Cavan County Council

Corranure Landfill

Annual Environmental Report 2013

ENVIROGUIDE CONSULTING,

93 UPPER GEORGES STREET,

DUN LAOGHAIRE,

CO. DUBLIN

TABLE OF CONTENTS

Cavan County Council i
Corranure Landfill i
Annual Environmental Report 2013 i
1.0 INTRODUCTION 1
2.0 SITE DESCRIPTION 1
3.0 EMISSIONS FROM THE FACILITY 3
3.1 NOISE MONITORING 4
3.2 SURFACE WATER 4
3.2.1 BOD 7
3.2.2 CONDUCTIVITY 7
3.2.3 pH 7
3.2.4 SUSPENDED SOLIDS 8
3.2.5 AMMONICAL NITROGEN 8
3.3 DUST 8
3.4 GROUNDWATER 10
3.5 LANDFILL GAS 15
3.6 LEACHATE MONITORING 17
4.0 WASTE MANAGEMENT RECORDS 17
4.1 QUANTITY OF WASTE ACCEPTED AT THE FACILITY 17
4.2 QUANTITY OF WASTE DISPOSED OF AT THE FACILITY 18
4.3 QUANTITY OF RECOVERED WASTE USED IN THE DEVELOPMENT / OPERATION OF THE LANDFILL 18
4.4 QUANTITY OF WASTE REMOVED OFF-SITE FOR RECOVERY OR DISPOSAL 19
4.5 STATEMENT ON ACHIEVEMENT OF THE WASTE ACCEPTANCE AND PRE-TREATMENT REQUIREMENTS 19
5.0 TOTAL CONSENTED LANDFILL VOID (M3) 19
6.0 TOPOGRAPHICAL SURVEY 19
7.0 UPDATES/AMENDMENTS TO ODOUR MANAGEMENT PLAN 20
9.0 COMPLAINTS SUMMARY 20
10.0 REPORTED INCIDENTS SUMMARY 20
11.0 SCHEDULE OF ENVIRONMENTAL OBJECTIVES & TARGETS 21
12.0 ENVIRONMENTAL MANAGEMENT PROGRAMME 22
13.0 POLLUTANT RELEASE AND TRANSFER REGISTER 22
14.0 WASTE ANALYSIS 22
15.0 METEOROLOGICAL DATA SUMMARY 22

16.0 Tank and Pipeline Inspection Report 23
17.0 Energy Efficiency Audit Report Summary 23
18.0 Resource Consumption Summary 23
19.0 Developmental/Infrastructural Works Summary 23
20.0 Management and Staffing Structure at the Facility 24
21.0 Programme for Public Information 25
22.0 Financial Provisions 25
23.0 Review of Environmental Liabilities 25
24.0 Statement of Costs of Landfill including Landfill Levy 25
25.0 Hydrogeological 25
26.0 Environmental Management System 25

List of Figures

Figure 3.2.1: SW1 Monthly Monitoring Results 2013 4
Figure 3.2.2: SW1 Monthly Monitoring Results 2013 Conductivity 5
Figure 3.2.3: SW1 Monthly Monitoring Results 2013 Suspended Solids and pH 5
Figure 3.2.4: SW2 Monthly Monitoring Results 2013 6
Figure 3.2.5: SW2 Monthly Monitoring Results 2013 Conductivity 6
Figure 3.2.6: SW2 Monthly Monitoring 2013 for Suspended Solids 7
Figure 3.3.1: Dust Monitoring 2013 9
Figure 3.4.1: GW01 (19mm) Monthly Monitoring Results 2013 10
Figure 3.4.2: GW01 (19mm) Monthly Monitoring Results for Conductivity 11
Figure 3.4.3: GW01 (50mm) Monthly Monitoring Results 2013 11
Figure 3.4.4: GW01 (50mm) Monthly monitoring Results for Conductivity 12
Figure 3.4.5: GW04 Monthly Monitoring Results 2013 12
Figure 3.4.6: GW04 Monthly Monitoring Results for Conductivity 13
Figure 3.4.7: GW05 Monthly Monitoring Results 2013 13
Figure 3.4.8: GW05 Monthly Monitoring Results 2013 for Conductivity 14
Figure 3.5.2: Average Monthly Concentrations at Engine/Flare 2013 16

List of Tables

Table 2.0.1: Waste Categories and Quantities accepted under Waste Licence W0077-04.....3
Table 3.6.1: Leachate Monitoring Results 2013.....17
Table 4.2.1: Quantity of Waste Landfilled pre-2013.....18
Table 4.3.1: Quantity of Materials Recovered 2008 to 2013.....18
Table 11.0.1: Objectives & Targets 2013.....21
Table 11.0.2: Proposed Objectives & Targets 2014.....22

List of Appendices

Appendix 1 Surface Water Monitoring Locations
Appendix 2 PRTR Offsite transfer of Waste
Appendix 3 Pollutant Release Transfer Register
Appendix 4 Slope Stability Assessment Report
Appendix 5 Hydrogeological Risk Screen

1.0 INTRODUCTION

Cavan County Council is the licensee for the Corranure Landfill Facility. The landfill facility is currently closed and is not accepting waste of any type for landfill.

A Civic Amenity (CA) facility is located at the landfill site. The CA facility was operated and managed by McElvaney Waste and Recycling in 2013.

The main activities on-site during 2013 were the capping of cell 3 and the management of landfill gas, landfill leachate and environmental monitoring. The facility was managed by Enviroguide Consulting for and on behalf of Cavan County Council. This annual environmental report (AER) has been completed by Enviroguide Consulting.

Waste Licence W0077-04 was granted to Cavan County Council on the 19th of May 2011. The original licence for the facility (Waste Licence Register Number 77-1) was granted on the 12th of June 2001. This is the 12th AER for the facility. The AER is prepared in accordance with the requirements as set out in Schedule F of the Waste Licence. The report format follows guidelines set in *"Draft Guidance on Environmental Management Systems and Reporting to the Agency"*, issued by the EPA in 1999.

The AER details the site activities from the 1st of January 2013 to the 31st of December 2013.

2.0 SITE DESCRIPTION

Corranure Landfill is located approximately 3km North-East of Cavan Town. It is located adjacent to the Cavan-Cootehill Road (R188), in the townlands of Corranure and Lismagratty. The total footprint of the landfill covers an area of 11 hectares.

The original Waste Licence, Waste Licence Register Number 77-1, for the facility was granted in June 2001 to Cavan County Council for the operation of a non-hazardous landfill with a licensed annual intake of 30,050 tonnes.

Cavan County Council applied to the Agency for a review of Waste Licence 77-1 in April 2003. Following this review process, a revised Waste Licence was granted to Cavan County Council by the Agency on the 10th of May 2005. This Licence was for the continued operation and expansion of the landfill and also provided for the operation of a civic amenity site at the facility. The facility boundary was extended to allow for two new lined

cells to be installed (Phase 3 -Cells 3 and 4). The annual waste intake was increased to 90,000 tonnes per annum.

In 2009 the EPA commenced a review of existing EPA waste licences issued for landfill facilities. The purpose of this review was to restrict the acceptance of biodegradable waste at landfills which will assist in complying with the targets set by the EU Landfill Directive, reduce the potential for odours from landfill facilities, reduce greenhouse gas emissions and maximise the use and value of waste prior to it being landfilled. As part of this review process, a review was initiated by the EPA in June 2009 on Waste Licence Register Number W0077-02. A revised Licence (W0077-03) was issued in March 2010. Limits on the acceptance of biodegradable waste were introduced in this Licence.

In September 2007 Cavan County Council entered into a Contract for Sale Agreement with a third party private waste management firm, Oxigen Environmental Ltd. Under the contract terms Cavan County Council proposed to sell lands which included Cell 3 and cell 4 of the landfill site.

Under the terms of the Agreement both parties were required to provide environmental indemnities to each other which were due to become effective on the completion of the sale. The liability in respect of Cells 0, 1 and 2 were to remain with Cavan County Council while liability for Cells 3 and 4 were to transfer to Oxigen Environmental Ltd. upon successful completion of the sale. Under a concessionary agreement with Cavan County Council, the landfill and civic amenity site were operated and managed by Oxigen Environmental since September 2007.

This Contract for Sale Agreement led to two licence applications being made to the Agency in September 2008. Cavan County Council submitted an application to review Waste Licence W077-02 to reduce the size of the landfill facility area of 11 hectares to a revised 7 hectares. This reduced area comprised of Cells 0, 1 and 2. Oxigen Environmental Ltd. concurrently submitted an application for a new waste licence for the development of an integrated waste management facility at the landfill site and to include the lands of Cells 3 and 4. Waste Licence Register number W0248-01 was assigned to the Oxigen Environmental application.

In May 2011, the EPA refused to grant waste Licence Register Number W0248-01 to Oxigen Environmental Ltd. A revised Waste Licence was granted to Cavan County Council, Waste Licence Register Number W077-04. This Licence was for the continued operation of the landfill and civic amenity site at the facility. The revised Licence limited the acceptance of waste for disposal to an intake of 45,000 tonnes per annum, a reduction from the previously authorised 90,000 tonnes per annum. The facility has operated under this licence since May 2011. Since the grant of the revised Waste Licence, the landfill facility has been managed by

Enviroguide Consulting. The Civic Amenity site was closed in April 2011 but reopened in August 2011. Since August 2011 the Civic Amenity Facility is operated and managed by McElvaney Waste and Recycling.

The Civic Amenity Site at the Facility was originally opened in February 2002 and is used by the general public for recycling. At present the Civic Amenity Facility accepts various waste types including segregated recyclables from householders, newspapers and magazines, cardboard, tetra-pak, glass bottles and jars, aluminium and steel cans, plastic containers and plastic shrink wrap, wood, textiles/footwear, electrical goods, fluorescent tubes, batteries wet and household, scrap steel, waste engine oil and oil filters, vegetable oil, C& D waste, gypsum material and green waste.

Table 2.0.1 below shows the waste categories which the facility is licensed to accept by Waste Licence W0077-04:

Table 2.0.1: Waste Categories and Quantities permitted under Waste Licence W0077-04

WASTE TYPE	MAXIMUM TONNES PER ANNUM
DISPOSAL AT LANDFILL	
Municipal (Household & Commercial) Waste	35,000
Construction and Demolition Waste	5,000
Industrial Solid Waste	4,000
Treated Sludge	1,000
TOTAL	**45,000**
COLLECTION AT CIVIC AMENITY FACILITY	
Non-hazardous waste	3,000
Hazardous household, commercial and agricultural waste	100
TOTAL COLLECTION AT CIVIC AMENITY FACILITY	**3,100**

Licensed waste disposal and recovery activities are carried out in accordance with the 3rd and 4th Schedule of the Waste Management Act as per Part 1 of Waste Licence W0077-04.

3.0 EMISSIONS FROM THE FACILITY

All monitoring was carried out in accordance with monitoring requirements as set out in Schedule C: Control & Monitoring of Waste Licence W0077-04 or as agreed with the Agency.

Environmental monitoring was carried out in 2013 by the following companies:

- Boylan Engineering, Main St., Mullagh, Kells, Co. Meath.

3.1 Noise Monitoring

Noise monitoring is required to be carried out on a quarterly basis under conditions of Waste Licence W077-04. As the facility is a closed landfill site and there is no waste being accepted for disposal at the facility, a request was submitted to the Agency to request the temporary cessation of noise monitoring until the acceptance of waste for landfill is recommenced. Following agreement from the Agency, no noise monitoring was conducted in 2013. Noise did not give rise to nuisance at the facility at any stage during the year.

3.2 Surface Water

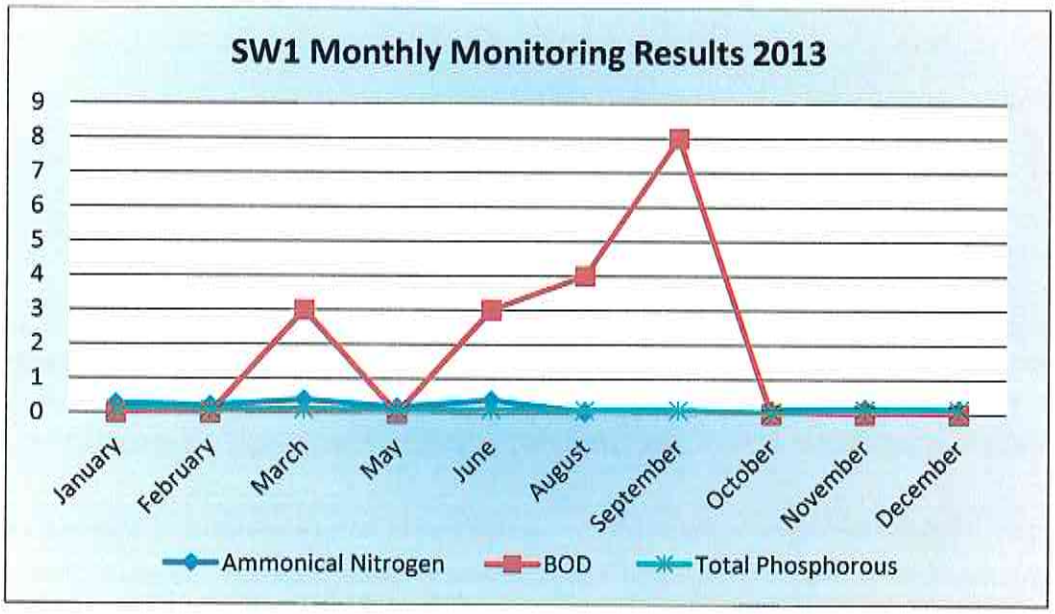
Surface water monitoring is carried out on a monthly and quarterly basis at Corranure Landfill as agreed with the Agency. Surface water monitoring was carried out by Boylan Engineering (January to December). Samples are taken from all monitoring points identified on surface monitoring location Maps 1 & 2 included in Appendix 1 of this report. SW1, S4 and S5 are located on the Corranure Stream and SW2 and S3 on the Lismagratty Stream.

SW1 and SW2, surface water discharge points, are monitored on a monthly basis while S3, S4 and S5, surface water sampling locations, are monitored on a quarterly basis.

Annual monitoring was carried on the 11th-12th September 2013 by Boylan Engineering for additional parameters as listed in Schedule C.2.2. Annual monitoring results have been submitted to the Agency as part of the monthly reports for the facility. Monitoring results were within the Emission Limit Values as set out in the Waste Licence. Results are discussed further in sections 3.2.1 to 3.2.6 of this report.

Monthly monitoring results are depicted in figures 3.2.1 - 3.2.6 below.

Figure 3.2.1: SW1 Monthly Monitoring Results 2013



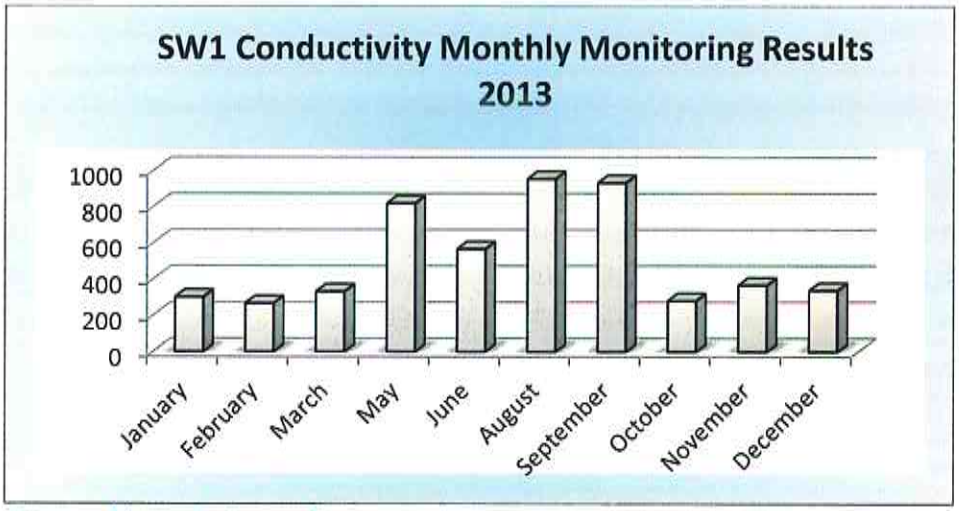


Figure 3.2.2: SW1 Monthly Monitoring Results 2013 Conductivity

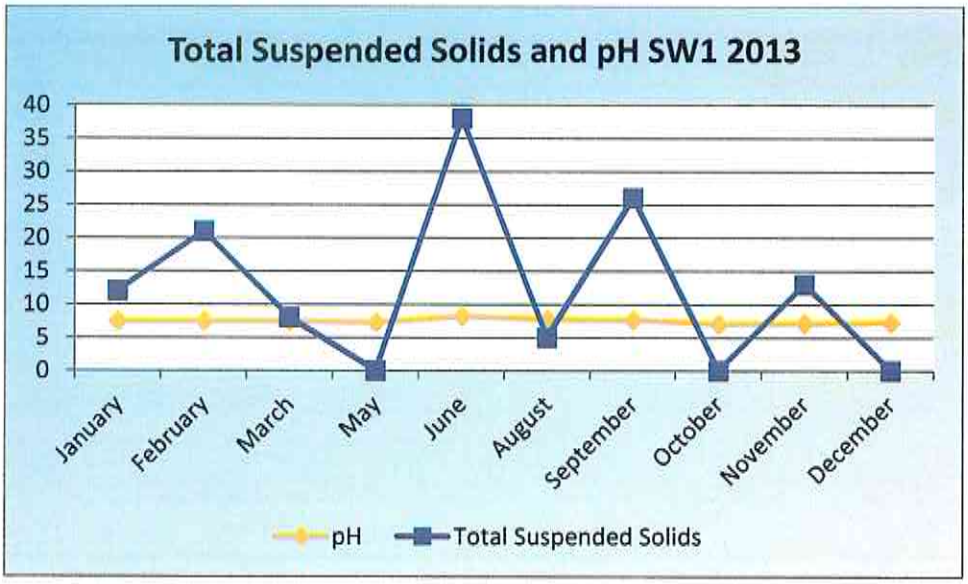


Figure 3.2.3: SW1 Monthly Monitoring Results 2013 Suspended Solids and pH

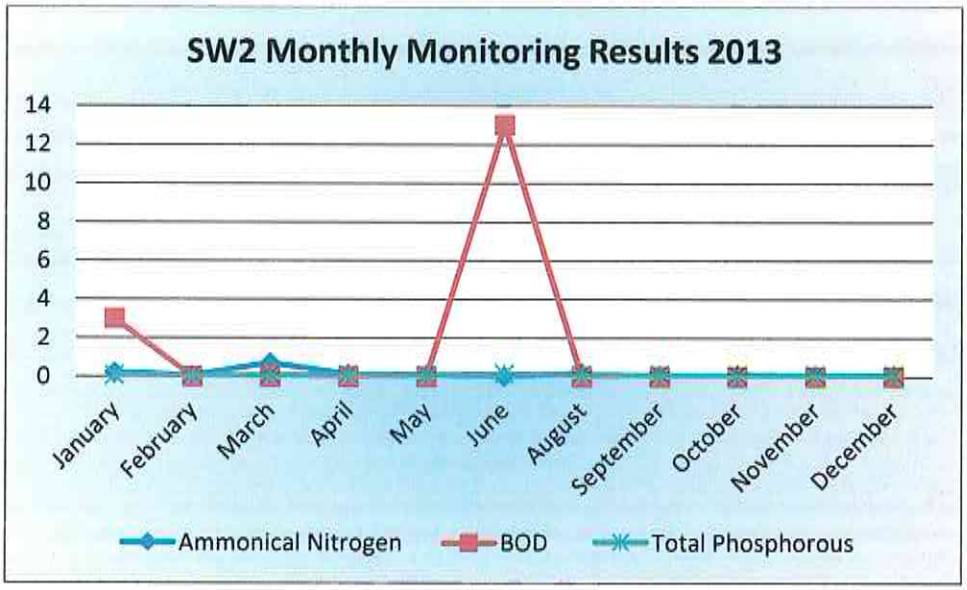


Figure 3.2.4: SW2 Monthly Monitoring Results 2013

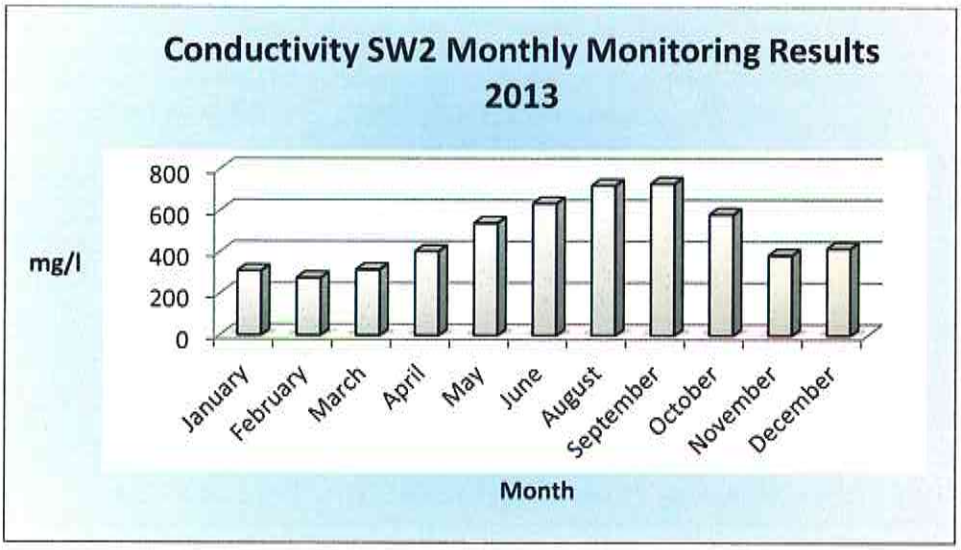


Figure 3.2.5: SW2 Monthly Monitoring Results 2013 Conductivity

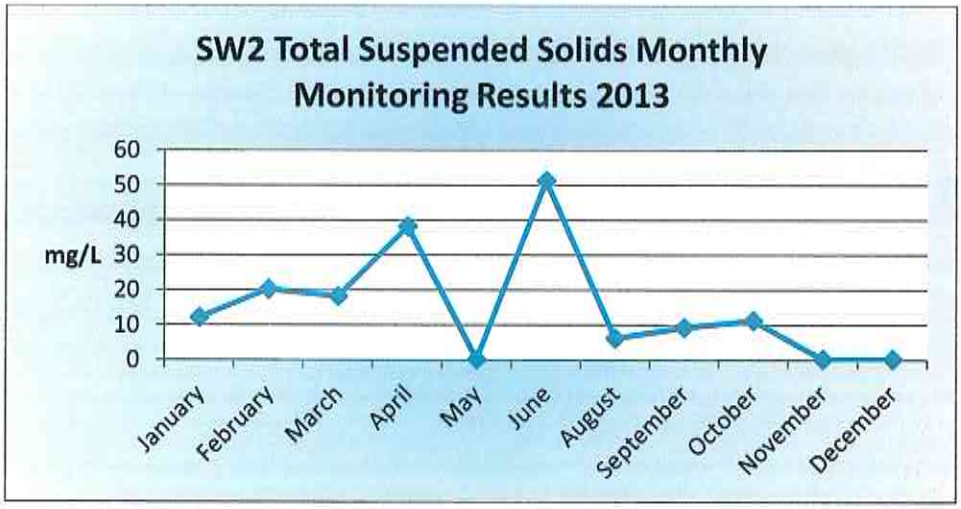


Figure 3.2.6: SW2 Monthly Monitoring 2013 for Suspended Solids

The results of analysis carried out were compared to Class A1 limits outlined in 1989 "European Communities (Quality of Surface Water Intended for Abstraction of Drinking Water) Regulations 1989".

3.2.1 BOD

There are no Licence limits for BOD in the Waste Licence for the facility. However, as per the S.I. No. 249 of 1989 "European Communities (Quality of Surface Water Intended for Abstraction of Drinking Water) Regulations 1989", the recommended level for BOD is 5mg/l. All monthly monitoring of SW1 and SW2 were under this recommended limit with the exception of SW1 in September with a BOD of 8 mg/l.

Quarterly monitoring results show that quarterly monitoring of SW1 and SW2 were within the recommended level for BOD with the exception of SW1 in September as discussed above. All quarterly results for S3, S4 and S5 were within the recommended BOD levels with the exception of S5 Quarter 2 with a BOD of 9mg/l.

3.2.2 Conductivity

The recommended limit for electrical conductivity is 1,000µS/cm. All monthly results for SW1 and SW2 and all quarterly results for SW1, SW2, S3, S4 and S5 were within this limit.

3.2.3 pH

According to Freshwater Fish Directive (78/659/EEC), pH limits range between 6 and 9. All monthly results for SW1 and SW2 and all quarterly results for SW1, SW2, S3, S4 and S5 were within this range.

3.2.4 Suspended Solids

An emission limit value of 35mg/l is set out in Schedule B.2 of Waste Licence W0077-04. This limit was exceeded in SW2 in April and June. This limit was also exceeded in SW1 in June 2013. All other monthly and quarterly samples at all monitoring points were compliant with this ELV.

3.2.5 Ammonical Nitrogen

Recommended concentrations for ammonia in surface water is 0.2mg/l. The emission limit value for ammonia as set out in Schedule B.2 of the Licence is 0.14mg/l.

Exceedances were recorded for ammonia at both SW1 and SW2 in Q1 and Q2 and also of the IGV's at S4 and S5 in Q1 and Q2 and S3 and S5 in Q4. A full copy of the monthly monitoring reports have been submitted to the EPA as part of the monthly site reports. These results indicate that there is a possible nitrogen enrichment of the waters which is most likely caused by agricultural activities including slurry spreading in the surrounding areas.

A range of other parameters were monitored during the annual monitoring at SW1, SW2, S3, S4 and S5. All monitoring results for Boron, Cadmium, Chromium, Faecal Coliforms, Total Coliforms, Copper, Cyanide, Fluoride, Lead, Mercury, Sulphate and Zinc were all within the Class A1 limits as set out in the Surface Water Regulation Limits (S.I. 294 of 1989). The Class A1 limit for total iron was exceeded at all locations. SW1 and S3 exceeded the Class A1 limit for Manganese. S3 exceeded the Class A1 limit for Orthophosphate and total Phosphate. Agricultural or fertilizer runoff is the most likely source of elevated levels of Orthophosphate and Phosphate in surface water.

3.3 Dust

Dust monitoring was carried out using Bergerhoff Instrument according to the VDI 2119 Standard Method. With this method atmospheric deposits are collected in vessels over a 30 day period ±2 days. The collected samples are then concentrated and the residue subjected to gravimetric weight analysis. Collection jars with a volume of 1.5 litres were placed in wire baskets. The top of the jar was positioned 1.5meters above ground level. Results were calculated from the formula correlating the dust collected, sampling period and the collecting surface of the jars. Results from dustfall determination at sites D1 - D5 are illustrated in Figure 7 below. All results were within licence limits.

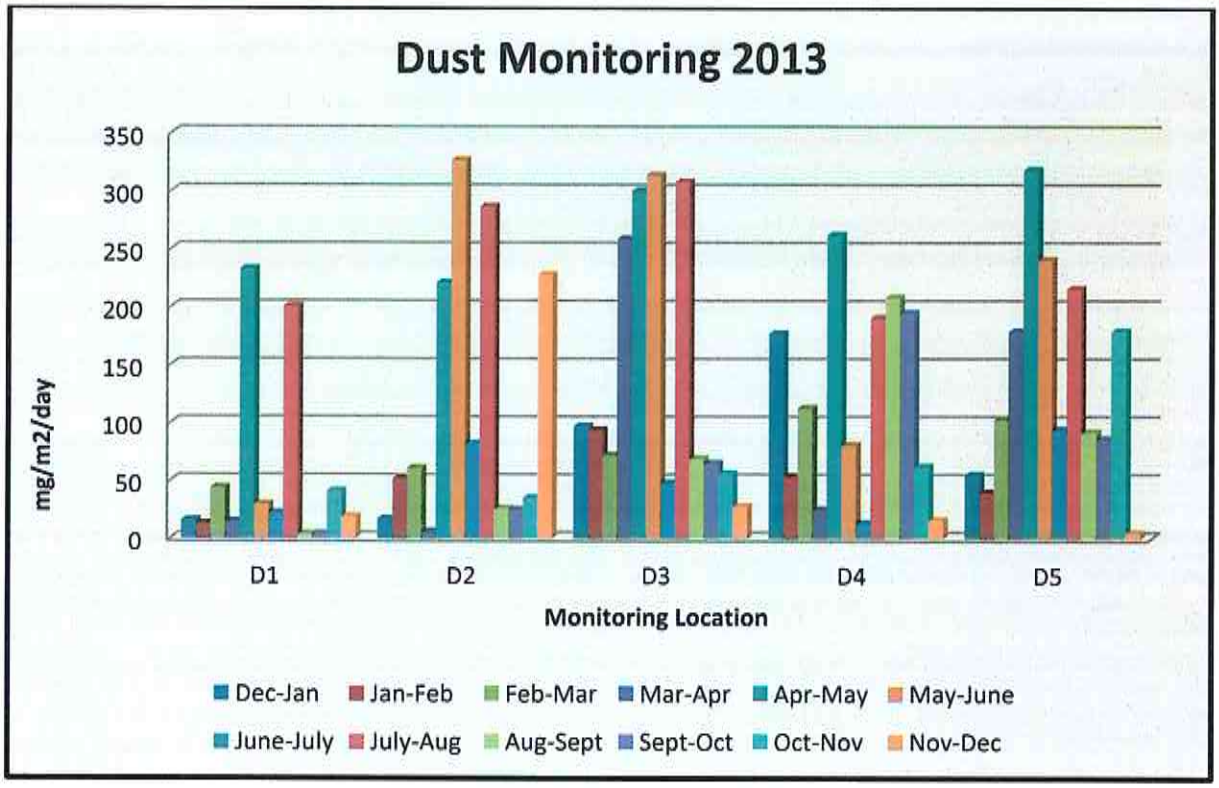


Figure 3.3.1: Dust Monitoring 2013

3.4 GROUNDWATER

There are no direct emissions to groundwater from the facility. The old landfill (Cell 0) was designed as a 'dilute and disperse' landfill and is underlain by stiff clays. Cells 1 to 3 are fully lined cells with separate leachate and surface water management systems. Groundwater is monitored on a monthly basis at points GW01 (shallow), GW01 (Deep), GW02, GW03, GW04, GW05. Results from all monthly monitoring are illustrated in Figures 3.4.1 to 3.4.8 below.

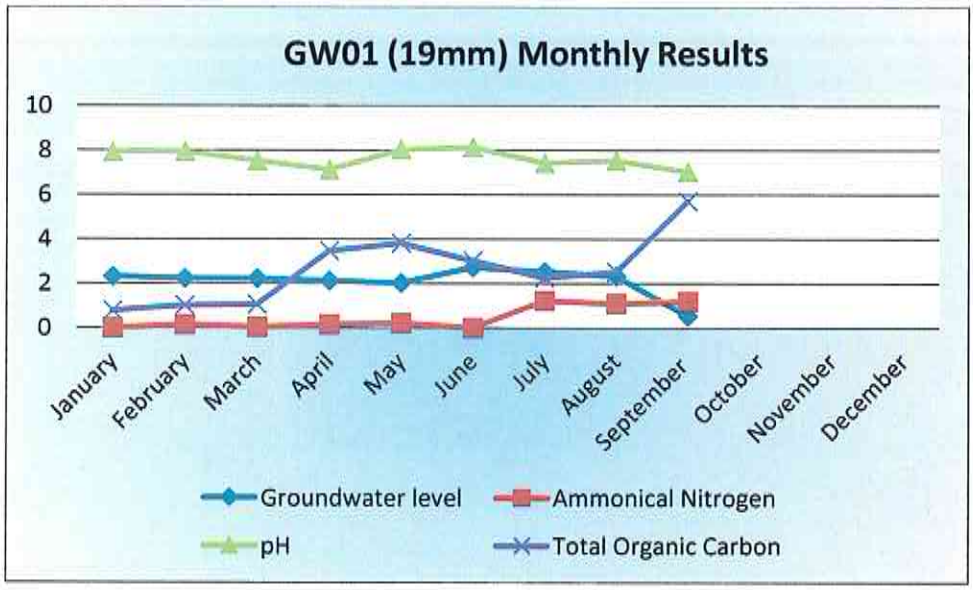


Figure 3.4.1: GW01 (19mm) Monthly Monitoring Results 2013

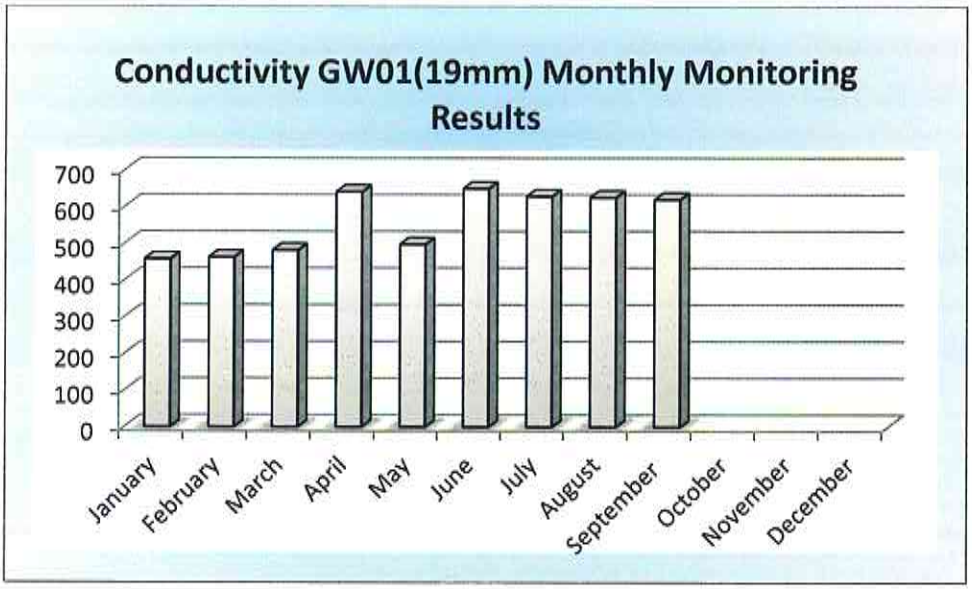


Figure 3.4.2: GW01 (19mm) Monthly Monitoring Results for Conductivity 2013

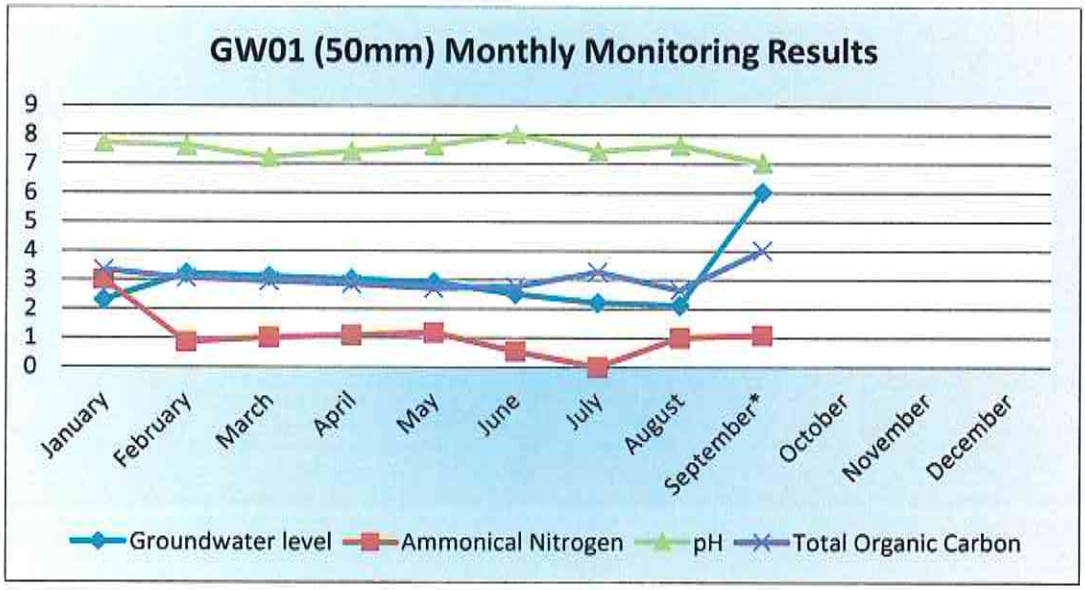


Figure 3.4.3: GW01 (50mm) Monthly Monitoring Results 2013

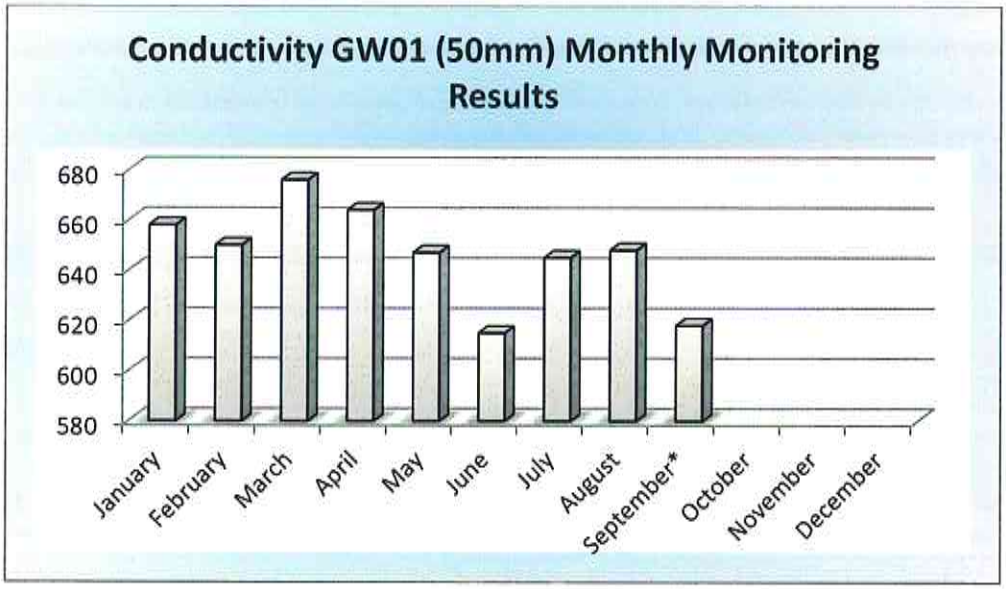


Figure 3.4.4: GW01 (50mm) Monthly monitoring Results for Conductivity

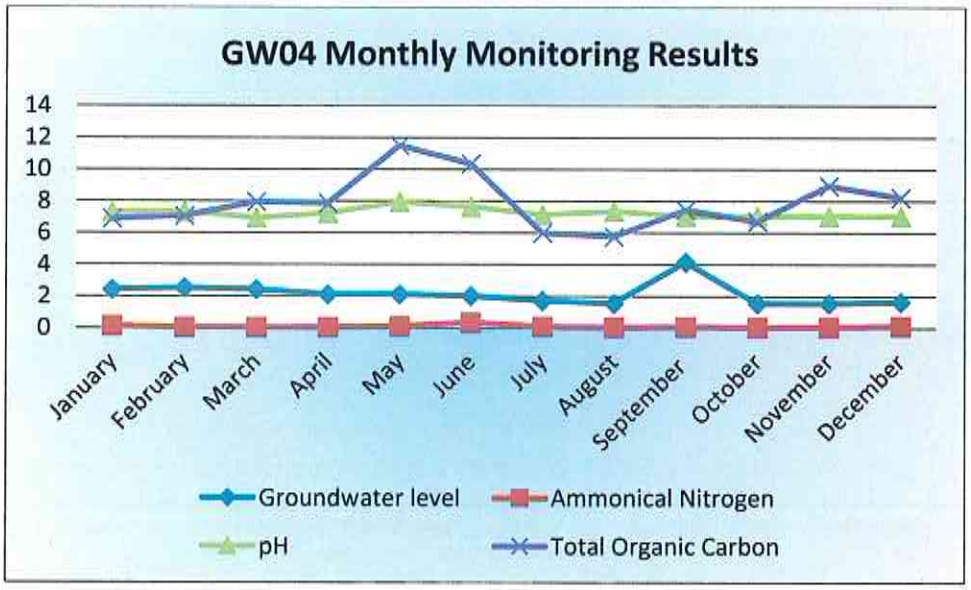


Figure 3.4.5: GW04 Monthly Monitoring Results 2013

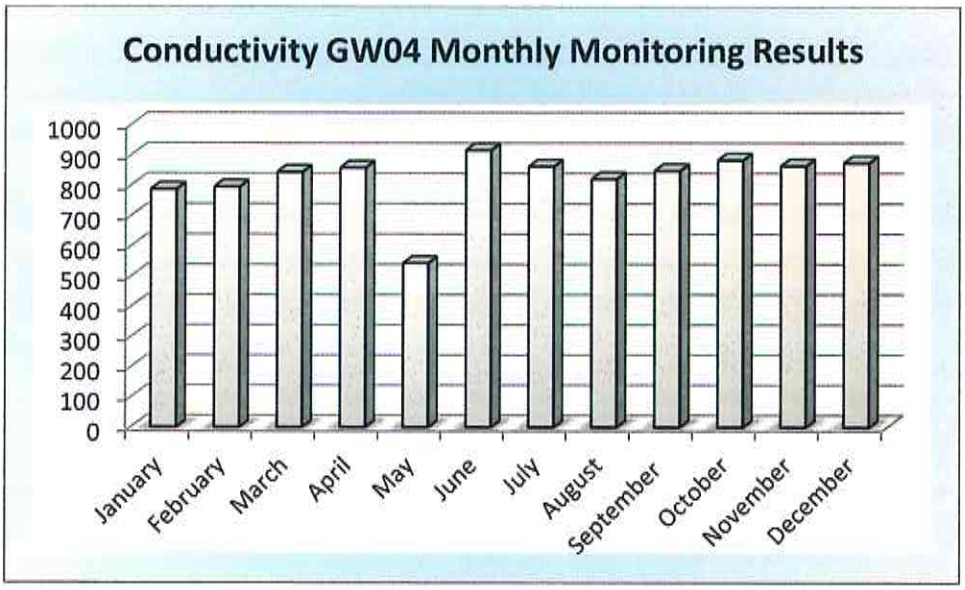


Figure 3.4.6: GW04 Monthly Monitoring Results for Conductivity 2013

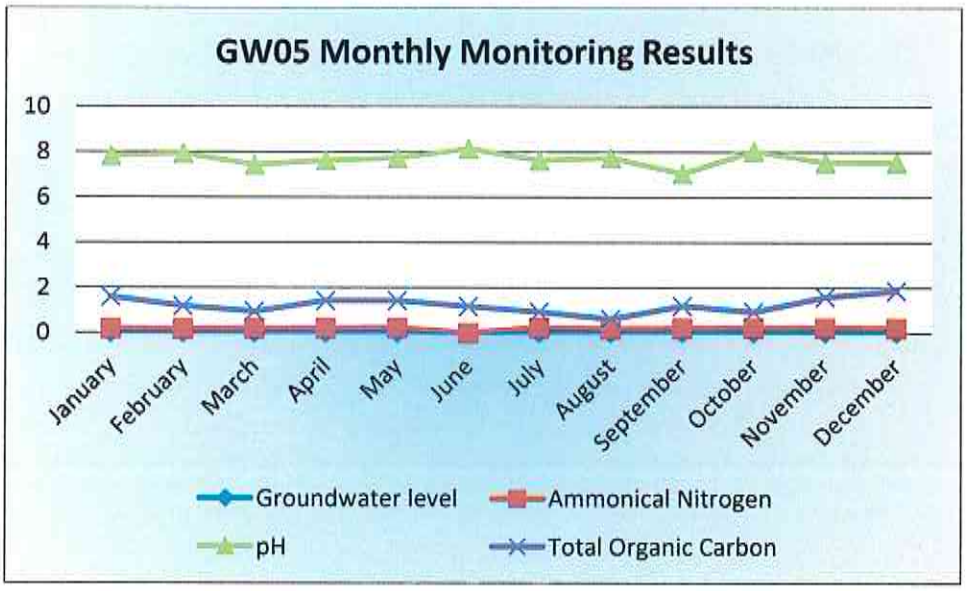


Figure 3.4.7: GW05 Monthly Monitoring Results 2013

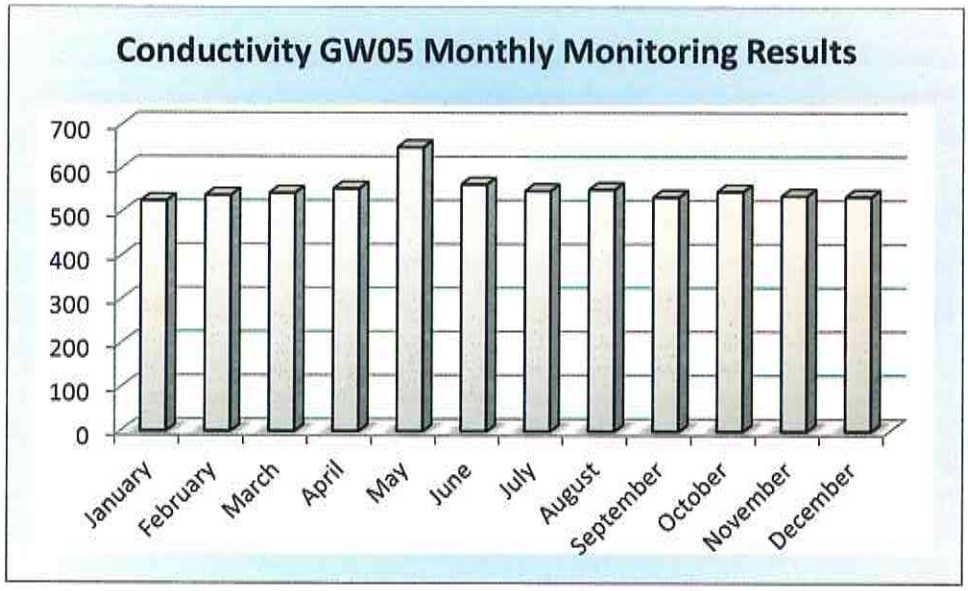


Figure 3.4.8: GW05 Monthly Monitoring Results for Conductivity 2013

Wells GW02 and GW03 were covered at times of sampling so samples could not be obtained. Samples could not be obtained from GW01 (19mm) and GW01(50mm) during October, November and December due to works on site.

In addition to the monthly groundwater sampling results depicted in the figures above, annual and quarterly groundwater sampling is carried out for an additional range of parameters. The quarterly and annual results of the analysis conducted on the groundwater are presented in detail in the monthly reports which were submitted to the Agency during the reporting period.

There are no emission limit values set out in the Waste Licence for the facility, therefore, groundwater parameters are compared with the Interim Guideline Values (IGVs) as indicated on the EPA Document "Towards Setting Guideline values for the Protection of Groundwater in Ireland -Interim Report". The results for the following parameters were all within the IGV's: TOC; pH; Conductivity; Chloride; Nitrate; Fluoride; Total Cyanide; Chromium; Sodium Dissolved; Calcium Dissolved; Copper Dissolved; Lead Dissolved;; Mercury Dissolved and Boron Dissolved.

Total coliform concentrations exceeded the IGV's at all locations.
Ammonia exceeded the recommended IGV at GW01S, GW01D,GW05. Total Phosphorus exceeded the recommended IGV's at all locations. This is considered to be due to the intensive levels of agriculture in the surrounding lands.

The Manganese levels recorded at all locations exceeded the IGV of 50ug/l as results ranged from 0.1621mg/l to 0.6255mg/l. Iron exceeded the recommended IGV's at GW01S and GW01D. Zinc exceeded the recommended IGV at GW01S . The most common sources of these elements in groundwater are naturally occurring from minerals and rocks.
Magnesium levels recorded at all locations exceeded the IGV of 0.05mg/l.

The results of analysis carried out on private wells are compared with limits outlined in S.I. No. 278 of 2007 "European Communities (Drinking Water) (No. 2) Regulations 2007- (2012)

3.5 LANDFILL GAS

Corranure Landfill currently has a 1 megawatt gas utilization plant operated in conjunction with 500m^3 capacity Flare extracting gas from cells 0 to 3. Concentrations of methane (CH4), carbon dioxide (CO2), oxygen (O2), temperature and flow are continuously monitored through the SCADA system. Gas at the utilization plant/Flare is monitored using a GA2000 or GA5000 gas monitor. All gas monitoring results are updated on a daily basis and maintained at the facility.

A 1500 cu m/hr Haas Flare is also on site to provide backup support in the event of a breakdown of the engine or during periods of maintenance.

Average monthly concentrations for the flare and the engine are shown in figures 3.5.1 below.

Landfill Gas monitoring was undertaken on a monthly basis at gas extraction boreholes. Analyses were performed on each sample for methane (CH4), carbon dioxide (CO2), oxygen (O2) and pressure. Copies of these sampling results have been submitted to the Agency as part of the monthly reports for the facility.

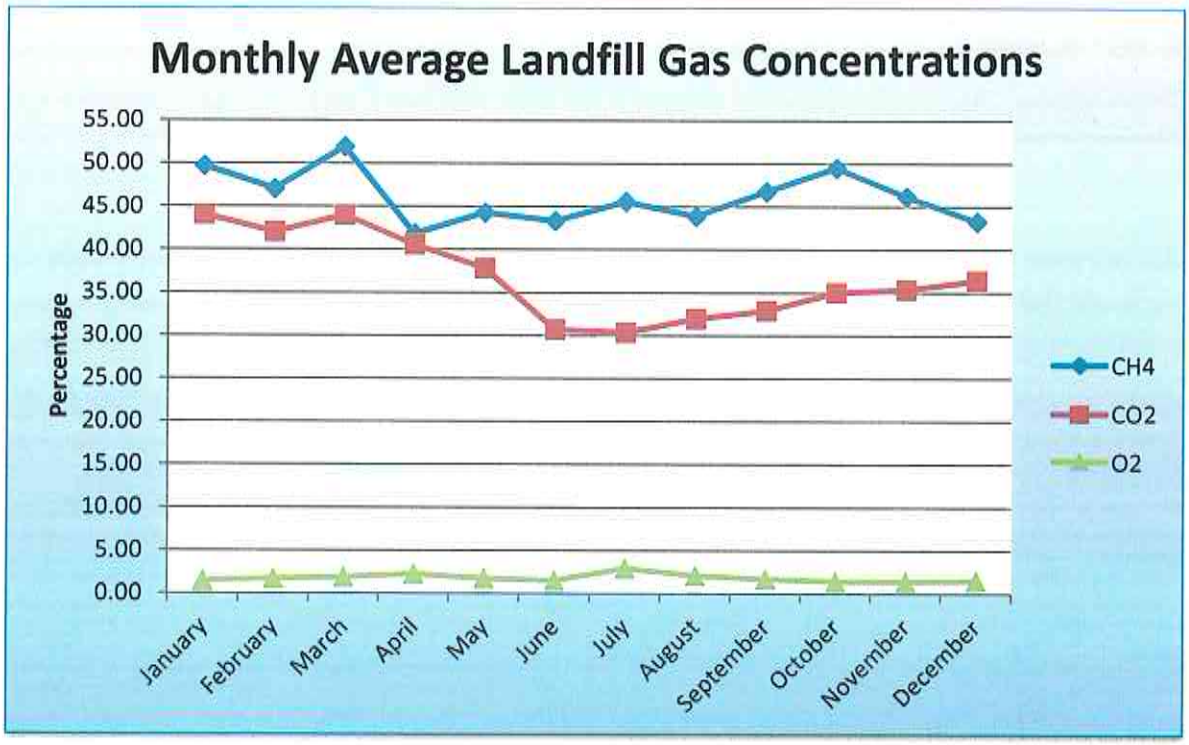


Figure 3.5.1: Gas Monitoring at Engine/Flare 2013

3.6 Leachate Monitoring

Annual leachate monitoring was carried out by Boylan Engineering on the 15th October 2013. Results from the sampling are outlined in table 3.6.1 below. Leachate produced on-site is pumped directly to the Cavan WWTP.

Table 3.6.1: Leachate Monitoring Results 2013

Parameter	Unit	Values at Landfill
Ammonia	mg/l	751.787
BOD	mg/l	116
Boron	mg/l	<0.02
Cadmium	mg/l	0.0175
Calcium	mg/l	176.5
Chloride	mg/l	1023.3
Chromium	mg/l	0.188
COD	mg/l	1290
Conductivity	µS/cm	9570
Copper	mg/l	0.059
Fluoride	mg/l	<0.1
Iron	mg/l	2.75
Lead	mg/l	11
Magnesium	mg/l	67.1
Manganese	mg/l	1.064
Mercury	mg/l	0.00053
Nickel	ug/l	0.1307
Nitrate	mg/l as N	<0.6
pH	pH Units	7.8
Potassium	mg/l	454.8
Sodium	mg/l	1044.4
Sulphate	mg/l	139.2
Total Cyanide	mg/l	58
Total Phosphorus	mg/l	6.1
Zinc	mg/l	1.388

4.0 Waste Management Records

4.1 Quantity of Waste Accepted at the Facility

The only waste accepted at the facility in 2013 was material that was delivered by public customers to the civic amenity site. In addition to this soil and stones were accepted for engineering works used in the capping of Cell 3 at the facility. No material was accepted for landfill at the facility.

On entry to the civic amenity facility not all materials are weighed in upon entry to the facility. All materials are weighed out when removing from the facility. As a result weights are only presented in Appendix 2 for all wastes removed from the facility during 2012.

4.2 Quantity of Waste Disposed of at the Facility

No waste was disposed of at the facility during 2013. Table 4.2.1 below shows the tonnages of wastes disposed of at the landfill in previous years since the grant of the original waste licence for the facility.

Table 4.2.1: Quantity of Waste Landfilled pre-2013

Period	Quantity (Tonnes)
11th March 2002 – 31st June 2002	4,469.25
1st July 2002 – 31st June 2003	36,206.21
1st July 2003 – 31st December 2003	19,911.21
1st January 2004 – 31st December 2004	53,813.44
1st January 2005 – 31st December 2005	45,889.47
1st January 2006 – 31st December 2006	85,869.00
1st January 2007 - 31st December 2007	83,262.91
1st January 2008 - 31st December 2008	87,238.32
1st January 2009 - 31st December 2009	88,932.96
1st January 2010 - 5th February 2010	4956.5
6th January 2010 - 31st December 2010	0
1st January 2011 - 31st December 2011	0
1st January 2012 - 31st December 2012	0
1st January 2013- 31st December 2013	0
Total	**510,549.27**

4.3 Quantity of Recovered Waste used in the Development / Operation of the Landfill

Recovered materials such as inert fines, soil & stones, rubble, crushed rubble or ash used to be accepted at the landfill for use as cover material, the construction of haul roads or for on-site landscaping. In 2012, approval was received from the Agency to accept soil and stones material from a customer who was carrying out site excavation works this material was also accepted during 2013. This material was inspected upon entry to the facility and recorded on the facility weighbridge system. The material was used exclusively for the profiling of the cell prior to it being lined. All of the material is underneath the lining system. GPS co-ordinates of where the material was tipped on-site were taken and are recorded on the facility weighbridge records. A copy of these records are maintained on-site and are available for inspection. The recovered materials that were accepted on-site for 2013 and previous years are outlined in Table 4.3.1 below.

Table 4.3.1: Quantity of Materials Recovered 2008 to 2013

Period	Quantity (Tonnes)
1st January 2008 - 31st December 2008	56,899.71
1st January 2009 - 31st December 2009	27,188.78
1st January 2010 - 31st December 2010	7,742.81
1st January 2011 - 31st December 2011	154.06
1st January 2012 - 31st December 2012	14,178.64
1st January 2013-31st December 2013	8910.09

4.4 Quantity of Waste Removed Off-site for Recovery or Disposal

All materials that were consigned offsite for onward recovery or disposal were all weighed and recorded at the facility weighbridge. These weights have been summarised and are presented in the PRTR returns for the facility. A copy of the PRTR waste treatment data is included in Appendix 2 of this AER.

4.5 Statement on Achievement of the Waste Acceptance and Pre-treatment requirements

It is considered that the waste acceptance and pre-treatment obligations have been met as materials accepted at the CA site were source segregated. No materials were disposed of at the facility.

5.0 Total Consented Landfill Void (m3)

As reported in the AER for the facility for 2012, Cell 4 has been constructed with an estimated total capacity of 314,825m^3. Filling of this Cell has not commenced to date, therefore the estimated remaining void space remains the same as that reported in 2011 (314,825m^3). Waste Licence W0077-04 that was granted in May 2011 states that the total permitted landfill capacity is 250,000m^3. None of the consented landfill void was developed in 2013 as no waste was accepted for landfill at the facility. Therefore no average compaction/ fill densities are reported as part of this AER. All filling of void landfill space will be subject to written agreement from the Agency and will only take place upon details of a fill plan for the cell being submitted to and approved in writing by the Agency.

6.0 Topographical Survey

No topographical survey was carried out in 2013 due to capping - works onsite. A topographical survey is planned for 2014.

A slope stability assessment of the site was completed in 2013 by RPS. The details and recommendations of this report are attached appendix 4 below.

7.0 Updates/Amendments to Odour Management Plan

An Odour Management Plan has been prepared by RPS for the facility. There were no updates or amendments to this Odour Management Plan in 2013. The facility is currently a closed landfill which is not giving rise to any offsite odours. Odour monitoring patrols are carried out on a daily basis, following the guidelines as laid out in the Odour Management Plan. An odour patrol route has been mapped. Any odours detected on this route are recorded on the daily odour patrol sheet. If an odour is detected that is considered to be originating at the landfill facility a full investigation will be carried out until the source of the odour is defined and the odour eliminated.

8.0 Statement of Compliance of Facility with any Update to Waste Management Plan

The Management of Corranure Landfill is fully committed to meeting all relevant policies and targets set out in the North-East Waste Management Plan. As the facility is a closed landfill site, no materials were accepted for landfill in 2013. However, a Civic Amenity is operated at the facility which provides a recycling platform for members of the public. This CA facility formed an integral part in meeting objectives and targets of the Litter Management Plan for County Cavan.

9.0 Complaints Summary

During the course of 2013 there was 1 complaint received at the facility. The complaint was relating to odours emanating from the facility. The complaint was handled in accordance to the Complaints Handling Procedure. It was determined that the complaint once investigated, was found not to be relating to odours from the facility but from surrounding agricultural odours. delete

An out of hours emergency help line is in operation in order to facilitate any potential complaints and to ensure that they can be investigated and addressed in a timely manner. A complaints folder is maintained on-site detailing all follow up investigations.

10.0 Reported Incidents Summary

There were 3 notified incidents during the reporting period.
Incident 1 occurred in March . An exceedance of Emission Limit Values for Ammonia (mg/l) at surface water monitoring points SW1, SW2, S4 and S5. This incident was reported on the 16/04/2013 following receipt of results. Corrective actions were put in place and the points were re-sampled.

Incident 2 occurred in April. An exceedance of emission limit value in Monitoring results for suspended solids at surface water monitoring point SW2.The incident was reported on the

02/05/13 following receipt of results. This exceedance was attributed to adverse weather conditions corrective actions were put in place and the SW2 was re-sampled.

An exceedance of emission limit value in monitoring results for ammonia at SW1 and suspended solids at SW1 and SW2 in June . Results of the samples were received on the 22/07/13 and the incident was reported to the Agency immediately. Surface water points were visually inspected and re-sampled.

11.0 Schedule of Environmental Objectives & Targets

Environmental objectives and targets were set in January 2013 by Enviroguide Consulting and reported as part of the AER for 2013. A summary of these objectives and targets are outlined in Table 11.0.1 below.

Table 11.0.1: Objectives & Targets 2013

Objective 1	**Target**	**Completion Date**
Capping of Cell 3	• Complete final capping works of Cell 3.	31.07.13
Objective-2	**Target**	**Completion Date**
Gas and Odour Management	• Constant upgrade and revision of gas and odour management so that the gas is suitable for gas utilisation and do not give rise to odours. • Invest in an upgraded gas analyser (GA5000) for the monitoring of landfill gas.	31.12.13 30.06.2013
Objective-3	**Target**	**Completion Date**
Gas Utilisation	• Utilise landfill gas to generate electricity on-site.	31.12.12

Summary of Objectives & Targets 2013

Objective 1: Capping of Cell 3

The capping of Cell 3 was ongoing during 2013. Capping is now complete.

Objective 2: Gas and Odour Management

The gas and odour management systems were reviewed periodically throughout 2013. As part of the capping works being carried out on-site up-grades were carried out to the gas infrastructure to ensure odour management. Balancing of landfill gas carried out on an ongoing basis throughout 2013 to ensure gas was suitable for utilisation and did not give rise to odours. GA 5000 gas analyser currently used on site to monitor landfill gas.

Objective 3: Gas Utilisation;

Electricity is now generated on site through the Gas Utilisation Plant.

Table 11.0.2: Proposed Objectives & Targets 2014

Objective 1	Target	Completion Date
Remediation of Cell 4	• Remediation of Cell 4 using non-hazardous soils to re-profile.	Ongoing in 2014
Objective-2	**Target**	**Completion Date**
Gas and Odour Management	• Constant upgrade and revision of gas and odour management systems and controls.	31.12.14
Objective-3	**Target**	**Completion Date**
Upgrade of surface water management system from CA site	• Upgrade surface water management system from CA site to include silt-trap and interceptor. This will reduce the amount of surface water being sent to the leachate system and accordingly reduce the amount of leachate from the facility.	31.12.14
Objective-4	**Target**	**Completion Date**
Weather station	• Upgrade of weather station on site.	31.05.14
Objective 5	**Target**	**Completion Date**
Site haul roads	• Upgrade all site haul roads	31.06.14

12.0 Environmental Management Programme

An environmental landfill management plan (ELMP) is in place at the facility in accordance with Condition 2.2.2.3 of the Licence. This programme outlines how the objectives and targets for the facility are going to be met. Responsibility for each target is assigned along with a completion date. An ELMP is completed for each forthcoming year and reviewed during internal audits as part of the EMS for the facility.

13.0 Pollutant Release and transfer Register

A copy of the 2013 pollutant releases data as reported in the PRTR returns is included in Appendix 3 of this report.

14.0 Waste Analysis

As no waste was accepted for landfill at the facility in 2013, no waste analysis was carried as required in Condition 8.2.16 of the Licence. Should the facility recommence the acceptance of waste, all waste analysis will be conducted as required by Licence conditions.

15.0 Meteorological Data Summary

A 'Davis Weather Station II' is used to record meteorological data at Corranure Landfill. This weather station records:

- Temperature,
- Sunshine,
- Precipitation, and
- Wind force and direction.

The following additional data is recorded at Clones Weather Station and can be obtained as per Schedule C.9 of the Licence.

- Humidity,
- Atmospheric Pressure, and
- Evapo-transpiration.

16.0 Tank and Pipeline Inspection Report

In accordance with Condition 6.10 of the Licence the testing of integrity and water tightness of all underground pipes, tanks, bunding structures and containers and their resistance to penetration by water should be carried out once every three years. All storage tanks (fuel & leachate) and bunds at the facility were inspected and tested on the 24th to 26th of October 2010. All structures were found to be in sound condition with their integrity verified. Inspection of bunds and pipelines will be carried out in compliance with the conditions of the waste licence.

17.0 Energy Efficiency Audit Report Summary

Electricity is used in site offices, canteen and welfare facilities. An energy awareness system is in place whereby all equipment and lighting is powered off when not in use or at the end of each working day. It is proposed to create visual awareness of energy consumption at the facility as part of the review process of the EMS for the facility.

18.0 Resource Consumption Summary

In 2013, the estimated electricity consumption at the facility was as follows:

- Day Time Units: ~209000 kWh
- Night Time Units: ~166250 kWh

19.0 Developmental/Infrastructural Works Summary

The capping works on Cell 3 commenced on 17th October 2011 with preliminary set up works and installation of haul road on the top of Cell 3 being the only works completed by the end of October 2011. Work re-commenced on 23rd April 2012 with the work focussing on re-grading the eastern slope. At the start of each working day the geohess was lifted and at the finish of each day the geohess was replaced and re-stitched.

Cavan County Council advertised that this work was commencing in the Anglo Celt, on local radio and held a meeting with representatives Cavan Better Waste Management group to advise them of same.

In August 2012 the lining works re-commenced. By the end of the month approximately half of the western flank was lined. By the end of December 2012 all of the Western and Northern flank linings have been completed including the tie-in with the basal liner. The capping work on cell 3 were completed by the end of June 2013.

In addition to the capping of Cell3 permission was sought from the EPA to drill 6 additional gas wells on Cell 3 in order to optimise gas extraction on this cell. This work was completed at the end of April 2013.

Following the completion of the capping works, Irish Biotech Services were contracted by Cavan County Council to upgrade all of the surface infrastructure on Cell 3. This included all well heads, pipes, knockout pots and valves. This work was completed by the end of December 3013.

Permission was also sought from the Agency to widen the gate into the facility to make for safer access for traffic using the Civic Amenity Site. This permission was granted and this work was carried out in February 2013.

Discussions were held with the EPA in respect of Cell 4 which was constructed but remained unused. It was agreed by the Agency that Cavan County Council could accept non-hazardous soil and stone into this cell in order to re-profile it. This activity is a remediation activity as it has been decided that waste would not be accepted into this cell. Following these discussions a filling plan was provided to the Agency and agreed.

The Construction Quality Analysis (CQA) report for Cell 4 was submitted to the Agency in November 2013 and further information supplied in December 2013. This was approved by the Agency in January 2014.

20.0 Management and Staffing Structure at the Facility

The facility was operated and managed by Enviroguide Consulting since April 2011 on behalf of Cavan County Council. Details of the new management structure were submitted to the Agency for approval prior to changes in management taking place. Below is the staffing structure for 2013.

- Landfill Manager: Jim Dowdall
- Deputy Landfill Manager: Gillian Free
- Deputy Landfill Manager: Janet O'Shea

21.0 Programme for Public Information

A programme for public information is in place at the facility. Any interested party wishing to view this public information is advised to make an appointment with the Landfill Manager. A suitable time will be arranged for the viewing of files to take place. A room will be provided to the interested party to view the public information files. Files available as part of the public information programme include the EPA Licence for the facility, the previous year's AERs, monitoring results and monitoring location maps. Any files specific or additional files that are required by the interested party can be requested and will be considered by the Landfill Manager.

In 2012, there were no requests made by any interested parties to view files at the facility.

22.0 Financial Provisions

The EPA has developed a dedicated financial model to facilitate and streamline the reporting to the EPA of compliance with Section 53(A). This financial model will be completed for Corranure landfill and submitted to the EPA annually as required. This will be done directly by Cavan County Council

23.0 Review of Environmental Liabilities

An ELRA and CRAMP has previously been submitted to the Agency for the facility. In 2010 Corranure Landfill was selected to take part in the Agency's Environmental Liability Risk Assessment (ELRA), Closure Restoration and Aftercare Management Plans (CRAMPs) and implementation of Financial Provision (FP) pilot programme. The site was reviewed as part of a programme of assessing twenty IPPC regulated facilities. No review of the environmental liabilities or review of the closure, restoration and aftercare management plan took place in 2012.

24.0 Statement of Costs of Landfill including Landfill Levy

This facility is currently a closed landfill site. No materials were accepted for disposal at the landfill therefore no costs or landfill levy were assigned.

25.0 Hydrogeological

A Hydrogeological Tier 1 Risk Assessment: for Corranure Landfill was carried out on the 10/10/13 as per *condition 6.29 of licence number W0077-04.* Details of Risk assessment attached in appendix 5.

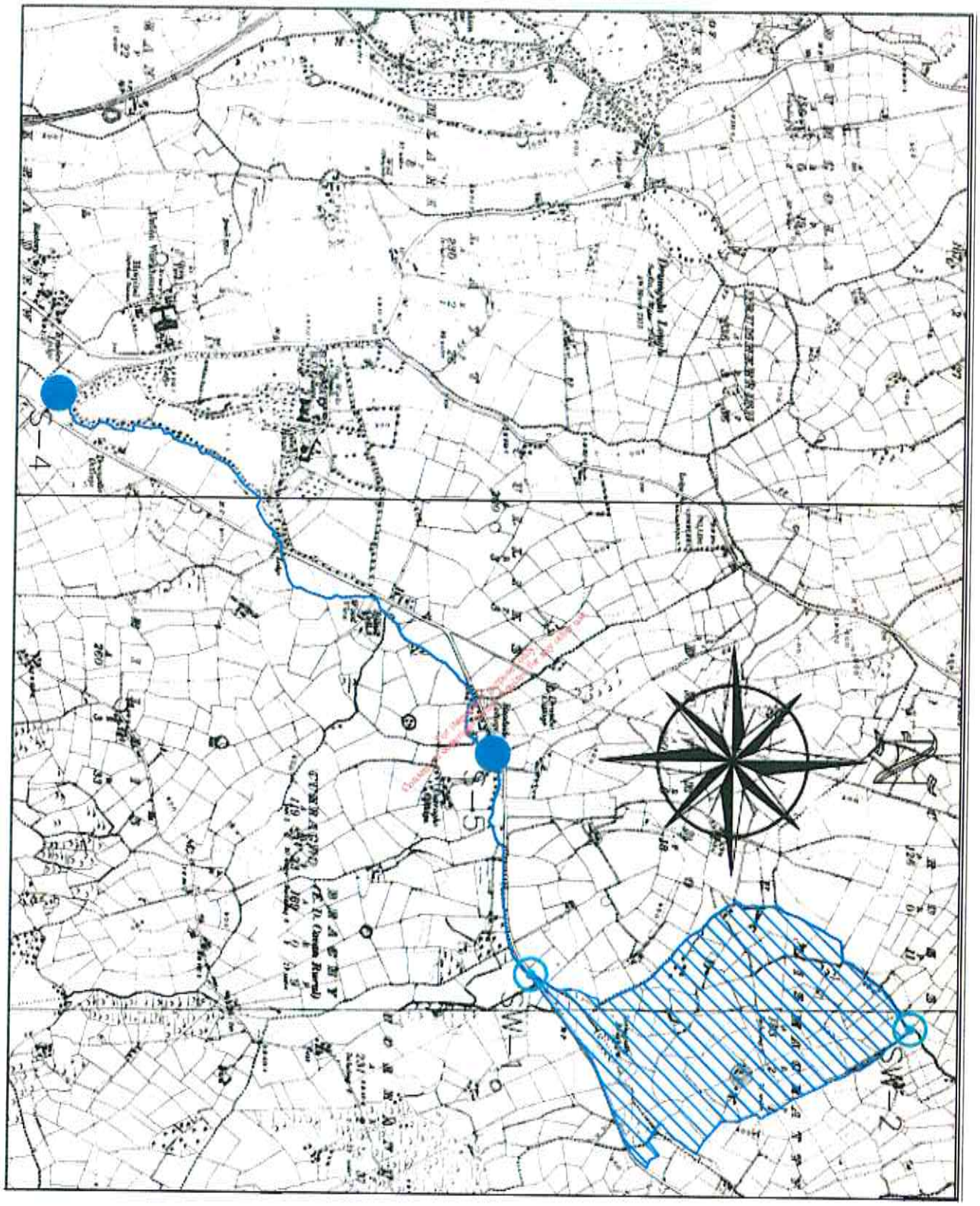
26.0 Environmental Management System

An certified environmental management system is in operation and maintained on site in accordance with condition 2.2 of licence number W0077-04. The Environmental Management System is certified to ISO 14001:2004 standard.

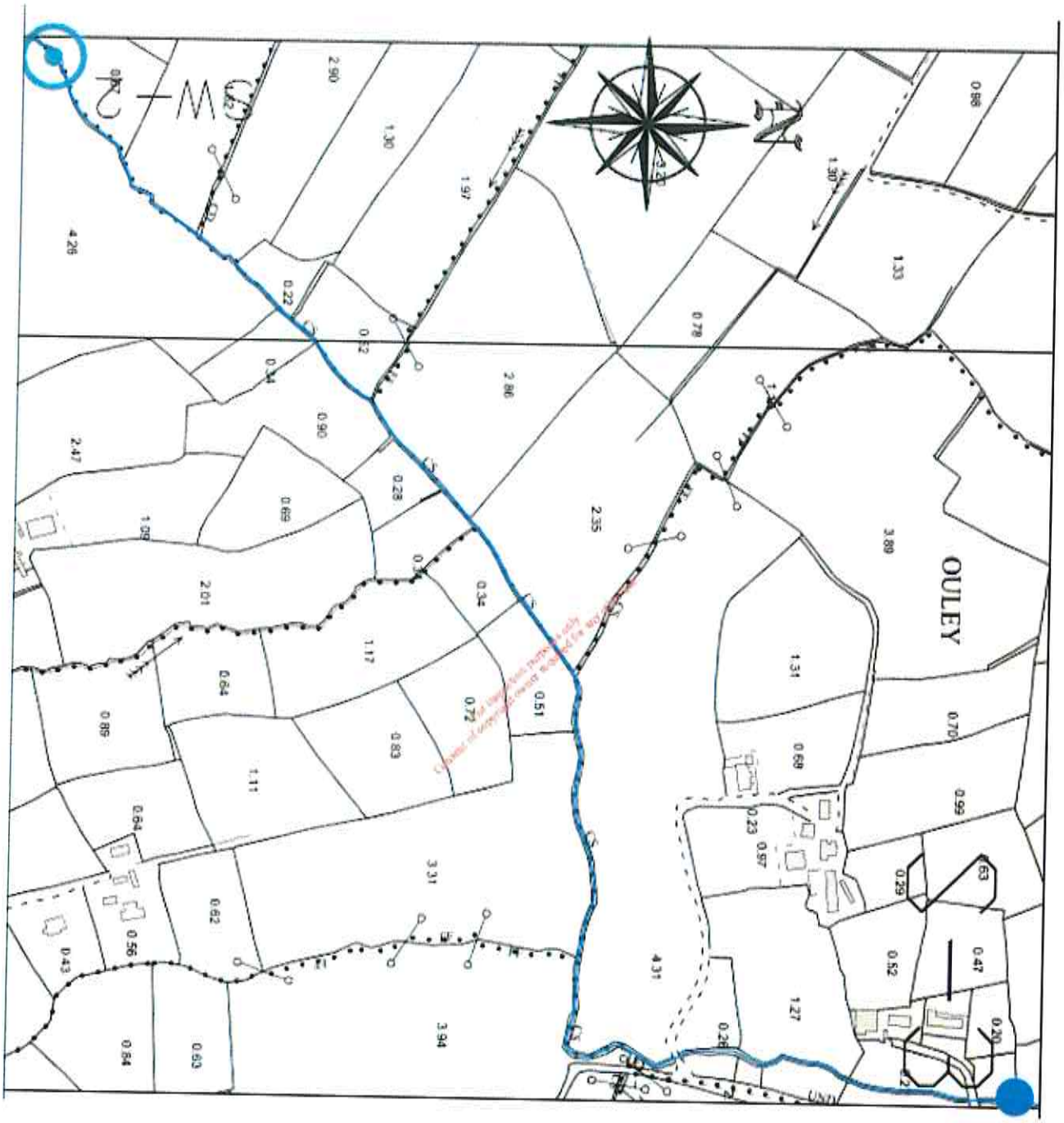
APPENDIX 1

SURFACE WATER MONITORING LOCATION MAPS

Map 1: Surface monitoring Locations SW1, S4, S5



Map 2: Surface Monitoring Locations SW2, S3



APPENDIX 2

PRTR OFFSITE TRANSFERS OF WASTE 2013

5. ONSITE TREATMENT & OFFSITE TRANSFERS OF WASTE

[PRTR# : W0077] [Facility Name : Corranure Landfill] [Filename : w0077_2013 (1).xls] [Return Year : 2013]

Please enter all quantities on this sheet in Tonnes

31/03/2014 11:23

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
Within the Country	08 03 18	No	0.1	waste printing toner other than those mentioned in 08 03 17	R13	M	Weighed	Offsite in Ireland	Kildarson Ltd,N/A	,,,,,,Ireland		
To Other Countries	13 02 08	Yes	2.86	other engine, gear and lubricating oils	R1	M	Weighed	Abroad	Enva Ireland Ltd.,W0184-01	Clonminam Industrial Estate ,Portlaoise ,Co. Laoise,,Ireland	RD Recycling,51727/1/KD,Houthalen,,,,,Belgium	Houthalen,,Belgium,,Belgium
Within the Country	15 01 01	No	81.0	paper and cardboard packaging	R3	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,Ireland		
Within the Country	15 01 02	No	25.0	plastic packaging	R3	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,Ireland		
Within the Country	15 01 04	No	3.0	metallic packaging	R4	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,Ireland		
Within the Country	15 01 04	No	7.0	metallic packaging	R4	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,Ireland		
Within the Country	15 01 07	No	45.0	glass packaging	R5	M	Weighed	Offsite in Ireland	Rehab Glassco Ltd.,WFP-KE-09-0357-01	Unit 4 Oberstown Industrial Park,Caragh Road,Naas,Co. Kildare,Ireland		
To Other Countries	16 01 07	Yes	0.06	oil filters	R13	M	Weighed	Abroad	Enva Ireland Ltd.,W0184-01	Clonminam Industrial Estate ,Portlaoise ,Co. Laoise,,Ireland	RD Recycling,51727/1/KD,Houthalen,,,,,Belgium	Houthalen,,Belgium,,Belgium
To Other Countries	16 05 04	Yes	0.32	gases in pressure containers (including halons) containing dangerous substances	R13	M	Weighed	Abroad	Enva Ireland Ltd.,W0184-01	Clonminam Industrial Estate ,Portlaoise ,Co. Laoise,,Ireland	RD Recycling,51727/1/KD,Houthalen,,,,,Belgium	Houthalen,,Belgium,,Belgium
Within the Country	16 06 01	Yes	3.69	lead batteries	R4	M	Weighed	Offsite in Ireland	Wilton Waste Recycling..	Kiffa,Crosserlough,Ballyjamesduff,Co. Cavan,Ireland	Recycling Village,WFP/MH/11/0005/01 ,Unit 21 Duleek Business Park,Commons,Duleek,Co. Meath,Ireland	Unit 21 Duleek Business Park,Commons,Duleek,Co. Meath,Ireland
Within the Country	17 01 07	No	74.14	mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	R13	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,Ireland		

Within the Country	1 -)7 03	No	landfill leachate other than those mentioned 22075.2 in 19 07 02	D9	E	Volume Calculation	Offsite in Ireland	Cavan County Council WWTP,	,,,,,,Ireland		
Within the Country	20 01 01	No	92.0 paper and cardboard	R3	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,,Ireland		
Within the Country	20 01 10	No	11.0 clothes	R12	M	Weighed	Offsite in Ireland	Textile Recycling Limited,N/A	504 A Grants Drive,Greenogue Business Park,Greenogue Industrial Estate,Dublin 24,Ireland		
To Other Countries	20 01 21	Yes	fluorescent tubes and other mercury-0.5 containing waste	R13	M	Weighed	Abroad	KMK Metals Recycling Limited,W0113-03	Cappincur Industrial Estate,Daingean Road,Tullamore,Co Offaly,Ireland	Remondis Electro Recycling,01/245A,ZAC des Marots,Route l'Ecluse,St Thilbault,BP0310800,France	ZAC des Marots,Route l'Ecluse,St Thilbault,BP0310800,France
Within the Country	20 01 23	Yes	discarded equipment containing 15.82 chlorofluorocarbons	R4	M	Weighed	Offsite in Ireland	ERP Ireland,,	Unit 9D ,Nutgrove Office Park ,Nutgrove Avenue ,Rathfarnham ,Dublin 14,Ireland		
Within the Country	20 01 25	No	0.86 edible oil and fat	R9	M	Weighed	Offsite in Ireland	Agri Pure,,	,,,,,,Ireland	EMR,,,,,,,,,,Ireland	,,,,,,Ireland
To Other Countries	20 01 25	No	0.0 edible oil and fat	R9	M	Weighed	Abroad	Frylite Ltd,,	Orchard Road Industrial Estate,Orchard Road ,Strabane,Co. Tyrone BT82 9FR,Ireland		
Within the Country	20 01 27	Yes	paint, inks, adhesives and resins 0.0 containing dangerous substances	R5	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co Monaghan,,,Ireland	HP Partners,,,,,,,,,,Ireland	,,,,,,Ireland
To Other Countries	20 01 27	Yes	paint, inks, adhesives and resins 1.04 containing dangerous substances	R13	M	Weighed	Abroad	Enva Ireland Ltd ,W0184-01	Clonminam Industrial Estate ,Portlaoise ,Co Laoise,,,Ireland	RD Recycling,51727/1/KD,Houthalen,,,,,Belgium	Houthalen ,Belgium ,Belgium
Within the Country	20 01 33	Yes	batteries and accumulators containing 0.0 these batteries	R4	M	Weighed	Offsite in Ireland	KMK Metals Recycling Limited,W0113-03	Cappincur Industrial Estate,Daingean Road,Tullamore,Co Offaly,Ireland	,,,,,,,,,,Ireland	,,,,,,Ireland
Within the Country	20 01 36	No	discarded electrical and electronic equipment other than those mentioned in 0.0 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighed	Offsite in Ireland	The Recycling Village,WFP/MH/11/0005/01	Unit 21 Duleek Business Park,Commons,Duleek,Co. Meath,Ireland		
Within the Country	20 01 36	No	discarded electrical and electronic equipment other than those mentioned in 100.99 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighed	Offsite in Ireland	ERP Ireland,,	Unit 9D ,Nutgrove Office Park ,Nutgrove Avenue ,Rathfarnham ,Dublin 14,Ireland		
Within the Country	20 01 38	No	93.0 wood other than that mentioned in 20 01 37	R3	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,,Ireland		
Within the Country	20 01 39	No	29.0 plastics	R3	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co Monaghan,,,Ireland		
Within the Country	20 01 40	No	58.0 metals	R4	M	Weighed	Offsite in Ireland	Wilton Waste Recycling,	Kilfa,Crosserlough,Ballyjamesduff,Co. Cavan Ireland		
Within the Country	20 02 01	No	82.0 biodegradable waste	R3	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,,Ireland		
Within the Country	20 03 01	No	642.0 mixed municipal waste	D15	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,,Ireland		
Within the Country	20 03 07	No	215.56 bulky waste	D15	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,,Ireland		
Within the Country	17 08 02	No	gypsum-based construction materials other 4.31 than those mentioned in 17 08 01	D15	M	Weighed	Offsite in Ireland	Scotch Corner ,W0020-02	Annyalla,Castleblaney ,Co. Monaghan,,,Ireland		

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

APPENDIX 3

POLLUTANT RELEASE AND TRANSFER REGISTER

| PRTR# : W0077 | Facility Name : Corranure Landfill | Filename : w0077_2013.xls | Return Year : 2013 |

Environmental Protection Agency

Guidance to completing the PRTR workbook

AER Returns Workbook

Version 1.1.18

REFERENCE YEAR	2013

1. FACILITY IDENTIFICATION

Parent Company Name	Cavan County Council
Facility Name	Corranure Landfill
PRTR Identification Number	W0077
Licence Number	W0077-04

Waste or IPPC Classes of Activity

N	class_name
3.5	Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment.
3.1	Deposit on, in or under land (including landfill).
3.11	Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.12	Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.13	Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.
3.4	Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.
3.7	##
4.11	Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.
4.12	Exchange of waste for submission to any activity referred to in a preceding paragraph of this Schedule.
4.13	Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.
4.2	Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).
4.3	Recycling or reclamation of metals and metal compounds.
4.4	Recycling or reclamation of other inorganic materials.
4.9	Use of any waste principally as a fuel or other means to generate energy.

Address 1	Lismagratty & Corranure Townlands
Address 2	Cootehill Road
Address 3	Cavan
Address 4	County Cavan
	Cavan
Country	Ireland
Coordinates of Location	-7.86062 53.3979
River Basin District	GBNIIENW
NACE Code	3821
Main Economic Activity	Treatment and disposal of non-hazardous waste

4.1 RELEASES TO AIR

Link to previous years emissions data

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs				
POLLUTANT		METHOD			ADD EMISSION POINT		QUANTITY		
			Method Used		Flare 01	Engine 01			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
01	Methane (CH4)	E	ESTIMATE		858520.0	662200.0	1520720.0	0.0	0.0

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

SECTION B : REMAINING PRTR POLLUTANTS

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

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

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

RELEASES TO AIR					Please enter all quantities in this section in KGs								
POLLUTANT		METHOD			ADD EMISSION POINT						QUANTITY		
			Method Used		01	02	03	04	05				
Pollutant No	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	Emission Point 3	Emission Point 4	Emission Point 5	Emission Point 6	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
210	Dust	M	ALT		537.00625	1143.438541667	1430.34375	1168.532291667	1345.025	0.0	5624.345833333	0.0	0.0

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

Additional Data Requested from Landfill operators

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

Landfill: Corranure Landfill

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

	T (Total) kg/Year	M/C/E	Method Used: Method Code	Method Used: Designation or Description	Facility Total Capacity m3 per hour	
Total estimated methane generation (as per site model)	1520720.0				N/A	
Methane flared	858520.0				750.0	(Total Flaring Capacity)
Methane utilised in engine/s	662200.0				300.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	0.0				N/A	

4.3 RELEASES TO WASTEWATER OR SEWER

Link to previous years emissions data

[PRTR# : W0077] Facility Name : Corranure Landfill Finance : w0077_2013 [Finalised/Return] 29/03/2014 11:25

SECTION A : PRTR POLLUTANTS

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE WATER TREATMENT OR SEWER					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD			ADD EMISSION POINT	QUANTITY		
			Method Used		Leachate Tank			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
06	Ammonia (NH3)	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	16595.85	16595.85	0.0	0.0
79	Chlorides (as Cl)	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	22589.55	22589.55	0.0	0.0
83	Fluorides (as total F)	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	2.21	2.21	0.0	0.0
13	Total phosphorus	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	134.66	134.66	0.0	0.0

ADD NEW ROW | DELETE ROW *

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

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE WATER TREATMENT OR SEWER					Please enter all quantities in this section in KGs			
POLLUTANT		METHOD			ADD EMISSION POINT	QUANTITY		
			Method Used		Leachate Tank			
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
303	BOD	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	2560.72	2560.72	0.0	0.0
306	COD	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	29477.01	29477.01	0.0	0.0
327	Nitrate (as N)	E	ESTIMATE	Estimate based on estimated leachate volumes and annual monitoring results	13.25	13.25	0.0	0.0

APPENDIX 4

SLOPE STABILITY ASSESSMENT REPORT

Corranure Landfill
Slope Stability Assessment
Report

DOCUMENT CONTROL SHEET

Client:	**Cavan County Council**					
Project Title:	**Corranure Landfill**					
Document Title:	**Slope Stability Assessment Report**					
Document No:	**MGE0068RP0002WPR**					
This Document Comprises:	**DCS**	**TOC**	**Text**	**No. of Appendices**	**List of Figures**	**List of Tables**
	1	1	9	1	-	-

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
A01	For client approval	R. Staunton	C. McGuinness	W. Madden	Galway	24.01.2014
F01	Final	R. Staunton	C. McGuinness	W. Madden	Galway	28.02.2014

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 OVERVIEW 1

2 REMEDIATED CELL 0 (OLD LANDFILL) 2

2.1 EAST SLOPE 2

2.2 SOUTH EAST SLOPE (WEST OF ENTRANCE) 2

2.3 SOUTH WEST SLOPE 3

3 REMEDIATED CELL 1 4

3.1 NORTH EAST SLOPE 4

3.2 NORTH WEST SLOPE 4

4 REMEDIATED CELL 2 6

4.1 NORTH EAST SLOPE 6

4.2 NORTH WEST SLOPE 6

5 REMEDIATED CELL 3 7

5.1 NORTH EAST SLOPE 7

5.2 NORTH WEST SLOPE 7

6 CELL 4 9

6.1 NORTH SLOPE 9

7 RECOMMENDATIONS 9

APPENDICES

Appendix A Site Location Map and Existing Site Layout

1 INTRODUCTION

A visual inspection of the soil slopes at Corranure Landfill was undertaken on the 3rd December 2013. Weather conditions were dry and overcast on the day of the assessment. There had been no significant rainfall at the site on the days preceeding the assessment.

General conditions and slope angles associated with the site are presented and some general maintenance measures outlined.

1.1 OVERVIEW

Corranure Landfill is located off the R188 Cootehill Road, County Cavan and is surrounded by farmland. This assessment is carried out in order to satisfy Condition 6.23 of the Waste Licence (W077-04) for Corranure Landfill which states:

"The licensee shall carry out a stability assessment of the side slopes of the facility annually. The results of this assessment shall be reported as part of the Annual Environmental Report (AER)".

The slope stability assessment focuses on the area of the landfill, which extends northwest from the Cootehill Road (refer Site Plan in **Appendix A**). The landfill operated from the mid 1980's to 2010. It is sited on what was originally a lake, which was subsequently in-filled with waste. Boreholes in the landfill have indicated that waste is found 2 to 3 metres below the current ground levels, and overlies significant thicknesses of low permeability clay.

The landfill previously accepted mainly domestic waste plus some commercial waste from private contractors. The landfill is now closed and is solely operated as a Recycling Facility.

The landfill consists of 5 sections as set out below:

- Remediated Cell 0 (Old Landfill) – unlined and capped.
- Remediated Cell 1;
- Remediated Cell 2; and
- Remediated Cell 3. Capping of Cell 3 was completed in 2013.

Remediated Cells 1 – 3 are engineered lined cells incorporating leachate and gas collection systems.

- Construction of Cell 4 was completed in July 2013. This cell is lined and is currently unfilled.

2 REMEDIATED CELL 0 (OLD LANDFILL)

2.1 EAST SLOPE

This slope is at an angle of about 1:2 (**Plate 1**) and is located at the site entrance (ref. **Appendix A**). It is well vegetated with grass, rushes and gorse. A drainage channel at the base of the slope appears to be working well with no signs of ponding. There are no signs of movement or distress on the slope. The slope appears stable.

Plate 1 East Slope Cell 0

2.2 SOUTH EAST SLOPE (WEST OF ENTRANCE)

The South East Slope as shown in **Plate 2** and **Plate 3** is bounded by the R188 (ref **Appendix A**). It is typically graded at an angle of approximately 1:2.5. It is well vegetated with lush grass, rushes and gorse. The drain at the toe of the slope appears to be functioning well with no signs of ponding. There are no signs of distress or movement and the slope appears stable.

Plate 2 South East Slope – Western End

Plate 3 South West Slope – Western End

2.3 SOUTH WEST SLOPE

The slope as shown in Plate 4 and Plate 5 (ref. **Appendix A**) is at an angle of about 1:2. It is well vegetated with lush grass and rushes, and is hummocky in places. A haul road is located at the base of this slope. There is a drainage channel between the road and the landfill boundary. There are no signs of distress or movement on the slope and the slope appears stable.

Plate 4 South West Slope (facing NE)

Plate 5 South West Slope (facing NW)

3 REMEDIATED CELL 1

3.1 NORTH EAST SLOPE

This slope is well vegetated with lush grass. The profile of this slope changes from a shallower gradient of about 1:3 at the northern end to about 1:2 at the southern end of the slope, where there is an access track to the top of the remediated cell.

A section of this slope was remediated in August 2007 from 1:3 to about 1:2. An extra layer of liner was placed over the slope and leachate and gas extraction wells were installed. There are no signs of distress or movement and the slope appears to be stable (**Plate 6** and **Plate 7**).

Plate 8 North West Slope Failure 2006

The toe of this slope had been left truncated for a month or more to facilitate the installation of a toe drain. This resulted in tensile loading of the liners which they are not designed for. It was also concluded that leachate streams which flowed from the top of the exposed landfill to the western face were a contributory factor to the failure.

Remediation measures included the installation of a geogrid and a reduction of leachate levels. An overall slope angle of 1:2.5 was attained. During capping works, care was taken to ensure that the toe of the slope would not be truncated or oversteepened. A toe bund was also constructed. The haul road now sits on this bund.

Plate 9 and **Plate 10** show the appearance of the slope in 2008 and December 2013, and illustrates that there is no sign of distress or movement.

Plate 9 North West Slope (February 2008)

Plate 10 North West Slope Cell 1 (December 2013)

4 REMEDIATED CELL 2

4.1 NORTH EAST SLOPE

This slope is well vegetated (**Plate 11**).with a gradient of about 1:3. Old farm buildings exist a small distance from the base of the slope and a haul road which serves Cell 3 runs along here also (ref. **Appendix A**). No signs of distress or movement are apparent and the slope appears stable.

Plate 11 North East Slope

4.2 NORTH WEST SLOPE

This slope is well vegetated with grass (**Plate 12**). The gradient is at approximately 1:2. Areas at the toe at the northern end of the slope were previously considered to be slightly oversteep during filling, and have therefore been regraded during capping. A haul road exists at the base of the slope and provides a toe bund to the slope. No signs of distress or movement are apparent on the slope and it appears stable.

Plate 12 North West Slope – Cell 2

5 REMEDIATED CELL 3

5.1 NORTH EAST SLOPE

The slope is vegetated with grass and is at an angle of 1:3. A haul road exists at the base of the slope. No signs of distress or movement are apparent on the slope and it appears stable (**Plate 13** and **Plate 14**). This slope was regraded during capping works.

Plate 13 North East Slope

Plate 14 North East Slope

5.2 NORTH WEST SLOPE

Again this slope is well vegetated with grass and is at an angle of 1:3. There are no signs of distress or movement and the slope appears stable (**Plate 15** and **Plate 16**). The unfilled Cell 4 is visible to the north of Cell 3 in **Plate 16**.

Plate 15 North West Slope facing south

Plate 16 North West Slope facing north

The surface of the northern end of Cell 3 is lined with a LLDPE landfill liner and a geofabric overliner (**Plate 17**). It is not permanently capped. A full inspection was therefore not possible.

Plate 17 North Slope Cell 3

6 CELL 4

6.1 NORTH SLOPE

Cell 4 is located directly to the north of Cell 3 (**Plate 18** and **Plate 19**). Construction of this cell was completed in July 2013. This cell is fully lined and is ready to accept waste.

Plate 18 Cell 4 facing west

Plate 19 Cell 4 facing east

The area around the top of the capped cells of the old landfill was also inspected. In general, the area is in a good state and there are no areas of concern. Some small settlement cracks were observed over Cell 3, but do not threaten the stability of the slope.

7 RECOMMENDATIONS

In general the side slopes around the circumference of the landfill are in a good state, are well vegetated and there are no signs of distress.

Some general recommendations would be to continue to ensure that water does not pond near the crest of slopes as this can cause weakening of the soil resulting in failure. Low spots should be re-graded to eliminate ponding and toe drains and ditches should be kept clean to ensure efficiency.

It is noted that this assessment is based on a visual inspection only. The last topographic survey was carried out at the site in March 2011, prior to the capping of Cell 3. A topographic survey is recommended to compare current levels to those in March 2011.

APPENDIX A

SITE LOCATION MAP AND SITE LAYOUT

APPENDIX 5

HYDROGEOLOGICAL RISK ASSESSMENT

envirologic

21st January 2014

FROM
envirologic ltd.

ADDRESS
Lurganboy,
Cootehill, Co.Cavan

PHONE
087 2024695

EMAIL
info@envirologic.ie

WEBSITE
www.envirologic.ie

ATTENTION:
Jim Dowdall
Enviroguide,
Corranure Landfill,
Corranure,
Co. Cavan.

RE: Monitoring Wells

Dear Jim,

Further to the report issued by Envirologic Ltd. on 10/10/13 entitled: *'Tier 1 Hydrogeological Risk Assessment: Corranure Landfill'*. a meeting took place between Colin O'Reilly and Jim Dowdall on 13/01/13 to discuss positioning of monitoring wells. It was agreed that the recommended monitoring borehole target locations be grouped in order of priority, which may facilitate a phased approach to monitoring well installation.

The boreholes are therefore grouped as follows, with reference made to Figures 11A, 11B and 12:

Essential to Infrastructure

These boreholes are deemed essential for compliance with the *Guidance on the authorisation of discharges to groundwater (EPA, 2010), i.e.* to characterise upgradient and downgradient groundwater conditions in various strata:

GW20D - upgradient of the site, exact positioning depends on off-site accessibility
GW23S - to complement/replace GW01
GW21D - compliance point to PW05BT and PW15.
GW21S - compliance point to downgradient Corranure stream in terms of overburden flow.
GW24D - immediately downgradient of Cell 0 in terms of bedrock flow
GW28D - characterise bedrock groundwater leaving site
GW28S - compliance point to downgradient Lisnagratty stream in terms of overburden flow.

Dependent upon the findings of boreholes installed under 'essential to infrastructure'

GW22 - immediately upgradient of the site in terms of bedrock flow
GW29 - compliance point to baseflow sump
GW31- compliance point to R. Annalee baseflow sump

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Recommended but not essential

GW25 - downgradient of leaching tank

GW26 - downgradient of service yard and refuelling area

GW27 - possibly downgradient in terms of bedrock groundwater flow

GW30 - possibly downgradient in terms of bedrock groundwater flow

Sincerely yours,

Dr. Colin O'Reilly

principle, envirologic ltd.

envirologic

Tier 1 Hydrogeological Risk Assessment: Corranure Landfill

Location:	Corranure, Cavan, Co. Cavan
Prepared for:	Boylan Engineering / Cavan County Council
Prepared by:	Colin O'Reilly BAgrSc, PhD, Envirologic Ltd.
date:	10/10/13
reference no.	11903

envirologic A Lurganboy, Cootehill, Co. Cavan T 087 2024695 E info@envirologic.ie W www.envirologic.ie

Introduction

The following hydrogeological risk screening has been prepared by Colin O'Reilly BAgrSc PhD, of Envirologic Ltd., on behalf of Boylan Engineering and Cavan County Council.

The report is intended to satisfy the requirements of Environmental Protection Agency (EPA), relating to a closed landfill facility at Corranure, County Cavan. The report has been commissioned on foot of amendments to waste licenses as per notification issued by EPA on 18/01/13.

"Within eighteen months of the date of this technical amendment, the licensee shall carry out a risk screening and where necessary a technical assessment in accordance with the Guidance on the Authorisation of Discharges to Groundwater, published by the Environmental Protection Agency.

A report on the outcome of the screening and where relevant the recommendations of the technical assessment in relation to the setting of groundwater compliance points and values, shall be included in the next AER.

Any actions required to demonstrate compliance with the European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended shall be agreed by the Agency and implemented before 22nd December 2015. Groundwater monitoring results shall be submitted annually or as required in the Schedules to this license."

Site Description

Site Location

The site location is indicated on Figure 1. The closed landfill site area is 7.2 ha, within an overall ownership boundary of 47 ha. The site is located 3.4 km northeast of Cavan Town, and 3.4 km south of Ballyhaise. The regional road R188, connecting Cavan Town with Cootehill (17km to the east) passes along the southern site boundary, with the N3 passing 1 km to the west. R188 road elevation declines from 112.6 mOD at the southeast corner of the site (site entrance) to 110.6 mOD at the southwestern site corner, and approximately defines the floor of a minor valley. The immediate surrounds of the site are accessed by a series of small laneways, with a low density network of local roads serving the wider area.

The site is located within a typically drumlin landscape in central/south Cavan, with pre-development topography around 110 mOD. The drumlin tails appear to be elongated along a southwesterly orientation but this is not consistent. The site is located within a slightly raised area to the northeast of Cavan town. Within this elevated area the site is tucked into a minor valley that begins to tend northeast. Drumlin ridges are apparent to the northeast along the R212 to Ballyhaise, and to the south of the R188 to Cootehill. The numerous peaks on these ridges are generally 150 mOD. The highest local peak is 218 mOD at Shantemon, 2 km to the east.

Land use in the surrounding area is almost exclusively grassland, supporting dairy, beef and sheep agriculture of low to moderate intensity. Peat bog has developed in the topographically depressed areas which are not considered important in terms of agricultural production.

Corranure recycling centre (operated by McElvaneys Waste & Recycling) is positioned outside the southeastern site boundary. A small laneway outside the eastern site boundary provides access to the rear of the landfill. Three derelict houses and an environmental services company (McBreen Environmental) are also accessible from this laneway.

Housing density in the area is low, typical of rural one-off housing, though it does become more urban in structure approaching Cavan town. There are no housing clusters in the immediate vicinity of the site.

Site Layout

A site layout map is presented in Figure 2. The site is accessed from the northern side of the R188, east of the recycling facility. A service area at 122 mOD, and to the north of the recycling facility, comprises a leachate storage tank, leachate pumping station, waste inspection/quarantine area, gas flare and associated services. To the north of this service area is the site compound, which contains site offices, machinery storage yard, and refuelling area.

The landfill accepted non-hazardous municipal waste from 1988 to 2009. The landfill is currently not accepting waste. The landfill was filled from south to north, such that Cell 0 fronts the local road. Details of each cell are summarised as follows:

- Cell 0 = 32,600 m^2; unlined, capped in 2001; peak 128 mOD;
- Cell 1 = 19,050 m^2; composite lined cell; active from 2001; capped 2006; peak 116 mOD;
- Cell 2 = 14,484 m^2; composite lined cell; active from 2005; capped May 2007; peak 116 mOD;
- Cell 3 = 20,398 m^2; composite lined cell; active from 2007; capped 2012; peak 116 mOD;
- Cell 4 = 20,398 m^2; composite lined cell; construction commenced in 2009; currently empty, proposed peak 129.5 mOD.

This risk assessment refers to waste license W0077-04 and as such is applicable only to Cells 0, 1 and 2. Hence the mapped site boundary only includes these areas (and not Cell 3 and service areas). As Cell 0 is unlined, it is theoretically the only waste unit discharging to groundwater. However cognisance will be given to the current site layout to facilitate a holistic risk assessment approach, and target compliance points to monitor any vertical or horizontal leachate migration from Cells 1, 2 and 3.

Leachate from Cells 1, 2 and 3 is collected in a drainage collection layer system at the base of each cell, above the HDPE and compacted soil, and directed toward an on-site overground storage tank from which it is pumped to Cavan Wastewater treatment plant. Leachate level is not permitted to accumulate to a level greater than 1 m within each of the waste cells.

Capping was performed to restrict infiltration of precipitation to each waste cell, thus limiting potential for leachate generation and surface water contamination. Cells 0, 1, 2 and 3 are capped. Capping consists of 150-300 mm topsoil, and subsoils, such that combined soil and subsoil thickness is minimum 1 metre. Final capping layer of minimum 0.6 m thickness has maximum permeability of 1 x 10^{-9} m s^{-1}, and/or a geo-synthetic material that provides equivalent protection. Cell 3 capping layer includes a 2 mm weldable HDPE over 500 mm of compacted bentonite enhanced soil. The sides of each cell were also capped, and graded to near natural ground level or surrounds. Base lining consists of a geo-synthetic layer over minimum 1 m layer of clay with hydraulic conductivity less than or equal to 1 x 10^{-9} m s^{-1}.

The base of Cell 4 is at an elevation of 96 mOD, and it is stated this is above static groundwater level. A minimum depth of 3 m of boulder clay was maintained above bedrock.

Desk Study

Soils

Figure 3 shows deep-poorly drained acidic mineral soils dominate the landscape. This soil unit occupies much of east and central Cavan, narrowing to the northeast. It is classified by Gardiner and Radford (1980) as a wet mineral and organic drumlin soil composed of an imperfectly to poorly drained surface water gley of loam to clay loam texture and of medium base status. Surface structure is a weak crumb, becoming massive at about 30 cm, below which soil consistence is plastic and root penetration poor. Drainage impedance is attributed to the heavy texture. The retentive nature of the subsoil predisposes it to periodic water saturation, and a seasonal 'perched' water table results. The main soil (40%) in the association consists of a moderately well-drained acid brown earth of loam to clay loam texture. This soil is shallower and freer draining in places, usually, but not exclusively, on elevated ground.

The southern part of the site is shown to be underlain by shallow soils, however this classification is likely indicative of the capping layer. The OS 6 inch maps show Cell 0 was formerly Lismagratty Lough, a waterbody filling the depressed landscape position and surrounded by waterlogged soils, indicative of peat. However, degradation of soils toward peat does not seem prominent in the wider area.

The majority of the local surface water bodies appear to be underlain by alluvial material, which infers that they were naturally formed. There is no Teagasc county soils book for Cavan.

Subsoils

Drumlins consist of a thick cover of boulder clay deposited in the form of small hills, typically oval in plan. The drumlins stretch from Leitrim and Meath, through Cavan and Monaghan toward Belfast. Figure 4 shows that these heavy impermeable boulder clays are derived from Palaeazoic shales (considered to be more free draining than those derived from upper carboniferous shales). Overburden has previously been described as stiff to hard, brown, silty, sandy, gravelly clay. Subsoil depth is deeper in the valleys, thinning considerably on elevated areas and steeper slopes. Subsoil depth is shown as thin within the southern half of the site. The denoted subsoil category pertaining to the site is associated with historic site activities.

Bedrock & Structural Geology

Figure 5 presents bedrock and structural geology. The site is underlain by formations that form part of the geological structure known as the Longford-Down Inlier. Bedrock in the wider area is classified as Metasediments of Ordovician age, these tending to comprise a series of layered sandstones, siltstones and shales with minor volcanic rocks. The site is underlain by the Red Island Formation, described as green to grey, medium to coarse grained greywackes with subordinate shales. On the northwestern side of the fault is the Coronea Formation of turbidites, shales and minor volcanics. Towards Cavan town we begin to observe limestones coming to the surface.

Structural faulting of the bedrock formations is mapped alongside, and parallel to, the northwestern boundary. A geophysical survey performed in 1999 suggested a possible bedrock fracture zone through the centre of the site. Geological literature shows that the bedding planes dip to the southeast at an angle of 25°.

Bedrock elevation at Cell 4 is between 91.3 - 92.33 mOD. GSI bedrock data in the area is limited but shows that:

- bedrock at 3m in Cross, 1.2 km northwest of the site;
- bedrock at 22.9 m in an agricultural/domestic well in Lismagratty, within 500 m of the site;
- bedrock at 29.3 in Unshinagh, 2.4 km northeast of the site.

No bedrock exposures were observed close to the site.

Aquifer Classification

Bedrock associated with the Longford-Down Massif is known to be of low permeability and the GSI classifies the Red Island greywackes as poor, being generally unproductive except for local zones (Pl). These aquifers are capable of supplying small abstractions with moderate to low yields. Groundwater flow occurs through a limited and poorly-connected network of fractures, fissures and joints and the permeability through these tends to decrease with depth. A shallow zone of increased permeability may exist along the top few metres of fractures/weathered rock. Overall permeability, storage capacity, recharge acceptance, length of flow path and baseflow are likely to be low. Groundwater discharge to streams as baseflow can significantly decrease during drier periods.

There are no karstified limestones in the area. The nearest karst features to the site mapped 27 km to the northwest, at Cuilcagh.

The site lies within the Corranure Groundwater Body (GWB), for which no interim report has been published. The Corranure GWB is surrounded by the Cavan GWB, for which the interim report confirms that well yield is generally low, with an average of 143 $m^3 d^{-1}$. Where yield is high, it is attributed to the well intercepting a fault/fracture zone. Specific capacities are low, averaging 4.3 $m^3 d^{-1}$, with transmissivity values similarly low (< 20 $m^2 d^{-1}$).

The low permeability soils, along with degradation of these soils to peats in depressed areas, can result in confined aquifer characteristics where boreholes penetrate bedrock.

Groundwater Vulnerability

Groundwater vulnerability is dictated by the nature and thickness of the material overlying the uppermost extent of the saturated zone. The GSI classification (Figure 6) shows that vulnerability decreases from Extreme on the southern site boundary, through to Moderate on the northern boundary. In the surrounding area we see that vulnerability is moderate in depressed areas. On raised ground, and as a function of decreasing subsoil depth, vulnerability increases to high through to extreme.

There is a risk associated with discharging to an area with high to extreme groundwater vulnerability, due to the short vertical travel times. Previous site investigation shows overburden is of low permeability, and generally over 10 m thick. This returns a site-specific vulnerability of low, on raised undisturbed areas. Site investigation works and borehole logs will be used to establish site-specific vulnerability.

Recharge

Gridded rainfall data from Met Éireann (Walsh, 2012) 1981-2010 = 999 mm yr^{-1}

PE (Clones, 19 km north of site) = 438 mm yr^{-1}

AE (95%PE) = 416.4 mm yr^{-1}

ER (AAR-AE) = 999 - 416 = 583 mm yr^{-1}

Recharge coefficients can be utilised to estimate the proportion of water infiltrating to bedrock, against that moving laterally as shallow subsurface flow and surface overland flow. As the landfill has been capped with approximately 1 m of imported subsoil, there may be a separate recharge coefficient at the ground surface, represented by moderate permeability subsoil overlain by 'poorly drained' soil, yielding a recharge coefficient of 33%. The recharge coefficient applicable to moderate vulnerability and basin peat is 4%, with this representing infiltration to bedrock below the waste material.

w = annual recharge to waste material, $m^3 m^{-2}$ = 33% ER = 33% of 583 mm = 0.192 $m^3 m^{-2}$ = 0.0005 $m^3 m^{-2} d^{-1}$

Source Protection Area (SPA)

The site does not appear within source protection areas as mapped by the GSI or EPA. The closest SPA to the site is 12 km north at Scotshouse, deemed to be too far to be at risk of impact.

Site Investigation

A useful amount of data has been obtained from site investigations at various stages of landfill development at Corranure. The two most intrusive site investigations took place in 1998 and 2003 with the results of these excavations giving an insight into the original undisturbed lithological profiles.

Table 1 shows summary data collected during field investigations in 1998, with the corresponding locations explored presented in Figure 7(a). The data was collected from a series of trial pits (TP) and boreholes, drilled using rotary core (RC) and shell and auger (SA) technique in the central and southern areas of the site. Trial pits logs show presence of a 1 metre thick layer of firm, slightly sandy CLAY with a small amount of pebbles. This is underlain by a subsoil generally described as a stiff, silty, gravelly CLAY with an assortment of cobbles and boulders throughout. Subsoil depth across the site is 15 - 20 m. Where encountered, bedrock is described as a shaley siltstone/sandstone, with the upper metre typically a weathered transition zone. In the unlined waste cell (Cell 0), the depth of waste encountered was 27 m, underlain by that subsoil just previously described.

Table 1 - Summary data acquired from site investigation works 1998 (see Figure 7(a) for locations).

Borehole ID	Easting, m	Northing, m	Ground elevation, mOD	Top of Casing elevation, mOD	Topsoil depth, m		Lithology
TP1	244193	307842			0.5	0.5 - 3.1	firm to soft sandy CLAY with pebbles/boulders
TP2	244181	307936			0	0 - 1.8	soft peats and grey CLAY
						1.8 - 2.0	soft silty CLAY with pebbles
TP3	244222	307955			0.2	0.2 - 0.8	firm slightly sandy pebbly CLAY
						0.8 - 3.0	firm to stiff pebbly bouldery silty CLAY
TP4	244257	307856			0.2	0.2 - 2.4	firm to soft slightly sandy pebbly CLAY
						2.4 - 2.8	stiff to v. stiff gravelly CLAY with some pebbles
TP5	244269	307755			0.2	0.2 - 3.0	firm to stiff pebbly, bouldery sandy CLAY
TP6	244319	307790			0.2	0.2 - 0.6	firm sandy CLAY
						0.6 - 2.5	firm to very stiff gravelly pebbly CLAY
SA1	244272	307984	117.38	117.74	0.3	0.3 - 1.8	firm to stiff silty sandy gravelly CLAY
						1.8 - 15.5	stiff/hard silty sandy gravelly CLAY with cobbles/ boulders
SA2	244184	307867	111.30	111.50	0.3	0.3 - 2.5	stiff silty sandy gravelly CLAY with cobbles
						2.5 - 14.4	hard silty sandy gravelly CLAY with cobbles/ boulders
						14.4 - 15.5	presumed SHALE rock with bands of shaley CLAY
SA3	244194	307896			0.2	0.2 - 2.0	firm slightly gravelly silty CLAY
						2.0 - 3.0	firm/stiff silty sandy gravelly CLAY with cobbles
						3.0 - 20.0	hard silty sandy gravelly CLAY with cobbles/ boulders
SA4/RC3	244315	307749			0.3	0.3 - 2.0	firm to stiff slightly gravelly sandy CLAY
						2.0 - 19.0	stiff silty sandy gravelly CLAY with cobbles/boulders
						19.0 - 22.7	SILTSTONE
						22.7 - 29.6	SANDSTONE
SA5	244211	307531	109.92	110.26	0.0	0.9 - 15.0	silty sandy gravelly CLAY with cobbles
						15.0 - 16.0	presumed boulder or rock
SA6	244348	307680			0.0	0 - 26.7	WASTE
						26.7 - 29.2	silty gravelly CLAY
RC2	244183	307892	109.98	110.28	0.0	0 - 14.1	CLAY and boulders
						14.1 - 21.0	SILTSTONE/SHALE
RC5	244480	307721			0.0	0 - 0.6	hardcore fill
						0.6 - 5.0	gravelly CLAY
						5.0 - 8.1	SAND with peat layers
						8.1 - 24.0	sandy gravelly CLAY with cobbles and boulders
						24.0 - 24.9	SILTSTONE/SANDSTONE
RC6	244214	307536	109.76	110.21	0.0	0 - 16.5	sandy gravelly CLAY with boulders

Borehole ID	Easting, m	Northing, m	Ground elevation, mOD	Top of Casing elevation, mOD	Topsoil depth, m	Lithology	
						16.5 - 16.9	fractured SANDSTONE rock
						16.9 - 21.2	SANDSTONE

Table 2 shows summary data collected during field investigations in 2003, with the locations referred to shown in Figure 7(b). The details show that the lithological profile as described is quite consistent across the site. A geophysical survey carried out in 2003 reinforce this, suggesting a 5 m gravelly clay, underlain by between 15-20 m boulder clay.

Intermittent mottling was observed confirming the poor drainage characteristics of the subsoil, and the existence of perched water tables. Depth to bedrock appears to be lower immediately north of Cell 4 than other parts of the site, where it is in the order of 10 m. Occurrence of peat appears to be somewhat isolated and is perhaps not original ground. Detailed graphical logs were not available for BHL01-BHL03 but were described as showing a waste layer up to 20.4 m in depth.

Table 2 - Summary data acquired from site investigation works 2003 (see Figure 7(b) for locations).

Borehole ID	Easting, m	Northing, m	Ground elevation, mOD	Top of Casing elevation, mOD	Topsoil depth, m	Lithology	
DTP01	244233	307882				0 - 1.1	made ground: gravelly sandy CLAY fill
						1.1 - 2.8	firm brown/grey coarse gravelly sandy CLAY
						2.8 - 6.7	stiff grey coarse gravelly sandy CLAY with cobbles
DTP02	244211	307950				0 - 0.6	made ground: gravelly sandy CLAY fill
						0.6 - 1.9	firm mottled brown/grey coarse gravelly sandy CLAY
						1.9 - 4.00	firm to stiff grey gravelly CLAY with cobbles
DTP03	244207	307857				0 - 1.0	made ground: gravelly sandy CLAY fill
						1.0 - 3.5	firm mottled brown/grey coarse gravelly sandy CLAY
						3.5 - 4.8	firm grey to grey-green gravelly sandy CLAY with cobbles
DTP04	244139	308109			0.4	0.4 - 2.6	soft to firm mottled grey brown gravelly sandy CLAY
						2.6 - 4.0	firm grey gravelly sandy CLAY with cobbles
DTP05	244105	308033			0.4	0.4 - 1.9	soft to firm mottled grey brown sandy gravelly CLAY
						1.9 - 3.0	stiff green brown gravelly sandy CLAY with cobbles
						3.0 - 5.6	firm green grey gravelly sandy CLAY with cobbles
DTP06	243984	308211			0.4	0.4 - 2.1	soft to firm mottled grey brown gravelly sandy CLAY
						2.1 - 3.0	firm grey gravelly sandy CLAY with cobbles
						3.0 - 4.7	stiff green grey gravelly sandy CLAY with cobbles
DTP07	244063	308323			0.3	0.3 - 2.3	soft to firm mottled grey brown gravelly sandy CLAY
						2.3 - 3.9	firm green grey gravelly sandy CLAY with cobbles
DTP08	244099	308378			0.5	0.5 - 2.6	soft to firm mottled grey brown gravelly sandy CLAY
						2.6 - 4.0	firm green grey gravelly sandy CLAY with cobbles
DTP09	244149	307931			0.5	0.5 - 1.3	made ground: light grey CLAY some organic material
						1.3 - 1.7	light brown spongy PEAT
						1.7 - 2.8	soft grey brown CLAY
						2.8 - 4.00	blue-grey stiff sandy gravelly CLAY
GW01	244514	307730				0 - 10.0	stiff brown gravelly sandy CLAY with cobbles
						10.0 - 13.0	very stiff dark brown organic SILT
						13.0 - 17.3	very stiff grey sandy CLAY
						17.3 - 20.0	moderately weak grey broken GREYWACKE
GW02	244201	307814				0 - 9.0	stiff brown gravelly sandy CLAY with cobbles
						9.0 - 13.0	stiff grey gravelly very sandy CLAY
						13.0 - 16.5	stiff light brown gravelly sandy CLAY with cobbles

Borehole ID	Easting, m	Northing, m	Ground elevation, mOD	Top of Casing elevation, mOD	Topsoil depth, m		Lithology
						16.5 - 21.0	moderately weak grey brown broken and highly weathered SHALE
GW03	244016	308022				0 - 12.0	stiff brown gravelly sandy CLAY with cobbles
						12.0 - 18.0	stiff light brown gravelly sandy CLAY with cobbles
						18.0 -21.5	weak light grey broken and fractured fine to medium grained SANDSTONE
BHR01	244212	307979				0 - 6.5	stiff brown gravelly sandy CLAY with cobbles
						6.5 - 8.5	stiff brown very sandy CLAY
						8.5 - 13.0	stiff brown gravelly sandy CLAY with cobbles
						13.0 - 17.5	stiff brown gravelly CLAY with cobbles
						17.5 - 21.0	weak brownish grey broken and weathered SHALE
BHR02	244059	308175				0 - 8.0	stiff brown gravelly sandy CLAY with cobbles
						8.0 - 9.0	stiff light brown sandy CLAY
						9.0 - 10.5	stiff brown gravelly CLAY with cobbles
						10.5 - 15.0	weak brownish grey broken and weathered SHALE
BHR04	244145	308124				0 - 8.0	stiff brown gravelly sandy CLAY with cobbles
						8.0 - 9.0	weak orange/brown weathered fine-grained SHALE
BHL01	244410	307736					no log
BHL02	244335	307701					no log
BHL03	244269	307617					no log

In summary, we can conclude that overburden is predominantly boulder clay, described as firm to stiff brown, sandy, gravelly clay with boulders and cobbles. Occasionally the boulder clay presents intermittent and thin layers more rich in sand or gravel.

The thickness of the boulder clay varies between 8 m (R04) and 25 m (RC5). The thickness of the boulder clay appears to be greater in the topographically depressed areas. Bedrock was returned as brown highly weathered shale, sandstone or grey fractured greywacke.

Information gained from installing boreholes in Cell 0 showed a waste layer up to 20.4 m in BHL01-BHL03, and a waste layer 26.7 m thick in SA6. This would infer that the base of the waste cell is at an elevation of approximately 101 mOD, suggesting it is 11 m below current road level at the site entrance. This would infer that waste was originally deposited in a hollowed area, namely Limagratty Lough. Results also infer that overburden depths across Cell 0 prior to infilling were greater than 10 m.

Landfill Vulnerability Classification

The GSI groundwater protection scheme operates a classification scheme that assesses the site suitability of a landfill based on hydrogeological factors. Based on a poor aquifer (Pl), and moderate vulnerability, Corranure Landfill is assigned a response matrix R2[1]. This is deemed to be acceptable subject to the condition:

- *special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant. Special attention must be given to existing wells downgradient of the site and to the projected future development of the aquifer.*

Hydrology

Catchment Delineation

It is important to consider the surface water catchment, and any other potential upgradient sources of contamination to local surface watercourses, and the fate of any potential contaminants downstream. Where accessible, local streams were surveyed on 25/06/13 using RTK R4 VRS technique and referencing Malin as elevation datum. These levels, along with topographical contours, were used to define the upgradient and downgradient catchment, as shown in Figure 8.

Surface waters generated from precipitation falling on capped areas within the site are diverted to the natural local surface water network. Catchments have been delineated based on topographical contours shown in Figures 1 and 2, and site survey drawings. The site drains to the headwaters of two different surface water catchments, splitting the central axis of Cell 1 along a southwest-northeast plane:

1. the southern portion of the site drains to the Corranure Stream, a tributary of the Cavan River. Surface waters from Cell 0 and Cell 1 drain along the perimeter of these cells toward the south west corner of the site to a culvert beneath the R188 and into the Corranure stream. Surface waters generated on the recycling facility, McBreen Environmental yard, and to a distance of 150 m immediately east of the site, flow into an open roadside drain at the base of the southern face of Cell 0. This drain also flows into the culvert in the southwest corner of the site. The Corranure stream follows the approximate route of the R188 westward before entering the Cavan River at Kinnypottle, 1 km downgradient of the site. The Cavan River enters Lough Oughter SAC 2.5 km downstream of this confluence; the outlet of this system ultimately discharging into Lower Lough Erne. Hydraulic gradient from the site to the Cavan River is 105 mOD to 62 mOD over a distance of 3 km.

2. the remainder of the site (northern part of Cell 1, Cell 2, Cell 3, Cell 4, northern site area) drains to the Lismagratty Stream, a tributary of the Annalee River. The headwater of the Lismagratty Stream starts on the northern ownership boundary of the site. This tributary joins with another tributary 500 m northeast of the site (indicated on Figure 8 as Lismagratty sub-catchment) and drains a small area in the south-east corner of the boundary of ownership, an area not currently linked to site activities. This area includes several houses, a woodworking workshop an agricultural contractors yard and several other farmyards. The Lismagratty stream flows north east, accepting a series of drains, before flowing into the Annalee River 4.5 km northeast of the site. The Annalee is a relatively large river, passing through Ballyhaise and Butlersbridge before entering the Lough Oughter SAC complex. Hydraulic gradient from the site to the Annalee is 96 mOD to 53 mOD over a distance of 4.5 km.

The degree of connectivity between these streams and overburden or perched water, and deeper bedrock aquifer flow is not well understood.

Site Water Management

Site water management and surface water flow directions are shown in Figure 2. Surface waters generated on the recycling facility are passed through an oil interceptor. It is assumed that this unit is correctly sized and has a maintenance plan. Surface waters generated on Cell 0 drain to an open drain on the southern boundary, and a combination of a culverted drain and an open drain on the western boundary. An inspectors report from 2000 states that the Corranure stream was diverted into a culvert in order to preclude leachate entry from the as then unlined landfill. A leachate interceptor drain was installed around the landfill at that time (Cells 0 and 1). These waters all collect in the southwest corner. There is no further treatment of these waters.

The discharge point to the north of this site, and the surface water management regime prior to discharge appears to have undergone regular alterations, many of which appear to be spontaneous, or in response to elevated suspended solids following rainfall events. There don't appear to be any detailed design specifications of this surface water route in the northern part of the site. There are open excavated ponds intended to capture suspended solids and the effectiveness of such is somewhat unknown. These ponds receive water from a number of open drains. From the ponds, waters pass

through a 1200 mm concrete pipe, before entering the headwaters of the Lismagratty Stream at the northern site boundary. There is further ponding near the outlet.

In the low-lying area to the east of the site access road, the drainage density increases to try and provide relief from the poor drainage properties. North of these streams is a derelict house, to the immediate north of which is a ring-fort feature. This is surrounded by an open drain which appears to contain stagnated water.

Designated Areas

The site lies 4 km east of the Lough Oughter and Associated Loughs SAC, a complex of 90 relatively small inter-drumlin lakes interconnected by small streams and rivers. The system covers a large area from Killeshandra 14 km south of the site, to the border with Northern Ireland, where this network discharges to Upper Lough Erne, 10 km northeast of the site.

Flood Risk

Reference is made to the OPW FloodMaps which shows there are benefitting lands within 1 km of the site. The nearest mapped flood event on the R188 where it passes adjacent to the site. County Council notes report that drains overflow here every year after heavy rain, as the drains backup from an inadequate culvert. It notes that the council has undertaken remedial work. The efficacy of this work, and evidence of any flooding at this point since the works were undertaken, is not known at time of writing.

The nearest hydrometric stations to the site are on the Cavan River at Lisdarn, and on the Annalee at Butlersbridge.

Hydrogeology

Groundwater Wells

Throughout much of the reviewed documentation, a large number of groundwater monitoring wells are referred to, and many of these have been outlined in Tables 1 and 2. However, very few of these wells remain in place on site, and given the scale of historical operations on site the monitoring network in place for groundwater is poor.

Details, and status, of the existing groundwater monitoring points are presented in Table 3, corresponding to Figure 9. The table includes the local third party wells that are monitored annually, which shows that only four boreholes exist on-site: two of these are paired as overburden monitoring boreholes at the site entrance, while the other two are located in the northern unused part of the site. GW05 exhibits artesian qualities most of the time and is thus of limited use in establishing groundwater level.

The third party domestic wells are mainly clustered at a hilltop location to the southeast of the site. Dipmeter was not dropped below submersible pumps so well depth is unconfirmed, but it is assumed these boreholes penetrate bedrock. PW13 refers to a surface spring well which is no longer used for domestic supply. PW02, at a derelict house northeast of the site, could not be located. On the survey date PW05-BT was pumping continuously, possibly due to a burst pipe or broken valve on discharge line, so this water level is disregarded. Well PW15, to the west of the site is believed to still be in use but could not be located on the day of the well survey (homeowner was absent).

Table 3 - Well Details (PW = Private Well; GW = monitoring well)

Borehole ID	Easting, m	Northing, m	Ground elevation, mOD	Top of Casing elevation, mOD	Well Depth, m	Inner Casing diameter, m	Depth to water, mbtoc 25/06/13	Static water level, mOD 25/06/13
GW01 (50mm)	244519	307729	109.03	109.81	2.92	0.05	2.56	107.25
GW01 (19mm)	244519	307729	109.03	109.81	8.39	0.019	2.59	107.22
GW04	243990	308139	104.65	105.08	17.51		12.96	92.12
GW05	244116	308424		90.46			full	90.46

Borehole ID	Easting, m	Northing, m	Ground elevation, mOD	Top of Casing elevation, mOD	Well Depth, m	Inner Casing diameter, m	Depth to water, mbtoc 25/06/13	Static water level, mOD 25/06/13
PW02	244513	308125	could not be located					
PW05BT * (pumping)	244158	307499	106.65					101.65
PW08	244990	307576	homeowner absent					
PW09	245025	307632	homeowner absent					
PW10	245053	307601	homeowner absent					
PW11	244982	307631	could not be located					
PW13	244665	307809	107.60					107.37
PW15	243955	307605	homeowner absent					
PW16	245073	307648	140.26	140.02			17.83	122.19

Groundwater Levels & Flow Direction

Groundwater levels were surveyed on 25/06/13 (see Table 3). The paucity of on-site groundwater monitoring boreholes means we are unable to decipher the groundwater flow direction through the site with a significant level of confidence.

Water table at the hilltop housing cluster is around 122 mOD (ground level = 140 mOD). Groundwater level in the topographically depressed area at the site entrance and to the east of the site entrance is just below surface at 107 mOD, and it is estimated that groundwater level in the unlined Cell 0 is approximately the same. Progressing north through the site, groundwater level declines to approximately 91-92 mOD.

Using the available data obtained from the small number of surrounding third party wells we can estimate that general groundwater flow direction is from southeast to northwest. This would suggest that the Annalee outlet and Lough Oughter are the main baseflow sumps. However, the catchment division through the site makes it difficult to confirm this. Furthermore there is not enough data to separate the overburden and groundwater flow regimes.

Given the poorly productive nature of the aquifer. it might be worth considering the dilute and disperse effect dominating in a radial pattern within close proximity to the landfill. As distance from the landfill increases, the groundwater flow direction becomes the main driver influencing groundwater transport of contaminants.

Any precipitation infiltrating the capping layer will infiltrate vertically until it encounters a water table. Where this is a perched water table it is likely to move laterally toward the surface water drainage network as shallow overburden groundwater flow. Based on this premise, shallow overburden flow emanating from Cell 0 is likely to migrate toward the drains on the southern and southwestern perimeter, ultimately flowing into the Corranure Stream. There may be a local radial aspect dispersing to the east and north of Cell 0. Migration to the north of Cell 0 may be restricted by the lining of Cell 1. This may also have the effect of promoting groundwater mounding within Cell 0.

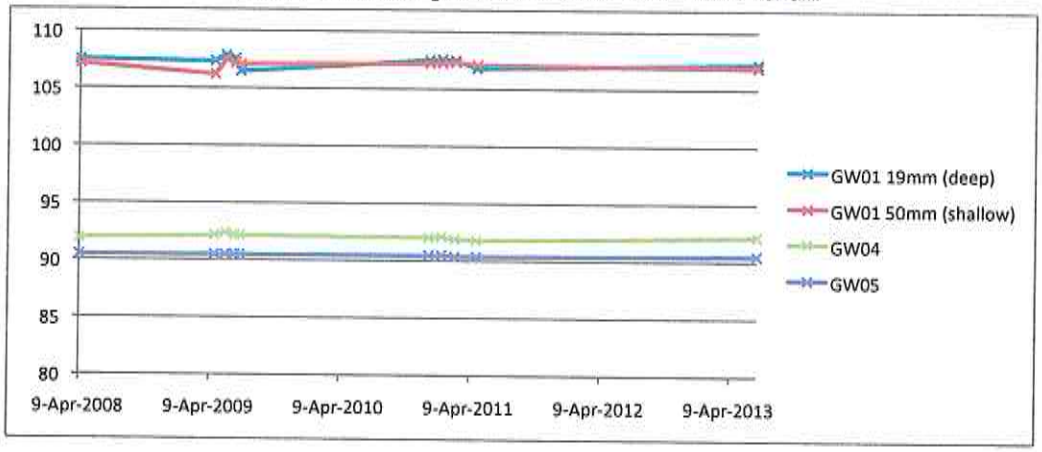
It is possible that the bedrock aquifer is confined, with recharge to the aquifer likely to be occurring on higher ground where soil depth is thinner and is composed of overburden with drainage characteristics typically better than those attributed to those on site. Bedrock groundwater is then held under the heavy clay layers, which can create a rise in piezometric head.

It is typical of heavy drumlin soils to have a high moisture retention capacity. This can lead to soils become easily waterlogged, and where a borehole penetrates overburden only, a high water table can be displayed. A perched water table exists where rate of infiltrating water is greater than vertical hydraulic conductivity. Overburden permeability was previously estimated using a falling head tests on a number of boreholes and was shown to be low, between 1×10^{-7} and 1×10^{-9} m s^{-1}, with the slightly higher values obtained in the slightly sandy lenses.

Historical Groundwater Levels

Historical data was also referred to in an attempt to identify any seasonal patterns in groundwater levels; collated data is shown in Graph 1. Resolution of available data was low. Of the data available, we can see that groundwater levels are relatively stable, although points appear to limited to spring months. Data acquired for GW05 showed artesian conditions for all but one measurement, making data from this borehole of limited use. It does again show a gradient from south to north.

Graph 1 - Historical groundwater levels at Corranure Landfill



Reference was made to the Annual Environmental Reports (AER) for the period 2009-2012, which includes monthly monitoring:

2009:

"Groundwater levels remained fairly constant throughout the year, with depths varying in wells from 2.1 m in GW01 to GW05 recorded as being consistently full for the year."

2010:

"Groundwater levels remained fairly consistent throughout the year, with depths varying in wells from 1.89 m in GW01 to GW05 recorded as being consistently full for the year"

2011:

Groundwater level in GW01 (19mm) remained consistent for most of the year at 2.2 m btoc, increasing to 1 m btoc in November, and subsequently dropping to 4 m btoc in December.

Groundwater level in GW01 (50mm) was consistent for the first half of the year at 2.2 m btoc, decreasing to 6 m btoc in September, rising to ground level in November, and subsequently dropping to 10 m btoc in December.

Groundwater level in GW04 was consistent for the first half of the year at 13 m btoc, rising to ground level in November, and subsequently dropping to 8.5 m btoc in December.

Groundwater level in GW05 exhibited artesian conditions for the entire year.

2012:

Groundwater level in GW01 (19mm) was very inconsistent, fluctuating between 0.5 and 8.5 mbtoc during the first six months of the year, steadying to 2.3 and 0.5 m btoc for the summer months, before falling and rising between 4.5 and 2.1 m bmtoc to the end of year.

Groundwater level in GW01 (50mm) was also very inconsistent, fluctuating between 1.0 and 6.5 mbtoc during the first six months of the year, steadying at around 6 m btoc for the summer months, before rising 2.7 m bmtoc at the end of year.

Groundwater level in GW04 also fluctuated, between 13 and 8.5 mbtoc during the first six months of the year, steadying at around 4 m btoc for the summer months, before rising to 2.0 m bmtoc at the end of year.

Groundwater level in GW05 was artesian for much of the year, except the months of February and May where it was slightly below surface.

The AER summaries imply that the pattern shown in Graph 1 is reasonable for the period 2008 to mid-2010 but does not accurately represent groundwater levels in these four boreholes for the period late 2010 - 2012. The haphazard nature of the data in this latter period makes interpretation difficult. Daily groundwater level data is required, in combination with daily rainfall data. This requires installation of long term dataloggers in these wells, and a rainfall station recording daily rainfall.

Groundwater levels during 2012 at GW01 appear to display an anomaly. At both boreholes, a rise in groundwater level was seen during February and April. The summer of 2012 was noted as being a very wet summer. GW01 (50 mm), as expected responds with an increase in groundwater level from May to July, and remains elevated until October. GW01 (19 mm) however shows a continual decline in groundwater levels from April to July, remaining until October.

The different response to climatic conditions of both GW01 boreholes suggests they penetrate different lithological layers. Collection of water level data at PW13 would perhaps provide some clarification in this regard. Accurate logs for each of these wells were unavailable. It is possible that the fluctuations in water levels within GW04 are due to construction works associated with excavation of Cell 4, capping of Cell 3, or installation of an unlined settlement lagoon.

Hydrochemistry

Surface Water Quality

A range of surface water quality parameters are measured on a regular basis. There are two locations where surface waters leave the site and enter the local surface water network, these being SW1 and SW2, which discharge to the Corranure (southwest of the site) and Lismagratty (northeast of the site), respectively. SW1 and SW2 are monitored on a monthly basis.

Surface water quality is also currently assessed on a quarterly basis at several downgradient monitoring locations, as per Figure 10. These are S3 on the Lismagratty Stream and S4 and S5 on the Corranure Stream. Historical monitoring was undertaken at different locations using A1-A5 on the Corranure Stream and B1-B5 on the Lismagratty Stream; these have been included in Figure 10 for reference.

The following general observations can be deduced:

- there does not appear to be a continuing deterioration of surface water quality.
- where there are exceedences of threshold values they appear to be greatest at the discharges from the site, and reduce with increasing distance from the site, likely due to dilution.
- isolated deterioration in water quality in the Lismagratty Stream is usually (but not exclusively) associated with elevated suspended solids. The loss of suspended solids to the north of the site has occurred during heavy rainfall events since 2007, primarily while construction and capping works were taking place, at Cell 4 and Cell 3, respectively. Mitigation measures to control suspended solids leaving the site are inadequate.
- ammonia concentrations at all monitoring points were elevated in 2009 and 2010, exceeding the 0.2 mg l^{-1} threshold value. There are no other pollutant sources in the stream catchments and these concentrations are attributed to the landfill.

- where elevated levels of ammonia at SW1 are not associated with suspended solids, it is likely linked to leachate migration from the waste cell. This is emerging directly through the cell walls, or getting to the surface drainage network via overburden groundwater flow, having reached a perched or permanent water table.
- ammonia concentrations and conductivity at SW1 were consistently elevated during 2012, peaking between May 2012 and August 2012 at 4.5 mg l^{-1}. This coincided with a very wet summer and higher water table at GW01. It is likely that higher water table is leaching more ammonia from seasonally submerged volumes of the waste cell, which is then draining to the surrounding collector drains.
- suspended solids were elevated through the same summer period at SW1. This indicates particulate losses from the capping material on the south of the site, and road runoff from the entrance area and recycling facility.
- suspended solids reached very high levels during August 2012 at SW2. Associated ammoniacal-N was acceptable during 2012 at SW2, as was orthophosphate This would indicate that the leachate collection systems on other Cells 1-3 are working adequately.
- orthophosphate concentrations were more elevated at SW2 than SW1. This is likely linked to the loss of suspended solids from the northern area of the site.
- iron and manganese concentrations are typically above normal. Further analysis is required to seperate the potential sources which are baseflow from an iron-rich geological formation, or reducing conditions within the waste mass which promote precipitation on emergence.
- pH is not significantly different between SW1 and SW2. pH downgradient is slightly more alkaline than at the outlet points of the site.
- chloride concentrations were all less than 250 mg l^{-1}.
- where conductivity values are elevated leaving the site they generally decreased downstream. However elevated conductivity values have repeatedly been observed at SW5 which would suggest SW1 is being taken upgradient of the confluence of the streams immediately southeast and west of Cell 0. Another surface water sampling point on the southern stream may be required. Further investigation of the drainage arrangement in the southwestern site corner is required also.
- conductivity measurements at SW1 in 2011 climbed steadily throughout the year, perhaps indicating a higher groundwater baseflow signature in the stream. The pattern at SW2 was less pronounced, seeming to be a fair representation of seasonality.
- exceedences at SW1 do not necessarily correspond to exceedences at SW2, suggesting rainfall is not the only variable promoting migration of pollutants from the site.

We have evidence of hydrochemical baseflow and subsurface drainage signatures. The summer in 2012 was very wet, and groundwater levels were elevated. The prolonged high water table may have exposed fresh areas of organic waste for leaching, and combined with summer temperatures, which would promote waste decomposition, may have seen higher ammonia levels in baseflow.

The occurrence of elevated suspended solids and nutrient concentrations at different times also reinforces the premise of two different groundwater flow regimes, i.e. two subsurface catchments. During some periods the baseflow element of discharge and streamflow increases. It needs to be confirmed whether these occurrences coincide with changes in meteorological conditions. It may be that leachate is escaping during prolonged periods of low intensity rainfall, and not high intensity rainfall events. Groundwater levels should facilitate interpretation, but this would require a higher density of groundwater monitoring points.

Groundwater Quality

Groundwater quality is measured at 3 no. on-site locations: GW01, GW04, GW05. GW01 consists of a shallow (2.9 m depth, diameter 50 mm) and a deeper borehole (8.4 m, diameter 19 mm). Both GW01 boreholes are in overburden. The borehole logs for GW04 and GW05 were not available at time of writing. GW05 exhibits artesian conditions and likely penetrates bedrock.

The following general observations can be deduced:

- ammonia levels consistently exceeded the IGV of 0.15 mg l^{-1} at on-site groundwater monitoring points.
- conductivity and ammonia are significantly higher in the deeper borehole at GW01 than the shallower borehole. This infers that radial leachate migration is occurring from Cell 0 through the deeper subsoil layer, and not the upper 2 m of overburden.
- ammoniacal-N does not show a strong correlation with water level at the deeper GW01 borehole during 2012, but does correlate better with groundwater levels in the shallow borehole, increasing with water table. Conductivity shows the same pattern in the shallow borehole.
- ammonia concentrations at the deeper GW01 borehole are consistently elevated above 1 mg l^{-1}, and have increased since early 2009. Ammonia is considered to be a good overall indicator of water quality impact attributable to unlined municipal landfills. It can be particularly useful where surface waters may be at risk, as it can be toxic to fish at low concentrations (1 mg l^{-1}). Ammonia levels are elevated as organic matter continues to degrade within a landfill.
- ammonia concentrations are lower in GW05, indicating there is limited leachate migration to the bedrock aquifer. This is based on the assumption that bedrock groundwater flows through Cell 0 in a southeast to northwest direction.
- elevated conductivity represents a higher concentration of free ions, and promotion of ion-exchange and chemical processes associated with dissolution/precipitation as material comes into contact with groundwater. Conductivity in GW04 has increased between 2009-2011 and then exhibited a continual month on month decline during 2012. A similar pattern is observed in GW05, where conductivity is much lower, indicating improving water quality.
- the leachate from non-hazardous waste landfills may produce reducing conditions beneath the landfill, allowing the solution of iron and manganese from the underlying deposits. iron concentrations in both GW01 wells are moderately high and suggest some leachate migration.
- iron concentrations at GW04 have increased over the same period, to excessively high levels of 9 mg l^{-1}. This indicates leachate migration in a northward direction, ad may be due to acidic waters promoting precipitation. Due to the lack of an upgradient bedrock monitoring borehole, it is not possible to clarify the source of iron.
- chloride is a mobile constituent which is often used as an indicator of contamination. chloride concentrations are generally within threshold limits.
- orthophosphate concentrations are elevated in all boreholes, generally between 0.05 - 0.25 mg l^{-1}.
- presence of coliforms was slight, and potentially linked to surface contamination at the wellhead.

Third party wells are also monitored annually. From this data it can surmised that:

- PW15, a domestic well to the west of Cell 0, is susceptible to leachate migration, via overburden groundwater flow. PW15 shows consistently high levels of iron, in the order of 2 mg l^{-1}. This level suggests more than background input from geological formation only. This could also be due to acidic waters emanating from the

landfill accelerating corrosion of steel casing. Modern groundwater well installations either remove or grout off against the steel casing, thus reducing the potential for this process to occur.

- ammonia concentrations are low at PW15 and it is free of faecal bacteria.
- PW13 is not used. It is an open spring well and is not protected from surface contamination. PW13 is useful for groundwater level monitoring but not assessing groundwater quality.
- the cluster of wells PW08, PW10, PW11 and PW16 exhibit good water quality and showed that in the main groundwater at domestic abstraction points satisfies the Drinking Water Regulations.
- PW09 in the same cluster has previously reported higher ammonia levels and presence of faecal coliforms. This is attributed to well head protection.
- clarification is required in terms of whether the zones of contribution to PW05BT and PW15 include part of Cell 0. This depends on abstraction rate and therefore a pumping test of these wells may be required. A compliance point is required between Cell 0 and these wells. The compliance point could be used as a drawdown monitoring point during any such pumping test.

Leachate Quality

The leachate control system aims to:

1. reduce the potential for seepage out of the landfill through the sides or the base by exploiting weaknesses in the liner or by flow through its matrix;
2. to maintain low leachate head to prevent leachate rising to such an extent that it can spill over and cause uncontrolled pollution to surface water, and
3. to minimise the interaction between the leachate and the liner to prevent groundwater contamination.

Leachate was previously pumped from leachate abstraction wells within the unlined Cell 0. This activity is no longer practiced. Leachate quality obtained from sampling the leachate tank is presented in Table 4. Leachate quality is as expected for a degrading landfill. As Cell 0 remains unlined some monitoring is required to confirm dynamics of leachate quality over time. A monitoring borehole penetrating water table in Cell 0 is therefore required to establish leachate quality. Given the leachate collection system, and lined cell base, there should be no risk associated with leachate migration from Cells 1, 2 and 3.

Table 4 - Historic groundwater quality at Leachate Tank (mg l^{-1}, unless stated)

Date	15/02/08	2011	2012
Date	15/02/08	2011	2012
pH	7.41	7.5	7.3
Temperature	13.2		
Conductivity	5270	3800	2090
Ammoniacal N	128		127 as NH_3
Alkalinity (as $CaCO_3$)		1526	
Total oxidised N (TON)	0.18		
TOC		118.5	
BOD	818		1.0
Cyanide	0.11		1.0
COD	1500	459	91
Boron	2.193	1.439	0.02
Chloride	722	292	228
Nitrite NO_2	<0.1		

Date	15/02/08	2011	2012
Nitrate NO_3	0.8	0.94 as N	0.086 as N
Sulphate as SO_4	176	80.1	
Arsenic	0.042	23.252	
Total coliforms	173287		
Faecal coliforms	6760		
Calcium	383.4	119.6	128
Cadmium	0.077	0.0004	0.0001
Chromium	0.031	0.048	0.0056
Copper	0.477	0.044	0.003
Iron	16.5	3.165	0.14
Lead	0.043	0.007	<0.3
Magnesium	103.6	22.9	23.7
Manganese	2.96	0.91	0.93
Nickel		0.028	0.0069
Potassium	220	95	0.059
Sodium	419.2	189	89
Zinc	0.132	0.065	0.0111
Mercury	<0.0005	0.0003	<0.02
Total P	13		5.14
Phosphate		1.603	
Fluoride	86	0.7	0.14
List I Organics	0.303		
List II Organics	<0.01		
Benzene	0.026		
Toluene	0.137		
Ethylbenzene	0.05		
xylenes	0.026		
DRO	0.064		

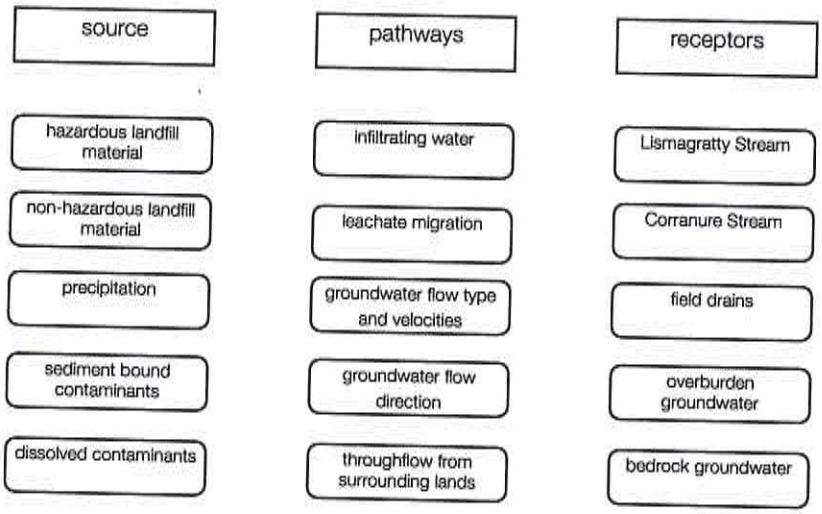
Hydrogeological Conceptual Model

The hydrogeological assessment is guided by the source-pathway-receptor (S-P-R) model, as outlined below. The S-P-R model is used to identify the sources of water and potential contaminants, the environmental assets affected by such, and the pathways by which water and contaminants reach those receptors. It is refined as the assessment evolves and more information is acquired.

A graphical interpretation of local hydrogeology can be derived and this is presented as Figure 11A representing an east-west plane and Figure 11B, depicting the north-south axis. The lines of section are shown in Figure 12.

Preliminary S-P-R

Following desk study findings, historical information and the site survey information, the preliminary conceptual source-pathway-receptor model is as follows:



- the overall site is quite large and is located in a northeast tending local topographical depression, tucked between a significant drumlin peak to the south, and a more minor drumlin hills to the northeast and northwest.
- the site contains three capped waste cells, one of which (Cell 0) is unlined, and an excavated area prepared for acceptance of future waste (Cell 4). The unlined cell is the focus of the study as it is the source of a discharge to groundwater.
- Cell 0 occupies an area of 3 ha. The depth of waste material in Cell 0 is 27 m. Peak elevation of Cell 0 is 128 mOD, and base elevation of the waste is estimated to be 101 mOD, approximately 11 m below road level on the R188 where it fronts Cell 0 and the site. Waste was clearly deposited in a depressed hollow, and this is shown on historical maps as Lismagratty Lough. It is unconfirmed whether waste was deposited directly into the surface water body.
- if consistent with surrounding lithology the Lough bed is underlain by a minimum of 10 m of silt gravelly clay till (boulder clay) of low permeability (1×10^{-9} to 1×10^{-7} m s^{-1}). Sandy lenses were noted in drill logs, and localised lateral flow velocities may be higher in these strata.
- depth to bedrock is generally 20 m, though appears to be less to the immediate north of Cell 4.
- bedrock is greywacke with layers of sandstone, siltstone and shales, with low permeabilities and transmissivities. The upper few metres of bedrock are weathered and can be considered a transition zone with the base of the clay till.
- bedrock head beneath Cell 0 is estimated to be between 95-100 mOD; bedrock head in the northern area of the site is around 91.5 mOD.
- Cell 0 was capped in 2001 with impermeable clays and is now sparsely vegetated.
- current infrastructure for groundwater monitoring is poor. There are four wells on site: GW01 houses two overburden boreholes at the site entrance; GW04 is to the north of Cell 4; GW05 is toward the northern site boundary and nearly always exhibits artesian conditions which indicates a confined aquifer.
- a number of third party wells in the vicinity of the site are monitored, but the areal spread of these limits collection of useful data.
- the impermeable nature of the overburden means there is typically a stagnant perched water level, which displays a different piezometric head than observed in bedrock aquifer.

- hence groundwater levels across the site, overburden groundwater flow direction and bedrock groundwater flow direction are not well understood.
- based on the limited data available it is conceptualised that overburden flow is toward the surface water drainage network.
- bedrock groundwater flow direction appears to be generally from the southeast to northwest. This may be true of regional flow, with the outflow of Annalee River, Lough Oughter complex and River Erne being acting as the major baseflow sinks.
- there is a catchment divide through the centre of the site. The southern part of the site, including Cell 0, drains toward the Corranure Stream which flows into the Cavan River. The northern part of the site, including Cells 2 and 3, drains toward the Lismagratty Stream which flows into the Annalee River. There is likely to be some radial migration of leachate across the catchment divides.
- there is no evidence that Cell 0 is lined. However the low permeability clay base restricts vertical infiltration to bedrock. At present there are no bedrock boreholes downgradient of Cell 0 to confirm this.
- permeability is so low in the clay till that vertical flow rates will be minimal, and confined to the upper couple of metres before moving laterally. Any infiltration excess will flow as surface water runoff to adjacent drains or emerge through the cell walls.
- groundwater discharge via the overburden pathway is likely to be radial. The presence of a high water table, coupled with the low permeability of the overburden and bedrock, suggests most of the potential recharge will come into contact with the waste material and re-emerge in the local drainage network. The Corranure Stream is therefore most at risk from Cell 0, but there is likely to be some emergence in the field to the east, which drains to the Lismagratty Stream.
- the clay nature of the low permeability subsoil provides potential for natural attenuation.
- the risk of migrating leachate emerging in local surface water sinks is deemed greater than risk of vertical migration to the bedrock aquifer. There are currently no overburden boreholes between Cell 0 and the Corranure Stream.
- at times water table in both GW01 boreholes appears quite stable, and at other times quite erratic. More frequent recording intervals using a datalogger, in unison with a rainfall gauge, would provide better understanding of the hydrological response in the area.
- the seasonality of the local water table has important implications as it can result in prolonged immersion of fresh waste in groundwater in future years.
- groundwater vulnerability may be considered to be moderate, given the depth of low permeability subsoil underlying the waste cell.
- a local domestic borehole to the west of the site may be at risk of impact.
- a cluster of domestic boreholes to the southeast of the site are upgradient of the site, or in a separate groundwater catchment, and are not believed to be at risk of impact.
- there is a potential risk of impact from other lined cells via vertical and horizontal leachate migration through the sides or base of the cell liners, or leachate overtopping at liner edges due to build up of leachate head.

Compliance Monitoring

Discharge activities subject to Tier 2 assessments must undertake compliance monitoring to verify predicted impact and check compliance with terms of the authorisation. Compliance monitoring dictates that receptor-based water quality standards (or threshold values) should not be exceeded at receptor locations. For this reason sampling is conducted to monitor water quality at receptors, as appropriate.

A compliance point is the point (location, depth) at which a compliance value should be met. Generally it is represented by a borehole or monitoring well from which representative groundwater samples can be obtained. In this case, the aim is to monitor baseflow before it enters local surface water bodies, i.e. groundwater downgradient of the site.

A compliance value is the concentration of a substance and associated compliance regime that, when not exceeded at the compliance point, will prevent pollution and/or achieve water quality objectives at the receptor. In this case, the aim is to protect surface water quality in the local rivers and nearby SAC, and bedrock aquifer quality.

The general chemical assessment test identifies groundwater bodies where widespread deterioration in quality has, or will, compromise strategic use of groundwater for existing or planned, human consumption and/or other potential purposes. Schedule 5 of the Groundwater Regulations (SI 9 of 2010) lists Threshold Values as shown in Table 5. Where significant and sustained upward trends are identified, correcting action must be taken.

Table 5 - Threshold Values (mg l^{-1}, unless stated)

Parameter	Units	Groundwater Regs (SI 9 of 2010)[1]	Drinking Water Standards	GSI Trigger Values	IGV	EQS for Surface Waters	Background conc. for lime-stones
Electrical conductivity	µS cm^{-1}	1875	1500		1000	1000	
Orthophosphate as P	mg l^{-1}	0.035	0.03		0.03	0.025-0.075	
Ammonium (as NH_4)	mg l^{-1}	0.225	0.30	0.15	0.15	0.15	0.13
Nitrite (as NO_2)	mg l^{-1}	37.5	0.1		0.15	0.2	
Nitrate (as NO_3)	mg l^{-1}	37.5	50	25	25	50	0.9
Chloride	mg l^{-1}	187.5	250	30	30	250	26
Sulphate (as SO_4)	mg l^{-1}	187.5	250		200	200	
Sodium	mg l^{-1}	150	150		150		8.8
Iron	mg l^{-1}		0.2	-	0.2		
Manganese	mg l^{-1}		0.05		0.05	0.3	

[1] Schedule 5 of SI 9 of 2010. Overall threshold range.

The compliance values applied to each individual sampling point will depend on the location of such, distance from source, and distance to nearest identified receptor.

Compliance Points

This assessment is required to ensure the site is investigated in terms of the guidelines on the authorisation for discharges to groundwater (EPA, 2011). In this regard, it is specifically targeted at assessing Cell 0, the unlined historic landfill area which was sited to disperse and dilute effluent leachate through the base of the waste cell.

The landfill operation was subsequently expanded northward as Cells 1, 2 and 3 (and likely in future Cell 4) which are lined waste deposits from which leachate is collected via a pumped system, and then treated at a proprietary treatment plant. The assessment, and any resultant recommendations, should also take account of the risk to groundwater from these cells, and the cumulative impact from the site as a whole.

Sampling will continue to take place at the existing groundwater monitoring boreholes and surface water monitoring points. Installation of new boreholes is proposed and it is recommended that these are included as part of the quarterly and annual monitoring programme.

Groundwater monitoring points need to be installed to facilitate compliance monitoring between Cell 0 and:

(i) local drains feeding the Lismagratty Stream and Annalee River;

(ii) local drains feeding the Corranure Stream and Cavan River;

(iii) domestic wells to the west of Cell 0;

(iv) downgradient bedrock groundwater quality and baseflow supplying Annalee River and Lough Oughter SAC. The arrangement of cells within the site effectively means that there are a number of lined waste cells downgradient of Cell 0 with respect to bedrock groundwater flow. Hence downgradient compliance points may also be installed outside the northern site boundary.

There don't appear to be any bedrock domestic supply boreholes within 1 km in a direction downgradient of the site (this needs to be confirmed). The potential downgradient receptors susceptible to a decline in bedrock groundwater quality are the Annalee River where it passes between Ballyhaise and Butlersbridge, which likely acts as a baseflow sump, and any abstractions further downgradient. Further clarification of the bedrock groundwater flow direction is required before such off-site boreholes can be installed.

Suggested groundwater compliance points are proposed as follows, and shown in Figure 12:

- GW20 = upgradient bedrock monitoring point;
- GW21 = compliance point to downgradient Corranure Stream in terms of overburden flow. Bedrock groundwater level monitoring point and compliance point to PW05BT and PW15.
- GW22 = immediately upgradient in terms of bedrock flow. Compliance point to downgradient drain in terms of overburden flow.
- GW23 = bedrock monitoring point adjacent to GW01.
- GW24 = immediately downgradient in terms of bedrock flow.
- GW25 = possibly downgradient of Cell 0 in terms of bedrock groundwater flow. Downgradient of recycling facility. Consider overburden borehole also.
- GW26 = immediately downgradient of compound and refuelling area. Consider overburden borehole also.
- GW27 = possibly downgradient of Cell 0 in terms of bedrock groundwater flow. Consider moving closer to eastern boundary.
- GW28 = downgradient of Cell 0 in terms of bedrock groundwater flow.
- GW29 = downgradient of Cell 0 in terms of bedrock groundwater flow.
- GW30 = downgradient of Cell 0 in terms of bedrock groundwater flow.
- GW31 = downgradient of Cell 0 in terms of bedrock groundwater flow. Final placement of this well requires confirmation of bedrock groundwater flow direction. It may be more prudent to move this borehole toward Ballyhaise or Butlersbridge as a compliance point to assess baseflow feeding the Annalee River.
- LW01 = leachate well penetrating the waste layer in Cell 0, in order to characterise the leachate being discharged to ground.

Proposed surface water compliance points to be included in annual monitoring protocol:

- Another surface water sampling point on the southern drain may be required prior to the culvert at the southwestern corner. Arrangement of the surface water drainage layout here needs to be confirmed.
- Compliance point on the stream to the east of Cell 0, before its confluence with the Lismagratty Stream, in order to capture any potential radial migration of leachate to the east of Cell 0.

Waste License Conditions

3.17.1 *Effective groundwater management infrastructure shall be provided and maintained at the facility during construction, operation restoration and aftercare of the facility. As a minimum, the infrastructure shall be capable of the following:*

a) the protection of the groundwater resources from pollution by the waste activities, and

b) the protection of surface waters and infrastructure, such as the liner, from any adverse effects caused by the groundwater.

3.17.2 *All wells and boreholes shall be adequately sealed to prevent surface contamination and, as may be appropriate, decommissioned according to the UK Environment Agency guidelines "Decommissioning Redundant Boreholes and Wells" (or as otherwise agreed by the Agency).*

3.17.3 *Groundwater monitoring wells shall be constructed having regard to the guidance given in the Agency's landfill manual "Landfill Monitoring".*

3.17.4 *The licensee shall implement any agreed groundwater management programme in the case of a high water table at the lining works phase to include a proposal on monitoring of extracted groundwater.*

5.7 *Emissions to Groundwater*

5.7.1 *There shall be no direct emissions to groundwater from the lined landfill cells.*

5.7.2 *Groundwater monitoring trigger levels shall be as agreed by the Agency and shall be in accordance with the requirements of Directive 1999/31/EC.*

5.7.3 *The trigger levels as specified in Condition 5.7.2 for groundwater shall be measured at monitoring boreholes specified in Schedule C.7: Groundwater Monitoring, of this license.*

6.25 *Within three months of the date of grant of this license, the licensee shall submit to the Agency an appropriately scaled drawing or drawings showing all the monitoring locations that are stipulated in the license including noise sensitive locations and private wells to be monitored.*

C.7 *Groundwater Monitoring*

Location:

- *Groundwater wells (GW01-GW09)*
- *Private wells (PW02, PW05BT, PW08, PW09, PW10, PW11, PW13, PW15, PW16)*
- *Discharge from any groundwater interceptor drain or drainage layer beneath the main liner system prior to entering the surface water attenuation system.*
- *Groundwater and private wells as shown in drawing number DG0055/01 submitted with the application, subject to its update in accordance with condition 6.25, or as may be otherwise agreed or directed.*

The groundwater wells GW02, GW06, GW07, GW08 and GW09 were proposed as part of a previous investigation. A different set of wells have been proposed as part of this assessment, with associated reasonings provided above. The locations of wells proposed in this report are subject to agreement.

Technical Assessment Recommendations

In addition to the recommended installation of the boreholes and surface monitoring points shown in Figure 12, the following additional measures are recommended to facilitate Tier 2 Risk Assessment.

1. Agree a revised groundwater and surface water sampling location map, removing all unused or redundant boreholes.
2. Verify current site boundary.
3. Remediate GW05 which currently displays artesian conditions. This may require increasing above ground standpipe height so that a static water level is maintained.
4. Following inspection it is deemed probable that wells GW04 and GW05 are at risk of faecal coliform contamination due to lack of protection from grazing animals, and lack of adequate headworks. Specifications for improvement of existing monitoring wells to be agreed.
5. Consider installation of dataloggers at GW01.
6. Install a rain gauge on-site to record hourly rainfall.
7. Consider pumping test of PW05 and PW15 to estimate zone of contribution.
8. The surface water monitoring programme should be designed to detect pollution from baseflow to the stream, and any leachate escaping through cells walls, or cell base. Consider a surface water sampling programme receptive to heavy rainfall events, rather than sampling strictly in accordance with pre-determined quarterly dates.
9. Sampling protocol will be as per present with the following considerations:
    - metals should be filtered and preserved;
    - list of parameters for analysis will be as per present and include those listed in Table 5, plus phenols.
10. Devise a coherent, permanent water management scheme to treat and attenuate waters prior to discharge to the Lismagratty Stream. This should include installation of concrete settlement lagoons, with discrete inflow and outflow points, and purpose made sampling chambers. Consider treatment trains as per the revised SuDS guidelines in the UK, for treatment of surface waters prior to discharge, for example:
    - cascades to volatalise ammonia, followed by
    - appropriately designed settlement lagoon to reduce suspended solids, followed by
    - reed bed, followed by
    - willow coppice.
11. Ensure all surface waters are passing through appropriate treatment and abatement methods for surface water runoff on site including oil/petrol interceptors, silt traps, etc.
12. Improve establishment of vegetation on Cell 0 to mitigate against particulate losses in runoff.
13. Groundwater levels to be measured at every borehole at each sampling visit.

14. A thorough door to door household well survey within 2 km of the site site is recommended, as existing data relating to domestic wells may now be outdated.

15. EPA have requested flow monitoring of local streams. This will give a clearer understanding of total loads leaving the site. And also the response of the site to variable intensity rainfall events, in terms of contaminant loads.

16. As per Tier 2 risk assessment recommendations the following analyses should be performed:

    - estimate hydraulic loading from recharge to the waste material;
    - use Darcy's Law to estimate groundwater flow beneath the fill material;
    - estimate time of travel using permeability values;
    - mixing equations of discharge with groundwater flow;
    - assimilative capacity calculations can be used to estimate downgradient concentrations. Downgradient boreholes will be used to verify these calculations.

Summary

A Tier 1 hydrogeological assessment has been carried out to assess risk to groundwater from an unlined landfill facility at Corranure. Results of this assessment have been used to inform recommendations for further technical assessment and a Tier 2/Tier 3 risk assessment.

The focus of further work, and any future compliance monitoring, needs to take into account general groundwater status downgradient of the landfill, baseflow to local surface water bodies, and hydrochemical quality of these surface waters.

References

BS5930: 1999. *The code of practice for site investigations*. British Standards Institute.

Cavan County Council. various years. Hard copy documentation pertaining to Corranure Landfill. Obtained on request.

EPA. 2003. *Landfill Manuals: Landfill Monitoring, 2nd Edition.* Environmental Protection Agency.

EPA. 2010a. *Classification of hazardous and non-hazardous substances in groundwater*. Environmental Protection Agency.

EPA 2010b. *Methodology for establishing groundwater threshold values and the assessment of chemical and quantitative status of groundwater, including an assessment of pollution trends and trend reversal.* Environmental Protection Agency.

EPA, 2011. *Guidance on the authorisation of discharges to groundwater.* Environmental Protection Agency.

Gardiner, M.J., Radford, T, 1980. *Soil associations of Ireland and their land use potential.* National Soil Survey of Ireland.

GSI, 2004. Cavan GWB: *Summary of Initial Characterisation*.

GSI. *Groundwater protection responses for landfills.* Geological Survey of Ireland.

IGI, 2007. *Guidelines on water well construction.* The Institute of Geologists of Ireland.

Misstear, B.D.R., Banks, D., Clark, L. 2006. *Water wells and boreholes.* Published by John Wiley & Sons Ltd.

Morris, J.H., Somerville, I.D., MacDermot, C.V. 2002. *Sheet 12: Geology of Longford-Roscommon. A geological description to accompany the bedrock geology 1: 100,000 bedrock series.* Geological Survey of Ireland.

Walsh, S. 2012. A summary of climate averages 1981-2010 for Ireland. Climatological Note No. 14, Met Éireann, Dublin.

Figures