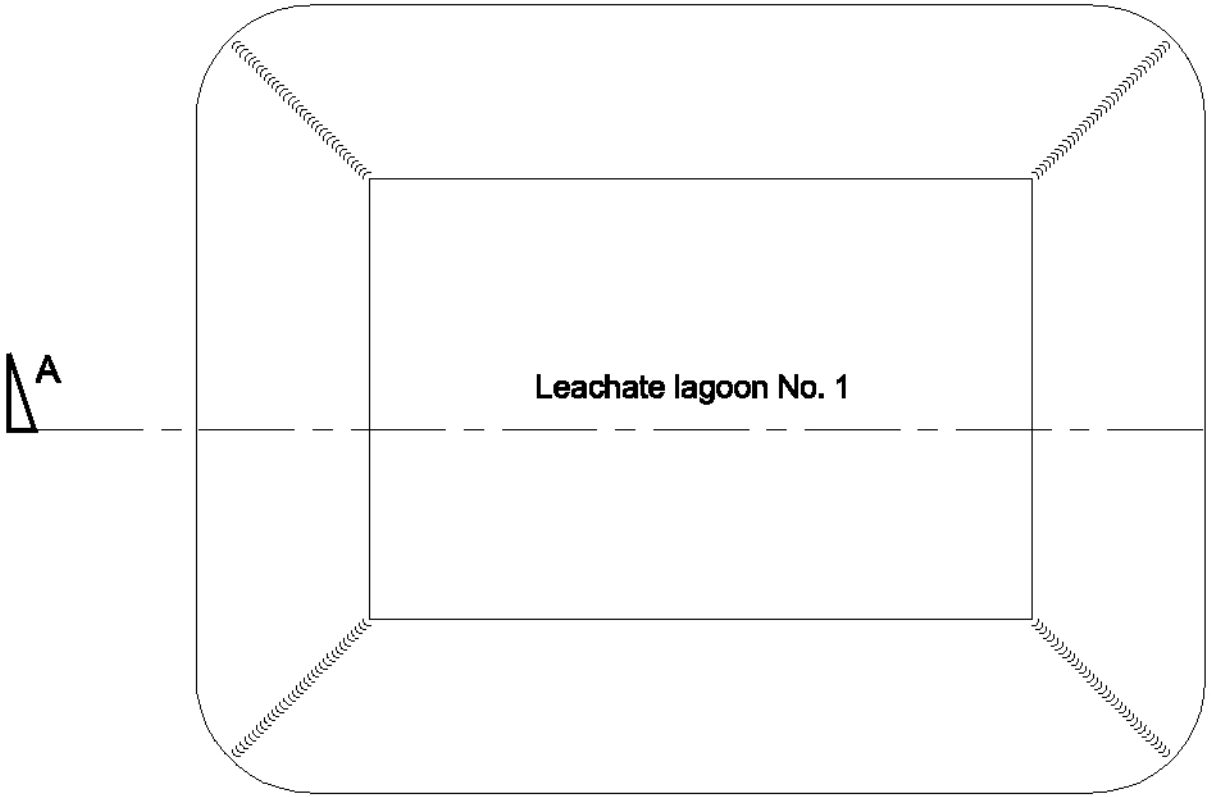
Stage 1: Liquid depth .400 metres. Survey carried out on the entire basal area.
Stage 2: Liquid level increased to 1.500 metres. Survey carried out on side slopes.

On completion of this Survey two (2) defects were located. The position of all defects located during the Mobile Electrical Leak Location Survey can be found in Section 4 of this Report. A summary of all defects located can be found in Section 5 of this Report.

Approved: F Lennon

Section 2:

Plan: Mobile Electrical Leak Location Survey Stages



GTS

Thornback Rd, Troyswood, Co. Kilkenny, Ireland
Tel/Fax: (056) 7770953
Mobile: (086) 8323113
Email: gts@o2.ie

Job:
East Cork Landfill

Title:
Leachate Lagoon No. 1
Mobile Electrical Leak Location Survey Stages

Section 3:

Mobile Electrical Leak Location Survey Methodology

GTS

Geomembrane Testing Services Limited

Thornback Road, Troyswood, Co Kilkenny, Ireland
Tel/Fax: (056) 7770953 Mobile: (086 8323113)
Email: gts@o2.ie

METHODOLOGY OF MOBILE ELECTRICAL LEAK LOCATION SURVEY

- Performing a Mobile Electrical Leak Location Survey (MELLS) has been found to offer an extremely reliable and sensitive way of ensuring the integrity of high-density polythene (HDPE) liners. Ruptures in the liner with effective areas of 6mm² are easily detectable and under ideal conditions pin-hole sized breaches can be located with an accuracy of ±50cm using the standard survey geometry of one reading per square metre. It should be borne in mind that leaks or defects in the liner can only be detected where the liner is in contact with the sub-grade. Wrinkles or folds in the liner caused by construction may result in defects not being in contact with the sub-grade and therefore remaining undetectable.

- The basic principle of a Mobile Electrical Leak Location Survey involves impressing a high voltage, direct current (DC) supply across the geomembrane. This is achieved by connecting a power supply to two steel electrodes, one placed in the cover material above the HDPE liner (in this case liquid) whilst the other is buried in natural ground outside the contained area. The liner acts as an electrical insulator between the cover material and the natural ground and if completely intact, theoretically produces a uniformly distributed potential field across the liner. If there are holes present, current is channelled through the defects and the potential field is disturbed in these areas.

- To conduct a Mobile Electrical Leak Location Survey the potential field above the HDPE liner is investigated by mapping the potential difference (voltage) between two non-polarising electrodes at regular intervals across the liner surface. Sampling is carried out on a grid basis with a grid spacing that is usually set to obtain a balance between maximising the sensitivity of the survey and increasing the rate of acquisition.
-

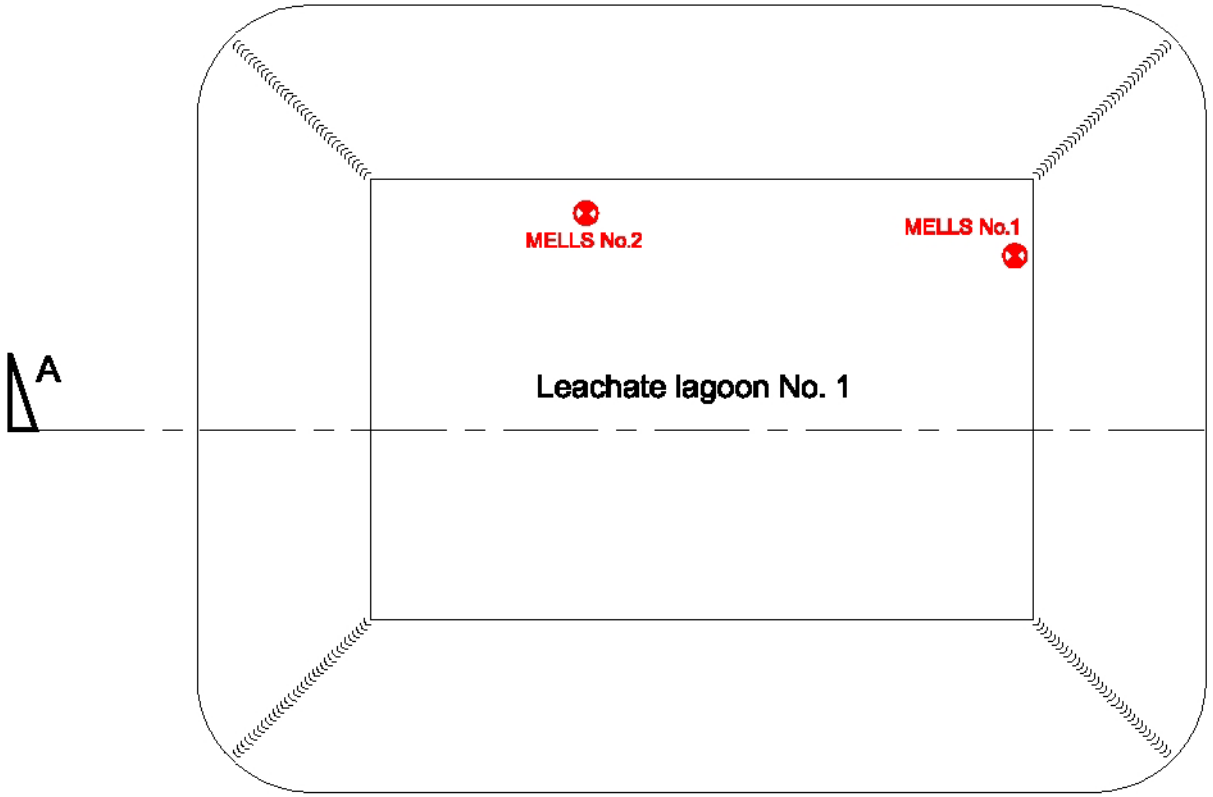
…/2

Calibration Test:

A small test leak is simulated in the geomembrane before data acquisition commences and at regular intervals throughout the survey period to provide a check on the sensitivity of the system and a rough calibration on the scale of any other holes. If no other holes are found, detection of the test hole provides confidence in the survey technique.

Section 4:

Plan: Mobile Electrical Leak Location Survey Defect Positions



GTS

Thornback Rd, Troyswood, Co. Kilkenny, Ireland
Tel/Fax: (056) 7770953
Mobile: (086) 8323113
Email: gts@o2.ie

Job:
East Cork Landfill

Title: Leachate Lagoon No. 1
Mobile Electrical Leak Location
Survey Stages & Defect Positions

ELECTRICAL LEAK LOCATION SURVEY DEFECT POSITION

Section 5:

Mobile Electrical Leak Location Survey Defects Summary

GTS

Geomembrane Testing Services Limited

Thornback Road, Troyswood, Co Kilkenny, Ireland
Tel/Fax: (056) 7770953 Mobile: (086 8323113)
Email: gts@o2.ie

GEOMEMBRANE
MOBILE ELECTRICAL LEAK LOCATION SURVEY

A Mobile Electrical Leak Location Survey was carried out in East Cork Landfill Development (Leachate Lagoon No. 1) in November 2010. On completion of this Survey two (2) defects were located. The position of all defects located can be found in Section 4 of this Report.

MELLS No. 1 - 26mm Diameter Puncture:

This defect was exposed during the Survey. The area was then cleaned and all moisture in the vicinity of the defect removed. This area was then resurveyed to eliminate the possibility of a second defect in the immediate area. No further defects were located. Repair and high frequency spark testing of this defect was carried out by Lining Technology Limited, re-tested by Geomembrane Testing Services Limited and found to be acceptable. The extrudate weld method was applied to carry out this repair.

MELLS No. 2 – 7mm Diameter Puncture

This defect was exposed during the Survey. The area was then cleaned and all moisture in the vicinity of the defect removed. This area was then resurveyed to eliminate the possibility of a second defect in the immediate area. No further defects were located. Repair and high frequency spark testing of this defect was carried out by Lining Technology Limited, re-tested by Geomembrane Testing Services Limited and found to be acceptable. The extrudate weld method was applied to carry out this repair.

Approved: F Lennon

Section 6:

Geomembrane Integrity Certificate

GTS

Geomembrane Testing Services Limited

Thornback Road, Troyswood, Co Kilkenny, Ireland
Tel/Fax: (056) 7770953 Mobile: (086 8323113)
Email: gts@o2.ie

HIGH DENSITY POLYETHYLENE MEMBRANE **(HDPE)** INTEGRITY CERTIFICATE

Based on results of the monitoring of integrity of the geomembrane liner as described herein, Geomembrane Testing Services Limited certifies that the geomembrane installation of East Cork Landfill Development, Leachate Lagoon No. 1, Carrigtwohill, Co Cork, was carried out in accordance with the Contract Specifications. Further to this, a Mobile Electrical Leak Location Survey (MELLS) was carried out using geophysical techniques, to verify the integrity of the lining system. The MELLS identified two (2) No. defects which were subsequently repaired, re-tested and found to be acceptable. It is the opinion of Geomembrane Testing Services Limited that the High Density Polyethylene Membrane was free from all defects at the time of final inspection.

_____

Frank Lennon
November 2010