EAST CORK LANDFILL

ROSSMORE
CARRIGTOHILL

CO CORK

ENVIRONMENTAL PROTECTION AGENCY

WASTE LICENCE W0022-01

ANNUAL ENVIRONMENTAL REPORT

1st JANUARY - 31st DECEMBER 2011

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 W0022-01 to operate waste disposal activities at 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. The landfill closed for waste disposal on 26th February 2007.

In accordance with Condition 2.8 of Waste Licence W0022-01 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 2011.

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

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 a public route. The surface is maintained and cleaned by Cork County Council under Condition 4.4.2.

2.2 Reporting Period

The period being reported on is that from 1st January to 31st December 2011.

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	MSW/tonnes	Bulky Waste/tonnes	Disposal Destination
January 2011	17.8	103.1	Youghal Landfill
February	23.84	102.2	Youghal Landfill
March	43.44	90.06	Youghal Landfill
April	49.4	93.6	Youghal Landfill
May	10.2	100.13	Youghal Landfill
June	27.26	85.69	Youghal Landfill
July	18.36	113.16	Youghal Landfill
August	7.64	92.91	Youghal Landfill
September	20.92	91.4	Youghal Landfill
October	0	94.64	Youghal Landfill
November	0	112.66	Youghal Landfill
December	0	78.3	Youghal Landfill
Total	218.86	1157.85	

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

No integrity testing was due in 2011.

3 SUMMARY OF MONITORING AND EMISSIONS

3.1 Landfill Gas

The possible migration of landfill gas is monitored weekly by site technical staff as per 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 installation of the Landfill Gas Flare in September 2004 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 27%, 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 results are relayed to a SCADA pc in the main office building.

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. Contractors Enva Ltd. sampled, analysed and interpreted 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. Contractors Enva 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. 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 little change in comparison to the last reporting period, with ranges from 7.79 to 8.45 in Lagoon 2.
BOD values range from 35 to 112mg/l for Lagoon 2 over the period. COD varies from 595 to 2770mg/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 52dBA 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 2011 are indicative of a further decline in site activity. The report by DixonBrosnan Ltd is contained in Attachment D.

3.6 Dust

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 88mm diameter.

The dust limit in Schedule G2 of 350mg/m^2/day was not exceeded in any location during the two monitoring periods.

3.7 Dust Survey

Date	Location	Duration	Dust Concentration	Dust Level $mg/m^2/day$
May/June	**Atlantic Shellfish D1**	30	0.0343	183.82
2011	**Civic Amenity D2**	30	0.0025	13.40
	South Road (pylon) D3	30	0.0298	159.70
	Northwestern corner D4	30	0.0118	63.24

Date	Location	Duration	Dust Concentration	Dust Level $mg/m^2/day$
July/August	**Atlantic Shellfish D1**	**30**	0.0096	51.44
2011	**Civic Amenity D2**	**30**	0.0077	41.26
	South Road (pylon) D3	**30**	0.0039	211.14
	Northwestern corner D4	**30**	0.0240	109.32

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 report for 2011 is featured in Appendix E.

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

No site developments took place in the reporting year

4.2 Proposed Development Works

No site developments are proposed in 2012

4.3 Slope Stability

Analysis of slope stability in accordance with Condition 9.20 on selected areas of the restored cells was carried out by Enviroglan Ltd. The analysis was conducted using the *Eurocode 7* software programme on three locations. Factors of safety ranging from 1.25 to 1.57 evolved indicating stable conditions. A full and comprehensive report is included in Appendix A.

4.4 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 and greenstar Ltd's facility at Sarsfields Court, Glanmire, Co Cork.

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

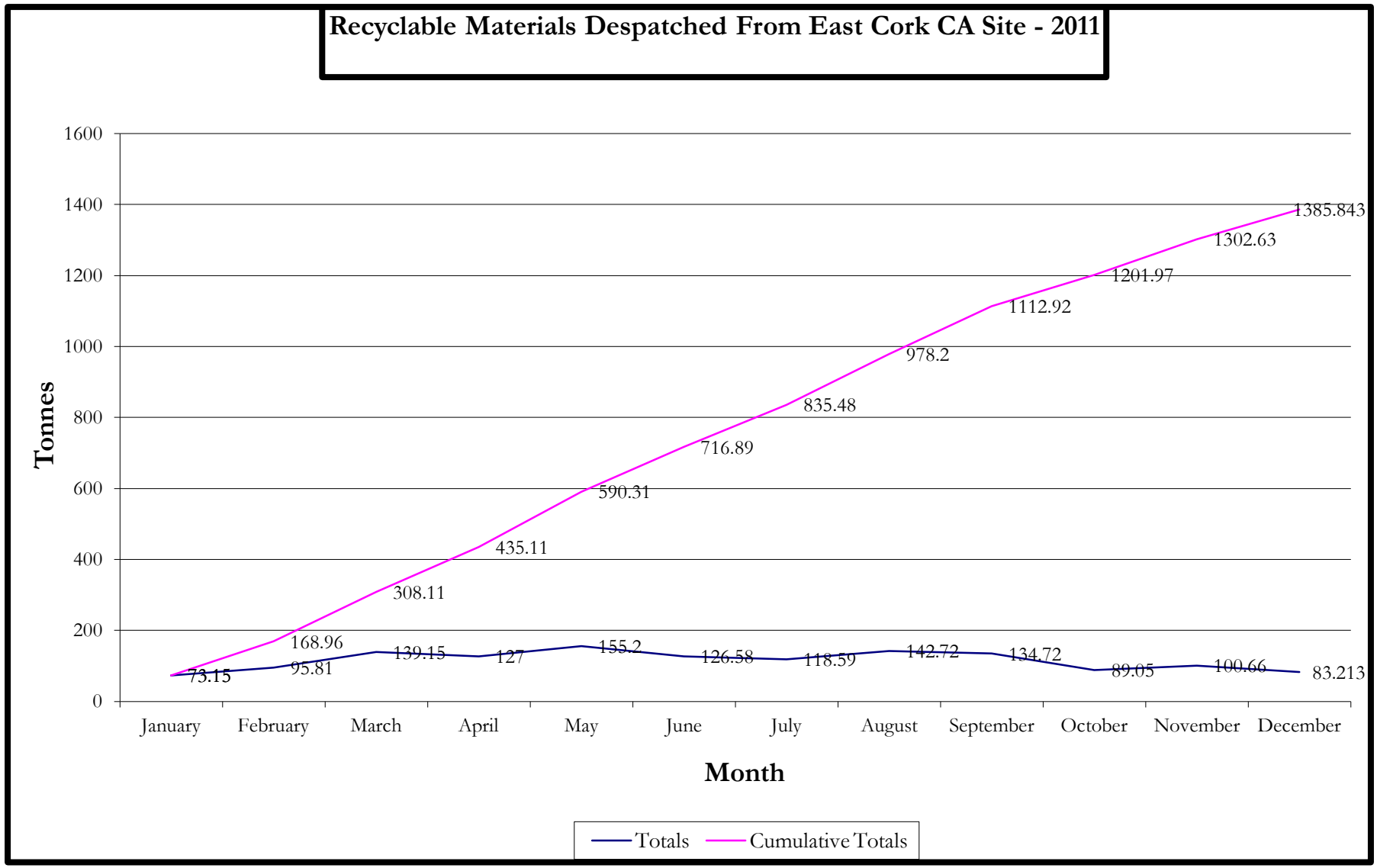
Flourescent tubes

Green waste

Textiles

Timber

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


Recyclable Materials Despatched From East Cork CA Site - 2011
Tonnes
1600
1400
1200
1000
800
600
400
200
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
73.15
168.96
308.11
435.11
590.31
716.89
835.48
978.2
1112.92
1201.97
1302.63
1385.843
95.81
139.15
127
155.2
126.58
118.59
142.72
134.72
89.05
100.66
83.213
Totals
Cumulative Totals

6 ENVIRONMENTAL INCIDENTS AND COMPLAINTS

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
17/03/11- 18/01/11	LFG flare shut down	High atmospheric pressure causing LFG depletion	No corrective action possible. Incident likely to be repeated.
02/02/11- 03/02/11	LFG flare shut down	High atmospheric pressure causing LFG depletion	As above
21/02/11	LFG flare shut down	High atmospheric pressure causing LFG depletion	As above
19/03/11	LFG flare shut down	High atmospheric pressure causing LFG depletion	As above
23/04/11- 24/04/11	LFG flare shut down	High O2 in gas field	Balance LFG field
15/05/11- 16/05/11	LFG flare shut down	Power outage from National Grid	No corrective action possible. Incident likely to be repeated. Constant problem at local ESB sub-station
17/05/11- 18/05-11	LFG flare shut down	Oil leak in air compressor controlling main gas valve	'Wear & tear' incident
30/05/11- 31/05/11	LFG flare shut down	Failure of flame detection device	Clean and restore UV sensor
02/06/11- 05/06/11	LFG flare shut downs	High atmospheric pressure causing LFG depletion	As above
12/06/11	Flare SCADA signal failure	Severed communication cables	Summoned electrician. Re-make cable joints
08/07/11	LFG flare shut down	Power outage from National Grid	No corrective action possible. Incident likely to be repeated. Constant problem at local ESB sub-station

Date	Nature of Incident	Cause	Corrective Action
08/07/11	SW discharge control actuator	Failure due to flooding	Remove & replace actuator
22/08/11- 23/08/11	Flare flame detection failure	Low LFG yield from gas field	Allow field to re-charge
07/12/11- 08/12/11	LFG flare shut down	Flare shut down to change CO sample pump. Unable to re-start	Allow field to re-charge

6.2 Complaints

There were no complaints registered against the site in 2011.

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 2011.

The total measure is 5,291.99 tonnes. This represents a reduction on 2010 of 2,772.18 tonnes and an indication of declining volumes of leachate arising.

Month	Leachate tonnes
January	1,177.46
February	1,365.61
March	890.98
April	59.11
May	0
June	0
July	0
August	0
September	528.06
October	532.39
November	1,066.70
December	301.68
Total	5,291.99

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 2011. 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 250-330m^3 per hour, depending on atmospherics, season 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 is 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 were supplied by Ekomille Ltd. Two units were in use at the Civic Amenity but have been discontinued on economics
grounds. Three cats now reside at the facility and are tended to by site staff.

Birds
Birds no longer present a nuisance on the site. The site has an abundance of pheasants and linnets. A kestrel can often be seen foraging over the site.

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 only store ten day's 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 on some occasions last year Cork County Council had to request the assistance of Irish Distillers/Pernod Ricard Ltd to provide missing data. Additional data was recovered locally from the website of Mr Cormac Gebruers, Cobh.

Monthly Rainfall Statistics

Month	Rainfall mm
January	75.4
February	114.4
March	22.6
April	16.4
May	81.6
June	114.6
July	39.6
August	66.0
September	50.6
October	80.4
November	156.4
December	78.6

Total rainfall	896.60 mm

This represents a considerable reduction of 71.1mm on 2010 and a continuing decline 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 2011
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

8.3 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 2011-onwards
			Balance the landfill gas collection system monthly and maintain records	Jerome O'Brien/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	Ongoing
2			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 operation.	Jerome O'Brien	July 2010
3	To improve the efficiency of	Ensure compliance with Condition 4.18 of the	Set up a training manual to contain maintenance, sampling and monitoring procedures for the	Lisa Collins	April 2010

	operation and monitoring of the leachate and stormwater management system	waste licence with reference to leachate management	stormwater pond and ensure all personnel are trained on its operation.		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
			Continue to monitor and control the site security of the facility through the CCTV system.	Jerome O'Brien	Ongoing
4	To maximise the efficiency and continuously improve operations at the civic amenity facility.	To increase the efficiency of the civic amenity	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
5	To maximise the efficiency and continuously improve operations at the civic amenity facility.		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 2011. 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 and Civic Amenity site. The totals include those of plant hire firm as well as Cork County Council usage for mechanical plant, offices, weighbridge, leachate pumps, compressor and landfill gas flare.

The reliance on fossil fuels continued the downward trend in 2011 over 2010 by 900 litres of gas oil for plant machinery. There was a decrease in usage of a staggering 37,446 kWh of electricity possibly attributable to the change of compressor supplying compressed air to the pneumatic pumps and flare from a constant to a variable speed unit.

Company	**Diesel**	**Electricity**
Ted Motherway AgriPlant Ltd	4,300 litres	
Cork County Council	2,200 litres	
Cork County Council		Day 60,300 kWh
Cork County Council		Night 36,226 kWh
Totals	6,500 litres	96,529 kWh

2011

Table 9.1

10 SUMMARY OF PROCEDURES DEVELOPED

No procedures were developed during the reporting year.

11 REPORTS ON FINANCIAL PROVISION

11.1 Financial Provision under the Licence

Cork County Council has always made necessary provision to ensure adequate funding for the management and aftercare 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, operation and aftercare of East Cork Landfill and Civic Amenity Site. The Senior Engineer, Environment, is responsible for the management of municipal waste and waste facilities. The site manager with responsibility for day to day site operations is the Executive Engineer, Zone 2, who is supported by the Environmental Technician in her roles as deputy manager.

Cork County Council will soon develop framework strategies for tendering the many and various services required by the Waste Services Section including the following;

Provision of site engineering assistance and support

Leachate tramsportation

Landfill gas flare maintenance

Environmental Liabilities Risk Assessment

Environmental monitoring of surface water, groundwater and leachate.

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 2012

	Contact Telephone No.
Senior Engineer:	
Mr Liam Singleton	(021) 4285286
Senior Executive Engineer:	
Mr Jerome O'Brien	(086) 8355143
Landfill Manager Executive Engineer:	
Mr John Paul O'Neill	(086) 3898364
CA Site Manager & Environmental Technician:	
Ms Lisa Collins	(021) 4533934
Deputy CA Site Manager & *Weighbridge Operator*	
Mr Brian Duggan	(021) 4883936

12 REVIEW OF MONITORING DATA AT ROSSMORE LANDFILL JANUARY TO DECEMBER 2011

INTRODUCTION

A comparison has been made with the environmental monitoring results for monitoring period January to December 2008 and the 2006 and 2007 monitoring data to establish if any changing trends in the composition of the leachate, groundwater or surface water are apparent.

This is the Annual Environmental Report for East Cork Landfill for 2011. It will look at all quarterly and annual results for ground water, surface water, leachate, dust and noise. SURFACE WATER MONITORING

Surface water quality and annual monitoring has been undertaken at three locations (SW1, SW2, and SW3) in the vicinity of Rossmore Landfill. Surface water results are discussed and reported in the quarterly reports for 2011. All quarterly reports were submitted to the EPA in 2011.

The results for 2011 are compared to environmental quality standards (EQS) set for surface water by the EPA in the publication "Towards Setting Guideline Values for The protection of Groundwater in Ireland" and the Drinking Water Directive.

SW1

Analysis of the annual parameters indicates a similar composition to that seen in 2010. SW1 is influenced by the tide; this is observed from high conductivity, chloride and sulphate results. Ammoniacal nitrogen results are within the Surface water directive limits for 2011. Annual metal sampling for cadmium, total chromium, copper, iron, lead, manganese, mercury and zinc are within the EQS limits set. Concentrations of magnesium and potassium exceed the limits set under the EQS. This is similar to previous years. Annual sampling for nitrite, total phosphorus, and nitrates are within the EQS limits set. It should be noted that the surface water in the vicinity of the site is not suitable for drinking water purposes due to the proximity of the site to the estuary.

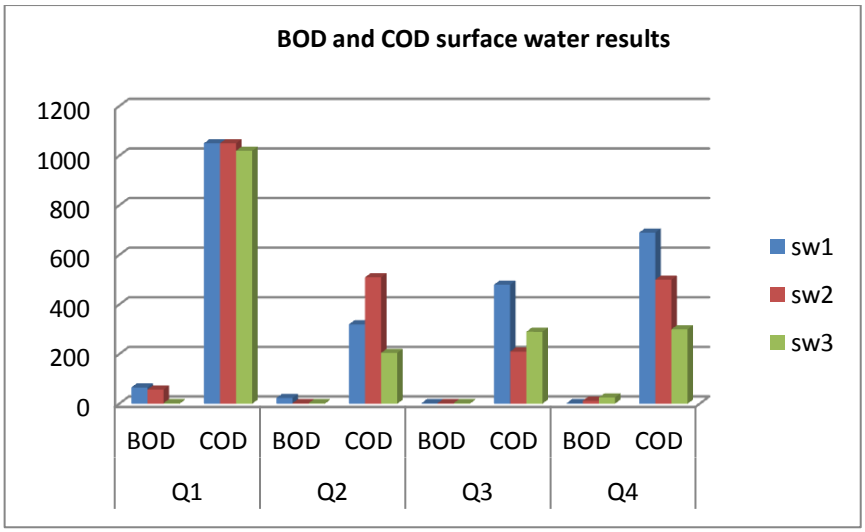
SW2

Analysis of the annual parameters indicates similar results to those seen previously at the site. The majority of the parameters are within the EQS for surface water. SW2 is influenced by the tide; this is observed in high conductivity, chloride and sulphate results. Ammoniacal nitrogen results are within the Surface water directive limits for 2011. Annual metal sampling for cadmium, total chromium, copper, iron, mercury, manganese, lead and zinc were within the EQS limits set for surface water. Concentrations for magnesium and potassium exceed the limits set under the EQS. This is similar to previous annual results. Annual sampling for Total phosphorus, nitrate, nitrite, TON are within the limits set under the EQS for Surface water.

SW3

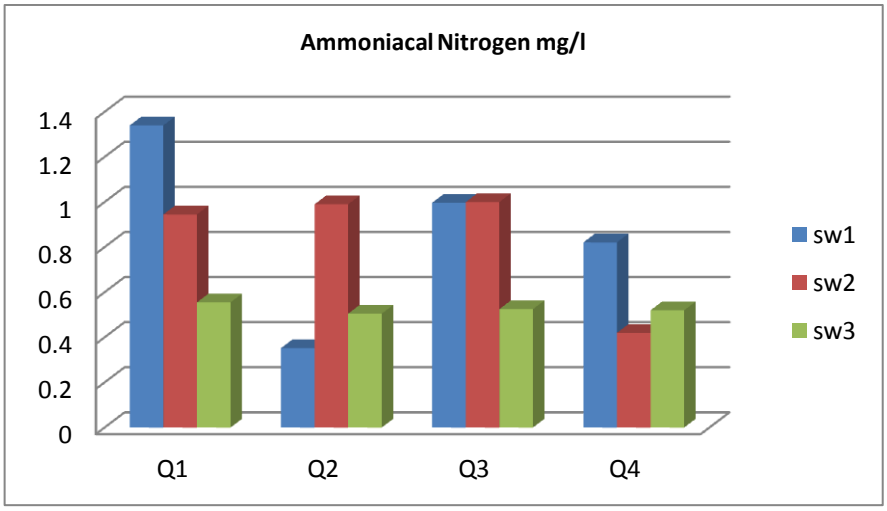
Analysis of the annual parameters indicates a similar composition to that seen previously. SW3 is tidal influenced. This is observed in high conductivity, chlorides and sulphates results. The majority of the parameters are within the EQS levels for surface water. Annual metal sampling of cadmium, total chromium, copper, iron, lead, manganese, mercury and zinc are within the EQS limits for surface water. Concentrations of magnesium and potassium exceed the EQS limits this is due to the location of the site. This is similar to previous results. Annual sampling of nitrite, nitrate, total phosphorus and TON are within the EQS limits set for surface water.

Table: Surface water results for BOD and COD



Note: COD and BOD levels exceeded were exceeded during 2011.

Table: Surface water results for Ammoniacal nitrogen for 2011



Note: Ammoniacal Nitrogen EQS limit is 0.02 mg/l.

SUMMARY OF SURFACE WATER MONITORING

As mentioned previously, the composition of the surface water is strongly influenced by the tidal nature of the estuary due to the location of the site within Cork Harbour. This results in all of the monitoring points having a naturally elevated electrical conductivity, chloride, magnesium, potassium, and sodium and sulphate concentration.

It is considered that land filling activities are not significantly impacting on the surface water quality in the vicinity of the site. No surface water site exceeds levels for heavy metals under the environmental quality standards set for surface water.

GROUNDWATER MONITORING PROGRAMME

Monitoring of the groundwater compositions was undertaken at five locations (BH1, BH2, BH3, BH4, and BH6) in 2011. In accordance with the Waste Licence for the site, monitoring of the groundwater composition at the site is undertaken on a monthly, quarterly and annual basis. During 2007, revised trigger levels were calculated for the concentration of ammoniacal nitrogen, electrical conductivity and total organic carbon in groundwater at monitoring locations BH1, BH2 and BH3. Ground water results are discussed and reported in quarterly reports for 2011. All quarterly reports were submitted to the EPA in 2011.

The monitoring results have been compared to the Interim Guideline Values (IGV) for groundwater recommended by the EPA in the publication "Towards Setting Guideline Values for the Protection of Groundwater in Ireland".

Groundwater Monitoring Parameters

BH1

The results of the analysis of the annual parameters in 2011 indicate a similar composition to that seen in 2010. None of the parameters exceed the IGV values for groundwater as recommended by the EPA. Ammoniacal nitrogen levels exceeded the IGV values. This is similar to previous results. Annual metal sampling for cadmium, total chromium, copper, cyanide, iron, lead, mercury, zinc and born are within the IGV limits set for Drinking water. Concentrations for manganese and magnesium exceeded the IGV set. Exceedence of these metals is due to tidal influence and the geology of the site.

BH2

The results of monitoring of the annual parameters in 2011 indicate that the concentration is similar to that seen previously with the majority of the parameters being less than the IGV for groundwater. Ammoniacal nitrogen levels exceeded the IGV levels this is similar to previous results. Annual metal sampling for cadmium, copper, total chromium, cyanide, lead, boron, iron and zinc did not exceed the IGV set. Manganese concentration did not exceed the limit. Magnesium calcium and sulphates exceeded the IGV set due to tidal influence. .

BH3

Analysis of the annual parameters in 2011 indicated that the majority of the parameters were within the normal levels seen at the site with some minor changes. Ammoniacal nitrogen levels exceeded IGV levels in 2011. This is similar to previous results. Annual metal sampling for cadmium, copper, total chromium, cyanide, lead, boron, and zinc did not exceed the IGV values. IGV for iron of 0.2 mg/l was exceeded by BH3 0.791 mg/l. Manganese and magnesium also exceeded the IGV limits. High levels of magnesium, sulphates, chloride and calcium are tidal influenced.

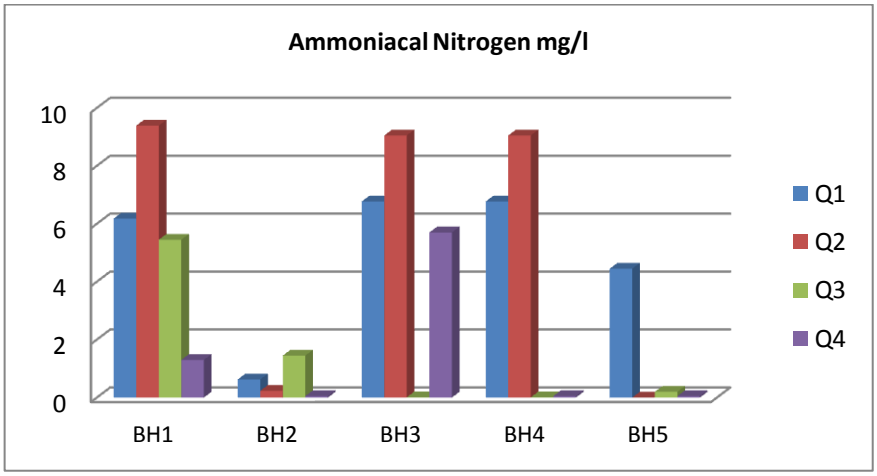
BH4

Analysis of the annual parameters in 2011 indicated that all of the parameters were within the EQS levels. Ammoniacal nitrogen IGV levels were exceeded during 2011. This is similar to previous results. Annual metal sampling for cadmium, copper, total chromium, cyanide, lead, boron, and zinc did not exceed the IGV set. Iron concentrations were above the limit of 1.0 mg/l but were under <2 mg/l. Magnesium and manganese concentrations are above the IGV values. Increased concentration of these metals including sulphates is tidal influenced.

BH5

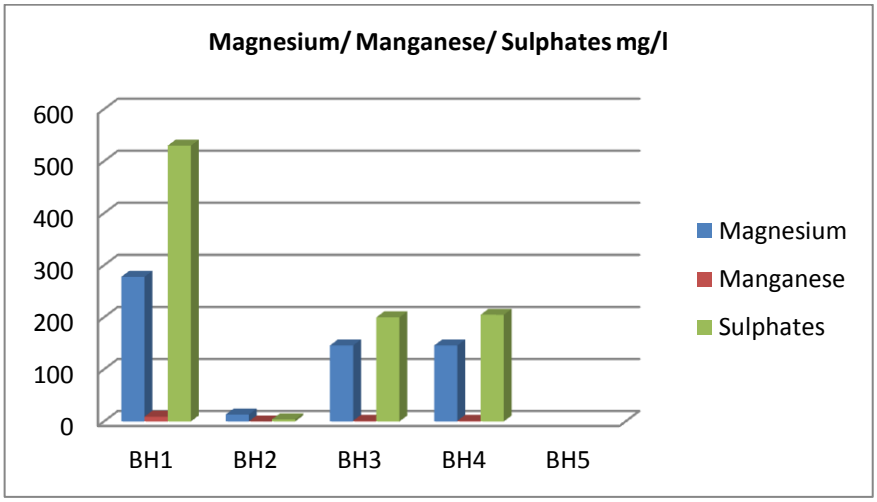
The borehole was dry in November 2011. Ammoniacal nitrogen IGV levels were exceeded during 2011 quarterly sampling. We can estimate that annual metal concentrations were within the IGV values. The results of the annual monitoring in 2008 indicated most of the parameters were within

Table: Ammoniacal nitrogen for ground water wells



Note: IGV value for ground water ammoniacal nitrogen is 0.15 mg/l.

Table: Magnesium, manganese and sulphate ground water results.



Note: Elevated levels of these parameters indicate tidal influence.

SUMMARY OF GROUNDWATER MONITORING

Analysis of the annual parameters was undertaken during November, 2011. The groundwater chemistry is strongly influenced by the proximity of the boreholes to the estuary. This results in a naturally elevated chloride, electrical conductivity, sodium, and potassium, and magnesium, sulphate concentration.

The majority ground water wells are within the IGV values for metals. BH1, BH2 and BH4 exceeded the IGV limit for manganese of 0.05mg/l. BH1, BH3 and BH4 exceeded the IGV limit for magnesium of 50 mg/l. Conductivity, sulphates and chlorides indicates the influence of the estuary on the ground water wells.

LEACHATE MONITORING

Monitoring of the leachate composition is undertaken at the leachate lagoon and from three monitoring points within the former unlined portion of the site (C1, C2 and C3). Monitoring of leachate composition is undertaken on a quarterly basis with analysis of a wider range of parameters on an annual basis. Leachate level monitoring is undertaken by Cork County Council.

Leachate Parameters

Analysis of the annual parameters was undertaken during November 2008. The composition of the leachate monitored at the site during the current monitoring period is similar to that seen previously at the site. A wide variation is seen in most of the parameters monitored.

C1

Annual metal sampling for cadmium, copper, total chromium, cyanide, lead, mercury and zinc are below the EQS levels for surface water. Iron, boron, magnesium are above the EQS values. Ammoniacal nitrogen levels ranged from 413 mg/l to 2070 mg/l, exceeding EQS limit of 0.02 mg/l. Biochemical oxygen demand (BOD)ranged

from <2 to 600mg/l and chemical oxygen demand (COD) ranged from 420mg/l to 1920 mg/l. These results are similar to previous years.

C2

The results of the annual monitoring indicate no significant change in the leachate composition the majority of the parameters are within the normal range seen at the site. Annual metal sampling for cadmium, total chromium, cyanide, lead, mercury, iron and zinc are below the EQS levels for surface water. Magnesium exceeded the EQS limit. Ammoniacal nitrogen results ranged from 415mg/l to 256 mg/l, exceeding the EQS limit of 0.02mg/l. BOD ranged from <2 to 30, while COD ranged from 200 to 317 mg/l. COD results exceed limits set under the surface water directive.

C3

Annual metal monitoring results did not significantly change. Parameters cadmium, copper, total chromium, lead, mercury, did not exceed the EQS values. Ammoniacal nitrogen ranged from 744 mg/l to 2820 mg/l. BOD ranged from 54 to 418 mg/l, while COD ranged from 500 to 1800 mg/l. Both COD and BOD exceed limits set under the Surface water directive.

CONCLUSIONS

The majority of annual metal parameters under Ground water, Surface water and leachate did not exceed the limits set under the environmental quality standards (EQS) set for surface water by the EPA in the publication "Towards Setting Guideline Values for The protection of Groundwater in Ireland" and the Drinking water Directive.

In all ground water wells and surface water sites, magnesium levels were above the IGV limit. All wells are tidal influenced and this is seen in high sulphates, chlorides, and potassium and magnesium levels.

East Cork landfill is not causing pollution in surface water or ground water wells monitored under licence W0022-01.

APPENDIX A

SLOPE STABILITY

SLOPE STABILITY REPORT

EAST CORK LANDFILL,

ROSSMORE,

CARRIGTOHILL

CO. CORK

WASTE LICENCE REGISTER W0022-01

PREPARED FOR CORK COUNTY COUNCIL

MARCH 2012

enviroglan
Waste & Environmental Management Services

TABLE OF CONTENTS

PAGE

APPENDICES

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

1. INTRODUCTION

General

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

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

Slope Stability Analysis Method

A total stress analysis for rotational failure within the landfill embankment has been undertaken in accordance with the principals of Eurocode 7: Geotechnical Design (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).

In accordance with the principals of Eurocode 7, rather than using a global factor of safety as per previous design codes, partial factors are applied to the chosen characteristic values to obtain design values. Actions (influences) are multiplied by the partial factors, while resistances are divided by the partial factors.

The Table below shows the partial factors applied to the characteristic values to give the design values used in the analyses.

TABLE 0.1: IS EN 1997-1 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

The definition of factor of safety using limiting equilibrium considers that failure is on the point of occurring along an assumed failure surface where the shear strength required to maintain a condition of limiting equilibrium is compared with the available shear strength of the soil. In accordance with Eurocode 7, geotechnical checks must be carried out to ensure that the resistance preventing a slide is greater than or equal to the actions which cause a slide, i.e:

$$E_d <= R_d$$

Where

E_d = Sum of design actions

R_d = Sum of design resistances

In order to verify that this condition is met, the following formula has been applied, using the design values obtained using the partial factors provided above. The resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e:

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

The assessment of the slope sections for both moment and force equilibrium is based on Bishops and Morgenstern-Price methods.

Design Criteria

Slope Sections

An assessment of three cross-sections through the waste slopes of the site were taken using the most recently available topographical survey by Focus Surveys Ltd. presented on Drawing No. 00-023_1 Rev ZP, dated December 2011.

The sections analysed are considered typical of the overall slopes considered for assessment. The locations of the sections considered for analysis are shown on Drawings 001 and 002. The model sections through the slopes A – A, B – B and C – C are presented in Figures 3.1 to 3.3.

Geology

The subsoils in the vicinity of Rossmore typically consist of sandy clays and minor sand and gravel deposits. The subsoils are underlain by carboniferous deposits of Waulsortian Limestone and Cork Red Marble. The Waulsortian Limestone consists of calcareous mudstone, wackestones and packstones, many of which contain original cavities filled with internal sediments and cements

Parameters

The parameters shown in the Table below are derived based on parameters used by Kolsch (1995) and Thomas *et al (1999).* Cognisant of the relatively young age of the waste within the landfill site, the more conservative figures for fresh waste have been used in the analysis.

TABLE 0.2: CHARACTERISTIC WASTE PARAMETERS

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

TABLE 0.3: 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

The characteristic parameters for the capping and clay liner based on available site data are outlined in the following Table.

TABLE 0.4: CHARACTERISTIC PARAMETERS FOR CAPPING & CLAY LINER

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 0.5: DESIGN PARAMETERS FOR CAPPING & CLAY LINER

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

Leachate Levels within the Waste Material

The leachate levels within the landfill are considered to be maintained 1 m above the clay liner by pumping. The effects of elevated leachate levels within the waste can reduce the stability of the landfill embankment slopes. Therefore, the leachate levels adopted for analysis purposes are considered to be 1 m below the toe of the slope.

Table 0.6: Modelled Leachate Levels

Slope	Leachate Level (mAOD)
A – A	8.0
B - B	8.5
C – C	4.0

Surcharge

To simulate vehicular movement a surcharge of 20 kN/m^2 has been applied to the slopes. 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 as part of the stability assessment.

Results

Slope Stability Analyses

Slope stability analysis was carried out for three representative sections of the landfill waste embankments. The results of the analyses are summarised in Table 3.1 with the resultant safety ratios calculated using Bishop and Morgenstern-Price methods.

The safety ratios for potential slope failures along the sections analysed at the site ranged from 1.25 to 1.57 and are presented on Table 3.1 below. By adopting the methods of analysis given in Eurocode 7 (IS EN 1997-1), the factor of safety against failure is *included* in the partial factors (ranging from 1.0 to 1.3 for various parameters) applied to the analysis rather than to the end result. In order to verify that this condition is met, the resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e.: An in-situ "safety ratio" of less than 1.0 indicates that the slope currently has an inadequate factor of safety against failure and therefore is potentially unstable. Ratios greater than 1.0 indicate an adequate factor of safety against failure and are considered stable.

TABLE 0.1: SLOPE ANALYSIS RESULTS

Slope name	Leachate Level (mAOD)	Bishop FoS	Morgenstern-Price FoS	Slip Length (m)	Slip location
A-A	8	1.25	1.25	35	Deep rotational slip through capping and waste materials
B-B	8.5	1.57	1.57	65	Deep rotational slip through capping and waste materials
C-C	4	1.30	1.30	48	Deep rotational slip through capping and waste materials

FIGURE 0.1: TYPICAL DEEP ROTATIONAL SLOPE FAILURE FOR SECTION A-A (BISHOP METHOD)

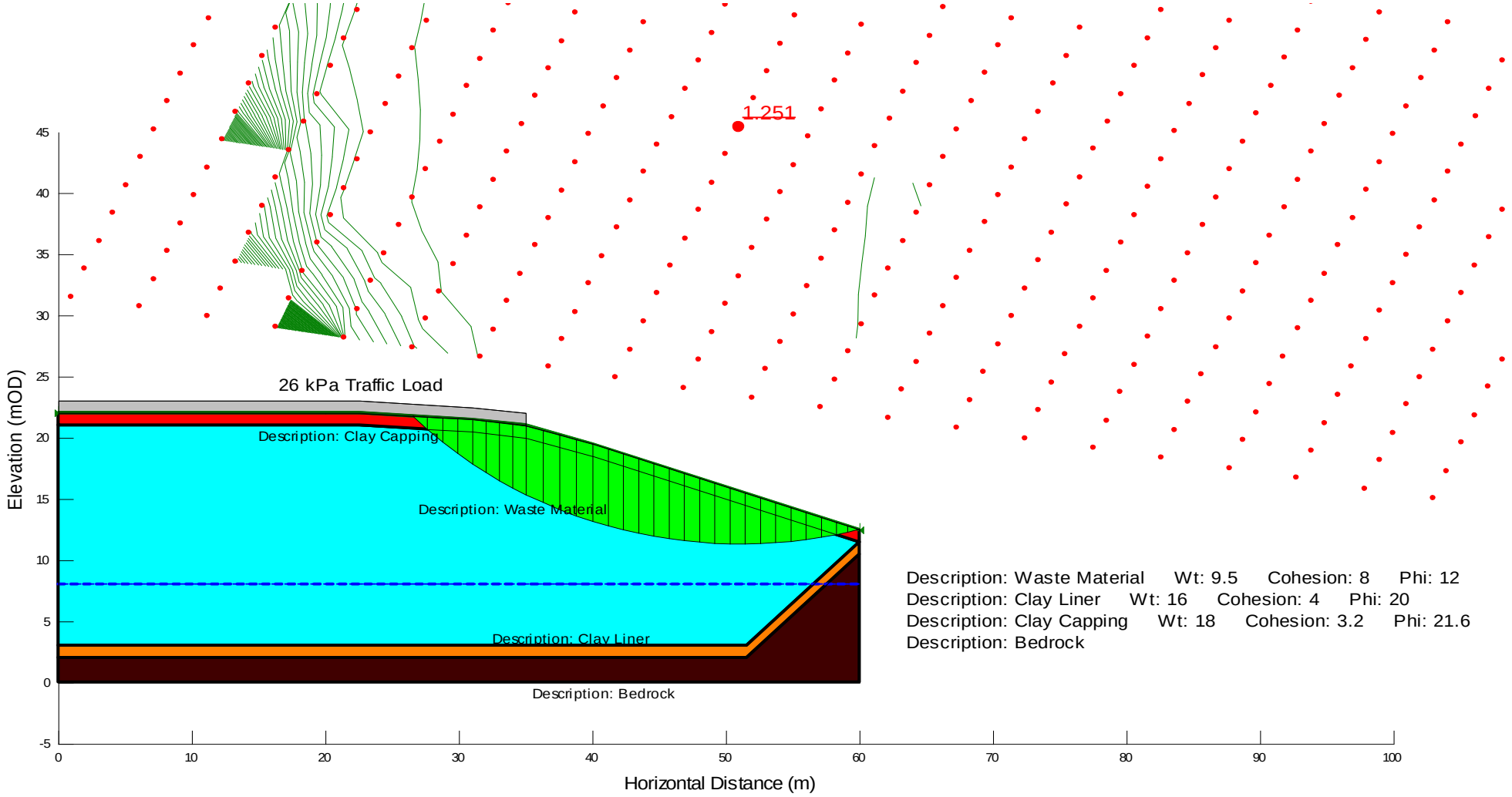
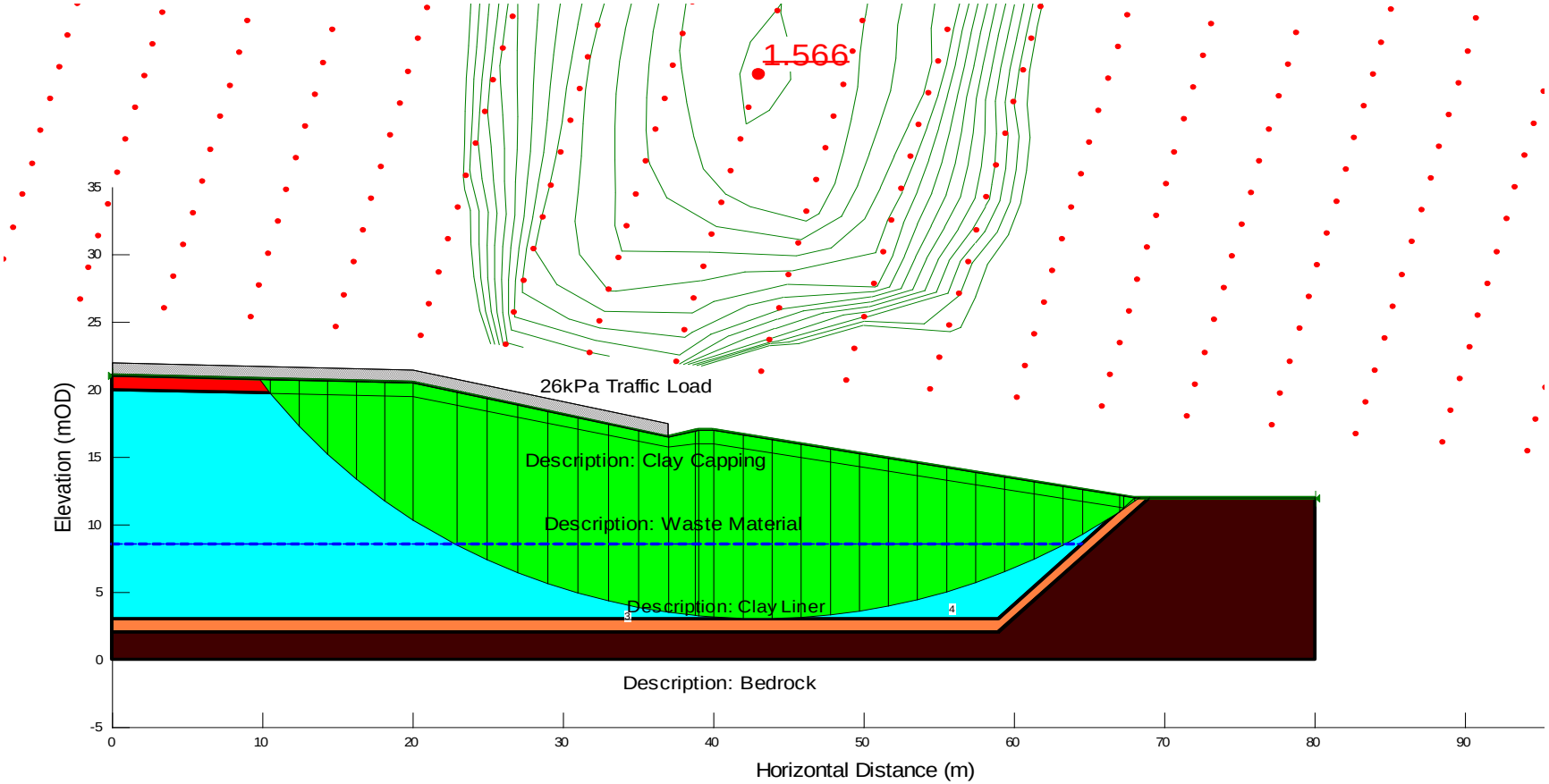
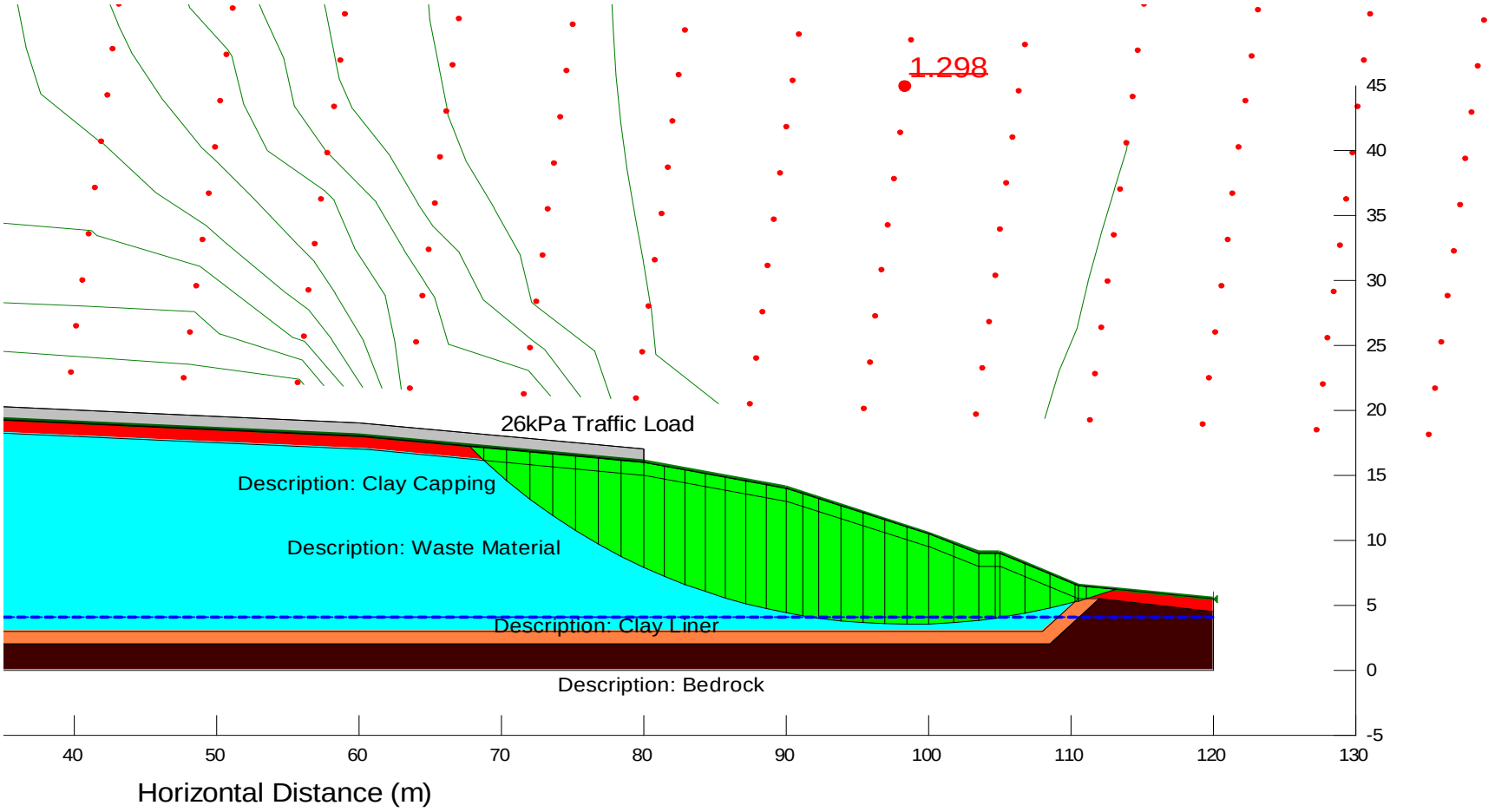


FIGURE 0.2: TYPICAL DEEP ROTATIONAL FAILURE FOR SECTION B-B (MORGENSTERN PRICE METHOD)



Description: Waste Material Wt: 9.5 Cohesion: 8 Phi: 12
Description: Clay Liner Wt: 16 Cohesion: 4 Phi: 20
Description: Clay Capping Wt: 18 Cohesion: 3.2 Phi: 21.6
Description: Bedrock

Figure 0.3: Typical Deep Rotational Failure for Section C – C (Morgenstern Price Method)



Description: Waste Material Wt: 9.5 Cohesion: 8 Phi: 12
Description: Clay Liner Wt: 16 Cohesion: 4 Phi: 20
Description: Clay Capping Wt: 18 Cohesion: 3.2 Phi: 21.6
Description: Bedrock

Discussions and Conclusions

The results of the stability analysis show safety ratio for potential deep rotational slope failures along the existing slope cross-sections modelled ranged from 1.25 to 1.57. All slopes analysed gave safety ratios above the minimum required safety ratio of 1.0 in accordance with IS EN 1997-1.

Safety ratios for deep seated and shallow failure through the waste material and supporting strata based on the analyses presented indicate the landfill side slopes are considered stable. It is noted that the waste parameters used in the analysis are considered to be conservative based on the information available.

Specific Recommendations Relating to Slope Safety

In order to maintain a long-term safety ratio of 1.0 or greater, leachate levels must be regularly monitored and pumped down (ideally within 1 m of the base of the landfill body) to prevent a build up of levels within the waste body and cause potential instability of the landfill slopes.

Temporary stockpiling or loading of additional soils, waste or materials should not be permitted along the upper portions of the landfill. Traffic should be prevented from accessing the existing capped slopes, particularly after periods of heavy or sustained rainfall.

It is also recommended that visual monitoring of the slopes be carried out on a daily basis after heavy rainfall in order to identify any saturated zones that may develop and cause potential instability within the landfill slopes.

References

1. 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.

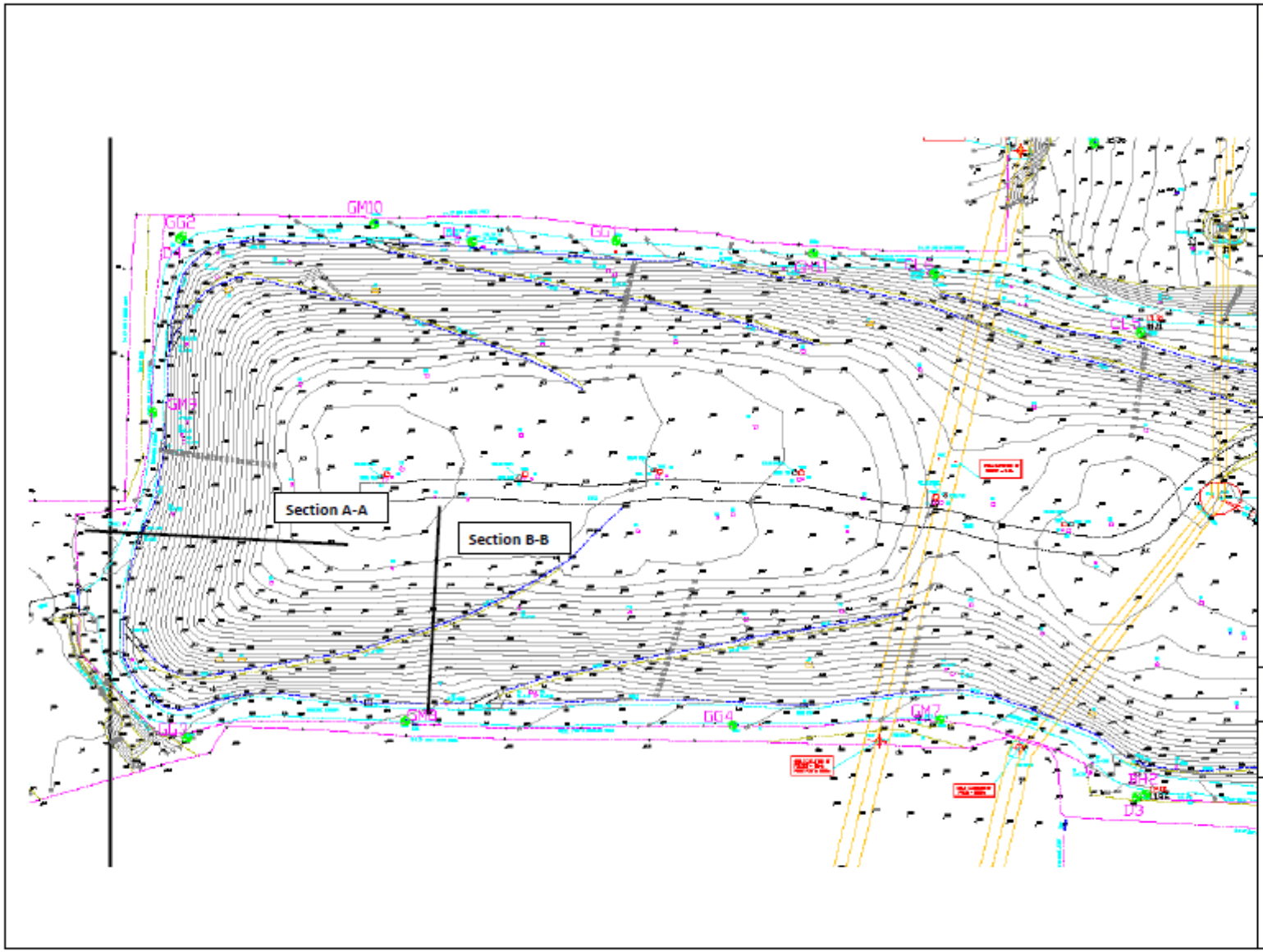
2. Kolsch (1995) Material values for some mechanical properties of domestic waste, Proceedings 5th Sardinia International Landfill Symposium, Vol 2, pp 711-729.

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

4. Survey Drawing No. 00-023_1 Rev ZP provided by Focus Surveys Ltd, Rossmore Landfill Site, updated 21 December 2011.

APPENDIX A

DRAWINGS 001 & 002



Notes
Drawing based on Topographic Site Survey No. 00-23-01 Rev ZP dated 21 December 2011

Client
Cork County Council

Title
East Cork Landfill Slope Stability

Drawing No. 001

Scale
1:1000

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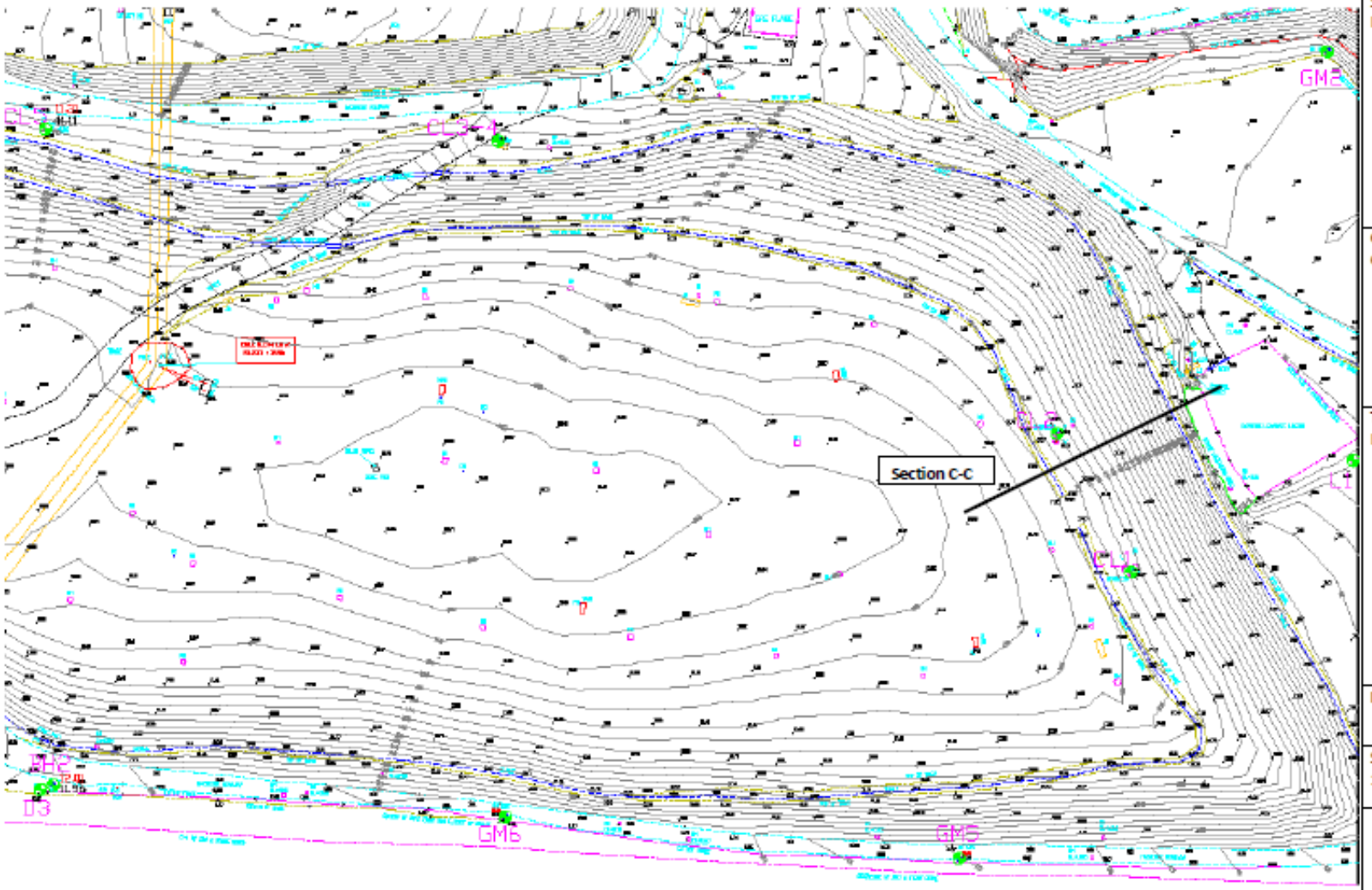
Waste & Environmental Management Services



Notes
Drawing based on Topographic Site Survey No. 00-23-01 Rev ZP dated 21 December 2011

Client
Cork County Council

Title
East Cork Landfill Slope Stability

Drawing No. 002

Scale
1:1000

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Waste & Environmental Management Services

APPENDIX B

Meteorological Report 2011

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Sat Jan 01 00:00:06 2011	0.6	0.0	7.2	7.9	5.5	83.8	90.4	77.3	1025.1	1027.0	1023.1	87.2	360.0	0.7	1.8	6.3	0.0
Sun Jan 02 00:00:06 2011	0.4	0.0	6.2	7.6	5.0	84.4	88.9	76.1	1027.1	1027.9	1026.5	223.4	360.0	0.5	1.1	5.7	0.0
Mon Jan 03 00:00:06 2011	0.5	0.0	3.6	5.7	2.3	79.2	88.8	69.6	1028.2	1029.1	1027.1	72.1	360.0	0.5	1.1	3.9	0.0
Tue Jan 04 00:00:06 2011	0.4	0.0	3.2	5.1	2.2	77.1	88.4	68.0	1022.3	1026.9	1017.7	112.9	360.0	0.5	0.9	4.4	0.0
Wed Jan 05 00:00:06 2011	0.4	0.0	4.8	7.8	2.8	89.8	97.0	78.9	1009.4	1018.2	1000.5	239.1	360.0	0.5	1.8	8.9	0.0
Thu Jan 06 00:00:05 2011	0.3	0.2	4.2	6.2	1.1	88.4	94.2	78.0	995.3	1000.6	992.9	236.4	360.0	0.5	1.1	8.5	0.0
Sat Jan 07 00:00:06 2012	0.8	0.0	8.5	11.8	5.0	85.3	89.3	77.6	1025.4	1027.4	1022.3	271.0	352.7	83.5	2.2	8.7	0.0
Sat Jan 08 00:00:05 2011	0.8	12.2	2.9	4.3	1.6	84.7	94.6	65.5	991.4	998.2	986.8	144.3	360.0	0.5	3.6	12.6	0.0
Sun Jan 09 00:00:05 2011	0.7	0.2	2.9	6.7	0.4	85.3	94.3	69.7	997.4	1004.3	988.7	285.0	360.0	0.5	2.9	10.1	0.0
Mon Jan 10 00:00:05 2011	0.5	1.4	3.1	7.5	-0.4	87.1	95.4	67.6	1009.9	1012.4	1004.9	234.6	360.0	0.5	1.3	10.2	0.0
Tue Jan 11 00:00:05 2011	0.4	9.4	8.4	10.6	5.8	91.4	94.1	83.2	997.3	1007.5	991.9	209.7	359.8	1.2	3.2	11.9	0.0
Wed Jan 12 00:00:06 2011	0.9	10.8	7.2	11.2	3.8	84.9	94.7	75.7	1007.1	1012.7	995.2	245.4	360.0	0.5	3.3	14.7	0.0
Thu Jan 13 00:00:06 2011	0.4	5.0	11.5	12.1	11.0	93.2	94.4	91.8	1004.6	1005.6	1003.4	242.8	358.5	1.6	2.9	8.2	0.3
Fri Jan 14 00:00:06 2011	0.5	1.6	11.1	12.2	9.6	92.3	94.2	89.3	1004.2	1006.5	1002.1	217.5	324.4	75.9	2.7	9.8	0.0
Sat Jan 15 00:00:06 2011	1.3	6.8	9.6	11.1	7.4	85.2	94.3	67.8	1003.7	1007.1	1001.2	236.0	351.6	102.1	4.3	14.9	0.6
Sun Jan 16 00:00:06 2011	0.9	21.6	11.0	11.6	10.0	90.0	91.6	87.8	1001.7	1003.0	1000.4	217.8	334.3	88.4	7.8	19.5	1.5
Mon Jan 17 00:00:07 2011	1.2	3.8	9.4	11.6	3.7	84.4	92.2	67.1	1007.8	1015.6	1000.9	237.5	350.4	4.9	3.7	17.4	0.0
Tue Jan 18 00:00:07 2011	0.0	0.2	3.9	9.2	1.3							315.0			0.8	2.7	0.0
Wed Jan 19 00:00:05 2011	0.5	0.2	2.7	8.6	-0.9	89.3	95.9	65.4	1030.6	1034.8	1025.1	249.7	360.0	0.5	1.2	3.5	0.0
Thu Jan 20 00:00:05 2011	0.4	0.2	1.6	7.6	-2.8	88.5	97.6	59.3	1034.4	1035.0	1033.6	157.3	360.0	0.6	0.8	6.6	0.0
Fri Jan 21 00:00:05 2011	0.2	0.0	2.8	8.1	-0.3	92.0	95.8	80.5	1036.4	1038.7	1034.7	124.3	360.0	0.6	1.0	5.4	0.0
Sat Jan 22 00:00:05 2011	0.2	0.2	1.3	5.8	-1.4	91.9	97.5	71.2	1040.1	1041.3	1038.6	149.9	360.0	0.5	0.7	2.9	0.0
Sun Jan 23 00:00:05 2011	0.3	0.2	1.3	6.5	-2.3	90.6	96.7	74.3	1040.3	1041.2	1039.6	242.8	360.0	0.5	1.0	4.3	0.0
Mon Jan 24 00:00:05 2011	0.4	0.0	2.9	7.5	-0.3	89.3	95.1	68.7	1039.0	1039.9	1038.0	242.0	360.0	0.5	1.0	4.9	0.0

Tue Jan 25 00:00:08 2011	0.8	0.0	4.6	7.8	0.7	79.6	93.1	63.9	1036.1	1039.2	1030.9	257.6	360.0	0.5	1.9	6.1	0.0
Wed Jan 26 00:00:06 2011	0.6	0.6	7.8	9.6	4.9	87.2	92.7	80.9	1022.6	1030.5	1014.8	305.0	360.0	0.5	3.2	10.0	0.0
Thu Jan 27 00:00:06 2011	1.4	0.4	6.7	8.9	3.7	75.5	90.6	54.2	1014.6	1017.1	1012.6	134.2	360.0	0.5	3.2	12.6	0.2
Fri Jan 28 00:00:05 2011	1.2	0.0	4.0	5.5	2.5	70.2	81.8	60.7	1020.8	1023.4	1016.8	66.8	360.0	0.6	3.5	9.9	0.4
Sat Jan 29 00:00:06 2011	0.7	0.0	1.9	3.5	-2.1	71.0	88.8	59.3	1023.1	1024.1	1022.5	109.3	360.0	0.5	1.9	7.4	0.0
Sun Jan 30 00:00:06 2011	0.4	0.0	-0.1	4.3	-3.0	81.9	91.4	61.3	1023.5	1024.8	1021.9	189.1	360.0	0.5	1.0	6.0	0.0
Mon Jan 31 00:00:06 2011	0.0	0.4	3.9	9.1	-1.7							180.0			1.7	9.4	0.0
Totals	17.8	75.4															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Tue Feb 01 00:00:04 2011	0.4	0.6	2.9	9.3	-3.8	92.5	96.8	79.1	1022.7	1024.7	1019.9	185.6	360.0	0.5	1.6	9.6	0.0
Wed Feb 02 00:00:07 2011	1.0	0.8	8.5	12.3	4.3	87.9	95.8	64.1	1022.7	1024.9	1018.9	258.1	360.0	0.5	2.3	10.6	0.0
Thu Feb 03 00:00:05 2011	1.8	0.8	9.5	12.5	5.1	80.4	92.5	59.6	1017.7	1022.9	1013.7	244.6	345.1	46.3	5.3	17.0	0.9
Fri Feb 04 00:00:05 2011	1.3	0.6	7.9	11.1	3.0	81.5	89.9	72.1	1016.8	1021.8	1009.9	234.8	360.0	8.9	5.1	19.9	0.0
Sat Feb 05 00:00:05 2011	1.6	0.4	11.8	12.7	11.0	83.1	90.0	76.1	1009.6	1011.0	1008.0	254.6	353.9	119.9	7.4	20.7	1.4
Sun Feb 06 00:00:08 2011	1.4	3.8	11.8	12.7	11.2	87.1	91.4	78.3	1009.0	1011.0	1007.2	248.0	319.5	132.3	8.3	20.0	1.9
Mon Feb 07 00:00:06 2011	1.0	2.8	11.0	11.7	10.0	89.4	91.7	84.5	1009.2	1011.1	1004.3	220.9	305.8	102.0	7.1	18.8	0.8
Tue Feb 08 00:00:06 2011	1.8	4.2	7.8	10.9	1.3	77.6	90.8	56.3	1009.2	1018.7	996.5	249.4	360.0	0.7	5.2	21.2	0.0
Wed Feb 09 00:00:06 2011	0.9	10.8	6.4	10.2	-0.6	89.1	95.2	74.7	1013.6	1018.6	1007.3	139.7	359.7	8.9	4.1	14.8	0.0
Thu Feb 10 00:00:06 2011	0.4	17.2	9.1	11.7	7.1	92.7	94.6	88.3	1007.3	1010.2	1006.4	195.5	360.0	0.5	2.7	9.1	0.0
Fri Feb 11 00:00:06 2011	0.5	0.8	6.7	9.4	3.7	92.3	96.3	81.6	1008.1	1010.8	1004.0	165.5	360.0	0.5	1.8	8.3	0.0
Sat Feb 12 00:00:05 2011	1.2	2.8	9.0	12.2	3.9	85.8	94.0	62.8	1005.0	1010.7	1001.0	229.5	360.0	0.7	2.8	12.4	0.0
Sun Feb 13 00:00:05 2011	1.1	15.2	5.6	9.6	-0.6	89.3	97.0	66.1	1005.2	1010.9	992.1	181.4	360.0	0.5	3.9	18.3	0.0
Mon Feb 14 00:00:07 2011	0.7	0.8	6.4	9.8	2.8	87.7	95.8	67.1	992.5	995.2	991.2	256.0	360.0	0.6	1.7	11.4	0.0
Tue Feb 15 00:00:05 2011	0.9	1.0	3.8	7.6	0.0	83.2	94.1	66.0	994.4	997.8	986.1	209.5	360.0	0.5	2.8	14.6	0.0

Wed Feb 16 00:00:05 2011	0.9	9.2	6.2	9.7	2.9	87.1	93.1	74.8	979.5	986.2	975.9	186.9	360.0	0.6	4.0	17.0	0.0
Thu Feb 17 00:00:05 2011	0.5	4.6	5.2	8.3	0.8	88.0	94.5	78.7	985.9	994.4	982.9	97.7	360.0	0.5	2.6	12.7	0.0
Fri Feb 18 00:00:05 2011	0.2	0.2	5.2	8.8	1.2	93.6	97.1	87.5	1000.9	1005.8	993.5	204.4	360.0	0.5	1.0	5.6	0.0
Sat Feb 19 00:00:06 2011	0.4	23.4	7.6	9.8	2.5	93.3	96.3	89.4	1001.2	1005.8	996.5	158.3	333.2	45.9	3.9	17.1	0.0
Sun Feb 20 00:00:05 2011	0.5	0.2	8.6	11.9	5.3	92.7	95.1	85.7	1005.2	1007.7	1000.2	189.6	360.0	0.7	2.0	8.8	0.0
Mon Feb 21 00:00:06 2011	0.7	0.8	9.4	10.4	8.5	90.2	93.0	86.8	1005.4	1007.2	1003.0	160.0	297.9	30.9	5.0	17.6	0.7
Tue Feb 22 00:00:06 2011	1.1	0.2	9.5	13.2	7.9	85.1	94.4	59.8	1006.9	1011.5	1004.2	180.8	360.0	0.7	1.7	5.1	0.0
Wed Feb 23 00:00:06 2011	0.4	7.0	9.4	11.4	7.7	93.3	94.8	86.9	1010.8	1011.7	1009.9	175.3	360.0	0.5	1.5	6.7	0.0
Thu Feb 24 00:00:04 2011	1.3	0.2	11.2	14.8	9.5	87.6	93.8	71.1	1011.4	1015.4	1009.8	244.0	337.5	121.6	3.1	11.1	0.2
Fri Feb 25 00:00:05 2011	0.8	0.2	10.7	11.9	9.1	88.3	93.3	81.1	1017.3	1019.2	1015.1	224.5	328.9	87.2	3.6	10.8	0.7
Sat Feb 26 00:00:05 2011	0.8	5.8	10.6	12.6	8.5	89.4	92.3	80.4	1016.7	1018.6	1014.1	225.3	345.3	62.9	3.0	12.8	0.0
Sun Feb 27 00:00:05 2011	1.3	0.0	7.3	9.9	3.8	80.0	91.0	61.4	1018.9	1024.2	1013.7	293.4	360.0	0.5	3.2	13.1	0.0
Mon Feb 28 00:00:05 2011	1.5	0.0	6.5	11.1	2.9	75.2	92.5	49.1	1026.1	1031.2	1023.0	285.7	360.0	0.5	2.5	10.9	0.0
Totals	26.5	114.4															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Tue Mar 01 00:00:08 2011	1.2	0.0	5.6	11.4	1.2	77.0	93.3	38.6	1033.2	1035.6	1030.9	237.4	360.0	0.5	1.2	4.9	0.0
Wed Mar 02 00:00:06 2011	0.7	0.0	4.4	9.5	0.0	81.2	95.8	56.4	1038.2	1039.4	1035.4	159.1	360.0	0.5	1.1	7.7	0.0
Thu Mar 03 00:00:06 2011	0.6	0.2	3.9	9.5	-0.2	81.9	93.3	55.7	1036.8	1038.1	1035.6	206.6	360.0	0.5	0.8	4.5	0.0
Fri Mar 04 00:00:06 2011	1.0	0.0	3.9	12.7	-1.1	85.7	96.5	44.8	1035.5	1037.1	1033.5	240.5	360.0	0.5	0.9	4.0	0.0
Sat Mar 05 00:00:07 2011	0.5	0.0	4.1	9.2	-0.6	88.1	96.6	69.9	1032.0	1033.6	1030.4	179.0	360.0	0.5	1.1	5.9	0.0
Sun Mar 06 00:00:06 2011	0.5	0.0	5.5	8.7	1.7	86.6	95.4	69.3	1030.1	1031.7	1028.9	195.6	360.0	0.5	1.2	4.7	0.0

Mon Mar 07 00:00:05 2011	0.9	0.0	6.5	9.4	5.4	76.6	89.5	54.9	1028.7	1029.3	1027.9	104.3	360.0	0.5	1.5	6.9	0.0
Tue Mar 08 00:00:05 2011	0.6	0.4	5.5	8.2	1.2	78.6	89.5	63.7	1027.2	1029.0	1024.4	114.6	360.0	1.0	1.3	5.7	0.0
Wed Mar 09 00:00:05 2011	1.1	0.4	5.6	11.2	0.1	83.8	94.2	61.5	1018.7	1024.4	1014.6	266.7	360.0	0.8	2.2	8.7	0.0
Thu Mar 10 00:00:05 2011	2.2	0.2	8.6	12.8	5.3	74.1	84.5	52.9	1016.0	1018.1	1012.8	278.0	353.6	167.7	4.3	12.4	0.9
Fri Mar 11 00:00:04 2011	2.2	1.0	9.1	12.4	4.8	70.4	89.1	51.9	1012.0	1014.5	1009.9	285.4	360.0	0.6	4.8	16.1	0.9
Sat Mar 12 00:00:05 2011	1.0	6.0	8.2	11.0	4.1	83.0	88.6	73.8	1008.5	1014.6	1001.5	223.6	360.0	0.5	3.7	15.7	0.0
Sun Mar 13 00:00:05 2011	0.9	1.2	6.0	9.2	1.5	84.0	91.4	72.7	996.8	1001.7	995.0	258.6	360.0	0.5	3.0	10.7	0.0
Mon Mar 14 00:00:06 2011	1.3	0.0	3.7	9.8	-1.5	78.1	94.4	47.4	1002.2	1008.6	997.3	238.0	360.0	0.5	1.8	9.9	0.0
Tue Mar 15 00:00:05 2011	1.0	0.0	5.4	9.5	2.6	74.5	87.9	50.3	1012.0	1014.3	1008.3	204.8	360.0	0.5	1.4	5.6	0.0
Wed Mar 16 00:00:05 2011	1.5	0.0	6.9	12.0	2.3	68.0	86.3	40.6	1014.4	1017.1	1012.7	214.6	360.0	0.5	1.6	7.2	0.0
Thu Mar 17 00:00:06 2011	1.5	0.8	5.0	12.1	-0.4	76.7	93.8	35.0	1014.6	1017.1	1012.1	245.8	360.0	0.5	1.5	6.6	0.0
Fri Mar 18 00:00:06 2011	1.3	0.0	6.9	10.7	3.0	70.1	91.8	42.0	1016.3	1020.5	1012.5	237.7	360.0	0.5	1.6	6.9	0.0
Sat Mar 19 00:00:06 2011	1.3	4.8	7.1	12.1	3.9	71.2	85.2	40.3	1023.4	1029.7	1019.3	224.7	360.0	0.5	1.2	7.8	0.0
Sun Mar 20 00:00:08 2011	1.1	0.0	5.9	9.6	0.7	88.0	94.7	61.5	1029.5	1031.4	1026.4	168.4	360.0	0.9	2.8	12.2	0.0
Mon Mar 21 00:00:05 2011	1.5	0.0	11.3	16.7	8.7	84.9	94.4	63.2	1027.4	1030.4	1024.9	251.6	360.0	0.5	2.4	8.0	0.0
Tue Mar 22 00:00:05 2011	0.8	0.2	10.9	14.1	8.6	86.4	92.5	78.7	1032.4	1035.3	1030.3	224.4	360.0	0.5	1.7	6.9	0.0
Wed Mar 23 00:00:05 2011	1.0	0.0	8.8	14.8	3.9	83.5	95.9	59.6	1037.4	1039.3	1035.1	209.9	360.0	0.5	1.1	4.0	0.0
Thu Mar 24 00:00:07 2011	1.2	0.0	8.4	15.2	3.2	82.6	95.2	58.5	1037.8	1039.3	1036.4	162.3	360.0	0.5	1.4	6.3	0.0
Fri Mar 25 00:00:05 2011	1.4	0.0	8.5	15.1	2.2	81.6	95.8	57.0	1031.4	1036.4	1025.4	187.8	360.0	0.5	1.8	9.3	0.0
Sat Mar 26 00:00:05 2011	1.5	0.0	8.9	13.8	4.5	79.4	91.0	60.7	1019.9	1026.0	1016.6	100.0	360.0	0.8	2.3	9.5	0.0
Sun Mar 27 00:00:06 2011	1.2	0.0	8.0	14.1	2.8	79.8	93.5	53.6	1014.1	1016.7	1012.3	156.2	360.0	0.5	1.3	6.6	0.0
Mon Mar 28 00:00:06 2011	0.8	0.2	7.9	11.8	2.8	81.4	92.4	65.1	1013.7	1015.3	1012.4	144.5	360.0	0.5	1.2	5.6	0.0
Tue Mar 29 23:00:04 2011	0.0	1.4	9.8	11.7	8.5	90.7	93.9	77.3	1008.4	1010.9	1007.1	157.2	193.0	104.0	1.8	6.4	0.5
Wed Mar 30 00:00:05	0.8	5.0	9.7	12.4	8.5	90.7	94.0	74.4	1008.4	1011.1	1006.9	161.2	326.7	49.8	1.8	6.4	0.0

2011																	
Thu Mar 31 00:00:05 2011	2.3	0.8	11.3	16.1	7.6	83.5	94.1	53.7	1004.2	1006.4	999.8	223.1	351.6	79.6	3.7	11.4	0.4
Totals	35.2	22.6															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Fri Apr 01 00:00:06 2011	2.3	1.2	12.9	16.2	10.9	81.9	93.3	61.9	1005.1	1009.4	998.1	241.7	345.6	102.6	5.6	16.7	0.9
Sat Apr 02 00:00:06 2011	0.9	1.4	11.1	11.9	10.6	91.1	94.4	84.4	1004.7	1008.7	999.2	188.5	306.9	55.6	5.9	16.5	1.2
Sun Apr 03 00:00:06 2011	2.0	0.2	10.2	14.7	5.8	81.8	92.8	55.0	1004.9	1008.8	999.2	235.9	360.0	0.8	3.6	14.4	0.0
Mon Apr 04 00:00:04 2011	2.1	1.2	8.8	12.9	5.3	73.9	93.1	35.5	1011.8	1015.7	1008.3	273.3	360.0	0.5	2.3	10.7	0.0
Tue Apr 05 00:00:04 2011	1.1	1.4	10.2	12.2	5.3	87.6	92.9	78.7	1012.9	1015.4	1009.7	218.3	331.1	84.3	5.5	17.2	0.7
Wed Apr 06 00:00:05 2011	0.8	0.0	12.2	13.9	10.8	91.5	93.6	86.5	1013.3	1018.4	1009.4	229.4	321.2	102.7	4.7	13.4	0.1
Thu Apr 07 00:00:05 2011	1.3	0.2	11.0	14.8	7.3	86.8	94.5	69.4	1020.4	1024.4	1018.2	225.3	343.0	86.9	2.8	8.1	0.0
Fri Apr 08 23:00:05 2011	0.0	0.2	13.2	17.2	9.3	86.8	94.5	74.0	1026.4	1029.4	1023.4	95.3	360.0	11.0	1.2	5.9	0.0
Sat Apr 09 00:00:04 2011	1.2	0.2	12.8	17.8	9.1	87.6	94.8	71.1	1026.2	1029.4	1023.1	130.4	360.0	0.5	1.6	5.9	0.0
Sun Apr 10 00:00:05 2011	1.7	0.0	11.5	14.7	8.3	83.0	93.1	61.6	1020.4	1023.4	1018.5	100.0	351.3	10.8	3.0	8.6	0.0
Mon Apr 11 00:00:05 2011	1.9	0.4	12.4	18.3	6.5	81.2	93.7	51.2	1022.8	1024.4	1020.6	189.1	360.0	0.5	1.6	6.2	0.0
Tue Apr 12 00:00:05 2011	2.7	0.4	10.9	13.6	5.5	70.5	91.7	40.9	1026.3	1032.4	1021.7	290.8	360.0	0.5	4.1	14.3	0.4
Wed Apr 13 00:00:05 2011	2.0	7.4	8.1	14.2	2.8	71.7	87.0	49.9	1031.0	1032.8	1025.7	255.8	360.0	0.6	2.4	10.5	0.0
Thu Apr 14 00:00:04 2011	1.3	0.0	10.5	15.1	7.1	86.2	93.1	76.9	1015.3	1025.8	1009.7	217.7	360.0	0.6	4.4	14.5	0.7
Fri Apr 15 00:00:08 2011	1.1	0.0	11.7	14.3	9.6	80.1	88.8	68.9	1014.9	1017.0	1013.2	295.6	360.0	0.5	1.7	7.1	0.0
Sat Apr 16 00:00:06 2011	1.6	0.2	11.6	15.5	8.3	75.8	90.0	57.2	1018.3	1020.2	1016.9	263.2	360.0	0.5	1.8	7.4	0.0
Sun Apr 17 00:00:06 2011	1.6	0.0	11.1	16.7	7.0	77.3	93.4	47.8	1021.9	1023.6	1020.0	224.0	360.0	0.5	1.3	5.7	0.0
Mon Apr 18 00:00:06 2011	1.4	0.0	10.0	15.0	6.4	83.0	93.1	63.6	1023.0	1024.2	1021.2	147.5	360.0	0.6	1.8	8.0	0.0
Tue Apr 19 00:00:06 2011	2.3	0.0	11.0	16.2	6.4	80.6	94.2	44.3	1015.2	1021.8	1009.9	102.7	360.0	0.7	2.3	10.3	0.0
Wed Apr 20 00:00:06 2011	2.4	0.0	11.8	18.3	5.7	71.8	91.6	42.4	1012.0	1015.2	1009.1	118.6	360.0	1.1	1.9	8.9	0.0

Thu Apr 21 00:00:06 2011	2.1	0.0	13.4	19.4	8.0	70.4	87.3	47.8	1013.8	1015.3	1012.5	160.9	360.0	0.5	1.3	5.7	0.0
Fri Apr 22 00:00:05 2011	2.5	1.4	14.0	19.2	10.0	74.4	90.5	52.3	1010.2	1013.6	1006.4	153.7	348.1	3.4	2.3	9.4	0.0
Sat Apr 23 00:00:05 2011	1.1	0.0	12.3	15.3	10.5	88.4	93.2	79.1	1004.1	1008.6	1002.1	153.1	360.0	0.6	3.0	8.8	0.0
Sun Apr 24 00:00:05 2011	2.8	0.2	11.9	17.1	7.2	64.5	86.3	36.0	1014.5	1018.6	1008.5	275.8	360.0	0.5	2.3	8.2	0.0
Mon Apr 25 00:00:05 2011	1.4	0.0	11.1	18.9	4.6	81.0	91.4	64.7	1020.7	1024.1	1018.3	252.8	360.0	0.5	1.4	6.6	0.0
Tue Apr 26 00:00:05 2011	1.9	0.2	11.8	17.2	8.4	73.4	82.2	54.8	1026.4	1028.5	1024.1	199.0	360.0	0.5	1.8	8.2	0.0
Wed Apr 27 00:00:05 2011	1.6	0.2	12.0	16.6	8.4	73.9	87.3	50.0	1026.6	1028.1	1025.0	132.7	360.0	0.5	1.2	5.9	0.0
Thu Apr 28 00:00:06 2011	1.5	0.0	12.5	18.3	8.9	79.4	92.4	57.3	1025.5	1026.6	1024.4	124.1	360.0	0.5	1.2	6.5	0.0
Fri Apr 29 00:00:05 2011	1.8	0.0	12.2	17.0	6.9	74.8	89.3	54.4	1021.3	1024.7	1018.3	116.0	349.6	1.2	1.6	7.2	0.0
Sat Apr 30 00:00:06 2011	2.0	0.0	11.5	18.3	4.4	76.6	93.0	50.8	1013.8	1018.2	1011.1	148.1	360.0	0.5	1.5	9.1	0.0
Totals	50.4	16.4															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Sun May 01 00:00:06 2011	2.9	3.8	14.0	19.0	8.7	72.5	91.7	50.2	1008.4	1011.5	1006.4	144.7	360.0	0.5	3.1	12.0	0.0
Mon May 02 00:00:06 2011	1.9	33.4	12.3	14.6	9.3	74.7	88.4	61.0	1006.5	1007.2	1005.9	81.7	360.0	0.7	3.6	13.6	0.1
Tue May 03 00:00:06 2011	1.4	0.2	9.7	12.7	8.7	88.6	94.1	65.0	1007.9	1009.7	1006.5	86.3	360.0	1.0	4.0	11.8	0.4
Wed May 04 00:00:05 2011	1.3	20.6	10.4	11.3	9.3	79.2	93.4	72.1	1012.2	1013.9	1009.5	122.8	360.0	3.0	4.5	12.2	0.0
Thu May 05 23:00:04 2011	0.0	9.0	12.9	15.7	11.8	90.3	93.4	79.7	1008.6	1010.7	1005.5	155.7	179.0	142.0	5.4	15.7	0.0
Fri May 06 00:00:05 2011	1.5	3.6	12.9	16.4	10.5	90.3	94.6	78.1	1008.4	1010.9	1004.9	155.1	325.8	1.1	5.4	15.7	1.1
Sat May 07 00:00:05 2011	1.1	1.2	12.9	14.7	11.8	89.6	94.1	82.3	1006.0	1006.5	1004.1	162.6	304.4	1.0	4.6	15.1	0.9
Sun May 08 00:00:05 2011	1.3	0.8	12.9	15.5	11.6	91.1	94.6	81.4	1001.2	1004.4	997.2	148.3	339.4	26.6	5.1	18.2	0.3
Mon May 09 00:00:05 2011	2.1	1.2	12.9	16.1	10.1	81.3	91.3	70.3	1000.7	1004.0	997.1	159.6	347.8	25.6	6.4	19.1	0.8
Tue May 10 00:00:05 2011	2.3	0.0	13.3	16.3	11.9	82.0	87.2	70.0	1008.8	1012.0	1003.4	176.9	356.4	54.5	5.8	17.2	1.3

Wed May 11 00:00:06 2011	2.6	0.0	13.1	16.7	10.8	77.2	89.8	56.3	1017.3	1021.8	1011.4	234.8	356.6	90.9	4.3	14.6	0.8
Thu May 12 00:00:06 2011	2.8	0.2	11.9	15.7	9.3	73.3	88.9	44.9	1021.0	1021.7	1020.0	266.4	353.8	161.4	3.5	11.8	0.1
Fri May 13 00:00:06 2011	2.7	0.2	11.4	15.8	7.5	69.0	86.4	44.4	1021.2	1022.1	1019.9	292.3	360.0	0.8	3.3	11.2	0.5
Sat May 14 00:00:05 2011	2.6	0.0	10.9	14.9	7.6	72.9	86.9	42.3	1018.9	1021.7	1017.6	285.6	360.0	0.5	3.0	10.6	0.0
Sun May 15 00:00:06 2011	2.5	0.0	11.2	14.9	8.3	72.5	88.1	51.2	1024.1	1028.5	1019.9	308.4	360.0	0.5	3.7	12.9	0.8
Mon May 16 00:00:05 2011	2.7	0.0	12.3	17.6	8.4	73.9	83.2	51.7	1027.7	1028.7	1026.6	293.0	360.0	0.5	3.1	11.7	0.3
Tue May 17 00:00:05 2011	2.5	0.0	13.2	17.2	9.7	73.1	86.3	56.9	1024.6	1027.3	1021.9	279.6	358.0	0.8	3.3	10.2	0.3
Wed May 18 00:00:05 2011	2.0	0.0	14.6	18.8	11.9	80.4	88.7	67.5	1018.6	1022.0	1015.3	264.6	353.2	0.6	2.9	7.7	0.4
Thu May 19 00:00:08 2011	2.7	0.4	12.6	16.5	9.1	69.3	90.5	46.5	1014.5	1018.1	1012.3	295.1	360.0	0.6	3.5	10.4	0.7
Fri May 20 00:00:05 2011	1.7	4.4	9.8	14.5	4.9	76.0	90.9	53.5	1018.0	1019.1	1016.2	256.7	360.0	0.6	2.1	8.5	0.0
Sat May 21 00:00:05 2011	2.9	0.2	12.0	16.2	9.1	71.8	90.2	44.2	1016.0	1017.8	1013.8	257.0	358.8	1.3	3.7	11.3	0.5
Sun May 22 00:00:05 2011	1.3	1.0	11.5	14.1	7.3	85.6	91.6	74.3	1010.9	1017.6	1005.7	210.2	336.8	62.4	3.9	14.5	0.0
Mon May 23 00:00:06 2011	3.6	0.0	11.9	16.6	8.8	69.9	84.6	42.8	1012.2	1017.7	1005.0	266.5	360.0	0.6	5.0	14.4	0.9
Tue May 24 00:00:06 2011	3.4	0.4	11.9	15.1	6.9	70.3	91.0	41.0	1013.9	1020.9	1007.7	261.7	356.2	4.3	6.1	17.9	0.7
Wed May 25 00:00:05 2011	3.0	0.2	11.4	17.2	6.5	67.8	85.3	42.9	1024.9	1027.0	1020.4	264.4	359.5	0.6	3.1	9.5	0.2
Thu May 26 00:00:06 2011	1.6	0.0	11.4	14.2	8.9	82.5	91.0	70.4	1013.2	1025.1	1005.6	206.2	349.8	4.7	4.5	15.1	0.0
Fri May 27 00:00:06 2011	2.5	0.0	11.2	14.2	8.3	73.7	90.9	56.6	1013.5	1022.0	1005.8	307.8	360.0	0.5	6.3	19.7	0.7
Sat May 28 00:00:05 2011	2.1	0.0	11.1	15.6	6.5	75.4	87.3	59.2	1020.4	1022.7	1015.4	289.1	360.0	0.5	3.2	9.7	0.4
Sun May 29 00:00:05 2011	3.2	0.8	13.6	17.6	11.3	73.8	88.4	48.0	1011.6	1015.4	1008.7	271.3	359.8	1.8	4.0	10.1	0.5
Mon May 30 00:00:05 2011	2.6	0.0	13.7	16.9	10.9	73.3	90.1	49.5	1008.3	1010.3	1006.1	280.4	360.0	0.8	3.3	11.5	0.0
Totals	66.7	81.6															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Wed Jun 01 00:00:05 2011	2.8	0.0	11.2	17.2	4.8	71.1	87.8	43.0	1021.1	1025.7	1015.2	274.5	360.0	0.7	2.7	10.4	0.3
Thu Jun 02 00:00:05 2011	1.9	0.0	14.1	18.0	11.1	81.0	87.0	67.9	1028.0	1031.8	1025.6	235.3	340.3	88.3	2.9	8.7	0.3
Fri Jun 03 00:00:07 2011	1.6	0.0	15.1	21.0	10.2	80.6	92.9	64.1	1033.7	1034.8	1031.6	196.7	360.0	0.5	1.3	5.2	0.0
Sat Jun 04 00:00:06 2011	2.6	0.0	16.9	24.0	8.6	74.2	94.1	48.9	1031.6	1034.2	1028.7	154.8	360.0	0.5	1.3	6.2	0.0
Sun Jun 05 00:00:05 2011	2.9	0.0	17.4	22.5	12.6	72.1	87.6	54.7	1025.2	1029.0	1020.1	239.3	360.0	0.5	2.0	8.4	0.0
Mon Jun 06 00:00:06 2011	2.9	0.0	12.8	16.7	9.4	72.4	86.3	45.1	1014.8	1019.9	1011.6	297.9	360.0	0.5	3.4	12.0	0.1
Tue Jun 07 00:00:06 2011	1.6	0.0	10.3	14.2	5.1	80.1	90.7	57.9	1006.9	1012.3	1001.9	260.2	360.0	0.6	2.3	8.3	0.0
Wed Jun 08 00:00:06 2011	2.1	1.8	11.1	14.8	7.8	77.8	89.0	59.5	999.5	1002.2	997.8	287.0	359.8	0.9	3.7	12.2	0.6
Thu Jun 09 00:00:05 2011	2.7	0.2	11.6	15.6	9.3	73.6	89.0	55.6	1004.9	1011.2	1000.0	305.9	360.0	0.6	5.0	14.2	0.9
Fri Jun 10 00:00:05 2011	2.1	0.0	9.8	14.4	6.7	72.1	86.6	43.6	1012.7	1013.7	1010.6	281.1	360.0	0.5	2.1	7.1	0.0
Sat Jun 11 00:00:05 2011	2.0	1.0	9.9	16.6	4.8	71.4	93.1	41.9	1013.5	1016.5	1011.8	242.7	360.0	0.5	1.5	7.1	0.0
Sun Jun 12 00:00:05 2011	2.3	0.0	10.6	17.0	4.4	69.8	91.0	46.3	1015.7	1017.2	1012.2	221.4	360.0	0.6	2.1	8.8	0.1
Mon Jun 13 00:00:05 2011	1.7	22.8	13.3	19.5	7.8	88.8	95.0	74.1	1002.0	1013.2	997.2	142.6	360.0	0.7	3.7	14.5	0.3
Tue Jun 14 00:00:07 2011	2.8	0.2	14.1	18.4	9.1	68.9	92.8	44.1	1009.7	1016.8	1001.1	298.5	360.0	0.5	2.6	7.7	0.0
Wed Jun 15 00:00:06 2011	2.5	4.4	12.3	17.3	6.0	81.5	93.6	49.7	1014.4	1017.2	1008.5	142.5	360.0	1.0	2.8	13.2	0.0
Thu Jun 16 00:00:05 2011	2.9	0.2	14.7	18.5	10.1	74.4	93.5	48.4	1009.1	1010.1	1008.1	239.8	352.5	3.3	3.2	13.2	0.3
Fri Jun 17 23:00:04 2011	0.0	28.4	13.0	16.1	10.5	79.1	93.3	55.0	997.9	1004.7	996.1	255.9	331.0	161.0	3.5	14.9	0.0
Sat Jun 18 00:00:05 2011	2.8	24.6	13.0	17.9	10.3	79.0	93.7	49.5	997.9	1005.0	996.0	255.5	360.0	0.5	3.5	14.7	0.0
Sun Jun 19 00:00:05 2011	2.4	1.2	12.6	16.0	9.9	76.9	89.6	56.9	1001.8	1009.6	997.0	290.8	360.0	0.7	3.9	13.1	0.2
Mon Jun 20 00:00:05 2011	2.4	0.0	12.7	18.8	7.4	74.8	89.9	50.4	1010.9	1011.9	1009.2	227.1	360.0	0.6	2.0	7.9	0.0
Tue Jun 21 00:00:05 2011	0.9	11.4	12.1	15.5	7.6	91.2	93.9	79.4	1006.9	1011.6	1003.0	137.7	358.1	4.3	2.2	11.0	0.0
Wed Jun 22 00:00:06 2011	2.0	1.2	13.9	17.4	11.8	86.4	92.5	63.5	1003.1	1004.4	1001.8	225.2	345.0	62.7	3.0	10.7	0.0
Thu Jun 23 00:00:06 2011	2.6	0.0	13.3	18.3	9.4	77.6	92.8	55.9	1007.5	1013.8	1003.1	291.7	360.0	0.6	3.2	11.6	0.0

Fri Jun 24 00:00:06 2011	3.0	0.0	13.0	17.5	10.0	69.6	86.8	45.6	1017.5	1021.1	1014.1	305.9	360.0	0.5	3.2	9.7	0.7
Sat Jun 25 00:00:07 2011	1.0	16.2	11.9	15.2	8.1	89.1	94.2	76.4	1017.3	1021.8	1011.5	188.7	360.0	0.8	2.9	12.5	0.0
Sun Jun 26 00:00:06 2011	1.3	0.0	15.6	18.7	13.5	88.9	92.9	80.4	1016.5	1019.6	1012.5	246.7	360.0	0.7	3.0	9.4	0.0
Mon Jun 27 00:00:04 2011	2.4	0.0	16.4	20.8	12.7	81.7	94.6	63.1	1015.9	1019.6	1013.2	170.3	360.0	0.5	2.3	9.4	0.0
Tue Jun 28 00:00:05 2011	2.5	0.0	14.1	17.0	10.1	70.9	86.3	51.2	1014.7	1018.1	1013.0	295.3	360.0	0.5	2.7	8.6	0.1
Wed Jun 29 00:00:05 2011	2.7	1.0	12.5	20.0	7.4	72.5	88.3	46.7	1019.6	1021.9	1018.1	281.7	360.0	0.5	1.9	8.6	0.0
Thu Jun 30 00:00:05 2011	2.6	0.0	12.7	18.5	8.2	71.4	89.3	46.7	1023.4	1026.5	1021.6	294.0	360.0	0.5	2.3	9.9	0.0
Totals	65.8	114.6															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Fri Jul 01 00:00:05 2011	2.2	0.0	13.0	18.4	7.9	71.8	92.0	48.8	1027.5	1028.3	1026.5	298.8	360.0	0.5	1.9	7.6	0.0
Sat Jul 02 00:00:05 2011	2.4	0.0	14.1	19.9	9.5	72.0	88.5	45.4	1026.5	1028.4	1023.6	234.6	360.0	0.5	1.5	6.8	0.0
Sun Jul 03 00:00:06 2011	2.2	0.0	13.6	20.6	7.1	76.0	92.9	47.4	1019.4	1023.6	1017.1	156.1	360.0	0.7	1.3	6.8	0.0
Mon Jul 04 00:00:06 2011	2.4	0.0	15.0	21.2	9.1	74.1	92.7	48.4	1016.5	1017.3	1015.3	162.4	360.0	0.6	1.3	7.0	0.0
Tue Jul 05 00:00:06 2011	3.0	8.2	15.7	21.7	11.3	78.8	92.6	53.9	1012.0	1015.6	1006.0	138.0	359.7	0.8	2.6	11.0	0.0
Wed Jul 06 00:00:07 2011	2.3	5.6	15.1	19.3	10.4	81.0	94.2	63.2	1004.1	1006.9	1003.2	220.4	336.7	23.9	3.3	12.5	0.4
Thu Jul 07 00:00:06 2011	1.8	12.2	12.5	17.1	8.3	85.8	93.2	61.4	996.5	1003.5	990.0	220.9	360.0	0.5	2.5	11.4	0.0
Fri Jul 08 00:00:05 2011	1.9	3.4	13.1	16.9	9.8	81.8	91.5	64.7	995.4	996.8	992.9	250.0	360.0	0.9	3.3	11.8	0.4
Sat Jul 09 00:00:05 2011	2.6	0.6	14.8	19.1	12.2	77.9	91.3	58.9	997.3	1004.0	992.7	291.4	360.0	0.7	3.5	10.1	0.5
Sun Jul 10 00:00:05 2011	2.2	0.2	15.3	20.1	10.7	77.1	92.1	54.1	1010.0	1015.4	1003.9	270.5	360.0	0.5	2.1	6.8	0.0
Mon Jul 11 00:00:05 2011	2.1	0.0	15.0	19.3	11.1	74.1	90.3	50.3	1017.5	1020.2	1015.4	307.1	360.0	0.5	1.7	5.7	0.0
Tue Jul 12 00:00:05 2011	1.8	0.0	15.7	20.9	12.1	75.6	88.0	55.1	1020.3	1020.9	1019.7	211.4	360.0	0.5	1.2	4.6	0.0
Wed Jul 13 00:00:05 2011	3.0	0.0	16.1	25.5	10.0	73.8	94.0	32.2	1019.8	1020.9	1018.9	159.7	360.0	0.5	1.0	6.3	0.0
Thu Jul 14 00:00:05 2011	2.9	0.0	16.8	23.3	11.7	76.1	92.9	46.6	1020.6	1021.5	1020.1	132.5	360.0	0.8	1.6	7.0	0.0
Fri Jul 15 00:00:06 2011	2.2	0.0	16.3	22.0	12.3	79.5	93.8	54.0	1020.0	1021.9	1018.1	192.5	360.0	0.5	1.4	7.4	0.0
Sat Jul 16 00:00:06 2011	1.5	0.6	14.9	17.6	12.5	85.8	91.7	65.4	1013.0	1018.2	1005.8	238.4	360.0	0.6	1.8	7.6	0.0

Sun Jul 17 00:00:07 2011	2.6	0.8	14.7	17.7	12.7	78.8	91.4	60.7	999.2	1005.8	996.3	289.1	360.0	0.5	4.4	16.0	0.6
Mon Jul 18 00:00:06 2011	1.9	0.0	13.5	15.5	12.1	80.9	89.4	71.6	998.6	1001.3	995.1	308.0	360.0	0.5	5.8	16.2	1.6
Tue Jul 19 00:00:05 2011	2.4	1.0	13.1	16.8	11.5	79.2	87.0	64.5	1000.4	1003.6	999.1	308.0	360.0	0.5	5.0	14.3	0.9
Wed Jul 20 00:00:06 2011	2.5	0.0	14.1	17.3	12.6	74.6	86.3	60.2	1007.6	1010.0	1003.1	308.1	360.0	0.5	3.9	13.1	0.0
Thu Jul 21 00:00:05 2011	2.0	0.4	14.0	19.2	11.0	75.3	91.1	45.3	1009.5	1014.2	1006.5	169.3	360.0	0.5	1.3	8.0	0.0
Fri Jul 22 00:00:05 2011	2.2	0.0	14.2	18.3	9.1	69.3	88.6	51.7	1016.2	1019.0	1014.0	260.6	360.0	0.5	2.1	8.7	0.0
Sat Jul 23 00:00:05 2011	2.7	0.0	14.7	20.2	10.1	64.7	86.1	42.4	1019.4	1020.4	1018.2	277.2	360.0	0.5	1.7	6.3	0.0
Sun Jul 24 00:00:05 2011	2.5	0.0	15.4	21.7	11.4	74.7	91.4	47.0	1016.3	1018.8	1014.3	265.2	360.0	0.5	1.6	5.7	0.0
Mon Jul 25 00:00:05 2011	2.6	0.0	18.6	26.8	13.9	81.6	91.6	52.7	1012.1	1014.9	1009.3	231.0	360.0	0.5	1.3	5.2	0.0
Tue Jul 26 00:00:05 2011	2.2	0.0	17.8	21.8	14.9	80.9	89.8	66.5	1011.2	1014.4	1009.4	304.0	360.0	0.5	2.5	8.8	0.0
Wed Jul 27 00:00:05 2011	3.5	0.0	16.9	23.5	12.9	70.3	88.2	43.1	1016.6	1019.6	1014.1	270.2	360.0	0.5	2.2	8.5	0.0
Thu Jul 28 00:00:07 2011	1.0	6.4	15.3	20.5	11.4	86.9	93.1	65.2	1020.6	1022.2	1019.1	176.9	360.0	0.9	0.7	3.7	0.0
Fri Jul 29 00:00:06 2011	2.3	0.2	16.5	19.3	14.4	76.3	93.1	53.9	1024.5	1026.0	1022.4	226.1	360.0	0.5	2.3	8.1	0.0
Sat Jul 30 00:00:05 2011	1.8	0.0	15.5	20.1	12.7	70.1	85.9	55.7	1023.9	1026.0	1021.6	182.2	360.0	0.5	1.3	5.4	0.0
Sun Jul 31 00:00:06 2011	2.5	0.0	15.4	21.1	11.5	79.3	91.2	53.1	1018.3	1021.7	1013.5	147.9	360.0	0.5	2.0	9.8	0.0
Totals	71.2	39.6															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Mon Aug 01 00:00:06 2011	1.6	2.2	16.7	19.3	14.9	84.9	94.1	68.7	1010.4	1014.1	1009.3	217.0	360.0	0.8	2.1	11.8	0.0
Tue Aug 02 00:00:05 2011	0.6	8.6	15.1	18.3	12.6	89.7	92.5	78.8	1009.9	1010.8	1009.2	184.3	360.0	0.5	0.8	5.0	0.0
Wed Aug 03 00:00:05 2011	2.3	0.0	14.5	18.7	11.2	71.5	87.1	44.6	1012.9	1014.7	1010.4	267.2	360.0	0.5	1.6	5.9	0.0
Thu Aug 04 00:00:05 2011	1.4	6.2	14.6	19.0	11.5	88.0	93.8	75.4	1011.0	1014.4	1007.8	165.0	348.0	10.1	2.7	12.8	0.0
Fri Aug 05 00:00:05 2011	2.3	0.4	16.3	20.6	12.7	83.4	93.0	63.9	1008.0	1013.1	1005.7	281.3	360.0	0.6	3.1	11.2	0.1
Sat Aug 06 00:00:05 2011	2.0	0.0	13.8	18.9	9.5	76.3	91.8	50.1	1012.2	1013.6	1008.9	263.9	360.0	0.6	1.6	7.2	0.0
Sun Aug 07 00:00:05 2011	1.7	1.2	13.7	20.0	11.1	82.4	92.3	64.3	1003.1	1008.9	1000.2	201.5	360.0	1.1	1.8	10.3	0.0
Mon Aug 08 00:00:07 2011	1.4	15.0	13.1	18.8	9.5	85.3	92.3	67.0	999.4	1002.5	997.5	255.3	360.0	0.5	1.5	6.8	0.0

Tue Aug 09 00:00:06 2011	3.0	0.0	14.9	19.8	11.6	75.2	89.1	54.0	1012.2	1020.9	1003.6	304.8	360.0	0.5	3.8	12.4	0.8
Wed Aug 10 00:00:05 2011	2.8	0.0	14.2	20.4	9.0	70.4	91.1	43.3	1025.1	1027.1	1020.3	285.8	360.0	0.5	2.1	7.3	0.0
Thu Aug 11 00:00:06 2011	1.9	5.2	15.9	19.2	13.9	85.0	92.5	69.9	1018.3	1025.6	1010.5	249.5	343.1	55.9	3.6	12.4	0.2
Fri Aug 12 00:00:06 2011	2.0	1.2	17.7	21.4	15.6	83.4	93.0	67.4	1008.8	1011.4	1007.9	278.1	360.0	0.6	2.6	8.3	0.2
Sat Aug 13 00:00:06 2011	1.3	1.4	16.1	20.2	14.4	89.3	93.3	74.7	1006.8	1009.7	1003.0	237.0	357.4	13.0	2.1	7.8	0.0
Sun Aug 14 00:00:05 2011	2.5	0.0	15.9	20.1	14.1	78.1	90.2	58.5	1003.0	1004.6	1001.9	265.4	360.0	6.6	2.7	7.2	0.3
Mon Aug 15 00:00:05 2011	3.4	0.0	15.2	20.1	11.1	70.3	87.8	41.9	1007.4	1012.0	1004.5	296.3	360.0	0.5	2.8	9.0	0.3
Tue Aug 16 00:00:05 2011	0.6	6.2	13.2	15.8	9.7	90.2	93.5	83.2	1012.5	1014.2	1009.0	181.1	360.0	0.6	2.0	11.3	0.0
Wed Aug 17 00:00:05 2011	3.0	0.0	16.0	20.3	12.1	73.3	93.1	46.3	1013.1	1017.3	1008.5	281.7	360.0	0.5	2.9	10.1	0.0
Thu Aug 18 00:00:05 2011	2.8	0.0	14.7	22.2	10.0	71.3	90.2	34.8	1016.9	1017.7	1016.3	156.6	360.0	0.5	1.3	6.6	0.0
Fri Aug 19 00:00:07 2011	1.8	0.0	13.8	21.1	9.3	79.0	93.9	48.1	1016.4	1017.4	1015.5	238.0	360.0	0.5	1.2	4.6	0.0
Sat Aug 20 00:00:06 2011	3.1	0.4	13.1	17.3	8.6	85.7	93.5	4.0	1014.9	1017.5	1012.6	239.4	360.0	0.7	2.3	11.4	0.0
Sun Aug 21 00:00:05 2011	1.5	0.0	13.8	20.2	9.3	87.1	94.5	68.0	1012.3	1015.3	1009.4	181.6	360.0	1.2	1.7	8.7	0.0
Mon Aug 22 00:00:06 2011	2.0	0.0	15.6	20.4	12.1	78.4	93.1	52.4	1012.8	1018.5	1009.1	282.8	360.0	0.5	1.7	6.9	0.0
Tue Aug 23 00:00:06 2011	2.3	0.0	14.3	21.4	8.4	72.7	94.3	37.3	1018.6	1020.0	1016.5	230.2	360.0	0.5	1.2	7.0	0.0
Wed Aug 24 00:00:06 2011	2.2	0.2	13.9	19.6	8.8	76.8	91.2	41.4	1013.0	1016.9	1009.9	219.8	360.0	0.5	1.5	8.1	0.0
Thu Aug 25 00:00:06 2011	2.2	9.8	13.5	17.9	8.2	77.4	91.4	51.7	1008.1	1009.6	1004.6	241.7	360.0	0.5	2.2	9.4	0.0
Fri Aug 26 00:00:05 2011	2.2	7.0	13.8	18.8	10.5	79.8	91.2	60.2	1001.3	1004.7	1000.0	172.5	353.1	7.9	2.8	11.0	0.0
Sat Aug 27 00:00:05 2011	2.5	1.0	13.4	18.8	8.2	76.4	92.7	50.1	1006.7	1012.6	1002.7	255.0	360.0	0.5	2.5	11.5	0.0
Sun Aug 28 00:00:05 2011	2.4	0.0	13.2	16.9	10.0	75.0	87.2	56.7	1015.3	1017.9	1012.6	301.6	360.0	0.5	3.6	10.8	0.0
Mon Aug 29 00:00:05 2011	2.5	0.0	13.1	18.8	8.4	74.9	92.8	50.0	1018.0	1020.1	1017.0	302.9	360.0	0.5	2.7	9.0	0.0
Tue Aug 30 00:00:07 2011	2.5	0.0	12.1	19.2	6.2	71.2	93.2	39.1	1020.6	1021.5	1019.7	275.9	360.0	0.5	1.8	7.8	0.0
Wed Aug 31 00:00:05 2011	1.5	0.0	13.3	16.7	11.1	74.9	86.9	55.2	1017.5	1020.3	1015.3	150.2	360.0	0.5	1.3	5.8	0.0
Totals	65.0	66.0															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Thu Sep 01 00:00:05 2011	2.4	0.0	14.1	18.8	11.2	72.6	88.9	49.8	1013.9	1015.1	1012.8	97.4	360.0	1.7	2.1	9.7	0.0
Fri Sep 02 00:00:06 2011	2.1	0.0	14.7	21.2	10.7	85.0	92.5	62.3	1010.2	1013.0	1007.5	127.8	354.1	1.0	2.5	7.7	0.2
Sat Sep 03 00:00:06 2011	1.7	0.2	15.8	18.6	13.4	84.0	92.5	65.4	1007.2	1008.5	1004.4	227.6	349.0	39.3	2.4	9.6	0.2
Sun Sep 04 00:00:06 2011	2.2	8.6	15.2	18.7	10.6	79.9	93.5	52.3	1003.3	1005.4	1001.1	264.6	360.0	0.6	2.6	10.4	0.4
Mon Sep 05 00:00:06 2011	2.6	6.4	12.3	17.3	8.6	81.9	93.9	48.5	1001.3	1005.1	999.5	210.0	360.0	0.5	3.5	13.8	0.0
Tue Sep 06 00:00:06 2011	1.8	1.4	13.8	16.5	10.0	82.8	91.5	67.6	1006.8	1009.6	1002.6	264.4	356.2	2.6	3.9	13.4	0.3
Wed Sep 07 00:00:05 2011	2.3	5.0	14.2	16.2	11.7	78.1	92.8	61.4	1002.6	1009.2	998.8	271.1	357.9	1.6	5.2	14.9	1.0
Thu Sept 08 00:00:05 2011	*	0.0	16.1	21.1	13.8	76.7	90.2	46.0	1002.7	1005.0	1001.8	229.1	268.0	197.0	3.1	5.8	1.2
Fri Sep 09 00:00:05 2011	3.0	0.0	16.1	22.9	13.2	81.6	93.3	47.2	1005.4	1007.9	1004.4	239.9	358.1	6.4	2.4	8.0	0.0
Sat Sep 10 00:00:06 2011	*	3.0	16.0	17.1	14.3	83.4	92.5	72.9	989.0	993.0	987.5	172.1	215.0	60.0	5.6	9.0	1.0
Sun Sep 11 00:00:06 2011	*	1.5	14.7	16.2	13.1	76.8	91.2	60.9	992.2	995.8	987.1	212.6	240.0	168.0	5.6	7.3	3.0
Mon Sep 12 00:00:06 2011	*	0.0	15.8	17.5	13.1	68.4	90.4	52.9	995.3	1004.9	986.0	242.2	269.0	217.0	6.8	10.9	3.8
Tue Sep 13 00:00:06 2011	*	0.0	13.1	15.6	10.7	67.4	84.4	15.4	1008.5	1012.4	1005.0	260.0	352.0	229.0	4.6	10.6	0.8
Wed Sept 14 00:00:05 2011	0.0	5.6	14.2	16.6	12.2	86.1	94.3	69.7	1011.4	1017.1	1006.5	170.5	264.0	143.0	3.9	4.8	0.0
Thu Sept 15 00:00:05 2011	2.0	5.6	14.3	17.5	11.9	86.1	94.5	66.0	1010.9	1017.0	1006.2	175.2	342.6	25.4	4.0	12.5	0.3
Fri Sep 16 00:00:05 2011	*	3.5	14.6	16.9	12.7	79.5	90.1	61.2	1004.6	1009.5	1002.3	198.1	258.0	84.0	4.3	8.3	0.8
Sat Sep 17 23:00:04 2011	*	0.2	12.3	14.7	9.7	75.4	85.4	60.6	1001.8	1003.1	1001.0	270.1	297.0	228.0	4.1	9.9	1.5
Sun Sep 18 23:00:05 2011	*	0.2	13.7	15.8	12.0	75.4	85.2	64.8	1006.4	1010.4	1003.0	277.9	323.0	27.0	5.4	9.7	1.9
Mon Sep 19 00:00:06 2011	*	0.5	14.7	18.0	12.2	84.5	90.0	72.7	1007.9	1009.0	1006.8	233.6	264.0	194.0	3.4	7.0	0.6
Tue Sep 20 00:00:06 2011	*	0.2	12.8	14.9	10.1	77.7	90.5	52.4	1011.2	1013.4	1008.2	237.0	294.0	21.0	2.4	4.6	1.1
Wed Sep 21 23:00:04 2011	0.0	1.0	14.0	15.7	12.6	80.4	90.3	70.9	1013.4	1015.9	1012.4	264.1	292.0	248.0	4.3	13.0	0.0
Thu Sep 22 23:00:04 2011	0.0	0.0	13.7	17.7	11.5	82.7	91.3	64.0	1017.6	1018.9	1016.1	244.2	296.0	29.0	2.3	8.4	0.0
Fri Sep 23 23:00:04 2011	2.0	1.4	14.3	16.0	13.0	87.1	92.7	80.5	1011.9	1017.0	1006.9	200.4	248.0	174.0	3.7	12.5	0.0
Sat Sep 24 23:00:04 2011	1.4	1.4	13.8	17.1	11.0	86.0	94.1	68.6	1007.9	1008.8	1006.7	206.0	270.0	112.0	2.2	8.6	0.0

Sun Sep 25 23:00:05 2011	1.6	16.8	14.3	16.1	12.4	87.5	93.5	76.8	1006.5	1010.0	1004.7	203.8	256.0	168.0	3.6	12.1	0.0
Mon Sep 26 23:00:04 2011	1.4	0.0	12.7	16.5	7.8	87.4	93.2	75.1	1016.3	1020.0	1010.8	169.8	268.0	73.0	2.1	7.9	0.0
Tue Sep 27 23:00:04 2011	1.3	1.0	14.8	15.8	13.7	94.4	95.1	92.8	1021.5	1023.3	1020.3	165.9	183.0	143.0	3.6	9.5	0.0
Wed Sep 28 23:00:04 2011	0.5	0.8	14.7	15.7	14.2	93.6	95.0	90.3	1017.3	1021.0	1014.4	153.3	164.0	147.0	4.2	13.9	0.0
Thu Sep 29 23:00:04 2011	0.7	1.8	15.0	15.9	13.6	93.2	94.6	85.4	1016.2	1017.5	1014.7	163.7	218.0	128.0	2.8	11.2	0.0
Fri Sep 30 23:00:04 2011	0.8	26.4	15.0	15.7	13.5	92.4	95.1	85.8	1014.7	1018.5	1012.6	204.3	334.0	145.0	3.1	10.6	0.0
Totals	9.6	50.6															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Sat Oct 01 23:00:04 2011	0.7	6.4	14.4	16.1	12.6	91.4	94.4	88.4	1019.7	1201.0	1018.6	203.3	351.0	28.0	1.3	5.6	0.0
Sun Oct 02 23:00:04 2011	0.4	2.0	15.4	16.8	14.7	94.9	95.1	94.5	1019.8	1020.8	1018.8	167.3	254.0	85.0	1.1	4.7	0.0
Mon Oct 03 23:00:04 2011	0.2	0.0	15.0	18.0	10.8	87.7	95.0	73.2	1015.5	1018.6	1013.0	249.8	317.0	138.0	2.5	11.1	0.0
Tue Oct 04 23:00:04 2011	0.0	0.2	10.9	15.9	5.6	92.3	95.3	86.3	1018.2	1019.8	1015.8	276.9	360.0	95.0	1.4	8.6	0.0
Wed Oct 05 00:00:05 2011	0.5	0.2	10.9	16.1	5.3	92.5	95.4	85.2	1018.2	1019.9	1015.6	232.1	360.0	0.5	1.5	8.6	0.0
Thu Oct 06 00:00:06 2011	1.4	1.4	15.0	18.0	10.2	88.7	92.5	77.6	1011.5	1015.8	1007.5	256.2	360.0	3.5	4.2	13.7	0.7
Fri Oct 07 00:00:06 2011	2.6	0.0	10.6	13.6	6.7	71.7	82.3	52.9	1014.4	1020.7	1010.7	290.2	360.0	0.6	5.0	17.7	0.8
Sat Oct 08 00:00:05 2011	2.2	0.0	11.2	15.0	9.5	74.7	83.4	56.1	1024.5	1028.0	1019.5	306.1	360.0	0.5	3.6	11.1	0.3
Sun Oct 09 00:00:05 2011	0.9	0.0	13.4	17.9	8.1	86.1	92.9	77.3	1024.9	1028.1	1022.1	273.9	359.2	0.6	2.0	7.3	0.0
Mon Oct 10 00:00:05 2011	1.8	0.0	16.2	19.9	13.3	84.6	90.7	75.2	1018.5	1022.1	1016.4	266.9	359.4	164.8	4.1	11.4	0.4
Tue Oct 11 00:00:05 2011	2.2	0.0	16.4	18.0	15.4	80.6	86.5	73.0	1016.2	1017.3	1014.8	269.1	355.1	171.4	5.4	14.2	1.1
Wed Oct 12 00:00:05 2011	1.7	0.0	16.0	18.6	14.3	84.1	89.6	74.2	1018.5	1019.7	1016.8	264.5	351.3	159.8	3.5	10.5	0.6
Thurs Oct 13 00:00:05 2011	0.0	0.8	12.8	16.3	10.9							160			1.1	8.1	0.0
Fri Oct 14 00:00:05 2011	1.0	1.0	13.1	18.2	10.4	89.1	94.2	70.2	1025.4	1026.2	1024.0	158.5	360.0	0.5	1.1	5.0	0.0
Sat Oct 15 00:00:06 2011	0.8	4.4	14.2	15.7	13.5	92.6	94.6	85.2	1023.4	1025.6	1021.1	156.2	322.8	48.9	3.5	10.4	0.4

Sun Oct 16 00:00:06 2011	0.5	7.6	13.4	14.7	9.1	92.3	93.8	88.6	1019.5	1021.5	1018.2	198.8	360.0	0.8	2.4	10.3	0.0
Mon Oct 17 00:00:06 2011	1.4	0.4	10.8	15.5	6.8	83.0	94.4	58.1	1020.4	1022.2	1018.2	231.4	360.0	0.5	1.9	10.0	0.0
Tue Oct 18 00:00:05 2011	1.4	2.2	11.3	14.7	7.1	82.9	91.4	73.0	1011.2	1018.3	1004.8	254.9	359.8	0.6	4.4	16.9	0.4
Wed Oct 19 00:00:06 2011	1.7	0.2	8.3	12.2	5.2	76.4	86.9	57.8	1012.6	1016.7	1010.2	293.6	360.0	1.0	3.4	15.0	0.7
Thu Oct 20 00:00:06 2011	1.6	0.0	7.5	12.2	4.1	78.1	92.2	50.4	1022.9	1028.5	1016.8	302.7	360.0	0.5	2.6	13.1	0.0
Fri Oct 21 00:00:05 2011	0.7	0.0	8.6	12.3	4.3	84.9	93.4	74.4	1026.3	1028.7	1021.7	239.0	360.0	0.5	1.6	6.4	0.0
Sat Oct 22 00:00:05 2011	1.9	0.0	12.8	14.8	11.8	79.0	83.8	69.9	1016.8	1021.7	1011.2	205.7	340.5	35.8	3.7	11.8	0.4
Sun Oct 23 00:00:05 2011	1.5	6.4	12.1	14.0	9.6	87.4	91.6	71.1	1002.7	1010.5	999.1	186.2	360.0	1.4	4.2	15.3	0.0
Mon Oct 24 00:00:05 2011	1.0	29.6	12.5	14.6	9.7	90.3	94.5	83.3	989.8	999.5	978.2	149.1	294.0	5.7	5.0	22.8	0.0
Tue Oct 25 00:00:05 2011	0.7	1.0	10.8	14.6	6.9	88.6	93.3	83.0	983.7	986.9	976.8	248.9	360.0	0.6	2.5	16.3	0.0
Wed Oct 26 00:00:05 2011	0.9	0.6	8.7	13.6	5.7	85.2	93.3	63.7	990.1	994.0	986.8	209.4	359.2	0.7	1.3	8.6	0.0
Thu Oct 27 00:00:06 2011	1.0	0.8	8.2	12.9	3.9	84.2	94.6	62.1	996.1	999.7	993.7	185.4	360.0	0.7	1.7	9.8	0.0
Fri Oct 28 00:00:06 2011	1.1	0.0	8.1	13.2	4.3	84.0	95.6	57.8	1006.0	1015.4	999.7	270.7	360.0	0.5	1.7	9.0	0.0
Sat Oct 29 00:00:06 2011	1.0	0.6	9.0	14.1	2.1	87.6	95.7	74.2	1017.4	1019.1	1014.8	160.5	359.9	3.7	2.7	13.4	0.0
Sun Oct 30 00:00:06 2011	1.3	14.0	13.4	16.0	11.9	89.5	94.3	75.7	1009.7	1014.8	1007.4	212.2	358.1	36.4	4.3	14.4	0.7
Mon Oct 31 00:00:06 2011	0.4	0.6	13.1	14.3	11.3	92.7	94.8	90.2	1010.0	1012.0	1006.1	194.6	306.6	1.0	2.5	8.5	0.1
Totals	19.8	80.4															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Tue Nov 01 00:00:05 2011	0.6	6.2	12.4	14.3	8.3	90.9	95.0	85.6	1001.7	1005.8	999.8	210.2	339.6	28.3	3.3	17.5	0.2
Wed Nov 02 00:00:05 2011	1.4	2.2	10.0	13.6	3.7	86.1	95.3	67.4	1002.1	1004.8	995.4	160.9	360.0	2.1	3.6	19.9	0.0
Thu Nov 03 00:00:05 2011	1.0	18.4	13.4	14.0	12.9	89.9	92.2	84.4	987.2	996.5	980.7	149.0	356.6	39.8	8.5	22.8	1.9
Fri Nov 04 00:00:05 2011	0.8	0.6	12.8	14.5	9.0	89.4	92.1	85.1	980.9	984.7	979.2	179.1	360.0	0.9	4.1	14.5	0.0
Sat Nov 05 00:00:05 2011	0.9	0.0	8.0	12.5	4.1	88.8	96.1	60.1	993.5	1003.0	985.4	276.7	360.0	0.9	1.3	6.3	0.0
Sun Nov 06 00:00:06 2011	1.0	0.0	6.1	11.5	3.0	85.6	95.3	58.7	1013.1	1022.4	1003.0	296.8	360.0	0.5	1.7	7.0	0.0

Mon Nov 07 00:00:06 2011	0.4	0.0	5.3	12.3	0.4	88.5	96.4	65.1	1025.8	1027.3	1022.3	199.3	360.0	0.7	0.7	4.3	0.0
Tue Nov 08 00:00:06 2011	0.8	0.0	6.5	11.6	0.7	83.8	96.8	61.5	1021.8	1027.2	1013.9	126.8	360.0	0.7	1.3	9.2	0.0
Wed Nov 09 00:00:06 2011	1.1	2.0	11.3	13.1	9.7	85.8	93.2	74.7	1008.8	1014.0	1003.9	145.3	275.5	12.8	3.6	12.1	0.0
Thu Nov 10 23:00:04 2011	0.0	0.0	12.6	14.5	11.0	85.0	88.4	80.1	1008.5	1010.4	1005.7	151.9	176.0	132.0	4.6	12.7	0.0
Fri Nov 11 00:00:05 2011	1.3	0.0	12.6	14.8	10.7	85.0	88.8	79.0	1008.5	1010.6	1004.4	150.8	290.0	0.8	4.6	13.8	0.7
Sat Nov 12 00:00:05 2011	1.8	15.2	12.8	14.8	10.4	84.5	92.3	71.6	1001.0	1006.2	997.6	160.2	327.8	21.6	6.8	25.4	0.9
Sun Nov 13 00:00:05 2011	1.1	0.2	11.1	13.9	6.4	85.3	91.0	75.7	1016.0	1020.0	1006.1	149.2	360.0	0.9	3.0	15.2	0.0
Mon Nov 14 00:00:05 2011	1.3	0.0	14.2	14.8	13.7	85.9	88.6	81.8	1016.0	1017.8	1014.6	106.4	359.3	1.3	4.7	14.6	0.5
Tue Nov 15 00:00:07 2011	0.8	0.0	13.0	13.8	12.3	89.9	91.9	88.4	1016.2	1017.6	1014.5	100.8	355.0	2.3	4.5	11.3	1.1
Wed Nov 16 00:00:06 2011	1.2	0.0	11.9	12.6	10.7	84.7	89.2	78.0	1012.7	1014.6	1010.5	102.2	358.5	10.8	3.9	10.7	0.5
Thu Nov 17 00:00:05 2011	0.8	5.4	11.5	14.0	7.4	89.0	92.4	83.1	1009.7	1010.8	1008.6	184.1	360.0	1.0	3.3	10.9	0.0
Fri Nov 18 00:00:06 2011	1.0	35.6	11.6	13.0	7.8	88.6	92.7	82.1	1006.1	1011.0	1003.2	182.9	326.0	30.3	6.1	21.6	0.2
Sat Nov 19 00:00:06 2011	0.9	17.8	13.0	13.4	12.5	90.5	91.7	88.8	1003.9	1005.0	1002.9	164.3	287.9	47.0	6.5	19.0	1.5
Sun Nov 20 00:00:06 2011	0.5	15.8	11.7	14.1	8.3	91.8	94.2	86.2	1007.9	1014.1	1003.0	143.1	360.0	0.6	1.9	15.6	0.0
Mon Nov 21 00:00:05 2011	0.4	0.8	11.7	13.1	10.0	91.9	94.4	87.9	1011.8	1014.2	1009.2	157.7	359.3	0.8	1.9	7.4	0.0
Tue Nov 22 00:00:05 2011	0.7	2.8	9.1	11.2	6.1	87.6	93.0	75.5	1010.2	1014.8	1008.3	262.2	360.0	0.5	1.8	8.9	0.0
Wed Nov 23 00:00:05 2011	0.7	0.0	7.5	11.7	2.1	86.0	93.7	72.4	1019.4	1021.4	1014.8	251.7	360.0	0.5	1.7	7.6	0.0
Thu Nov 24 00:00:05 2011	1.0	0.2	12.4	13.4	11.3	86.1	90.7	81.0	1020.8	1022.3	1020.0	232.5	326.7	122.5	4.4	12.2	0.8
Fri Nov 25 00:00:05 2011	1.4	3.8	12.2	13.4	8.2	83.6	89.4	75.3	1016.9	1022.2	1011.8	218.3	359.4	64.6	5.3	15.9	0.8
Sat Nov 26 00:00:05 2011	1.2	0.2	8.7	11.1	6.1	78.2	86.7	66.1	1022.7	1026.2	1015.0	258.6	357.0	141.2	2.8	11.0	0.0
Sun Nov 27 00:00:05 2011	1.3	0.0	12.3	13.6	9.7	83.7	89.6	76.6	1019.3	1024.9	1010.7	248.8	326.6	124.4	5.1	18.2	0.6
Mon Nov 28 00:00:05 2011	1.9	1.0	9.7	13.5	7.5	72.4	90.6	54.4	1021.2	1025.7	1010.0	271.2	360.0	0.6	3.6	18.7	0.0
Tu Nov 29 00:00:06 2011	1.7	3.4	11.5	13.0	9.0	82.1	92.4	63.4	1011.7	1023.6	1000.1	196.2	298.6	5.3	4.5	14.9	0.1
Wed Nov 30 00:00:06 2011	1.6	24.8	8.8	12.8	4.8	83.1	92.1	65.5	1000.6	1011.7	989.1	247.2	360.0	0.7	5.0	18.3	0.2

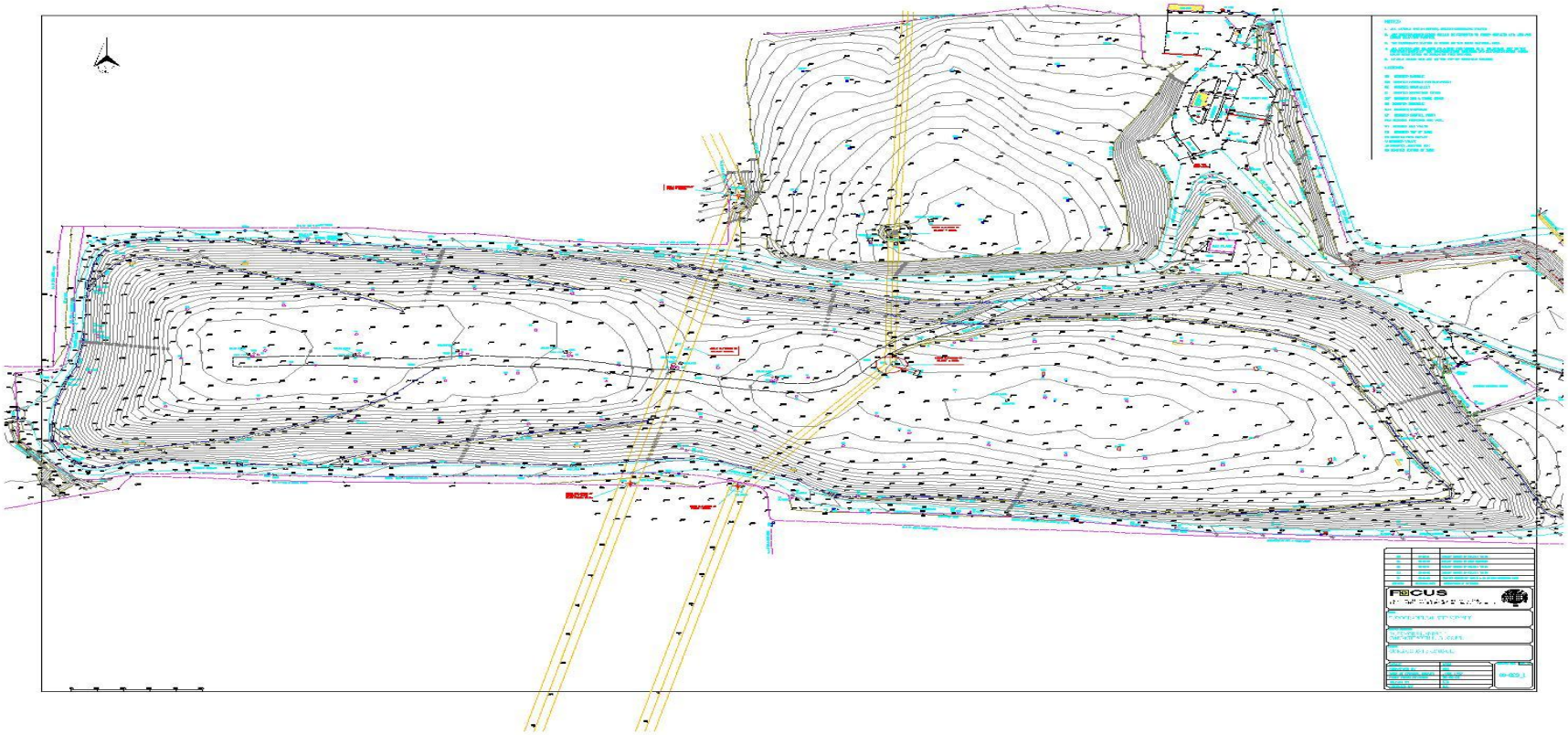
Totals	30.3	156.4															

time	Evap_Daily Calc mm	PR_Sum24h value mm	TA_24h Avg °C	TA_24h Max °C	TA_24h Min °C	RH_24h Avg %	RH_24h Max %	RH_24h Min %	PA_24h Avg mb	PA_24h Max mb	PA_24h Min mb	WD_24h Avg Deg	WD_24h Max Deg	WD_24h Min Deg	WS_24h Avg m/s	WS_24h Max m/s	WS_24h Min m/s
Thu Dec 01 00:00:06 2011	1.1	12.6	9.0	11.3	5.8	81.9	93.8	73.4	1008.1	1013.0	997.2	218.4	354.1	2.4	4.6	17.9	0.1
Fri Dec 02 00:00:05 2011	0.4	0.2	5.0	7.9	3.0	85.5	92.6	75.8	1005.0	1009.9	1000.6	275.9	360.0	0.5	1.2	6.2	0.0
Sat Dec 03 00:00:05 2011	0.5	1.2	6.5	11.3	1.2	89.6	94.1	82.9	1009.6	1014.5	1002.7	268.8	360.0	0.5	2.7	11.3	0.0
Sun Dec 04 00:00:05 2011	1.1	0.0	9.6	11.3	7.3	80.0	88.8	71.7	1004.7	1006.1	1002.7	282.1	359.9	0.7	3.0	12.0	0.0
Mon Dec 05 00:00:05 2011	1.0	1.8	6.3	9.4	3.1	81.2	87.3	68.5	1003.8	1007.9	1000.7	283.7	360.0	0.7	3.2	12.6	0.7
Tue Dec 06 00:00:05 2011	0.8	2.0	4.2	6.9	2.7	84.3	90.6	72.1	1008.8	1010.0	1007.4	283.5	360.0	3.8	3.0	10.8	0.5
Wed Dec 07 00:00:05 2011	0.7	0.0	6.0	9.4	2.6	82.8	91.6	75.1	1007.9	1009.8	1004.9	279.4	355.6	4.0	2.8	9.6	0.0
Thu Dec 08 00:00:05 2011	1.3	0.2	7.3	9.4	4.6	76.2	85.1	64.9	1012.2	1017.8	1005.2	288.6	360.0	3.9	3.8	12.9	0.0
Fri Dec 09 00:00:05 2011	1.6	0.8	8.7	12.3	3.9	80.4	89.4	67.8	1007.0	1015.9	1002.2	272.1	358.0	0.5	5.7	19.2	0.7
Sat Dec 10 00:00:06 2011	0.9	0.0	4.4	7.3	1.4	78.7	92.3	64.7	1012.5	1015.8	1009.9	284.3	360.0	0.6	2.7	9.4	0.0
Sun Dec 11 00:00:08 2011	0.4	1.0	4.0	9.4	-0.2	89.6	94.2	80.3	1013.6	1016.5	1007.8	253.2	360.0	0.6	1.5	9.1	0.0
Mon Dec 12 00:00:06 2011	0.6	1.8	6.2	9.9	2.5	87.4	93.3	75.8	1002.4	1007.3	999.2	270.6	360.0	1.0	2.4	9.5	0.0
Tue Dec 13 00:00:05 2011	0.7	21.4	6.3	11.1	2.0	86.7	91.2	81.0	994.3	1003.8	979.9	240.5	360.0	0.5	3.7	20.4	0.0
Wed Dec 14 00:00:06 2011	1.4	1.8	3.8	6.7	2.0	76.9	92.1	55.7	984.9	988.0	980.0	269.9	360.0	5.0	5.2	21.2	0.7
Thu Dec 15 00:00:05 2011	0.7	4.4	3.7	6.8	1.3	84.1	90.4	77.6	988.1	991.1	982.4	255.0	359.6	2.3	3.9	15.9	0.0
Fri Dec 16 00:00:05 2011	0.5	1.6	4.2	5.6	2.8	83.3	89.8	73.8	995.2	1000.6	988.7	238.0	360.0	0.5	2.3	13.8	0.0
Sat Dec 17 00:00:05 2011	0.7	3.2	3.3	6.6	0.4	86.6	93.7	74.1	995.8	1010.1	988.3	301.5	360.0	0.6	3.5	14.1	0.0
Sun Dec 18 00:00:05 2011	0.8	0.6	3.6	6.0	1.4	83.0	90.7	69.1	1016.2	1021.1	1010.6	304.5	360.0	0.5	3.2	11.1	0.4
Mon Dec 19 00:00:05 2011	0.2	0.0	2.8	6.2	-0.4	91.4	94.5	86.1	1021.0	1021.7	1019.6	287.7	360.0	0.6	1.3	4.9	0.0
Tue Dec 20 00:00:05 2011	0.7	7.0	7.7	11.3	2.5	88.1	94.3	75.1	1014.0	1019.6	1010.4	261.4	360.0	0.6	2.2	10.0	0.0
Wed Dec 21 00:00:05 2011	0.8	0.0	9.0	12.1	6.7	84.2	89.9	76.5	1017.1	1020.0	1014.7	273.2	358.8	1.8	2.2	7.3	0.0

Thu Dec 22 00:00:05 2011	1.1	0.0	11.5	13.8	8.4	83.2	89.5	71.1	1021.1	1025.0	1016.6	279.1	360.0	0.6	2.4	9.6	0.0
Fri Dec 23 00:00:06 2011	0.8	0.4	11.0	12.5	8.8	87.7	91.6	81.9	1022.5	1025.0	1016.6	238.6	360.0	0.6	3.2	11.6	0.0
Sat Dec 24 00:00:06 2011	1.2	7.0	6.9	11.6	2.3	83.2	91.8	70.0	1019.0	1029.1	1012.2	291.0	360.0	0.5	3.8	15.3	0.0
Sun Dec 25 00:00:06 2011	0.9	0.0	8.0	10.9	1.9	84.9	89.8	76.6	1025.7	1029.4	1023.0	250.9	360.0	0.7	3.8	12.5	0.0
Mon Dec 26 00:00:08 2011	0.9	0.0	12.0	12.9	10.7	87.2	90.1	84.3	1023.5	1026.5	1020.8	253.0	336.4	146.0	4.8	13.1	0.7
Tue Dec 27 00:00:05 2011	0.9	0.8	11.2	12.4	9.9	87.1	90.4	84.2	1026.8	1027.9	1025.9	233.5	337.0	94.2	4.8	13.2	1.0
Wed Dec 28 00:00:05 2011	1.1	5.4	10.3	10.7	9.6	83.4	90.6	74.2	1024.4	1028.2	1014.2	200.9	322.9	53.3	4.0	15.8	0.3
Thu Dec 29 00:00:05 2011	1.1	3.2	5.9	8.8	4.8	79.7	86.6	72.9	1021.4	1029.2	1014.2	285.4	358.7	1.1	4.3	15.7	0.6
Fri Dec 30 00:00:05 2011	1.4	0.2	8.7	10.7	4.2	77.4	84.8	70.8	1024.5	1029.1	1021.8	287.7	357.3	7.6	5.2	16.4	0.9
Totals	26.4	78.6															

APPENDIX C

Topo Survey 2011



APPENDIX D

NOISE MONITORING

DixonBrosnan

noise ecology water

dixonbrosnan.com

Project

2011 annual environmental noise survey at

East Cork Landfill, Rossmore, Carrigtohill, Co. Cork

Client

Cork County Council

Project no	No pages	Client reference	©DixonBrosnan 2011
1151	9	W0022-01	v191011

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

Report no	Date	Edit	Prepared by	Chkd
1151.1.1	25.10.11	Release 1	Damian Brosnan	CD

1 Introduction

1.1 DixonBrosnan noise consultants were instructed by Cork County Council to carry out the 2011 annual environmental noise survey at their East Cork Landfill (ECL) facility at Rossmore, Carrigtohill, Co. Cork. The survey is a requirement of Environmental Protection Agency waste licence W0022-01, issued in respect of the facility. Several noise conditions attached to the licence are presented in appendix 1.

1.2 The noise survey was undertaken on Friday 14.10.11 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. As the facility does not operate at night, the survey was confined to daytime hours.

1.3 The civic amenity area of the ECL facility was open to users throughout the survey. Noise emissions arose from user waste disposal activities at the amenity area, located 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. There were no noise sources of significance deeper within the facility. Offsite, noise emissions from a quarrying operation north of the ECL site significantly affected noise levels at several stations.

2 Results

2.1 Recorded noise data are presented in appendix 4, and frequency spectra in appendix 5. ECL emissions were inaudible at one of the measurement stations: offsite noise sensitive location N1. It follows that emissions here were significantly lower than the 55 dB daytime limit specified in licence W0022-01.

2.2 Emissions from ECL noise sources were audible to varying degrees at the five onsite stations:

- N3: Activities at civic amenity area faintly audible occasionally. ECL contribution estimated at less than 33 dB.

- N4: Noise emissions audible occasionally from amenity site users disposing waste, vehicles through entrance, and onsite waste management operations. ECL contribution estimated at 45-50 dB.
- N5: Vehicles through site entrance occasionally slightly audible. Contribution estimated at less than 41 dB.
- GG1: No ECL emissions audible, apart from one local car movement associated with borehole testing. ECL contribution less than 30 dB.
- GG4: No ECL emissions audible, other than cyclic hissing noise slightly audible from gas collection point at 100 m. Contribution calculated at 30 dB.

2.3 From the foregoing, ECL noise emissions measured significantly lower than 55 dB at all measurement stations. No audible tones or impulses were noted at any of the stations.

3 Conclusions

3.1 ECL noise emissions were audible to varying degrees at the five onsite measurement stations. The contribution from same was estimated at less than 55 dB in all cases. At offsite sensitive location N1, the only station to which limits apply, landfill emissions were significantly lower than the 55 dB daytime noise limit set out in the licence.

3.2 No audible tones or impulses were noted in site emissions.

Appendix 1: W0022-01 noise conditions

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]

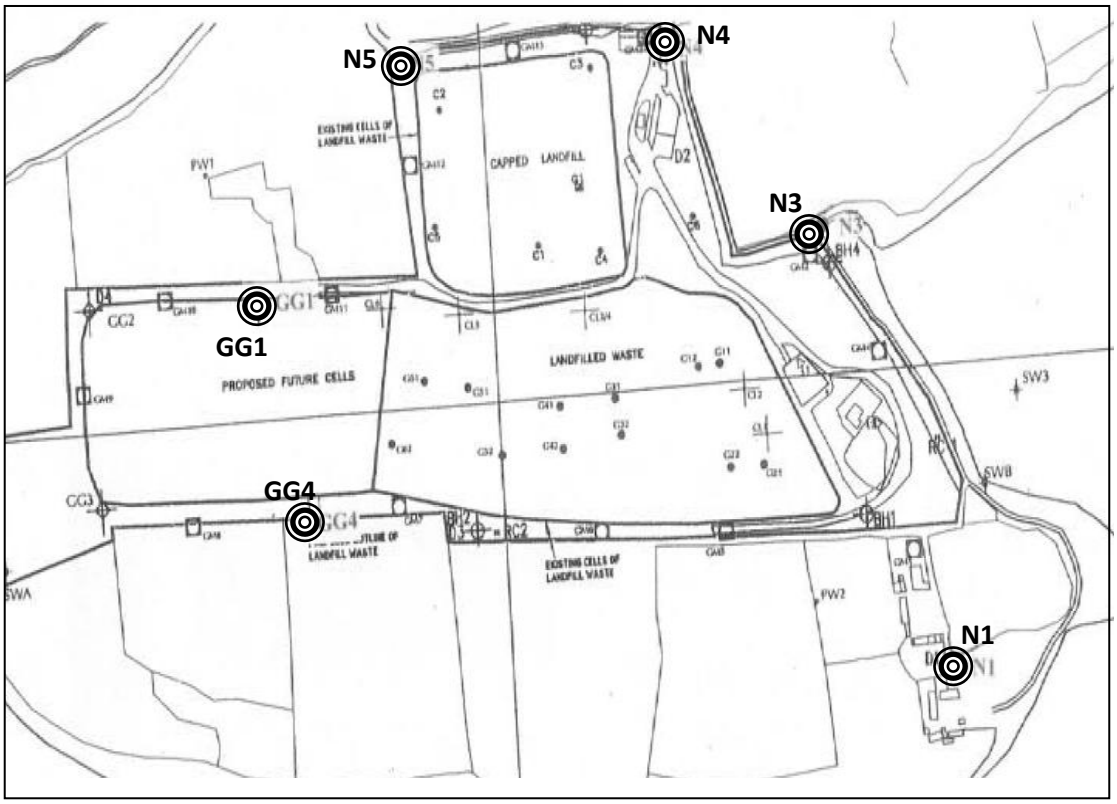
Note 1:"International Standards Organisation. ISO 1996. Acoustics - description and Measurement of Environmental noise. Parts 1, 2 and 3."

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

Appendix 2: Monitoring stations

N



Appendix 3: Survey details

File	Project ref.	1151
	Location	Rossmore landfill Carrigtohill
	Stations	N1 N3 N4 N5 GG1 GG4
	Purpose	2011 annual waste licence compliance survey
	Comment	Civic amenity area in used, landfill proper closed
Event	Date	14.10.11
	Day	Friday
	Time	1130-1600
	Operator	Damian Brosnan BSc MIOA MIEnvSc
Conditions	Cloud cover	100 %
	Precipitation	0 mm, although becoming misty with drizzle from 1500
	Temperature	14 ^{0}C
Wind	Direction	SE
	Speed	0-2 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	14/10/2011 11:56:09
	Calibration type	External
	Sensitivity	47.78 mV/Pa
	Post measurement check	93.9 dB
Onsite calibrator	Instrument	Bruel & Kjaer Type 4231
	Instrument serial no.	2342544
	UKAS calibration	13.10.10
	UKAS calibration certificate	Available on request
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

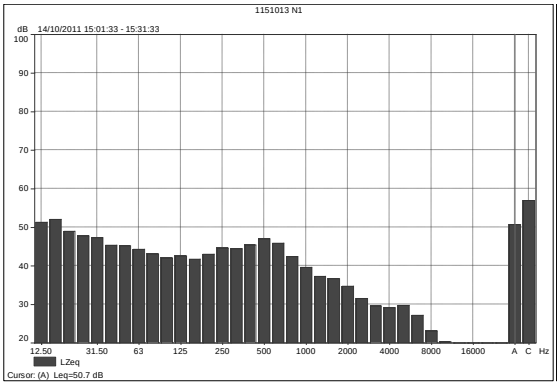
Survey date: 14.10.11

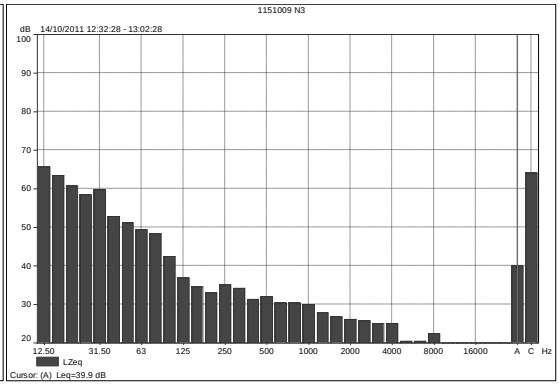
Station	Time	$L_{Aeq\ 30\ min}$ dB	$L_{AF10\ 30\ min}$ dB	$L_{AF90\ 30\ min}$ dB	Specific level* dB	Noise audible
N1	1501-1531	51	42	36	<36	No emissions audible from landfill facility. Sources audible here: bird song/calls, aircraft, rustling vegetation, distant traffic to SW, and tractor to S. Sporadic noise audible at low level from activity near local dwelling.
N3	1232-1302	40	38	33	<33	Activities at civic amenity area faintly audible from time to time. Continuous emissions from quarry facility to NW audible at low level. Passing car outside boundary x1. Distant traffic to SW almost continuously slightly audible. Bird

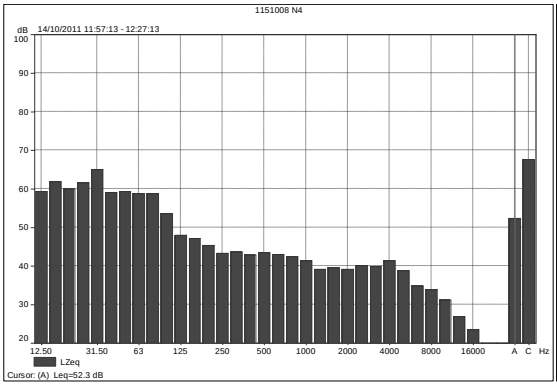
						song/calls and aircraft.
N4	1157-1227	52	54	43	45-50	Noise emissions arising occasionally from amenity site users disposing waste, and from user's vehicles through entrance. Emissions audible at low level from wheeled excavator in use immediately S of civic amenity area 1219-1225. Offsite, emissions continuously audible from quarrying facility to N, with energy in 31.5 Hz band. Lightly rustling vegetation nearby. Bird song/calls and aircraft.
N5	1419-1449	44	47	41	<41	Vehicle movements through site entrance occasionally slightly audible. Offsite emissions from quarry batching plant to NE continuously audible and dominant. Bird song/calls and aircraft. Rustling vegetation.
GG1	1344-1414	33	34	30	<30	No facility emissions audible, apart from one local car movement associated with borehole testing. Continuous emissions from quarry batching plant to N audible at low level. Quarry plant movements also slightly audible. Bird song/calls and aircraft.
GG4	1307-1337	33	33	29	30	No landfill emissions audible, other than cyclic hissing noise slightly audible from gas collection point at 100 m. Distant road traffic to SW continuously slightly audible. Bird song/calls and aircraft.

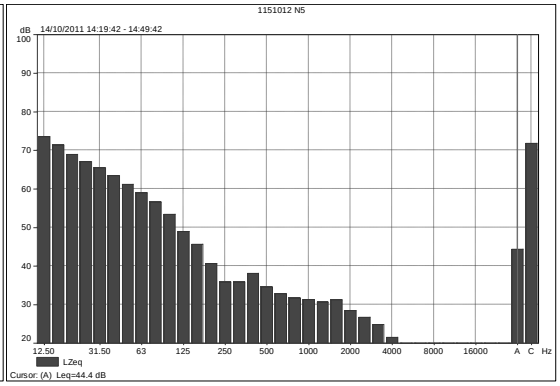
*Specific level: Sound pressure level contribution considered attributable to facility, determined using real time assessment, field notes, time history profiles, statistical analysis, frequency spectra, near field correction if applicable, and other parameters.

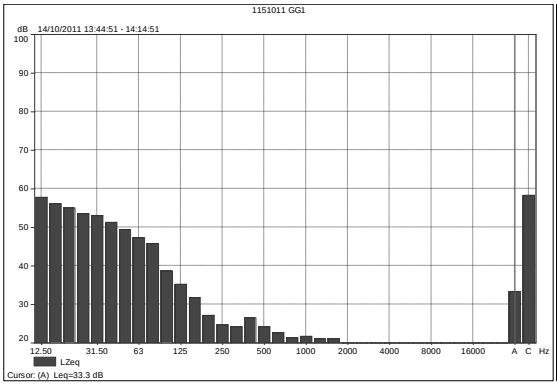
Appendix 5: Frequency spectra

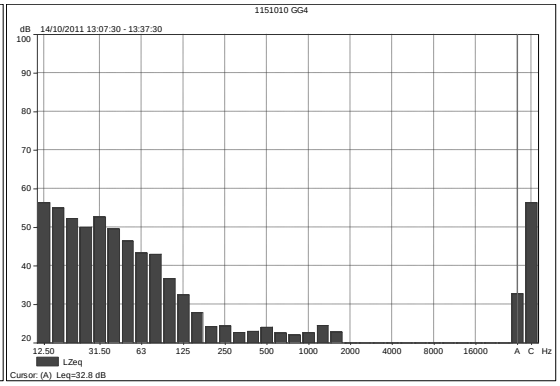












Appendix 6: Glossary

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 T.	$L_{AF90\ T}$. 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.
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. Equivalent to $L_{Ar\,T}$ used by EPA.
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.

Ecological Monitoring of East Cork Landfill 2011

Report for

Cork County Council

December 2011

LIMOSA ENVIRONMENTAL
ECOLOGICAL AND ENVIRONMENTAL CONSULTANCY

Report Reference:	RP11-GW007-04-0
Draft	Final Report
Prepared by:	L J Lewis
Checked by:	L J Lewis
Report Date:	December 2011
Sign-off date:	February 22nd 2012
Signature:	

Table of Contents

SUMMARY

This report presents the results of the 2011 ecological surveys and monitoring of East Cork Landfill and surrounding area, in fulfilment of the requirements of the East Cork Landfill Waste Licence.
The 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.

The landfill habitats recorded in 2011 have undergone the least amount of change, relative to other years. This is because the landfill is now closed and the capping and re-profiling works that have brought about differences to habitats in previous years have now finished. Many habitats are now therefore fully developed or are still re-colonising but approaching full cover.

One 'new' plant species were recorded this year. Yellow Bartsia was recorded within ED3 habitat and has not been recorded previously. This species is relatively scarce in Ireland with a distribution restricted to the south-west.

Habitats outside of the landfill boundary continue to support a diversity of flora and fauna and no obvious differences in their extent or quality was noted. The scarce plant Yellow-wort continues to occur within the exposed calcareous rock habitat on the south-east of the peninsula.

There appears to have been relatively little increase in the cover of the invasive species *Spartina anglica* during the assessment time period. This contrasts to some locations close to the site e.g. Belvelly, where *Spartina* now extends over vast areas.

Results of the intertidal survey suggest that the community of the 'hard' shoreline has been stable across the sampling period. *Fucus vesiculosis* and *Ascophyllum nodosum* are the dominant flora and together they form the biotope (*'Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock' (LR.LLR.FVS.AscVS)) that dominates the hard shore habitat and which has been present consistently throughout the entire landfill monitoring programme.

The long-term macroinvertebrate dataset (benthic core sampling) shows that the characterising species have continued to be present and abundant across the monitoring period. Biotope composition has remained relatively stable across the sampling years.

Sediment chemical analyses showed that most parameters were recorded within the expected levels. However, levels of Arsenic were above the ER_L at six sites and although recorded levels are in the usual range for an urban/industrially-influenced estuary, adverse ecological effects may result. One sample located within Brick Island embayment, contained levels of Mercury that surpassed the upper level of the OSPAR EAC (0.5mg/kg), the upper criteria of the Irish Sediment Quality Guideline (SQG) (related to dredged sediment) and the US EPA effects range (ER_M). This level is therefore unusually high and as such has the potential to have adverse effects upon marine life.

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. While numbers of Shelduck have declined within Rossmore Bay over the past five years, numbers of Oystercatcher have increased in recent years with particularly high numbers recorded this winter. The data also suggest an increase in the numbers of Black-tailed Godwit, Redshank and Curlew. Waterbird surveys of Zone B (Brick Island) revealed a different pattern however. The peak count for all species this winter was lower than the peak count recorded in 2010. For two species (Shelduck and Oystercatcher) the peak count recorded was the lowest on record. This is unusual and particularly so for Redshank which are usually abundant within this site. This suggests some site-based reason for a decline such as poor invertebrate recruitment or high levels of disturbance. Core sample data for this area appeared 'normal' although only two sampling stations are located within Brick Island. A high level of disturbance was not recorded. A causative factor is therefore not obvious. Data from the Irish Wetland Bird Survey (I-WeBS) for 2011/12 are not yet available but it will be interesting to compare the two datasets in the future.

1.0 INTRODUCTION

1.1Background and introduction to the 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 being largely agricultural in nature. There is a nearby active quarry and a disused quarry to the north-east.

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

Habitats around East Cork Landfill are afforded protection under international and national conservation legislation. Because of the importance of these habitats, East Cork Landfill is required to undertake annual ecological monitoring in fulfilment of its annual Waste Licence (Environmental Protection Agency Reg. No. 22-1, Condition 9.14).

The licence requirements are 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

Conservation designations in the vicinity of East cork Landfill are as follows:-

(1) Great Island Channel Special Area of Conservation (SAC 1058) (EU Habitats Directive 92/43/EEC)

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 lies 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) 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.

(2) 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.

Intertidal habitats surrounding Rossmore Peninsula form an integral part of Cork Harbour SPA. This site qualifies for designation because it supports over 20,000 waterbirds during winter and because several species occur in numbers of international and national importance. Further information can be seen in the site synopsis (NPWS) given in Appendix 1.1.

1.2Scope of works

During 2011, Limosa Environmental completed a series of surveys designed to meet the requirements of the landfill licence. The scope of works is as follows:

- 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 anglica* distribution.
- Waterbird surveys of the intertidal mudflats surrounding Rossmore Peninsula. Assessment of waterbird data including a review of the relative importance of the North Channel within Cork Harbour SPA.
- Chemical analysis of estuarine sediments at pre-determined sampling points and following criteria 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 (as the regulatory body has now changed, data are obtained from the Marine Institute).
- Consultation with the National Parks & Wildlife Service.

1.3Report 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, mammals 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*^{TM}). 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 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 Methods

A habitat survey was conducted on 21st July 2011. 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 list of plant species was compiled for each habitat recorded within the landfill site and target notes were made, including notes as to the dominant plant species and an assessment of changes since the 2010 and previous surveys.

During the habitat and other surveys conducted across the survey area, records were made of other fauna species encountered (e.g. terrestrial birds, mammal species).

2.2 Results

Throughout the text, common names are used for plant species. A list of plant species by habitat type is presented in Appendix 2.1 along with species Latin names. A habitat map for 2011 is shown in Figure 2. Other fauna recorded during the habitat and other surveys are listed in Appendix 2.2.

Landfill Habitats

In 2011, the landfill site was found to comprise 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 comprises areas of built land (buildings) or any areas where artificial surfaces have been used e.g. tarmac, concrete, paving stones. This is a relatively minor habitat within the site and occurs 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.

Spoil and bare ground (ED2)

As its name implies, this habitat refers to areas of bare ground or piles of spoil and rubble but may also include areas with unpaved surfaces kept clear of vegetation through regular use or being regularly driven over (i.e. unpaved tracks or paths). Within the landfill site ED2 is now a relatively minor habitat and relates mostly to the landfill track which runs from the built area southwards before dividing into east and western routes which extend around the perimeter of the site.

At the time of survey, a small bank of earth was present between the area of amenity grassland and the landfill track in the north of the site. This bank is likely to rapidly vegetate over.

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.

By its nature, this habitat has little or no vegetation cover.

Spoil & bare ground (landfill track)

Recolonising bare ground (ED3)

Recolonising bare ground refers to areas where bare or disturbed ground are being recolonised by vegetation. Vegetation cover must be greater than 50% (Fossitt, 2000). In 2011 there was less ED3 present than in previous annual surveys mainly because the landfill capped areas, which had been recolonising previously, have now vegetated over to such an extent to now be classified differently. One of the main areas of this habitat occurs along the western boundary (See Figure 2). Here grasses and White Clover dominate as well as a variety of herbs such as Self Heal, Birds-foot Trefoil, Red Bartsia and Ribwort Plantain. Yellow Bartsia was recorded occasionally. The other main area of ED3 occurs adjacent to the artificial pond (leachate pond) in the west of the site. Plant species were dominated by Common Orache, Creeping Thistle, Red Bartsia with Common Centuary, Common Speedwell, Self Heal with occasional Sea Campion and Yellow Bartsia.

Recolonising bare ground also occurs at the edge of the landfill track; essentially the re-colonising edge of the ED2 (spoil and bare ground habitat). Species diversity in this location can be high because there is 'room' for an interesting mix of plants to occur, all competing for space and resources, before either the dominant adjacent species 'take over' or the plants are removed by use of the track. Species include Common Ragwort, Hawkbit sp., Greater Willowherb, Teasel, Meadow Buttercup, Common Figwort, Ox-eye Daisy, Butterbur and Black Medic.

Amenity grassland (GA2)

A small area of grassland occurs alongside the built area just inside the landfill entrance in the north of the site. This is classified as amenity grassland (GA2) and is regularly mown (and frequently grazed by rabbits). Grass species dominate although a variety of herbs were also recorded such as Daisy and Dandelion.

Unimproved/Semi-natural grassland (GS)

The three capped landfill cells are now all classified as Unimproved/Semi-natural grassland (GS). The northern cell is the most established (oldest) and the cap in the south-west is the most recent, the latter having been classified as recolonising bare ground (ED3) last year. This habitat is being used as a breeding habitat by Meadow Pipits and Pheasants.

Although these habitats have resulted from seeding and are dominated by grass species, they are not so intensively managed to warrant the classification of improved grassland, nor are they natural enough to fit within the semi-natural classifications of Fossitt (2000). Therefore the broad habitat category Unimproved/Semi-natural grassland (GS) is assigned.

The area in the north of the site is the oldest and is largely grass-dominated although an increasing area along its western border is 'scrubbing-up' with brambles, and a large expanse of Creeping Thistle which was in flower at the time of survey (see photo to the right). The GS in the south-east is grass-dominated but also has large expanses of Broad-leaved Dock, especially along its southern, northern and eastern banks. The newest capped area in the south-west is now similar to the eastern side although docks have yet to take such a hold except in one location along the northern banked edge.

Scrub (WS1)

Scrub occurs in small patches around the landfill boundary in association with hedgerows (WL1) or treelines (WL2) (unmapped). The largest patch of scrub occurs 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, (unimproved/semi-natural grassland GS). A large stand of the alien, invasive species Japanese Knotweed occurs here. Bramble-dominated scrub also occurs just south of this along the landfill track

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.

<u>Habitats outside the landfill boundaries</u>

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. Note that intertidal habitats are considered in Section 3. In 2011 the following habitats were recorded:-

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 shore (LS1).

Terrestrial habitats

The dominant habitats in the immediate vicinity of the landfill site are agricultural in nature. Fields are mostly improved agricultural grassland (GA1) although there is one example of unimproved/semi-natural grassland (GS) which relates to an unmanaged field. Fields are bordered mostly 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. In the south-east of the study area is an area of bare, exposed rock, bordered by scrub (predominantly gorse). This 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.

Yellow Wort

Exposed calcareous rock

Coastal Habitats

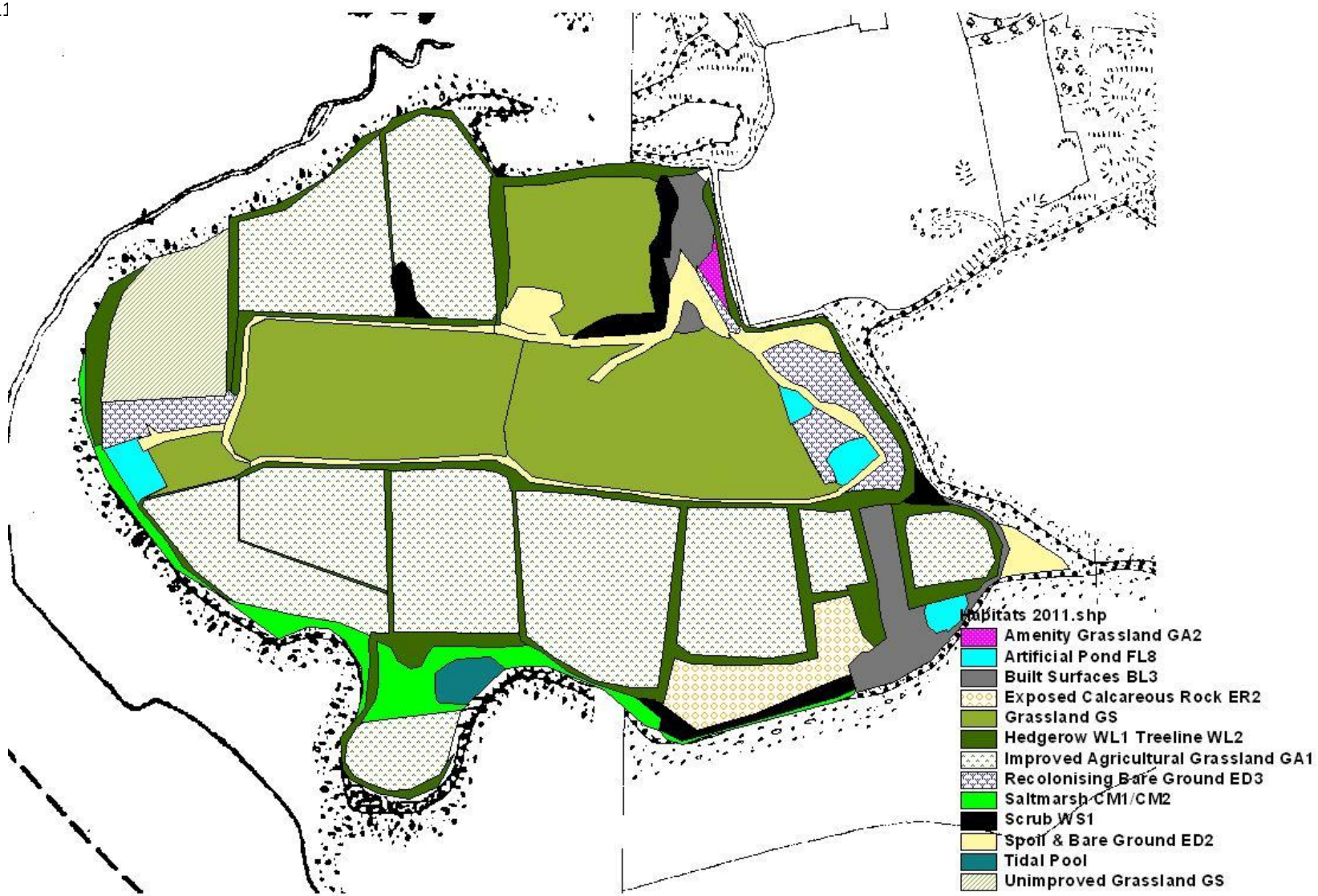
Saltmarsh forms the transition between the terrestrial habitats and the intertidal (littoral) habitats that surround Rossmore peninsula. Saltmarsh is divided into lower saltmarsh (CM1) and upper saltmarsh (CM2) depending on their vertical location. Saltmarsh habitat is present to varying degrees all around Rossmore Peninsula. The largest expanses occur in the inner parts of Rossmore Bay, the inner sections of Brick Island Embayment and around the tidal pool near the tip of Rossmore Peninsula.

Lower saltmarsh in Rossmore Bay is dominated by Common Cord-grass (*Spartina anglica*) 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. Saltmarsh around the tidal pool on the southern point of Rossmore Peninsula is dominated by Glasswort sp, Annual Sea-blite, Common Orache and Sea Beet. The pool is connected to the sea via an inlet.

In addition to these three main areas, 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.

The saltmarsh within the study area corresponds to the Annex I habitat Atlantic Salt Marsh (Glauco-Puccinellietalia maritimae) (1330). This is the most common type of saltmarsh within Ireland (McCorry & Ryle, 2009) and one of the main threats to this habitat is encroachment by Common Cord-grass (*Spartina*) (See Section 2.3.2).

Figure 2. Habitat Map 2011



2.3 Discussion and Conclusions

2.3.1 Habitat changes across time

The landfill habitats encountered in 2011 have undergone the least amount of change, relative to other years, in the 12-month period since the 2010 survey. This is because the landfill is now closed and the capping and re-profiling works that have brought about differences to habitats in the past few years have now finished. Many habitats are now fully developed or are still re-colonising but approaching full cover.

The main contrast to previous surveys is the near full vegetation cover of the landfill capped areas. Recolonising bare ground (ED3) and spoil and bare ground (ED2) are now relatively minor habitats within the site.

One 'new' plant species were recorded this year. Yellow Bartsia was recorded within ED3 habitat and has not been recorded previously, although surveys have been undertaken at a relatively similar time each year. This species is relatively scarce in Ireland with a distribution restricted to the south-west (Preston et al. 2002).

Also of note in 2011 was the absence of the previously-recorded species Bristly Ox-tongue. This relatively scarce species was probably introduced to Ireland and grows on disturbed or waste ground; the relatively undisturbed nature of the landfill site this year likely explaining its absence.

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, with a further stand along the southern boundary and several small stands close to the leachate lagoon in the west of the site. Although having not spread any more in the past 12 months, as an aggressively competitive alien species, its potential to spread into the surrounding coastal habitats of high conservation importance should not be overlooked. Useful guidelines on this species' management can be found at http://www.invasivespeciesireland.com.

Habitats outside of the landfill boundary continue to support a diversity of flora and fauna and no obvious differences in their extent or quality was noted in 2011. 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*)

The spread of Common Cord-grass is listed as one of the three main threats upon Atlantic Saltmarsh, an Annex I habitat (McCorry & Ryle, 2009). This is through the transformation of the lower-pioneer saltmarsh community dominated by Common Saltmarsh-grass and/or Sea Purslane. *Spartina* often significantly alters the sward structure. However some studies and observations suggest that negative impacts may not be as serious as previously predicted (McCorry *et al.*, 2003) and 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.

The extent of *Spartina* cover within Rossmore Bay has been mapped in previous years. However, mapping by eye is inherently difficult.

In the early 19th century the American cord grass *S. alterniflora* was accidentally introduced into England via ship ballast water. 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. Its potential use as a tool to reclaim mudflats led to the grass being planted on many sites around the coasts of Britain, Ireland and Northern Europe during the 1920's. Common Cord-grass was first planted in 1925 in Cork Harbour (Cummins, 1930) and subsequent plantings occurred along many other coastal stretches.

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. In relation to intertidal macroinvertebrates, it remains inconclusive whether Common Cord-grass decreases or changes diversity and effects are often site-specific. Effects upon wintering wildfowl and waders include a reduction in foraging areas

Figure 3 shows the mapped estimation of the extent of the plant within inner Rossmore Bay in winter 2011. The estimated distribution during 2005 was also 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. *Figure 3 Mapped estimation of extent of Spartina anglica within inner Rossmore Bay 2005 and 2011. Aerial photo from Google Earth™.*

This comparison, however crude, suggests little increase in cover of *Spartina* during the time period. 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.

It is interesting that even though *Spartina* swards were found to be well-developed at many saltmarshes, the national saltmarsh monitoring project 2007 – 2009 (McCorry & Ryle, 2009) found that there was very little quantitative evidence that this species was spreading. This appears to be the case within inner Rossmore Bay.

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.	Hawkweed sp.	Frequent	ED3
Holcus 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

Other fauna recorded during the 2011 habitat and other surveys.

(1) Terrestrial bird species recorded inside East Cork Landfill and within the surrounding environment.			
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*	*	*	
Goldfinch *Carduelis carduelis*		*	
Great Tit *Parus major*	*	*	
Greenfinch *Carduelis chloris*	*	*	
Hooded Crow *Corvus corone cornix*		*	
Jackdaw *Corvus monedula*		*	
Kestrel *Falco tinnunculus*	*	*	Amber-list
Linnet *Carduelis cannabina*	*	*	Amber-list
Magpie *Pica pica*	*	*	
Meadow Pipit *Anthus pratensis*	*	*	
Pheasant *Phasianus colchicus*	*	*	
Pied Wagtail *Motacilla alba*		*	
Raven (*Corvus corax*)		*	
Robin *Erithacus rubecula*	*	*	
Rook *Corvus frugilegus*	*	*	
Song Thrush *Turdus philomelos*	*	*	
Starling *Sturnus vulgaris*	*	*	Amber-list
Stonechat *Saxicola torquata*		*	
Swallow *Hirundo rustica*	*	*	Amber-list
Willow Warbler *Phylloscopus trochilus*		*	
Wood Pigeon *Columba palumbus*	*	*	
Wren *Troglodytes troglodytes*	*	*	

(2) Other fauna recorded within the study area		
Mammals	Protective Status	Notes
Rabbit *Oryctolagus cuniculus*	none	Signs of rabbits occur widely inside and outside the landfill site. Rabbit burrows occur extensively along the southern boundary (inside landfill) and along the western boundary (outside landfill)
Fox *Vulpes vulpes*	none	Tracks and signs observed mainly along the perimeter of the landfill site and at several locations around Rossmore peninsula. Often identified by smell.
Brown Rat *Rattus norvegicus*	none	Likely to be present within the landfill site but no visible signs were observed and a pest control programme is evident. Some signs outside of the landfill e.g. along roadway running along eastern boundary but much less obvious this years in comparison with previous years.
Badger *Meles meles*	Wildlife Act 1976 and Wildlife (Amendment) Act 2000. Appendix III Bern Convention	Droppings observed in a field to the north-east of the landfill site.
Otter *Lutra lutra*	Annex II and IV EU Habitats Directive. Appendix II Bern Convention	Spraint (droppings) found along saltmarsh embankment of Brick Island.
Butterflies	Protective Status	Notes
Meadow Brown *Maniola jurtina*	none	widespread and common species of meadows
Large White *Pieris brassicae*	none	

3.0 INTERTIDAL SURVEY OF ROSSMORE BAY AND PENINSULA

3.1 Introduction

This section presents the results of the intertidal survey of the 'hard shore' and intertidal mudflats of Rossmore Bay, Rossmore Peninsula (North Channel) and the Brick Island Embayment. In addition, sediment samples were taken and sent for laboratory analysis and the results assessed for sediment chemical and metal content, and particle size (granulometry).

3.2 Methodology

The survey was undertaken on the 7th and 15th October 2011. Sampling sites are located around Rossmore Peninsula, Rossmore Bay and Brick Island Embayment (see figure In Appendix 3.1). The position of these sites was determined at the onset of the monitoring programme and the sites are re-located each year with the help of GPS. 22 sites are sampled for flora and fauna while sediment sampling is carried out at a further nine sampling sites.

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 is taken on the hard shore directly above the mudflat where the cores were taken).

Firstly, a qualitative assessment was made of each core sampling location. This included recording physical features such as sediment type, 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 including abundance of Lugworm (*Arenicola marina*) casts.

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 were detected by eye and placed into labelled sample storage containers with 70% Ethanol.

Sample identification was aided by 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 nine sampling sites (Figure 3) on 7th October 2011 (Table 3.1). An additional control sample was taken; sample 10 being a duplicate of sample 8.

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	**182000**	**070221**

At each site, three small scoops of sediment (to a depth no greater than 10cm) were taken for organic carbon, metals and granulometry analysis. The samples were placed in clean, sterile, plastic bags and labelled.

Samples for chemical analysis were packed for transport (via courier) to City Analysts, Dublin. Samples for granulometry analysis were packaged 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	LOD*
Granulometry	Sieving	% Coarse Sand (2mm – 710μm); % Medium Sand (710 μm – 250 μm); % Fine Sand (250 μm - 63 μm); % Silt/Clay (< 63 μm)	N/A
Organic Carbon	Loss on Ignition (LOI)	%	0.10%
Kjeldahl Nitrogen	Kjeldahl digestion	mg/kg	5 mg/kg
Arsenic	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Cadmium	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Chromium	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Copper	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Lead	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Nickel	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Zinc	Atomic adsorption spectrometry (AAS)	mg/kg	1 mg/kg
Mercury	Atomic adsorption spectrometry (AAS)	mg/kg	0.02 mg/kg

*** limits of detection (as specified by City Analysts Ltd)**

There is no one unified method for assessing contaminant levels within marine sediment and we examined the 2011 results using three different criteria as follows:

(1) Agreed ecotoxicological assessment criteria (OSPAR 1997, 97/15/1 Annex 6);
(2) Irish SQG's for dredged sediment (Marine Institute, 2006);
(3) The US EPA Effects Range (ER) values.

These criteria are outlined in Appendix 3.3.

3.3 Results

3.3.1 Intertidal flora and fauna

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.

The majority of sampling sites are characterised by an intertidal zone comprising of an upper shore of cobbles/pebbles which extends vertically downwards to a mudflat. The 'hard shore' of these sites can be classed as a 'mixed sediment shore' (Fossitt, 2000) and a zonation in sediment particle size from the upper to lower hard shore can be observed, the upper shore comprising of boulders, larger cobbles and pebbles which become progressively smaller down shore to where pebbles and finer gravels grade into soft sediment (mudflat). In many cases there is no clear division between the hard (stone) and 'soft' (sediment) littoral habitat. Sites M10 and M11 differ from this general pattern in that they have no 'hard' shore, rather saltmarsh lying above the mudflat.

In 2011 the fucoid zone, as in previous years, was dominated by the brown alga Egg Wrack (*Ascophyllum nodosum*) with varying amounts of Bladder Wrack (*Fucus vesiculosis*). Channel Wrack (*Pelvetia canaliculata*) can occur as a narrow band on the upper shore at some sites, most notable along the north of Rossmore Bay (M1 – M5).

The green alga *Ulva* (formerly classified as *Enteromorpha*) was recorded at seven sites. Algal mats occurred upon the mudflat and were particularly prevalent along the northern shore of Rossmore Bay.

The faunal species observed were the same as recorded in previous annual surveys. Barnacles (*Semibalanus balanoides* and *Elminius modestus*) were sparse. Amphipod crustaceans occurred that belong to the families Talitridae (Sandhoppers) and Gammaridae. Littorinid periwinkles were identified as the Common Periwinkle (*Littorina littorea*) and the Flat Periwinkle (*Littorina obtusata*). The Flat Periwinkle was more abundant on the mid to lower shore (although this was not quantified) while the Common Periwinkle was found at all shore heights. This pattern is consistent with known zonations for these species (e.g. Bishop, 2003).

It is clear that the abundance of fauna recorded on the hard shore will depend largely on how much time has elapsed since the tide has receded from the shore. This year we found that sites M1 to M8 recorded larger concentrations of species because they were sampled not long after the tide had receded. Other sites, sampled later, yielded a much lower abundance because mobile invertebrate species (e.g. crabs, amphipods) had moved, likely to seek damper conditions as the algae had dried out.

The marine biotopes assigned to the mixed substrata shoreline (hard shore) are 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*).
-
- *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 on the mudflat surface 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	38	9		100	4	9	40	86				64			30	24	9	75	63	33	80
Fucus vesiculosis		56	58	47	1	4	<4	17						49		26	43	33	25	25	1	1
Ulva sp	8		17		3	4	2						16	36								
Presence/Absence																						
Polysiphonia lanosa	X																X		X	X	X	X
Fauna																						
Barnacles (% cover)	2	8	2	8	4		2	12									2			2		
Other fauna (SACFOR Scale)																						
Amphipods	C	F	C	C	C			F	C					F		F	O		F	F		O
Carcinus maenas	A	A	A	A	A	C			A							C						
Littorina spp.		C	C	A	F	C	F	C	F					C		C	F	C		C	C	C
Arenicola marina (Casts)		X		X		X								X		X						

Flora and fauna of the mudflats

Core sample macroinvertebrates are shown in Table 3.4. Descriptions for each sampling site are given in Appendix 3.1.

A total of 14 invertebrate taxa were found within the samples (the same as in 2010). Species richness, (a measure of the total number of species or taxa per sample) varied from one to five across all sampling stations. As reported in previous annual surveys, species richness was highest within Rossmore Bay sites (e.g. M1 – M8) and generally lower at sites along the southern shore of Rossmore Peninsula (North Channel).

The total number of individuals within a sample ranged from two to 60, the latter recorded for site M1 which recorded a large abundance of the Mud Snail *Hydrobia ulvae.*

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 fit easily into a biotope category so a best-fit is used, or an upper biotope code assigned. Biotopes assigned in 2011 are as follows (and see Appendix 3.1):

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 sandy 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.
2. LS.LMu.UEst.Hed *Hediste diversicolor* in littoral mud – a biotope of mid and lower shores in upper or mid estuaries and characterised by abundant or superabundant Ragworms *Hediste diversicolor.*
3. LS.LMu.UEst.Hed.Cvol *Hediste diversicolor* and *Corophium volutator* in littoral mud
4. LS.LSa.MuSa Polychaete/bivalve dominated muddy sand shores - an upper biotope code used to cover a range of biotopes that could occur**.**

These results are discussed in Section 3.4

Table 3.4 Benthic macrofauna within core samples (2011). 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	2		4		1										1						1	
Nepthys sp.	2			1			1		1			2	1	2		3		1	1			3
Spionid indent.					1									3		2			1			
Arenicola marina													1									
Ampharete acutifrons	5			2																		
Class Oligochaeta																						
Oligochaetes								1						3								
Phylum Mollusca																						
Class Gastropoda																						
Hydrobia ulvae	50	2	23		1	11	2	3					1									
Littorina littorea		1	1					1	1	1												
Class Bivalvia																						
Cerastoderma edule												1										
Scrobicularia plana	1		1						1			1	1									

Phylum Crustacea																						
Order Amphipoda																						
Corophium volutator					1				1	20	20			40	1	1						
Gammarus sp.						1				1												
Order Decapoda																						
Crangon crangon										1		1				2		1			1	
Carcinus maenas								1														
Total No. Individuals	60	3	29	3	4	12	3	6	4	23	20	5	4	48	2	8	0	2	2	0	2	3
Total No. Species/taxa	5	2	4	2	4	2	2	4	4	4	1	4	4	4	2	4	0	2	2	0	2	1

3.3.2 Sediment particle size analysis (granulometry)

Results of granulometry (sediment particle size) analysis are shown in Table 3.5 and discussed in Section 3.4.2.

Table 3.5 Granulometry Results 2011

Site	% Gravel >2mm	%Coarse Sand 2mm-710µm	% Med Sand 710-250 µm	% Fine Sand 250-63 µm	% Silt/Clay < 63 µm	Notes
SS1	0.00	0.0	0.0	3.8	96.2	Silt Clay (Mud)
SS2	0.0	0.4	0.3	39.3	60.0	Silt Clay (Mud)
SS3	0.0	0.2	1.2	34.3	64.3	Silt Clay (Mud)
SS4	0.0	0.2	0.7	26.0	73.1	Silt Clay (Mud)
SS5	0.8	0.6	0.0	46.2	52.3	Sandy Silt (Sandy Mud)
SS6	0.0	0.2	0.5	42.9	56.4	Sandy Silt (Sandy Mud)
SS7	0.0	0.4	0.9	34.3	64.5	Silt Clay (Mud)
SS8	0.0	0.5	7.9	49.3	42.2	Muddy sand
SS9	15.4	3.8	4.0	32.0	44.7	Sandy Silt (Sandy Mud)
SS10	0.0	0.5	12.6	51.9	34.9	Muddy sand

3.3.3 Sediment chemistry results

Sediment chemical analysis

Results of the sediment chemical analyses are shown in Table 3.6 and discussed in Section 3.4.2. The highest result of any parameter is shaded. Note that SS10 is a control (duplicate) of SS8.

Table 3.6 Sediment Chemical Analysis (2011)

Parameter	Units	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10
Organic Carbon	%	2.3	3.4	4.1	3.0	6.7	3.9	4.2	2.9	3.6	2.6
Kjeldahl Nitrogen	mg/g N	0.52	0.78	.25	0.44	1.00	0.12	0.22	0.25	0.71	0.53
Arsenic	mg/kg	7.9	8.1	9.5	7.5	8.3	8.1	9.4	8.5	11.0	10.0
Cadmium	mg/kg	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium	mg/kg	15.0	20.0	21.0	14.0	18.0	22.0	21.0	13.0	19.0	16.0
Copper	mg/kg	9.0	13.0	14.0	18.0	19.0	15.0	15.0	9.0	13.0	10.0
Lead	mg/kg	17.20	21.4	28.5	23.0	22.5	22.5	22.7	15.0	20.1	16.9

Nickel	mg/kg	11.4	13.8	15.1	10.9	13.8	16.4	14.3	10.0	13.7	12.3
Zinc	mg/kg	61.7	82.0	86.5	69.9	84.7	88.1	87.6	61.1	82.1	69.0
Mercury	mg/kg	0.71	0.41	0.34	0.24	0.21	0.19	0.21	0.15	0.17	0.14

3.4 Discussion

3.4.1 Intertidal flora and fauna

Monitoring by definition is the intermittent measuring or observation of a feature over time, in order to assess whether this feature is deviating from an accepted 'norm.' Therefore the following discussion examines selected characteristics of the intertidal habitat and communities and assesses how these may have changed over time.

Hard Shore flora and fauna

Species/community composition

The macroalgal community is dominated by Egg Wrack (*Ascophyllum nodosum*). Percentage cover at 12 of the 22 sampling sites has averaged at over 50% over the past six-year period.[1] In general, sampling sites along the northern shore of Rossmore Bay have a greater cover of this seaweed; site M5 for example has exhibited a very stable community with % cover ranging from 83% to 100% (average 95% ± 8) over the past six years. *Ascophyllum nodosum* is generally a stable species and can live up to 25 years (Connor et al. 2004). Sampling sites around Rossmore Peninsula have a more variable cover of this alga, and this is to be expected given the greater exposure of this area as opposed to the comparative shelter of Rossmore Bay.

Abundance of Bladder Wrack (*Fucus vesiculosis*) has been more variable across the years. Of note is the absence of this species at M8 (directly south of the quarry) since 2006.

The green macroalga *Ulva* sp. occurs in varying amounts and occurs regularly as an algal mat along the northern shore of Rossmore Bay, the extent of which does not seem to have increased over the years.

The species composition of the 'hard shore' fauna has remained relatively consistent throughout the monitoring period. Amphipods, shore crabs and Littorind periwinkles have been recorded in every year. Barnacles have shown the consistent trend of being more abundant along the northern shore of Rossmore Bay and less abundant at sampling sites around Rossmore Peninsula.

Invertebrate abundance

Little can be inferred from looking at invertebrate numbers as it is clear that abundance of invertebrates within quadrats is linked to the time of sampling (i.e. how long since the tide has receded from the shore) and because sites cannot be sampled at the same time, they are all likely to differ. This year sites along the northern shore of Rossmore Bay were sampled just after the tide had gone out (15/10/11) and we recorded large abundances of some invertebrates (e.g. littorinid periwinkles, amphipods) as well as a greater frequency of occurrence of shore crabs (*Carcinus maenas*) in comparison with recent years. Of note along this shoreline was a very large concentration of Littorind periwinkles upon the upper shoreline (above the fucoid zone). Phenomenal numbers were present, the

[1] Analysed over the past 6 years during which Limosa Environmental has collected quantitative data in the same way each year; sampling methodology varied somewhat previous to this.

snails literally carpeting the shoreline, and this was causing a waterbird 'feeding frenzy' that was observed as the survey commenced.

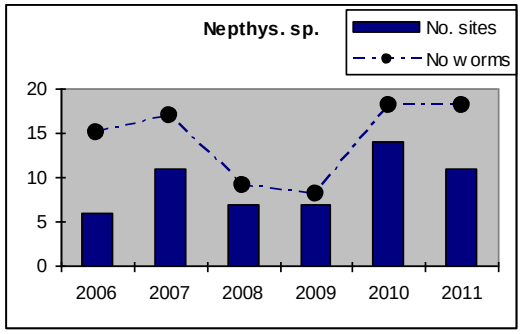
Overall the monitoring results suggest that the community of the 'hard' shoreline has been stable across the sampling period. *Fucus vesiculosis* and *Ascophyllum nodosum* are the dominant flora and together they form the biotope (*'Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock' (LR.LLR.FVS.AscVS)) that dominates the hard shore habitat and has been present consistently throughout the entire landfill monitoring programme. In general, biotope distribution of the 'hard' shore has been very consistent over time.

Mudflat flora and fauna

Species/community composition

The large polychaete *Nepthys* sp. (*Nepthys caecea* and *Nepthys hombergi*) continues to dominate the macroinvertebrate community and apart from lower abundances in 2008 and 2009, has been relatively stable across time in terms of total abundance (Figure 4). This species is listed as a characterising species for the Great island Channel SAC (NPWS, 2001).

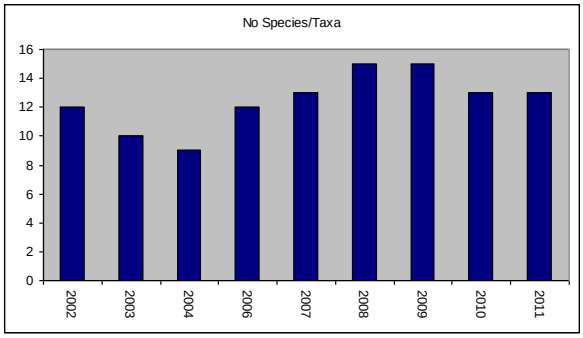
Figure 4 Total number of *Nepthys* sp. worms and number of sites it was recorded at 2006 – 2011.



The polychaete *Hediste diversicolor* is also a characterising species and has been present in every sampling year. The crustacean *Corophium volutator* occurs consistently at sites M9, M10 and M11 (in at least five of the past six years), associated with the soft silt sediment of inner Rossmore Bay. It has been recorded with less frequency at several other sites.

Species diversity in 2011 was the same as recorded for 2010 (Figure 5). The overall trend since 2002 has been for stable/increasing species diversity. Sampling sites within Rossmore Bay (M1-M9) are more diverse than sites along the southern shore of Rossmore Peninsula (North Channel).

Figure 5 Species diversity (total no species/taxa each year) across the monitoring programme



Invertebrate abundance

The Mud Snail *Hydrobia ulvae* was the second most widespread invertebrate in 2011; recorded at eight sites. Only in one other year (2008) has such widespread distribution been recorded. The abundance recorded in 2011 is the highest in recent years (Figure 6).
The Mud Snail occurs almost exclusively within sampling sites of Rossmore Bay (M1 – M9) and within M13.

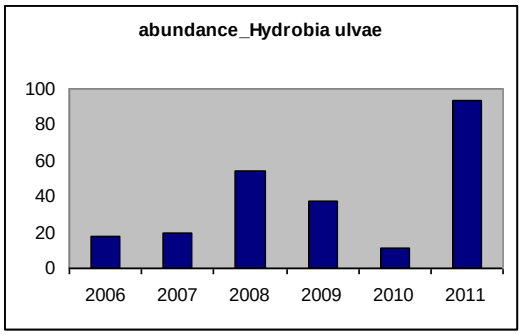


Figure 6 Total number of *Hydrobia ulvae* recorded 2006 – 2011.

Numbers of the polychaete *Hediste diversicolor* were down slightly this year in contrast to recent previous years. This may be due to the domination of *Nepthys* sp. (Figure 4) which may out-compete *Hediste*. Indeed, previous research has shown patterns of oscillating dominance between these two species, one year *Nepthys* sp. dominating and the following year *Hediste* dominating. Variations in salinity have been postulated as a reason but the true reason for the observed pattern is not known (Gray & Elliott, 2009) and could simply be due to variations in annual reproduction rates.
Overall, the long-term macroinvertebrate dataset shows that the species that characterise the sampling area have continued to be present and abundant across the monitoring period. Biotope composition has remained relatively stable over time.

3.4.2 Granulometry & sediment chemistry - discussion

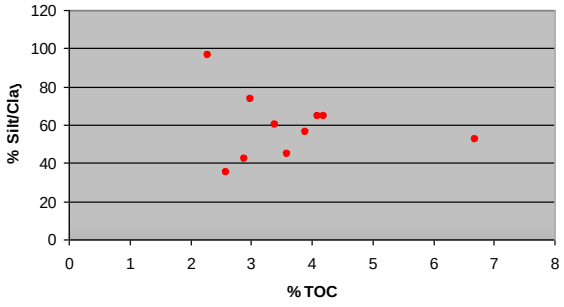
Granulometry

Granulometry results show that the sampling stations are comprised mostly of fine silt sediment (mud), although a sand fraction is more obvious in samples SS5, SS6 and SS9. Two samples, SS8 and SS10 are classified as muddy sand and comprised a greater proportion of sand. This result is reasonably consistent with previous years when SS8 recorded variable amounts but approaching 50% sand particles. Note that SS10 was a replicate (control) of SS8 and the two results therefore compare favourably. SS9 was notable in containing 15% gravel. As found in previous annual surveys, Site SS1 had the greatest proportion of fine particles (i.e. particles < 63 µm in size).

Sediment chemical analysis

- *% 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 often closely correlated with sediment particle size; higher organic carbon being found in muddier sediments. This relationship was tested with the results from 2011 sampling and although appearing to hold true for six of the samples, overall no linear relationship between these carbon and % silt/clay was found (see graph).



Recorded OC values ranged from 2.3% (SS1) to 6.7% (SS5); values over 5% generally indicate 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 ranged from 0.12 mg/g N (SS6) to 1.00 mg/g N (SS5) and are within the considered normal range for an estuary that is subject to a variety of anthropogenic influences.

Metals

- **Arsenic**

With the exception of one sample (SS9), no recorded level exceeded the upper range of the ecotoxicological assessment criteria (EAC) proposed by OSPAR. Four levels however were above the Irish Sediment Quality Guideline (SQG) lower level. Six samples were above the lower effects range (ER_L) values as proposed by the US EPA but no samples were above the median effects range (ER_M).

- **Cadmium**

No sample exceeded the upper range of the ecotoxicological assessment criteria (EAC) proposed by OSPAR, or the upper Irish Sediment Quality Guideline (SQG), or the US EPA lower effects range (ER_L). Based on the definitions of the assessment criteria, no ecological effects are therefore considered likely.

- **Chromium**

Concentrations ranged from 13mg/kg to 22mg/kg (SS6) and no sample exceeded the upper range of the ecotoxicological assessment criteria (EAC) proposed by OSPAR, or the lower Irish Sediment Quality Guideline (SQG). Based on the definitions of the assessment criteria, no ecological effects are therefore considered likely.

- **Copper (Cu), Lead (Pb) and Nickel (Ni)**

For these three metals, no sample exceeded the upper range of the ecotoxicological assessment criteria (EAC) proposed by OSPAR, or the lower criteria value of either the Irish Sediment Quality Guideline (SQG) or the US EPA effects range (ER_L). Based on the criteria definitions, the recorded levels are considered unlikely to impart any ecological effects.

- **Zinc**

All samples exceeded the lower range of the ecotoxicological assessment criteria (EAC) proposed by OSPAR (50mg/kg) but no sample exceed the upper range (500mg/kg). No sample exceeded the lower criteria value of either the Irish Sediment Quality Guideline (SQG) or the US EPA effects range (ER_L). Based on the definitions of the assessment criteria, no ecological effects are therefore considered likely.

- **Mercury**

All sediment samples contained levels that exceeded the lower range of the ecotoxicological assessment criteria (EAC) proposed by OSPAR (0.05mg/kg). One sample however (SS1) located within Brick Island Embayment, contained 0.71mg/kg mercury, surpassing the upper recommended level (0.5mg/kg). Sample SS1 also exceeded the upper criteria value of the Irish Sediment Quality Guideline (SQG) and the US EPA effects range (ER_M). Recorded levels at SS1 therefore have the potential to have adverse effects upon marine life.

General discussion

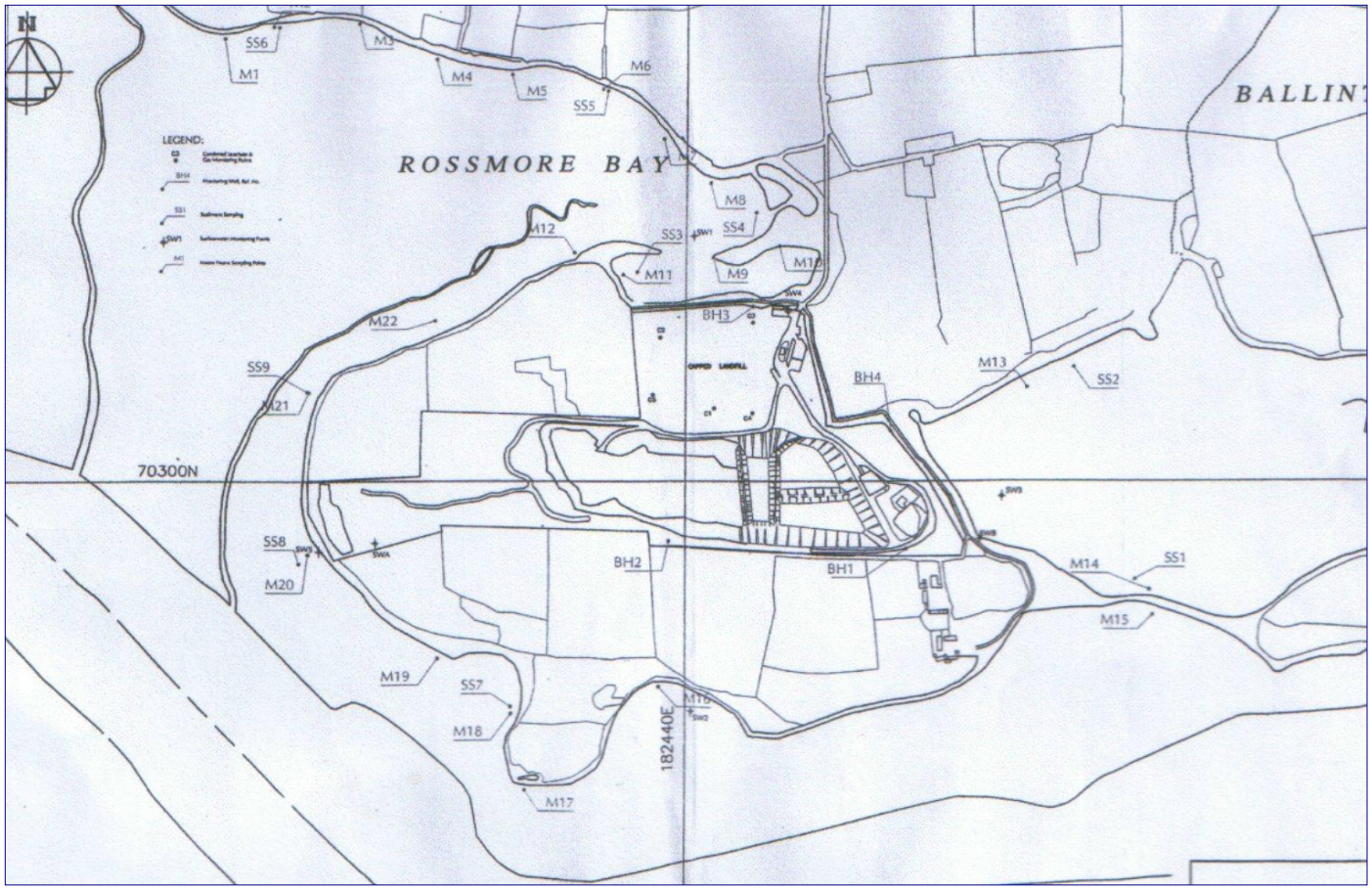
Two metals were recorded this year in concentrations that are notable:-

►Levels of Arsenic were above the ER_L at five sites (SS3, SS5, SS7, SS8 & SS9) and based on the definitions of the US EPA Effects Range assessment criteria, adverse ecological effects may result. By way of comparison, Giltrap (2008) reported levels in Dublin Bay of up to 15.4mg/kg. Recorded levels within the study area are therefore in the usual range for an urban/industrially-influenced estuary, albeit that these levels have the potential for adverse effects upon marine life.

►One sample (SS1) located within Brick Island embayment, contained levels of Mercury that surpassed the upper recommended level of the OSPAR EAC (0.5mg/kg), the upper criteria value of the Irish Sediment Quality Guideline (SQG) (related to dredged sediment) and the US EPA effects range (ER_M). The recorded levels at SS1 (0.71 mg/kg) therefore have the potential to have adverse effects upon marine life.

By way of comparison, the background concentration (i.e. pristine sites) is proposed at 0.05mg/kg (OSPAR Agreement 2005-06). Giltrap (2008) reported levels in Dublin Bay of up to 0.28 mg/kg, significantly lower than recorded at SS1 and taken from a port-side sampling station. The levels recorded within Brick island embayment are therefore considered particularly and unusually high, all levels in 2010 for example being <0.35mg/kg.

Appendix 3.1



Intertidal sampling sites. Macrofaunal sampling sites are numbered M1 to M22; sediment sampling sites for chemical analysis are numbered SS1 to SS9.

Appendix 3.2

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 sediment composition and the fauna recorded within core samples. For the 'hard shore' a biotope is assigned based on the results of the quadrat sampling (flora and fauna).

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 (mud) sediment. Patchy algal mat**	**Below zone of barren stones/cobbles (c15m) is a narrow (*c* 1m) zone of Channel Wrack (*Pelvetia caniculata*) followed by a circa 13m fucoid 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)**
M2	**181912 070885**	**Northern shore of Rossmore Bay. As M1.**	**Soft silt (mud) sediment classified as sandy mud following granolometry analysis of SS6. Similar to M1. Patchy algal mat. Lugworm casts abundant.**	**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. Algal mat present.**	**Wider zone of barren boulders and cobbles at top of intertidal. Fucoid zone is *c* 8m wide.**	**Hard Shore: *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) Mudflat: LS.LMu.UEst.Hed *Hediste diversicolor* in littoral mud**
M4	**182091 070864**	**Northern shore of Rossmore Bay. Upper shore bordered by hedgerow & treeline of quarry site.**	**Fine silt/clay sediment. Algal mat present.**	**Similar to M1-M3 but fucoid zone not as dense.**	**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.**	**Sandy mud sediment (as confirmed by granolometry analysis of SS5). Patchy algal mat but less dense than m1-M4.**	**Upper zone (*c* 25m) of barren cobbles merges into narrow (6m) fucoid zone.**	**Hard Shore: *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) Mudflat: LS.LMu.UEst.Hed *Hediste diversicolor* in littoral mud**
M6	**182352 070793**	**Northern shore of Rossmore Bay.**	**Sandy mud sediment. Patchy algal mat. Lugworm (*Arenicola marina*) casts present.**	**Quarry track on upper shore then a 10m zone of barren cobbles/ pebbles. Below is a 10m fucoid zone (sparse cover).**	**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)**
M7	**1820415 070714**	**Northern shore of Rossmore Bay.**	**Sandy clay sediment. Patchy algal mat.**	**Similar to M6, 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**	**Firm silt/clay sediment.**	**Quarry road above. Mixed substrata shore.**	**Hard Shore: *Ascophyllum nodosum* and *Fucus***

		Rossmore Bay, directly south of quarry.		**Patchy fucoid zone.**	***vesiculosis* on variable salinity mid eulittoral rock (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. No algal mat. Lugworm casts abundant.**	**Upper zone of saltmarsh (10m). Fucoid zone extends down onto gravely mudflat.**	**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 – upper saltmarsh (Sea Purslane) grades into lower saltmarsh (*Spartina*).**	**Saltmarsh (LS.LMp.Sm) Mudflat: Polychaete/bivalve dominated mid estuarine shore**
M11	**182339 070562**	**Sheltered inner Rossmore Bay surrounded by lower saltmarsh incl. *Spartina* sp.**	**Soft silt/ clay.**	**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.**	**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, then a 20m fucoid**	**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) 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. c 12m fucoid 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)**
M14	**182966 070163**	**Along southern shore of Brick Island embayment.**	**Soft silt/clay. Lugworm casts abundant. Green algal mat c 12m out.**	**Saltmarsh upon upper shore dominated by Sea Purslane. Then a very narrow zone (c12m) of sparse algae.**	**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.**	**Mud covered cobbles on upper mudflat**	**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 mid-eulittoral variable salinity boulders and stable mixed substrata (LR.LLR.Fves.VS) Mudflat: LS.LMu.UEst.Hed.Cvol *Hediste diversicolor* and *Corophium volutator* in littoral mud.**
M16	**182428**	**Southern shore**	**Gravelly mud.**	**Has a typically observed**	**Hard Shore:**

	070041	**of Rossmore peninsula.**		**zonation: saltmarsh and shingle on upper shore – large stones/cobbles – fucoid zone (c12m wide) – mudflat.**	***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.**	**Gravely mud.**	**Mixed substrata shore (boulders, cobbles & pebbles.**	**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. Fucoid 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. Channel approx. 100m offshore.**	**Wide strip of saltmarsh above a 30-40m algal zone. Mid shore of pebbles/gravel substratum. Fucoid zone is sparse.**	**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 peninsula.**	**Muddy sand sediment. Channel is *c* 15m distance. Smooth surface, no surface signs of invertebrates.**	**Upper zone of saltmarsh; zone of cobbles and pebbles then a fucoid zone (c30m width).**	**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).**
M21	**181996 070458**	**Western shore of Rossmore peninsula.**	**Narrow area of mudflat as a channel occurs just offshore (15m). Sandy mud sediment.**	**Mixed substrata shore – larger cobbles give way to smaller pebbles/gravel down shore. Sparse fucoid zone.**	**Hard Shore: *Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock (LR.LLR.FVS.AscVS) Mudflat: LS.LMu.UEst.Hed *Hediste diversicolor* in littoral mud**
M22	**182165 070536**	**Southern shore of Rossmore Bay**	**Clay sediment.**	**Narrow upper band of saltmarsh. Mixed substrata shore (boulders, cobbles & pebbles). Sparse algal zone c 20m width..**	**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 3.3 Sediment Quality Guidance Criteria

(1) OSPAR Environmental Assessment Criteria (EACs)

OSPAR are currently developing Environmental Assessment Criteria (EACs) based on available ecotoxicological information (Ospar Commission, 2009). In the interim, ecotoxicological assessment criteria are sometimes used to assess contaminant levels but these are only provisional levels.

Agreed ecotoxicological assessment criteria (OSPAR 1997) 97/15/1 Annex 6.

Substance	Unit	Provisional sediment criteria
As	mg/kg	1 – 10
Cd	mg/kg	0.1 – 1
Cr	mg/kg	10 – 100
Cu	mg/kg	5 - 50
Hg	mg/kg	0.05 – 0.5
Ni	mg/kg	5 – 50
Pb	mg/kg	5 - 50
Zn	mg/kg	50 - 500

(2) Irish Sediment Quality Guideline (SQG)

The Marine Institute (MI) has developed guidelines for the assessment of dredge material for disposal in Irish waters (Marine Institute 2006). They include guideline 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 parameters content uses a system 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	**mg/kg^{-1}**	**120**	**370**
Copper	**mg/kg^{-1}**	**40**	**110**
Lead	**mg/kg^{-1}**	**60**	**218**
Mercury	**mg/kg^{-1}**	**0.2**	**0.7**
Nickel	**mg/kg^{-1}**	**21**	**60**
Zinc	**mg/kg^{-1}**	**160**	**410**

(3) The US Environmental Protection Agency (EPA) - Effects Range (ER)

The US Environmental Protection Agency (EPA) have developed Effects Range (ER) values to be used to assess the quality of coastal and estuarine environments and the ecological significance of the concentrations of hazardous substances found in sediment (USEPA, 2002; Long et al. 1998). ER values were established as sediment quality guidelines to be used to predict adverse biological effects on organisms. Two main assessment criteria were calculated. The ERM is defined as the median concentration (50th percentile) of a contaminant observed to have adverse biological effects in literature studies. A more protective indicator of contaminant concentrations is the ERL criterion, which is the 10th percentile concentration of a contaminant, represented by studies demonstrating adverse biological effects in the literature. Ecological effects are not likely to occur at contaminant concentrations below the ERL criterion (Long et al. 1998).

Substance	Unit	ER_L	ER_M
As	mg/kg	8.2	70
Cd	mg/kg	1.2	9.6
Cr	mg/kg	81	370
Cu	mg/kg	34	270
Hg	mg/kg	0.15	0.71
Ni	mg/kg	20.9	51.6
Pb	mg/kg	46.7	218
Zn	mg/kg	150	410

4.0 WATERBIRD SURVEY AND ASSESSMENT

4.1 Overview of study area

East Cork Landfill is located adjacent to Cork Harbour North Channel. 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 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 wetland complex, together with enrichment from the river inputs, have resulted in Cork Harbour being one of the prime sites for waterbirds within Ireland, and one of a short list that regularly support greater than 20,000 waterbirds 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 relatively 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 site is of international importance both for the total numbers of wintering birds (i.e. >20,000) and also for its internationally important[2] wintering populations of Black-tailed Godwit and Redshank. In addition, there are over 15 wintering species that have populations of national importance, as well as a nationally important breeding colony of Common Tern, an Annex I species. Several other species which occur regularly are also listed on Annex I of the E.U. Birds Directive, e.g. Golden Plover and Bar-Tailed Godwit.

The qualifying interests (now called 'species of special conservation interests') for Cork Harbour SPA 4030 are listed in Table 4.1. The SPA Site Synopsis (NPWS) is shown in Appendix 1.1.

TABLE 2: WATERBIRD SPECIES OF SPECIAL CONSERVATION INTEREST FOR CORK HARBOUR SPA (ALPHABETICAL ORDER)

Common Name	Scientific Name	Annex I Species
Bar-tailed Godwit*	*Limosa lapponica*	*Yes*
Black-headed Gull	*Chroicocephalus ridibundus*	
Black-tailed Godwit	*Limosa limosa*	
Common Gull	*Larus canus*	
Common Tern*	*Sterna hirundo*	*Yes*
Cormorant	*Phalacrocorax carbo*	
Curlew	*Numenius arquata*	
Dunlin	*Calidris alpina*	
Golden Plover*	*Pluvialis apricaria*	*Yes*
Great Crested Grebe	*Podiceps cristatus*	

[2] Definitions and descriptions of 'internationally' and 'nationally important' thresholds are provided in Section 4.3.

Grey Heron	*Ardea cinerea*	
Grey Plover	*Pluvialis squatarola*	
Lapwing	*Vanellus vanellus*	
Little Grebe	*Tachybaptus ruficollis*	
Oystercatcher	*Haematopus ostralegus*	
Pintail	*Anas acuta*	
Red-breasted Merganser	*Mergus serrator*	
Redshank	*Tringa totanus*	
Shelduck	*Tadorna tadorna*	
Shoveler	*Anas clypeata*	
Teal	*Anas crecca*	
Wigeon	*Anas penelope*	

4.2 Methodology

As part of the annual ecological monitoring, surveys and assessment are required of the waterbirds that occur within Cork Harbour adjacent to East Cork Landfill. The monitoring objectives are met through the undertaking of waterbird surveys and examination of their results, and through the review of data from the Irish Wetland Bird Survey (I-WeBS), as follows:

(1) Waterbird Surveys of Rossmore Bay & Brick Island Embayment

Throughout the time period that the East Cork Landfill monitoring programme has been undertaken, annual 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).

For the 2011 monitoring period, surveys were undertaken on 29/10/11, 11/11/11, 25/11/11, 28/12/11 and 07/01/12. On each visit, waterbird counts were conducted on an hourly basis, alternating between Zone A and Zone B within each 30-minute period. Each 30-minute period was split into 20 minutes for counting waterbirds and 10 minutes for walking between vantage points. 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.

(2) Waterbird Survey of Rossmore Peninsula

On one occasion (07/10/11) a waterbird survey was undertaken within four survey zones A-D, as shown in Figure 7. The survey was undertaken on a rising tide. This survey aimed to record the full range of waterbird species that may be present in the estuarine habitat surrounding the landfill site.

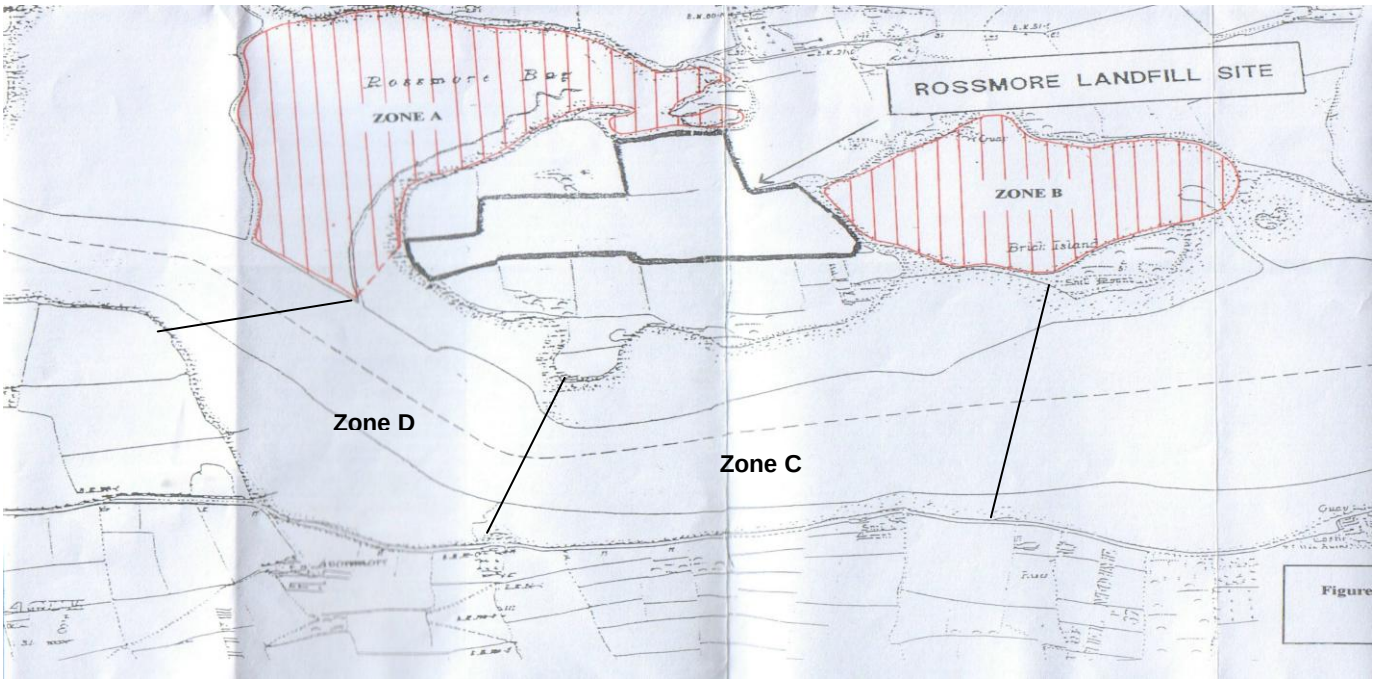


Figure 7 Estuarine Bird Survey Zones A-D

(3) Review of data from the Irish Wetland Bird Survey

Wintering waterbirds are monitored annually at major wetland sites around Ireland by the Irish Wetland Bird Survey (I-WeBS). This survey 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 waterbird 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 its 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 subsites:

- North Channel – Ballintubbrid (W 810 702) – the largest subsite and running directly south of Rossmore peninsula
- Weir Island (W 810 710)
- Brick Island (W820 700)
- Ballintubbrid (W840 702)
- Rathcoursey & Ahanesk (W870 700)

I-WeBS data were obtained from BirdWatch Ireland for subsites adjacent to East Cork landfill and for the entire Cork Harbour wetland complex. Data obtained for each of the previous annual landfill monitoring assessments were

compiled to result in a dataset that spans the period 1998/99 – 2009/10. Analyses and assessment were carried out as described in Section 4.3.

4.3 Data assessment and presentation

Throughout the text, common names are used for bird species. A list of all bird species mentioned in the text together with their Latin names, is given 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. Because the Irish Wetland Survey is a survey undertaken during a rising tide or at high tide, we designed the waterbird surveys at Rossmore to be undertaken during the low tide period, and importantly when most waterbirds are feeding. To allow comparison of 2011 data with previous data, we compiled data collected in a similar way since 2006[3] and assigned 'tidal stages' to each survey undertaken (see box below). Thereafter during data analyses, we used only data that had been collected during tidal stage 2 or 3 to ensure consistency between the annual datasets.

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 assessed peak numbers. Averaging numbers across a season is erroneous because the species concerned are migratory and numbers may differ throughout a wintering season due to e.g. the influx of passage birds. Because the data has been collected in a standard manner over the past six years (see above), we also employed an indexing and trend analysis method for selected waterbird species. This was also used for assessment of I-WeBS data for two subsites: Brick Island and Weir Island; this method could not be used for the North Channel-Ballintubbrid subsite because there have been changes in the subsite boundary and dataset during the data period. 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

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).

❖ **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

[3] 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.

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 surveys were assessed in light of national and international legislation and with reference to 'Birds of Conservation Concern in Ireland' (Lynas et al., 2007) as follows:

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.

Wildlife Act, 1976 and Wildlife Amendment Act (2000) principal national legislation that protects all bird species, their nests and eggs.

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

4.4.2

A list of all waterbird species recorded during the 2011 surveys is shown in Appendix 4.1 (final column of table). 26 waterbird species were recorded in total in 2011. This list included two species listed on Annex I of the EU Birds Directive (Little Egret & Bar-Tailed Godwit).

A diversity of species was recorded representing several waterbird families: 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. Notably absent this year were Grebe species Great Crested Grebe and Little Grebe, usually recorded in the North Channel (Zones C and D) and occasionally within Brick Island Embayment.

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

Data from the bird survey covering the four zones around Rossmore peninsula (A, B, C & D) are given in Table 4.1. Eight waterbird species were recorded overall, with a maximum six species within any one count zone. In comparison with previous years, species diversity was low with a low number of species within the North Channel zones (C & D) and a notable lack of regular species such as Great Crested Grebe and Red-breasted Merganser. However, these results are in line with other counts at Irish wetland sites during October 2011, the low abundance of waterbirds likely related to later-arriving migratory birds as a result of weather patterns (L.J. Lewis. *pers. obs.* NPWS Waterbird Survey programme).

Numbers of birds within Zone B (Brick Island) far exceeded those in other zones. Despite the rising tide, many waders were still finding feeding opportunities within higher raised sandflats in the middle of the subsite, including good numbers of Black-tailed Godwits and Redshank. As the tide encroached, Redshank were seen to fly off to roost along

the northern shore of Brick Island. This is a known important roosting area and over 100 Redshank roosted there by the end of the observation period.

Table 4.1 Data from the North Channel bird survey 07/10/2011

	07/10/2011			
	Zone A	Zone B	Zone C	Zone D
Time	14:55	13:54	14:09	14:35
Tide Time	HT – 1	HT – 2	HT – 1	HT – 1
Tidal State	Rising	Rising	Rising	Rising
Conditions	30-70% cloud, Light – moderate breeze. Good visibility (bright & sunny)			
Cormorant	10			2
Oystercatcher	11	2	1	24
Black-tailed Godwit		47		
Curlew	6	5		
Greenshank	1	5		1
Redshank	4	123	3	2
Turnstone				
Black-headed Gull	7	10	5	
Total No. Species	6	6	3	4
TOTAL	39	192	9	29

4.4.5 Waterbird surveys of Zones A and B

Raw 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 of 24 waterbird species were recorded within Zone A and 21 waterbird species within Zone B.

The highest number of waterbirds recorded within Zone A (Rossmore Bay) during any one count was 1,163 on 11th November 2011; 63% of which comprised Black-tailed Godwits. This is the second highest peak number recorded in the six-year data period.

Zone B (Brick Island) recorded its peak number (230 waterbirds) on 29th October 2011. This peak is the second lowest recorded during the six-year data period.

The peak total numbers and peak diversity (2006 – 2011) (Table 4.2b) shows great variation across time but species diversity is relatively stable.

Table 4.2a Peak total waterbird numbers and peak number of species within any one replicate survey of Zone A and Zone B **on each of the survey dates**

Zone	Peak Numbers	**Peak no. species**	**Peak Numbers**	**Peak no. species**
	Zone A	**Zone A**	**Zone B**	**Zone B**
29/10/11	**241**	**9**	**230**	**14**
11/11/11	**1,163**	**9**	**76**	**8**
25/11/11	**649**	**8**	**72**	**7**
28/12/11	**380**	**8**	**159**	**7**
07/01/12	**366**	**8**	**70**	**7**

Table 4.2b Peak total waterbird numbers and peak number of species within any one survey of Zone A and Zone B 2006 - 2011

Zone	Peak Numbers	**Peak no. species**	**Peak Numbers**	**Peak no. species**
	Zone A	**Zone A**	**Zone B**	**Zone B**
2011	**1,163**	**9**	**230**	**14**
2010	**833**	**14**	**631**	**14**
2009	**556**	**14**	**337**	**18**
2008	**1,558**	**14**	**931**	**12**
2007	**727**	**13**	**152**	**9**
2006	**446**	**9**	**792**	**11**

The most regularly-occurring species within Zone A were Shelduck, Wigeon, Oystercatcher, Dunlin, Black-tailed Godwit, Curlew, Redshank and Black-headed Gull. The most regularly-occurring species within Zone B were Wigeon, Oystercatcher, Black-tailed Godwit, Curlew, Redshank, Greenshank and Black-headed Gull.

Dunlin only occurred within Zone B during three replicate surveys on two survey days (maximum number 82). As in previous years, this small wader was more regularly recorded within Zone A. The high arctic-breeding wading bird Knot occurred once on 29/10/11 within Zone B (127 individuals). Lapwing, a species previously recorded at the sites, was not recorded during 2011. Gull numbers and diversity was very low.

Table 4.3 shows the peak number of selected waterbird species for each of the survey dates. The season peak number is shaded. This dataset highlights the great variability between monthly counts with different species peaking in numbers in different months. Shelduck numbers rose from a low ten individuals in October 2011 and then remained relatively stable within Rossmore Bay (Zone A) across the survey period. Black-tailed Godwit numbers fluctuated greatly within both zones. Peak numbers of Redshank were remarkably similar across the survey period within Brick island Embayment (Zone B). Curlew numbers were slightly higher within both zones earlier in the survey period then remained relatively stable for the latter surveys.

Table 4.3 Peak numbers of selected waterbird species within Zone A and Zone B on each survey date

Species	29/10/11	**11/11/11**	25/11/11	**28/12/11**	**07/01/12**
Zone A					
Shelduck	**14**	**74**	101	69	80
Wigeon	**-**	**10**	38	2	12
Oystercatcher	**26**	**73**	145	267	207
Dunlin	**71**	**270**	359	1	-
Black-tailed Godwit	**31**	**730**	21	28	23
Curlew	**41**	**32**	15	9	11
Redshank	**71**	**81**	90	44	61
Black-headed Gull	**104**	**4**	-	3	1
Zone B					
Wigeon	**3**	**5**	22	23	17
Oystercatcher	**10**	**15**	5	3	9
Black-tailed Godwit	**43**	**1**	5	1	-
Curlew	**18**	**13**	10	7	9
Redshank	**52**	**41**	41	44	35
Greenshank	**1**	**3**	-	1	1
Black-headed Gull	**2**	**2**	5	2	4

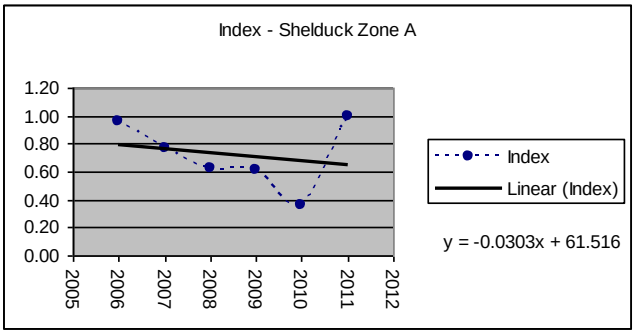
To enable comparison between years we compiled a dataset containing the annual peak numbers for each species that were recorded during the low tide period (tidal stages 2 or 3). Within this standardised format, data is available for the six-year period 2006 – 2011 inclusive.

Table 4.4 shows peak waterbird numbers within Zone A. The dataset shows great variability for species between years and by 'eye-balling the dataset trends are not always obvious. Further investigation of the dataset was therefore carried out using the population indexing method (See Section 4.3 for details) and selected species are discussed below.

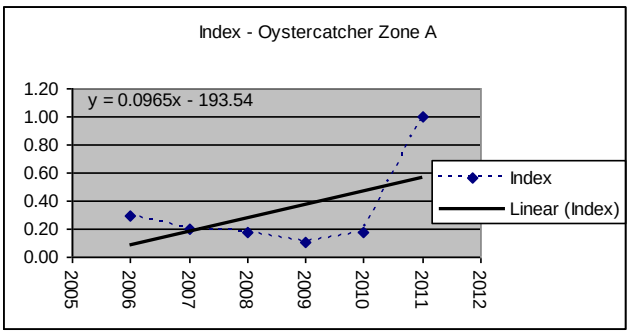
Table 4.4 Peak numbers of selected waterbird species during the low tide period within Zone A 2006 – 2011.

	2011	2010	2009	2008	2007	2006
Shelduck	101	36	62	63	78	97
Wigeon	38	0	43	15	62	50
Teal	8	43	0	21	0	45
Oystercatcher	267	42	28	46	53	80
Ringed Plover	6	13	33	9	1	0
Dunlin	359	420	381	1300	470	200
Black-tailed Godwit	730	437	0	35	80	60
Curlew	41	44	24	9	17	14
Redshank	90	199	112	108	97	139
Turnstone	56	16	81	51	65	43
Black-headed Gull	104	21	7	3	0	0

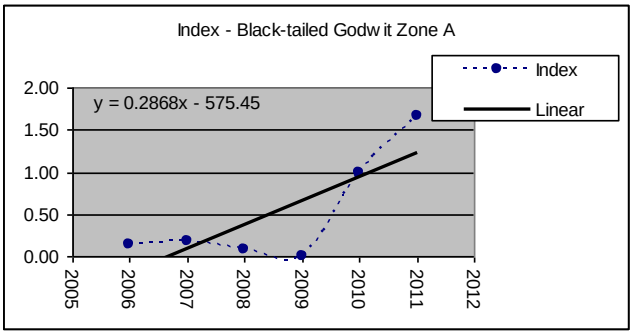
Shelduck – indexing of peak numbers reveals a steady decline across the five-year period, although higher number recorded in 2011 has moderated the decline somewhat. Indeed the numbers recorded during 2011 were the highest within the six-year data period.
During surveys, larger numbers of Shelduck were regularly observed just outside of the count area and closer to Weir Island.



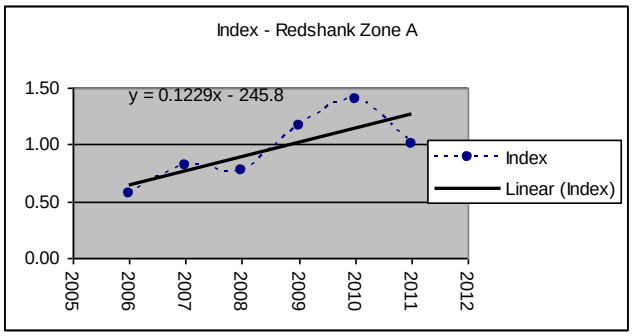
Oystercatcher – there appeared to be a steady decline up to 2009, numbers increased slightly in 2010 and significantly this year.



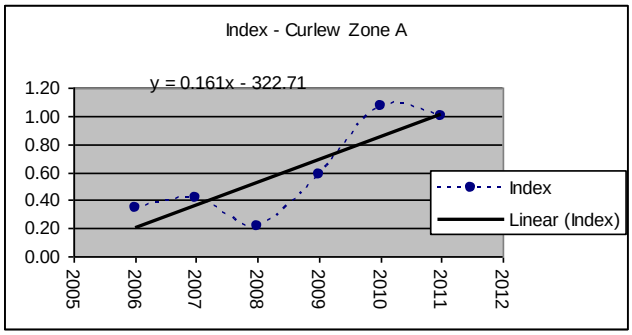
Black-tailed Godwit – have shown a steady increase in numbers since 2009. The peak count in 2011 (730) surpasses the threshold of international importance.



Redshank – despite lower numbers in 2011, the overall trend is for an increase in numbers within Rossmore Bay across the years.



Curlew – there was a very low peak count in 2009, but numbers have increased during the six-year data period.



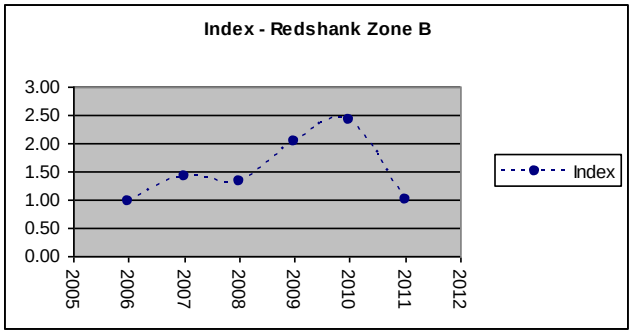
Overall therefore, the data suggest an increase in the numbers of Black-tailed Godwit, Redshank, Curlew and Oystercatcher within Zone A (Rossmore Bay). Numbers of Oystercatcher were significantly higher this year, possibly as a consequence of a good breeding season and juvenile recruitment over the past few years of their favoured prey the Cockle (*Cerastoderma edule*) that occurs as cockle beds across the mid-shore of Rossmore Bay. Overall, numbers of Shelduck appear to have declined over the six year period but numbers recorded this year were relatively high. Numbers of Dunlin, although variable have been relatively stable.

Table 4.5 shows peak waterbird numbers within Zone B across the six-year period 2006 to 2011. It is evident that the peak count for all species listed is lower than the peak count recorded in 2010. For two species (Shelduck and Oystercatcher) it is the lowest count in the dataset (lowest numbers in the dataset shaded grey). Given that the peak counts were generated from five replicate survey days and with replicate counts on each day, this resulting pattern for all species is unusual.

Table 4.5 Peak numbers of selected waterbird species during the low tide period within Zone B 2006 – 2011.

	2011	2010	2009	2008	2007	2006
Shelduck	2	52	4	13	8	12
Wigeon	23	77	14	21	2	43
Teal	4	168	0	10	3	37
Oystercatcher	15	54	39	20	23	25
Dunlin	82	176	108	824	0	620
Black-tailed Godwit	43	97	18	15	32	74
Curlew	18	34	22	12	23	18
Greenshank	3	4	4	2	2	2
Redshank	52	126	105	69	74	51

The result is particularly unusual for Redshank, which is normally a numerous species within this subsite and, up until 2010 was showing an increase in numbers at the site.



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

I-WeBS count subsites that are closest to East Cork Landfill are (1) Ballintubbrid; (2) Weir Island (to the west) and (3) Brick Island (directly east). The most recent I-WeBS data for these sites (2005/06 – 2009/10) are shown in Appendix 4.3 together with data for the entire Cork Harbour I-WeBS 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 2005/06 to 2009/10, Ballintubbrid supported 20 regularly-occurring waterbird species[4] including Annex I species Little Egret and Bar-tailed Godwit. Shelduck and Black-tailed Godwit occurred in numbers of national importance. Average numbers of Red-breasted Merganser were close to the national threshold.

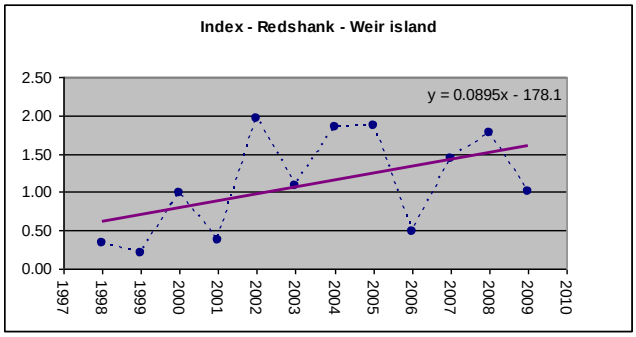
The mean number of Shelduck within Ballintubbrid between 2005/06 to 2009/10 was 235, which is 23% of the mean number recorded for the entire site of Cork Harbour for the same time period. Similarly, the mean number of Black-tailed Godwits within Ballintubbrid was 6.5% of the whole site average. This subsite is therefore of considerable importance for these two species.

Sub-site: Weir Island

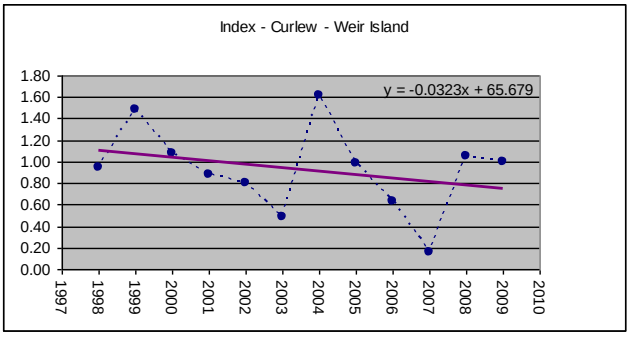
Weir Island supported 13 regularly-occurring waterbird species during the period 2005/06 to 2009/10. This subsite is particularly important for Redshank (5-yr mean peak of 236 individuals) as well as for Shelduck (5-yr mean peak of 99 individuals).

Lapwings have declined at this subsite in recent years. This wader species was present in every year from 1998/99 to 2005/06 but were not been recorded in 2006/07 or 2007/08. Relatively low numbers (peak of 57) were present during the winter of 2009/10.

Numbers of Redshank within Weir island subsite have increased across the I-WeBS dataset 1998/99 to 2009/10. The slope of the fitted trend line (line of best fit) indicates an annual % change in numbers of + 9%).

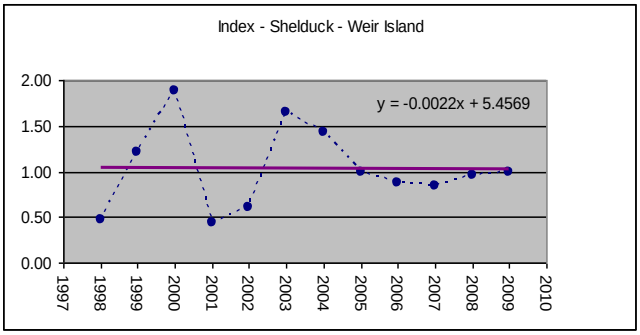


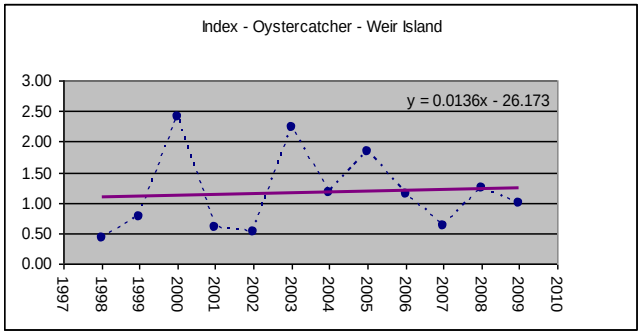
Curlew numbers recorded at Weir Island have declined steadily since 1998. Examination of the I-WeBS dataset for Cork Harbour (entire site) suggest the species has declined overall; as noted in Section 4.4.2, this decline is in line with the overall national and International decline of this species (Wetlands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



[4] Regularly-occurring is defined as a species that occurred in four out of the five years.

According to the analysis, numbers of Shelduck and Oystercatcher within the Weir Island subsite have remained stable across the data period.



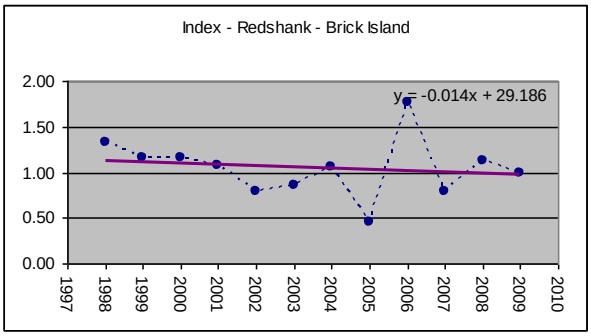


Brick Island

Brick Island is known to be an important area for intertidal feeding and supports an important roost site along its shoreline (as noted during the landfill surveys). 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 when other areas are already covered. Similarly, as the tide retreats more slowly, waterbirds that feed at the tide edge can avail of this activity for longer.

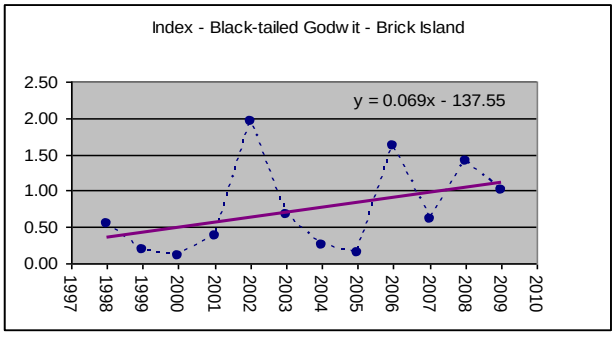
Brick Island supported 11 regularly-occurring waterbird species during the period 2005/06 to 2009/10.

The landfill surveys this year (Zone A and B) found a trend for lower numbers of Redshank within this area. The indexing of I-WeBS data also suggests a small decline in numbers using this subsite (annual decline of 1% over time).



Numbers of Redshank within Cork Harbour as a whole have also decreased over time. The recent whole site average of 1,516 (2005/06 - 2009/10) is lower than the average 2,121 for the period 1996/97 to 2000/01) (Crowe, 2005).

Numbers of Black-tailed Godwit have increased, in line with the national and all-Ireland trend. Numbers within Cork Harbour as a whole have also increased a recent average of 2,219 (2005/06 - 2009/10) as opposed to an average 2,021 for the period 1996/97 to 2000/01) (Crowe, 2005).



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 and this is in line with the trend for Cork Harbour as a whole, and national/all-Ireland trends.

The use of a population indexing method helps to reveal that numbers of Shelduck have declined within Zone A (Rossmore Bay) over the past five years. Numbers of Oystercatcher have increased in recent years with particularly high numbers recorded this winter (2011/12). The data suggest an increase in the numbers of Black-tailed Godwit, Redshank and Curlew also.

Repeat surveys of Zone B found that the peak count for all species this winter was lower than the peak count recorded in 2010. For two species (Shelduck and Oystercatcher) the peak count recorded was the lowest count in the longer-term dataset. This is unusual and particularly so for Redshank which are usually abundant. I-WeBS data for 2011/12 are not yet available but it will be interesting to compare the two datasets in the future. The I-WeBS dataset (1998/99 – 2009/10) also suggests a small decline in the number of Redshank using this subsite. Future analyses would prove useful.

Appendix 4.1 Waterbird species mentioned within the text; the final column highlights species recorded during 2011 waterbird surveys for East Cork Landfill.

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 EU Birds Directive	Recorded during 2011 waterbird surveys
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)		√
Common Tern *Sterna hirundo*	Amber-list (BL)	*	
Cormorant *Phalacrocorax carbo*	Amber-list (BL)		√
Curlew *Numenius arquata*	Red-list (BDp, SPEC, WDMp, WL)		√
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)		√
Grey Plover *Pluvialis squatarola*	Amer List (WL)		√
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)		√
Shoveler *Anas clypeata*	Red-List (WDp, SPEC, BI, WDMp)		√
Snipe *Gallinago gallinago*	Amber-list (SPEC)		√
Teal *Anas crecca*	Amber-list (BDMr)		√
Turnstone *Arenaria interpres*			√
Wigeon *Anas penelope*	Amber-list (WL)		√

Appendix 4.2 **Waterbird Survey Data**

Waterbird Survey 2011		Date:-	29.10.2011								
Replicate Zones A & B		A	A	A	A	A	B	B	B	B	B
Count Time		11:50	12:50	13:50	14:50	15:50	12:20	13:20	14:20	15:20	16:20
Time of High Tide (Cobh)		20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00	20:00
Time of Low Tide (Cobh)		13:50	13:50	13:50	13:50	13:50	13:50	13:50	13:50	13:50	13:50
Tidal state at count		2	2	2	3	3	2	2	3	3	3
Cormorant	CA			2	2	2		1			
Little Egret	ET						1	1		1	
Grey Heron	H		1			3	1	1		2	
Mute Swan	MS						2				
Shelduck	SU	12	14	6	5	11	2				
Wigeon	WN									1	3
Mallard	MA						2				
Oystercatcher	OC	10	1	12	9	26	4	7	7	9	10
Ringed Plover	RP				2			1			
Knot	KN						127				
Dunlin	DN	51	71		33	1	12	12			
Black T Godwit	BW	2	5	12	5	31	15	29	36	38	43
Bar T Godwit	BA								1		
Curlew	CU	32	41	27	33	26	9	15	16	11	18
Redshank	RK	18	41	48	71	10	52	35	48	25	48
Greenshank	GK						1	1		1	
Turnstone	TT	7				8					
BH Gull	BH	104	1				1	2	1	1	
Common Gull	CM					1					
GBB Gull	GB	5					1				
Kingfisher										1	

Waterbird Survey 2011		Date:-	11.11.2011								
Replicate Zones A & B		A	A	A	A	A	B	B	B	B	B
Count Time		10:25	11:25	12:25	13:25	14:25	10:55	11:55	12:55	13:55	14:55
Time of High Tide (Cobh)		05:25	05:25	05:25	05:25	05:25	05:25	05:25	05:25	05:25	05:25
Time of Low Tide (Cobh)		11:25	11:25	11:25	11:25	11:25	11:25	11:25	11:25	11:25	11:25
Tidal state at count		2	2	3	3	3	2	3	3	3	3
Cormorant	CA					5					
Little Egret	ET							2			
Grey Heron	H								1		
Shelduck	SU	47	18	26	74			1			
Wigeon	WN				10		5			4	
Shoveler	SV				2	2					
Oystercatcher	OC	62	72	64	60	73	3	5	7	11	15
Ringed Plover	RP				6						1
Grey Plover	GV		2	2	2	2					
Knot	KN	1									
Dunlin	DN	270	45	47	89	1					
Snipe	SN					1					
Black T Godwit	BW	730	730		721	2				1	
Bar T Godwit	BA	3	2		3						
Curlew	CU	32	22	25	24	8	10	9	12	13	11
Redshank	RK	17	31	38	81	65	15	38	37	37	41
Greenshank	GK		1			1	1	2		1	3
Turnstone	TT		8	12	56	31					
BH Gull	BH			1	2	4	2	2	1	1	5
LBB Gull	LB	1	1								
H Gull	HG				1		1			1	
GBB Gull	GB				1						

Waterbird Survey 2011		Date:-	25.11.11						
Replicate Zones A & B		A	A	A	A	B	B	B	B
Count Time		10.30	11.30	12.30	13.30	11.00	12.00	13.00	14.00
Time of High Tide (Cobh)		17.13	17.13	17.13	17.13	17.13	17.13	17.13	17.13
Time of Low Tide (Cobh)		11.22	11.22	11.22	11.22	11.22	11.22	11.22	11.22
Tidal state at count		2	2	3	3	2	3	3	3
Shelduck	SU	24	101	32	50				
Wigeon	WN	38	36	22	1	3	22	9	4
Oystercatcher	OC	131	120	134	145	2	1	2	5
Knot	KN				1				
Dunlin	DN	27	51	359	5				
Snipe	SN								7
Black T Godwit	BW	7	9	21	1		3	5	3
Curlew	CU	7	15	15	9	7	9	10	5
Redshank	RK	70	90	65		29	37	41	36
Turnstone	TT			1					
BH Gull	BH					5		3	5

Waterbird Survey 2011		Date:-	28.12.2011						
Replicate Zones A & B		A	A	A	A	B	B	B	B
Count Time		12.00	13.00	14.00	15.00	11.30	12.30	13.30	14.30
Time of High Tide (Cobh)		19.54	19.54	19.54	19.54	19.54	19.54	19.54	19.54
Time of Low Tide (Cobh)		14.10	14.10	14.10	14.10	14.10	14.10	14.10	14.10
Tidal state at count		2	2	2	3	2	2	2	3
Little Egret	ET								1
Shelduck	SU	23	69	50	46				
Wigeon	WN				2	23			

Teal	T								4
Oystercatcher	OC	267	220	229	248	3	1	1	1
Knot	KN				1				
Dunlin	DN	1				82			
Snipe	SN	6	1						
Black T Godwit	BW	28	27	18	13		1		
Curlew	CU	8	9	3	5	4	4	4	7
Redshank	RK	44	40	15	33	44	39	42	42
Greenshank	GK							1	
BH Gull	BH	3				2	2		
Common Gull	CM					1			

Waterbird Survey 2011		Date:-	07/01/2012						
Replicate Zones A & B		A	A	A	A	B	B	B	B
Count Time		9.00	10.00	11.00	12.00	9.30	10.30	11.30	12.30
Time of High Tide (Cobh)		16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20
Time of Low Tide (Cobh)		10.24	10.24	10.24	10.24	10.24	10.24	10.24	10.24
Tidal state at count		2	2	3	3	2	2	3	3
Shelduck	SU	37	33	39	80				
Wigeon	WN	12	12		6	4		17	
Teal	T	8	7	7	4				
Mallard	MA	2	2						
Oystercatcher	OC	152	207	194	180	7	9	6	9
Snipe	SN					6	6	6	6
Black T Godwit	BW	4	6	9	23				
Curlew	CU	10	7	9	11	7	6	9	9
Redshank	RK	11	10	10	61	24	29	31	35
Greenshank	GK					1			
BH Gull	BH				1	4		1	
Common Gull	CM			1					

Appendix 4.3

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

I-WeBS

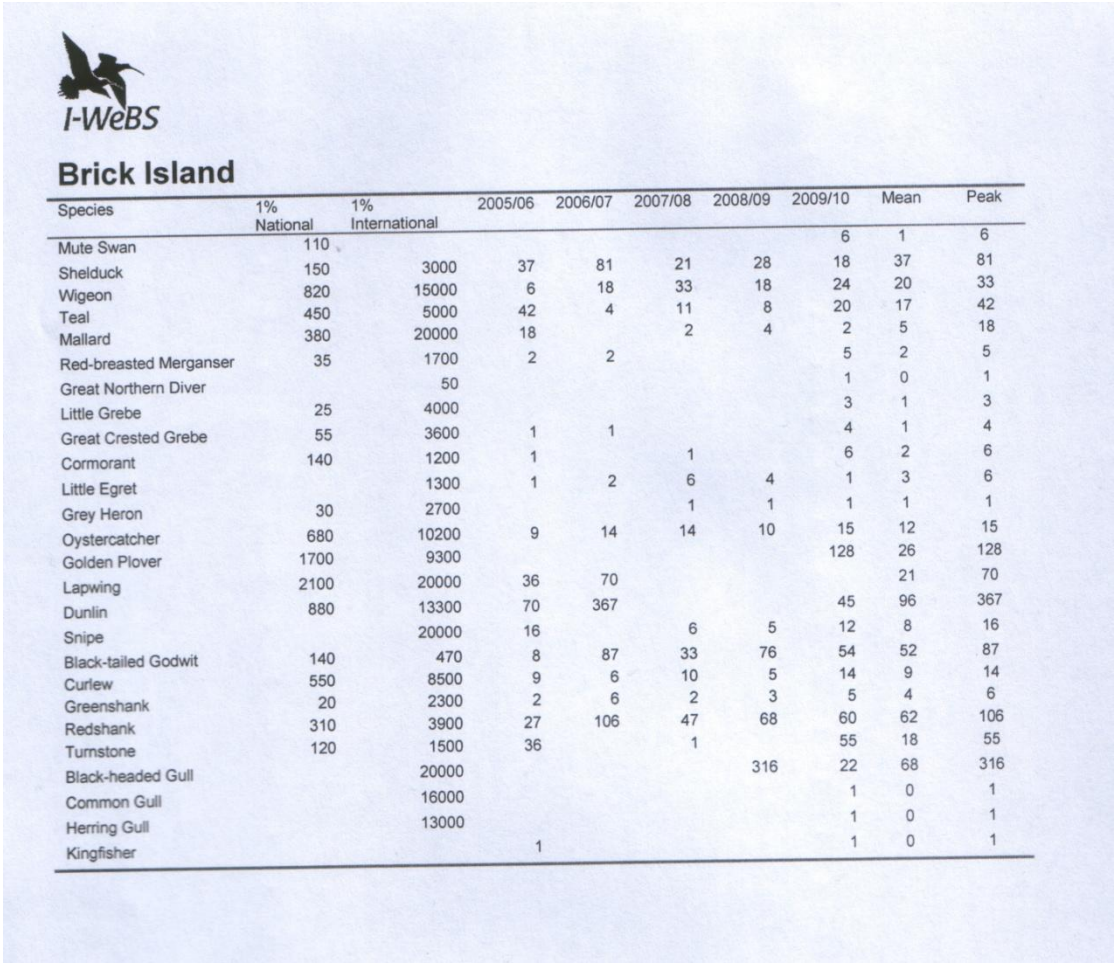
North Channel - Ballintubbrid

Species	1% National	1% International	2005/06	2006/07	2007/08	2008/09	2009/10	Mean	Peak
Mute Swan	110		2				17	4	17
Shelduck	150	3000	264	311	8	298	293	235	311
Wigeon	820	15000	338	210	8	366	262	237	366
Gadwall	20	600				1		0	1
Teal	450	5000	196	87	3	428	238	190	428
Mallard	380	20000	9	43	17	60	31	32	60
Pintail	20	600	14	1		22	27	13	27
Shoveler	25	400					1	0	1
Tufted Duck	370	12000			2			0	2
Eider	30	12830	1	1			1	1	1
Red-breasted Merganser	35	1700	32	33	25	27	31	30	33
Great Northern Diver		50		1	2		1	1	2
Little Grebe	25	4000	4	4		1	2	2	4
Great Crested Grebe	55	3600	37	29	29	18	36	30	37
Cormorant	140	1200	15	31	21	16	40	25	40
Shag					3		1	1	3
Little Egret		1300	17	27	6	17	38	21	38
Cattle Egret						3		1	3
Grey Heron	30	2700	21	25	6	10	17	16	25
Oystercatcher	680	10200	225	161	280	198	242	221	280
Ringed Plover	150	730				1		0	1
Golden Plover	1700	9300		2				0	2
Grey Plover	65	2500	3	2	1	2	3	2	3
Lapwing	2100	20000	250	26	264	109	154	161	264
Knot	190	4500		55		32		17	55
Dunlin	880	13300	200	45	120	63	303	146	303
Snipe		20000	2				20	4	20
Black-tailed Godwit	140	470	50	148	65	250	210	145	250
Bar-tailed Godwit	160	1200	8					2	8
Whimbrel		2000	1	1				0	1
Curlew	550	8500	134	295	46	268	231	195	295
Greenshank	20	2300	8	16	10	11	19	13	19
Redshank	310	3900	260	331	56	280	204	226	331
Turnstone	120	1500	30	30	39	43	117	52	117
Mediterranean Gull				1			2	1	2
Black-headed Gull		20000		50		26	189	53	189
Common Gull		16000					6	1	6
Lesser Black-backed Gull		4500		29			1	6	29
Herring Gull		13000		57		1	7	13	57
Great Black-backed Gull		4800		7			2	2	7
Sandwich Tern				2		1		1	2
Kingfisher						1		0	1

I-WeBS

Weir Island

Species	1% National	1% International	2005/06	2006/07	2007/08	2008/09	2009/10	Mean	Peak
Mute Swan	110				2		8	2	8
Shelduck	150	3000	106	92	89	102	106	99	106
Wigeon	820	15000	42	38	50	21	65	43	65
Teal	450	5000	34	8	2	2	23	14	34
Mallard	380	20000	3	2	2	1	2	2	3
Little Grebe	25	4000		3			8	2	8
Great Crested Grebe	55	3600				4	2	1	4
Cormorant	140	1200	6	1			4	2	6
Little Egret		1300	2	2	8	4	3	4	8
Grey Heron	30	2700	1	1	1	1	1	1	1
Oystercatcher	680	10200	243	153	83	166	133	156	243
Ringed Plover	150	730			2		4	1	4
Lapwing	2100	20000	210			1	57	54	210
Knot	190	4500	60	6		1		13	60
Dunlin	880	13300	314	132		86	65	119	314
Snipe		20000	1	2	4	1	3	2	4
Black-tailed Godwit	140	470	68	6	16	158	80	66	158
Bar-tailed Godwit	160	1200					86	17	86
Curlew	550	8500	73	47	12	78	74	57	78
Greenshank	20	2300	1	1			2	1	2
Redshank	310	3900	335	87	259	319	180	236	335
Turnstone	120	1500	27	43	78	54	32	47	78
Black-headed Gull		20000					70	14	70
Common Gull		16000					2	0	2
Lesser Black-backed Gull		4500					14	3	14
Herring Gull		13000					45	9	45
Great Black-backed Gull		4800					3	1	3



I-WeBS

Brick Island

Species	1% National	1% International	2005/06	2006/07	2007/08	2008/09	2009/10	Mean	Peak
Mute Swan	110						6	1	6
Shelduck	150	3000	37	81	21	28	18	37	81
Wigeon	820	15000	6	18	33	18	24	20	33
Teal	450	5000	42	4	11	8	20	17	42
Mallard	380	20000	18		2	4	2	5	18
Red-breasted Merganser	35	1700	2	2			5	2	5
Great Northern Diver		50					1	0	1
Little Grebe	25	4000					3	1	3
Great Crested Grebe	55	3600	1	1			4	1	4
Cormorant	140	1200	1		1		6	2	6
Little Egret		1300	1	2	6	4	1	3	6
Grey Heron	30	2700			1	1	1	1	1
Oystercatcher	680	10200	9	14	14	10	15	12	15
Golden Plover	1700	9300					128	26	128
Lapwing	2100	20000	36	70				21	70
Dunlin	880	13300	70	367			45	96	367
Snipe		20000	16		6	5	12	8	16
Black-tailed Godwit	140	470	8	87	33	76	54	52	87
Curlew	550	8500	9	6	10	5	14	9	14
Greenshank	20	2300	2	6	2	3	5	4	6
Redshank	310	3900	27	106	47	68	60	62	106
Turnstone	120	1500	36		1		55	18	55
Black-headed Gull		20000				316	22	68	316
Common Gull		16000					1	0	1
Herring Gull		13000					1	0	1
Kingfisher			1				1	0	1

Cork Harbour

Species	1% National	1% International	2005/06	2006/07	2007/08	2008/09	2009/10	Mean	Peak
Kittiwake						3		1	3
Mute Swan	110		54	73	70	42	70	62	73
Whooper Swan	130	210			3	1	1	1	3
Black Swan				2				0	2
Greylag Goose	50	870	3	1	6			2	6
Canada Goose			11	13	22	5	9	12	22
Light-bellied Brent Goose		260	26	11	17	6	24	17	26
Black Brant							1	0	1
Feral/hybrid Goose					5			1	5
Shelduck	150	3,000	1,350	918	829	1,121	952	1,034	1,350
Wigeon	820	15,000	2,332	1,492	1,428	1,313	1,236	1,560	2,332
Gadwall	20	600	13	7		6	8	7	13
Teal	450	5,000	1,302	667	698	989	753	882	1,302
Mallard	380	20,000	406	423	498	344	285	391	498
Pintail	20	600	14	2		22	27	13	27
Garganey		20,000					1	0	1
Shoveler	25	400	45	62	51	26	25	42	62
Pochard	380	3,500	7	2	3	2	4	4	7
Tufted Duck	370	12,000	14	19	16	22	36	21	36
Scaup	45	3,100	2			1		1	2
Eider	30	12,830	15	1			1	3	15
Common Scoter	230	16,000	7		1	1		2	7
Velvet Scoter					3			1	3
Goldeneye	95	11,500	10	5	14	17		9	17
Red-breasted Merganser	35	1,700	80	68	84	53	63	70	84
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	16	5	16
Little Grebe	25	4,000	69	58	65	48	56	59	69
Great Crested Grebe	55	3,600	137	63	106	79	183	114	183
Slavonian Grebe		55	2				1	1	2
Black-necked Grebe							1	0	1
Cormorant	140	1,200	308	163	309	168	170	224	309
Shag				2	8	3	1	3	8
Little Egret		1,300	126	143	154	122	184	146	184
Cattle Egret						3	1	1	3
Grey Heron	30	2,700	76	84	90	85	59	79	90
Great White Egret							1	0	1
Spoonbill					1			0	1
Water Rail			2	2	2	1		1	2
Moorhen	20		33	55	25	25	22	32	55
Coot	330	17,500	16	19	7	2	4	10	19
Oystercatcher	680	10,200	2,076	1,061	1,678	1,110	1,190	1,423	2,076
Ringed Plover	150	730	67	17	27	38	34	37	67
Golden Plover	1,700	9,300	3,002	3,266	5,232	248	4,500	3,250	5,232
Grey Plover	65	2,500	24	12	39	17	10	20	39
Lapwing	2,100	20,000	4,096	3,321	3,331	3,218	1,974	3,188	4,096
Knot	190	4,500	117	124	111	119	58	106	124
Sanderling	65	1,200	33					7	33
Curlew Sandpiper			4	1				1	4
Dunlin	880	13,300	3,874	4,456	3,579	5,091	2,632	3,926	5,091
Ruff		12,500	1		3	2		1	3
Snipe		20,000	49	32	75	17	72	49	75

The counts presented in the table refer to the peak counts of species in each I-WeBS season. The peak is calculated as the peak count over the most recent five season period, while the mean is calculated as the average of the season peaks. Blank columns indicate seasons for which no data are available, while blank cells within columns which contain positive values for one or more species constitute Zero for those species.

I-WeBS

Black-tailed Godwit	140	470	3,337	1,433	2,823	2,050	1,453	2,219	3,337
Bar-tailed Godwit	160	1,200	218	389	306	281	396	318	396
Whimbrel		2,000	4	1	1	1	11	4	11
Curlew	550	8,500	1,809	1,595	1,827	831	992	1,411	1,827
Common Sandpiper			2	1	4	3		2	4
Green Sandpiper			1					0	1
Spotted Redshank		900	1	1	1			1	1
Greenshank	20	2,300	68	72	84	76	79	76	84
Redshank	310	3,900	1,543	1,459	1,771	1,440	1,365	1,516	1,771
Turnstone	120	1,500	136	129	214	115	136	146	214
Mediterranean Gull			15	24	48	65	21	35	65
Bonaparte's Gull				1				0	1
Black-headed Gull		20,000	2,627	2,210	2,103	725	466	1,626	2,627
Common Gull		16,000	188	214	207	71	193	175	214
Lesser Black-backed Gull		4,500	31	1,250	72	192	60	321	1,250
Herring Gull		13,000	40	123	51	41	90	69	123
Iceland Gull						1		0	1
Glaucous Gull					1			0	1
Great Black-backed Gull		4,800	157	137	98	43	17	90	157
Sandwich Tern			225	2	17	1		49	225
Common Tern			1	1	1			1	1
Arctic Tern					1			0	1
Kingfisher			3	1	2	3	2	2	3
Wildfowl & allies total			*6,461*	*4,360*	*4,518*	*4,510*	*4,195*	*4,809*	*6,461*
Waders total			*20,462*	*17,370*	*21,106*	*14,657*	*14,902*	*17,699*	*21,106*

The counts presented in the table refer to the peak counts of species in each I-WeBS season. The peak is calculated as the peak count over the most recent five season period, while the mean is calculated as the average of the season peaks. Blank columns indicate seasons for which no data are available, while 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

A 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. Usually this involves an assessment of datasets for the trace metal concentrations of shellfish. These data are obtained from the Marine Institute. In 2011 however, no new data are available (correspondence with Marine Institute available on request). Therefore Section 5 proceeds to review data pertaining to shellfish waters and Cork Harbour North Channel that are publicly available, from mostly web-based sources.

5.2 Background to Shellfish Monitoring

- **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, amended by SI No 55 of 2009). The responsible department is the Department of the Environment, Heritage and Local Government.

The aim of this 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 shellfish waters and it 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.

Cork Great Island North Channel is designated as a shellfish growing area No. 39 (DoEHLG, 2009). The area covers 3.4 km^2 and extends from Weir Island, eastwards to Brown Island. Oyster (*Crassostrea gigas*) cultivation dominates. Note that the harvesting of Mussels (*Mytilus edulis*) is prohibited in Cork Harbour as the naturally-occurring paralytic shellfish poisoning (PSP) is endemic in the wild mussel population.

- **Live Bivalve Molluscs Regulations**

Since January 2006, these controls are driven by EC Hygiene regulations 'laying down specific rules for food of animal origin' (Nos. 852/853/854 of 2004). The Sea Fisheries Protection Authority (SFPA) is the competent body for the classification of Live Bivalve Mollusc Production Areas in accordance with Annex II of Regulation (EC) 854/2004.

5.3 Review of Shellfish Monitoring in Cork Great Island North Channel

Marine Institute Shellfish Monitoring –

This programme involves analysing for general components, trace metals and organic contaminants in both water and biota (shellfish) samples. 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 therefore 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).

Data are usually obtained annually from the Marine Institute but no data are available this year. Limosa Environmental (2010) reported on data for 2008/2009 and found that all recorded levels of trace metals and other compounds were within the accepted guidance limits.

A review by DoEHLG (2009) found that data analysed for Cork Great Island North Channel Shellfish Area did not breach any of the guideline values.

Shellfish Health Monitoring Programme -

Sampling carried out by the Sea Fisheries Protection Authority (SFPA) allows for the classification of Live Bivalve Mollusc Production Areas. The current classification for the Cork Great Island North Channel is as follows (dated 15th July 2011):

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

The classification of Class B requires that oysters harvested from the area are depurated, heat treated or relayed before going for human consumption (Appendix 5.2)

National 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, amongst others, the toxins Diarrhetic Shellfish Poisoning (DSP), Azaspiracid poisoning (AZP), Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP). Samples of shellfish are sampled by the Marine Institute and analysed routinely for the presence of these toxin groups. Based on the results of the sampling, shellfish production areas are deemed as either 'open' or 'closed' and this is displayed on the Marine Institute website. As of the 14th December 2011, Cork Harbour is determined as 'Open' (www.marine.ie).

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, 2011).

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. 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 minimum 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 Polychlorinated Biphenyls: Sum of ICES 7CBs	 µg.litre-1^{-1} (seawater) µg.kilogram-1^{-1} wet weight @ 1 per cent lipid (shellfish flesh)	 0.30 300.00 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.	Gas chromatography after extraction with suitable solvents and purification.	Half-yearly
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.

Appendix 5.2

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

6.0 REVIEW OF WATER QUALITY DATA FOR THE NORTH CHANNEL

6.1 Introduction

The Water Framework Directive (Directive 2000/60/EC) was adopted in 2000 as a single piece of legislation covering rivers, lakes, groundwater and transitional (estuarine) and coastal waters. It also includes heavily modified and artificial waterbodies. The objectives of the directive are to prevent further deterioration of the status of all bodies of surface water, and to protect, enhance and restore all bodies of surface water with the aim of achieving good status by 2015.

The existing EPA estuarine and coastal waters monitoring programme was replaced by the Water Framework Directive (WFD) Monitoring Programme in 2006. The new WFD programme for transitional and coastal waters[5] is undertaken by the Environmental Protection Agency (EPA) in collaboration with the Marine Institute, Inland Fisheries Ireland and the National Parks and Wildlife Service. The monitoring programme includes a total of 117 water bodies consisting of 82 transitional and 35 coastal water bodies.

The Environmental Protection Agency (EPA) developed classification systems and Environmental Quality Standards (EQS) for the assessment of the status of surface waters in Ireland. Draft EQS's were superseded in 2009 by a set of regulations which were published by the Department of Environment, Heritage and Local Government (DoEHLG) on 24 July 2009: SI No 272 of 2009 - European Communities Environmental Objectives (Surface Water) Regulations. These Regulations apply to all surface waters and give effect to the measures needed to achieve the environmental objectives established for bodies of surface water by Directive 2000/60/EC or the 'Water Framework Directive.'

6.2 Review of water quality data for Cork Harbour North Channel

In 2011, water quality data for the North Channel were obtained directly from the Environmental Protection Agency (EPA).[6] The dataset spans the period 2006 – 2010. These data were examined in light of environmental quality standards (EQSs) set out in SI No 272 of 2009 (and shown in Appendix 6.1). In addition, we examined data supplied by the EPA in 2010 which includes an assessment under the EPA 'Trophic Status Assessment Scheme' (TSAS). This scheme was designed to detect the occurrence of eutrophication in estuarine and nearshore waters and is required for the Urban Waste Water Treatment Directive and Nitrates Directive. The most recent assessment of the water quality of transitional and coastal waters in Ireland is provided by O'Boyle et al. (2010) in McGarringle et al. (2010).

The following review considers various parameters of water quality:-

- **Dissolved Oxygen (DO)**

Oxygen is a key parameter of interest in water quality monitoring because nearly all aquatic life needs oxygen to survive. DO is the level of oxygen in the water column in molecular form that is available to support life, and is influenced by mixing at the air/water interface, temperature and salinity, the level of photosynthesis (which produces oxygen), and decomposition of organic material (which depletes oxygen).

Low oxygen levels as a result of pollution can have adverse effects on aquatic organisms including slower growth rates, impaired immune response and in severe cases, mortality (O'Boyle et al. 2010).

DO values in the North Channel dataset (2006 – 2010) are shown as percentage saturation, which is a measure that expresses how close the value is to the equilibrium value for the temperature at which the DO was recorded. Recorded values range from 59.2% to 136.9% across the total dataset (198 samples) and only two samples recorded levels below the lower limit EQS (80% for transitional waters (35 psu)). Ten samples (5% of total) recorded levels

[5] Under the WFD, estuarine waters are now known as transitional waters.
[6] The EPA stressed that data provided in 2011 were taken directly from the database and are not fully quality controlled. Data are therefore not reproduced in this report.

above the upper limit EQS (120% (35 psu)). Excessively high levels (supersaturation0 can indicate problems such as excessive plant growth.

- **BOD**

Biochemical oxygen demand (BOD) is the amount of oxygen required for microbial metabolism of organic compounds in water. The higher the BOD levels, the greater the amount of organic material present and the more oxygen is used up for aerobic oxidation which depletes the amount of dissolved oxygen that is available for aquatic life.

The EQS for transitional water is ≤4.0 mg/l BOD (Appendix 6.1). The values recorded in the North Channel during the period 2006 – 2010 (range 0.4 – 4.0 mg/l) are within the permitted range and represent oxygen levels capable of supporting nearly all marine life.

- **pH**

Although pH is not generally considered as critical as Dissolved Oxygen, it is important to ecosystem health because most aquatic plants and animals are adapted to a specific range of pH and alkalinity. Sharp variations outside of this range can be detrimental. No standards are set for the pH of transitional or coastal waters. The pH of marine waters usually varies between about pH 7.5 and pH 8.4 (Kiely, 1997). The values recorded in the North Channel during the period 2006 – 2010 (range 7.5 – 8.4) are therefore considered normal for estuarine waters.

- **Ammonia**

Total ammonia (or total ammonia nitrogen) in aqueous solution exists in two principal forms: the ionised ammonium ion (NH_4^+) and un-ionised ammonia (NH_3), the latter being the most toxic.

The values recorded in the North Channel during the period 2006 – 2010 are in the range 0.005 mg/l to 0.418 mg/l NH_3.

Levels above 1mg/l, even for short time periods can cause damage to fish. Lethal concentrations for fish in marine water are reported as 0.068 – 2.0 mg/l (Eddy, 2005). Acute toxicity of ammonia in fish increases with low dissolved oxygen concentrations and lower pH.

- **Total Oxidized Nitrogen (TON) and Dissolved Inorganic Nitrogen (DIN)**

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.

Ammonium ($NH4^+$), nitrite ($NO2^-$) and nitrate ($NO3^-$) are the most common ionic (reactive) forms of dissolved inorganic nitrogen in aquatic ecosystems. The measure of Total Oxidized Nitrogen (TON) is the sum of nitrate and nitrite. TON plus Ammonium ($NH4^+$) is the measure Dissolved Inorganic Nitrogen (DIN) for which an EQS is set for coastal water bodies only (Good Status: ≤0.25 mg N/l at salinity 34.5; High Status: ≤0.17 mg N/l at salinity 34.5). Elevated levels of nitrogen are linked to eutrophication via their role in stimulating or enhancing primary production. Nutrient enrichment can cause significant ecological effects to aquatic communities because the overproduction of

organic matter and its subsequent decomposition may result in low dissolved oxygen levels in both water column and sediments, hence it is intrinsically linked to the measures of DO and BOD discussed above.

TON values recorded in the North Channel during the period 2006–2010 are in the range 0.01 mg/l to 1.99 mg/l TON (some higher, anomalous values occur earlier in the dataset but are disregarded because they did not occur in previous quality-controlled datasets).

Water quality data provided by the EPA in 2010 for the period 2007–2009 showed that winter levels of Dissolved Inorganic Nitrogen (DIN) exceeded the threshold of 0.825 mg/l for transitional waters (North Channel DIN - median 1.4 mg/l N and maximum 2.1 mg/l N). For this reason the EPA TSAS assessment for 2007-2009 classified the North (Great) Channel as 'potentially eutrophic.' The most recent review of water quality (McGarringle et al. 2010) also classifies the North Channel as 'potentially eutrophic' having failed to comply with the environmental quality standard (EQS) for DIN (S.I. No. 272 of 2009). The Owenacurra Estuary (main river flowing into the North Channel) has an improved classification of 'intermediate,' on the previous assessment period.

- **Phosphorus**

The concentration of both phosphorus, as molybdate reactive phosphorus (MRP), and nitrogen, as dissolved inorganic nitrogen (DIN) described above, is monitored in winter when levels are expected to be at their seasonal maximum due to the absence of any significant plant or algal growth (McGarringle et al. 2010). Levels of MRP are also monitored in summer to capture the potential effect of seasonal changes in river flow which in turn can result in higher phosphate concentrations in some estuaries during summer.

The values recorded in the North Channel during the period 2006 – 2010 are in the range 0.01 mg/l to 0.11 mg P/l. Across the entire dataset reviewed, 5% of samples exceed the EQS of ≤0.04 mg P/l at salinity 35. No samples taken in 2010 exceeded the EQS, and the previous EPA TSAS assessment (2007-2009) based on median levels of MRP passed the threshold.

- **Chlorophyll *a***

Chlorophyll *a* is the most commonly used parameter for monitoring phytoplankton biomass and nutrient status, as an index of water quality. The values recorded in the North Channel during the period 2006 – 2010 largely fall below the upper threshold limit (20 ug/l) and 67% of all recorded values are below the 'good' threshold (10 ug/l). The EPA TSAS assessment (2007-2009) based on median levels of Chlorophyll *a* were compliant with the required threshold.

Conclusion

Previously, the trophic status of the North Channel has varied from 'eutrophic' (1995 – 1999) to the improved classification of 'intermediate' (1999 – 2003) (Toner et al. 2005). Lucey (2009) classified the North Channel as 'potentially eutrophic' for the period 2006-2008, and this status is retained in the most recent assessment (up to and including 2009) (McGarringle et al. 2010). The main parameter of non-compliance is Dissolved Inorganic Nitrogen (DIN).

The Owenacurra Estuary (main river flowing into the North Channel) has an improved classification of 'intermediate' (O'Boyle et al. 2010) having been previously classified as 'potentially eutrophic' (1995-1999) and 'eutrophic' (1999-2003) (Toner et al. 2005).

Appendix 6.1 **Criteria for calculating surface water ecological status and ecological potential as per *SI No 272 of 2009 - European Communities Environmental Objectives (surface water) Regulations***

Biological quality element	Classification system	Ecological quality ratio		High – good boundary	Good – moderate boundary
Phytoplankton		High - good	Good - moderate	Chlorophyll (ug/l)	
	Phyoplankton biomass (Chlorophyll)	0.66	0.33	2.5 (median value) and 5.0 (90 %ile value) 5.0 (median value) and 10.0 (90 %ile value)	5.0 (median value) and 10.0 (90 %ile value) 10.0 (median value) and 20.0 (90 %ile value)
	Phytoplankton composition	0.84	0.43	% of single taxa counts above thresholds	
				20	39

Biological quality element	Classification system	Ecological quality ratio	
Macroalgae		High - good	Good - moderate
	Rocky shore reduced species list	0.80	0.60
	Opportunistic macroalgae	0.80	0.60

Thermal Conditions	Rivers	Lakes	Transitional	Coastal
Temperature	Not greater than a 1.5^{O}C rise in ambient temperature outside of the mixing zone			

Oxygenation Conditions	Rivers	Lakes	Transitional	Coastal
Biochemical Oxygen Demand (BOD) mg O_2/l	High Status ≤ 1.3 (mean) or ≤2.2 (95%ile) Good Status ≤ 1.5 (mean) or ≤2.6 (95%ile)		≤ 4.0 mg/l (95%ile)	
Dissolved Oxygen Lower Limit	95%ile>80% saturation	0psu Summer 95%ile >70% saturation 35psu Summer 95%ile >80% saturation		35psu Summer 95%ile > 80% saturation
Dissolved Oxygen Upper Limit	95%ile<120% saturation	0psu Summer EQS (95%ile) <130% 35psu Summer 95%ile <120% saturation		>35psu Summer EQS (95%ile) <120%

Acidification Status	Rivers	Lakes	Transitional	Coastal
pH	Soft Water 4.5< pH < 9.0		N/A	N/A

Nutrient Conditions	Rivers	Lakes	Transitional	Coastal
Total Ammonia (mg N/l)	High Status ≤ 0.040 (mean) or ≤0.090 (95%ile) Good Status ≤ 0.065 (mean) or ≤0.140 (95%ile)		≤ 4.0 mg/l (95%ile)	
Dissolved Inorganic Nitrogen (mg N/l)				Good status (0 psu) ≤2.6 mg N/l (95%ile) (34.5 psu) ≤0.25 mg N/l (95%ile) High status (34.5 psu) ≤0.17 mg N/l (95%ile)
Molybdate Reactive Phosphorus (MRP) mg P/l	High Status ≤ 0.025 (mean) or ≤0.045 (95%ile) Good Status ≤ 0.035 (mean) or ≤0.075 (95%ile)		(0 – 17 psu) ≤0.060 (median) (35 psu) ≤0.040 (median)	

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APPENDIX F

LFG Flue Gas Emissions Testing

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

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:	20th Jun. 2011
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 Jul. 2011
NAME AND THE FUNCTION OF THE PERSON APPROVING THE REPORT:	Dr. Brian Sheridan, Managing Partner, Odour Monitoring Ireland
REPORT NUMBER:	2011A224(1)
REVIEWERS:	

TABLE OF CONTENTS

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Client: *Cork County Council*

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Project Number: 2011A224(1)			Document Reference: Air emission testing of one Landfill flare located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork		
2011A224(1)	Document for review	J.W.C	J.W.C	B.A.S	25/07/2011
Revision	Purpose/Description	Originated	Checked	Authorised	Date

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 20th June 2011. 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	20/06/2011	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 20th June 2011 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	28	%
CO_2	29.1	%
O_2	1.4	%
Total Landfill gas volumetric airflow rate	322	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)	90
Total Volumetric Oxygen loading (m^3/hr)	4.5
Ratio to complete combustion of methane assuming no excess Oxygen	9.57
Oxygen concentration level in flue gas (%)	6.12
Flue gas temperature (Kelvin)[2]	1,288
Theoretical calculated Volumetric exhaust airflow rate (m^3/h)	1,673
Normalised average exhaust airflow rate ($Nm^3\ h^{-1}$)[3]	354

Notes: [1] denotes data from 20th June 2011.
[2] denoted converted from degrees Celsius to Kelvin ($^0C + 273.15$);
[3] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 2.4. Emission value results 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	1.54	mgC/m^3	2.4	3.25	16.63	<20 mg/Nm^3	As Normal
Temperature	1015	degrees	1288K	-	-	>1273 K	As Normal
CO	3.1	ppm	3.8	4.69	15.08	<50 mg/Nm^3	As Normal
O_2	6.12	%	-	-	-	-	
Total NO_X as NO_2	11	ppm	22.5	27.3	6.18	<200 mg/Nm^3	As Normal
SO_2	35	ppm	99.7	120	-	-	As Normal
CO_2	8.15	%	-	-	-	-	As Normal
Volumetric airflow rate (Nm^3/hr)	-	-	-	268	-	<3,000	As Normal
Inlet methane concentration	64	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

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- 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

20th June 2011

6.1.3 Personnel Present During Sampling

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

MCERTS: MM0674

6.1.4 Instrumentation check list

Testo 350 MXL/454 in stack analyser;

Federal Method 2 S type pitot and MGO coated thermocouple;

L type pitot tube

Testo 400 handheld and appropriate probes.

Ceramic and Inconel 625 sampling probes.

Portable Signal 3030PM FID calibrated with Propane with non-methane hydrocarbon cutter.

ODOUR & ENVIRONMENTAL ENGINEERING CONSULTANTS
Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922 Fax: +353 46 9483696

Mobile: +353 86 8550401

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LICENCE NUMBER:	WL0022-01
LICENCE HOLDER:	Cork County Council
FACILITY NAME:	East Cork Landfill Facility
DATE OF MONITORING VISIT:	11th Nov. 2011
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:	09th Jan. 2012
NAME AND THE FUNCTION OF THE PERSON APPROVING THE REPORT:	Dr. Brian Sheridan, Managing Partner, Odour Monitoring Ireland
REPORT NUMBER:	201223(1)
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TABLE OF CONTENTS

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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)	Horiba PG250 All analytes, Oxygen EN14789, Oxides of Nitrogen Chemiluminescence, Carbon Monoxide EN15085.
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 11th Nov. 2011. 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	11/11/2011	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 11th Nov. 2011 for monitoring of landfill flare.

Parameter	Approx. Sampling period for 1 landfill flare
Inlet CH_4	40 minutes
Inlet O_2	40 minutes
Volumetric air flow rate	Theoretically calculated
SO_2	40 minutes
NO_x	40 minutes
CO	40 minutes
O_2	40 minutes
CO_2	40 minutes
Stack gas temp	40 minutes
TOC	40 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	27.6	%
CO_2	31.4	%
O_2	1.9	%
Total Landfill gas volumetric airflow rate	305	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)	84
Total Volumetric Oxygen loading (m^3/hr)	5.7
Ratio to complete combustion of methane assuming no excess Oxygen	9.57
Oxygen concentration level in flue gas (%)	7.1
Flue gas temperature (Kelvin)[2]	1,285
Theoretical calculated Volumetric exhaust airflow rate (m^3/h)	1,673
Normalised average exhaust airflow rate ($Nm^3\ h^{-1}$)[3]	355

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

Table 2.4. Emission value results 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	1.8	mgC/m^3	2.88	4.03	15.45	<20 mg/Nm^3	As Normal
Temperature	1012	degrees	1285K	-	-	>1273 K	As Normal
CO	1	ppm	1.25	1.62	16.54	<50 mg/Nm^3	As Normal
O_2	7.1	%	-	-	-	-	
Total NO_X as NO_2	15	ppm	30.75	39.89	9.12	<200 mg/Nm^3	As Normal
SO_2	25	ppm	71.25	92.42	-	-	As Normal
CO_2	7.4	%	-	-	-	-	As Normal
Volumetric airflow rate (Nm^3/hr)	-	-	-	253	-	<3,000	As Normal
Inlet methane concentration	60	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:

6. A theoretically exhaust flue gas volume was calculated for the landfill flare.
7. NO_x as NO_2, SO_2, CO, O_2, and TOC 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, NO_x as NO_2, and TOC 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

11th Nov. 2011

6.1.3 Personnel Present During Sampling

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

MCERTS: 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.

APPENDIX G: PRTR 2011

5	24											21
			Quantity (Tonnes per Year)			Method Used			Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/ Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/ Disposer	Name and License / Permit No. and Address of Final Recoverery / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
Transfer Destination	European Waste Code	Hazardous	Quantity T/Year	Description of Waste	Waste Treatment Operation	M/ C/ E	Method Used	Location of Treatment	Name and Licence / Permit No. of Recoverer / Disposer / Broker	Address of Recoverer / Disposer / Broker	Name and Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)	Licence / Permit No. of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
Within the Country	20 03 01	No	1368.0	mixed municipal waste	D1	M	Weighed	Offsite in Ireland	Youghal Landfill,W0068-03	Mudlands,Foxhole, Youghal,Co Cork,Ireland		
Within the Country	15 01 01	No	54.0	paper and cardboard packaging	R3	M	Weighed	Offsite in Ireland	greenstar Ltd,W136-02	Corbally North,Srasfields Court,Glanmire,Co Cork,Ireland		
Within the Country	20 01 01	No	70.0	paper and cardboard	R3	M	Weighed	Offsite in Ireland	greenstar Ltd,W136-02	Corbally North,Srasfields Court,Glanmire,Co Cork,Ireland		
Within the Country	15 01 07	No	30.0	glass packaging	R5	M	Weighed	Offsite in Ireland	Mr Binman,W0061-01	Luddenmore,Grange ,Kilmallock,Co Limerick,Ireland		
Within the Country	20 01 02	No	17.0	glass	R5	M	Weighed	Offsite in Ireland	MSM Recycling Ltd,W0079-01	41-42 Cookstown Industrial Estate,Tallaght, Dublin,D24,Ireland		
Within the Country	20 01 40	No	126.0	metals	R4	M	Weighed	Offsite in Ireland	Pouladuff Dismantlers Ltd,CK/0584/01	Pouladuff Rd,Togher,Cork,Cor k,Ireland		
Within the Country	15 01 02	No	21.0	plastic packaging	R5	M	Weighed	Offsite in Ireland	Green Dragon Recycling Ltd,CK/09/0629/01	Corbally North,Sarsfields Court,Glanmire,Co Cork,Ireland		
Within the Country	20 01 11	No	4.0	textiles	R5	M	Weighed	Offsite in Ireland	Textile Recycling Ltd,WCP-DC-08-1225-01	Glen Abbey Business Park,Tallaght,Dubli		

										n,D24,Ireland		
Within the Country	20 01 38	No	301.0	wood other than that mentioned in 20 01 37	R13	M	Weighed	Offsite in Ireland	CTO Environmental Solutions Ltd,CK/09/0018/02	Tait's Farm,Rostellan, Midleton,Co Cork,Ireland		
Within the Country	16 06 01	Yes	0.36	lead batteries	R6	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland
Within the Country	16 06 04	No	2.95	alkaline batteries (except 16 06 03)	R13	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland		
Within the Country	13 02 08	Yes	6.0	other engine, gear and lubricating oils	R9	M	Weighed	Offsite in Ireland	Enva Ltd,W184-01	Clonminam Industrial Estate,.",Portlaoise, Co Laois,Ireland	Enva Ltd,W184-01	Clonminam Industrial Estate,".",Portlaoise, Co Laois,Ireland
Within the Country	20 01 28	No	15.94	paint, inks, adhesives and resins other than those mentioned in 20 01 27	R1	M	Weighed	Offsite in Ireland	Enva Ltd,W184-01	Clonminam Industrial Estate,".",Portlaoise, Co Laois,Ireland		
Within the Country	20 01 23	Yes	33.757	discarded equipment containing chlorofluorocarbons	R4	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland
Within the Country	20 01 36	No	70.963	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland		
Within the Country	20 01 36	No	123.69	discarded electrical and electronic equipment	R4	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland		

Within the Country		20 01 35	Yes	45.814	other than those mentioned in 20 01 21, 20 01 23 and 20 01 35 discarded electrical and electronic equipment other than those mentioned in 20 01 21 and and 20 01 23 containing hazardous components	R4	M	Weighed	Offsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,Daingean Rd,Tullamore,Co Offaly,Ireland
Within the Country		19 07 03	No	1368.38	landfill leachate other than those mentioned in 19 07 02	D8	M	Weighed	Offsite in Ireland	Carrigtwohill Wastewater Treatment Plant,D0044-01	Wastewater Treatment Plant,Tullagreen,Carrigtwohill Wastewater Treatment Plant,Co Cork,Ireland		
Within the Country		17 01 07	No	70.41	mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	D5	M	Weighed	Offsite in Ireland	Youghal Landfill,W0068-03	Mudlands,Foxhole, Youghal,Co Cork,Ireland		
Within the Country		15 01 04	No	2.0	metallic packaging	R4	M	Weighed	Offsite in Ireland	Mr Binman,W0061-01	Luddenmore,Grange ,Kilmallock,Co Limerick,Ireland		