

ANNUAL ENVIRONMENTAL REPORT

2010

Waste Licence No.: W0029-04

Licencee: Offaly County Council.

Location of Activity: Derryclure Landfill,
Derryclure,
Tullamore,
Co. Offaly

Inspector: Dermot Burke
Office of Environmental Enforcement
Environmental Protection Agency
Seville Lodge
Callan Road
Kilkenny

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Tullamore,
Co. Offaly

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Introduction

Offaly County Council operates Derryclure Landfill Facility under the terms of Waste Licence WL 029-4. This Annual Environmental Report is compiled in accordance with Condition 11.7 and Schedule H of WL 029-4. This report covers the period 1st January 2010 to 31st December 2010.

Derryclure Landfill is located approximately 5 km from Tullamore town on the Tullamore-Killeigh road (National Secondary Road - N80). The landfill site is located on what was originally a cut-away peatland area. The Northern, Southern and Eastern sides of the landfill are bounded by raised peatlands while the Western side is bounded by pastoral land. Topographically, the Tullamore area is extensively low-lying, and as such is characteristic of the low lands of central Ireland. The land uses of the area are a mixture of peat extraction on the raised peatlands and agricultural use on the pastoral land.

The site has operated under the EPA Licensing regime since the 16 November 1999, when WL29-01 was issued. In October 2010, the EPA issued the Final Decision for WL29-04, which are the conditions under which the site now operates.

Items of note for 2010 include:

- Granting of WL 29-04, which increased the annual tonnage permissible for disposal from 40,000t to 100,000t.
- The extension of the gas extraction and collection system, with the addition of three horizontal wells in January 2010.
- The management of the on-site Civic Amenity Site (CAS) saw a new company taking over this role for the Council site in June 2010.
- In late 2010, the CAS footprint was extended to include a hardcore area which allows servicing vehicles to access the waste receptacles. This work also allowed for the re-organisation of the site and the addition of new waste streams acceptable on the site.
- The landfill was subject to an audit in July 2010 by the EPA which resulted in a compliant audit report issued by the Agency.
- A revision of the waste management practices was undertaken to allow for the separate collection of food wastes at the public reception area and also within the CAS.

Waste Activities undertaken at the facility

Derryclure Landfill is licensed to accept household waste, commercial waste, industrial non-hazardous solids, sewage sludge and construction and demolition waste as per third schedule of the Waste Management Act 1996 and waste for recovery as per the Fourth Schedule.

The waste activities on the site can be sub-divided into three areas:

1. Disposal of waste in fully engineered lined cells
2. Reception area for waste at front of site, termed the Public Reception Area, where waste is deposited by the public into large skips, and these are transferred to the working face by Council staff
3. Civic Amenity Site (CAS) where segregated recyclable, wastes bio wastes and general wastes are accepted from the domestic sector.

Quantities of Waste received, disposed of and recovered in 2010

A. Wastes accepted for disposal:

Schedule A defines the quantities and categories of waste that may be accepted at the site. The table below illustrated the limits for each waste category, and the volumes of each accepted in 2010.

<i>Waste Type</i>	<i>Licence WL 29-03 Jan- Oct 2010(t)</i>	<i>Licence WL 29-04 Oct – Dec 2010(t)</i>	<i>Total waste accepted in 2010 (t)</i>
<i>Household Waste</i>	20,000	45,500	<i>10,426.07</i>
<i>Commercial Waste</i>	6,000	39,500	<i>9,440.93</i>
<i>Industrial – non haz</i>	5,550	11,000	<i>0.0</i>
<i>Treated Municipal Sludge</i>	5,550	2,000	<i>103.68</i>
<i>C & D</i>	3,000	2,000	<i>23.82</i>
<i>Total</i>	40,000	100,000	<i>19,994.5</i>

B. Waste Accepted for Recovery:

The wastes accepted for recovery relate to the waste accepted at the Civic Amenity Site and also the green waste accepted at the Public Reception area. Volumes for each waste stream are included in Appendix B, included in the PRTR Return as “5. *Off site Transfers of Waste*”.

Remaining capacity of the landfill site

In 2003, the EPA granted a licence to develop nine additional cells at Derryclure. It is estimated that there is approximately 934,000 tonnes of landfill capacity, if the landfill is developed to the full extent allowable under the current licence.

Waste Handling and methods of deposition of waste

Municipal/Commercial Solid Waste

Waste handling and disposal practices include the weighing, inspection and recording of all wastes at the weighbridge office prior to disposal. The Site Manager and site staff ensure that the waste received at the site is in accordance with WL 029-04 and that the waste correlates with the description as supplied by the producer. Upon acceptance of the waste, drivers are directed to the working face where waste deposition takes place. Since July 2010, the BMW content of waste is also recorded.

The compactor/loading shovel operator also conducts spot checks at the working face prior to disposal. Waste is deposited adjacent to the active cell, the compactor pushes the waste onto the working face and compacts the waste. The track machine shapes the sides of the working area, maintains previous slopes and manages the covering of the working face on a daily basis.

Cover is placed over the waste, with a synthetic membrane or 150 mm depth of cover on a daily basis and 300 mm at weekends. The cover comprises of a inert materials such as soil, peat and fines (EWC 19 12 12) and is managed in accordance with procedures.

Rejected loads resulting from weighbridge or staff inspections are directed to the designated quarantine area for further inspection.

On the basis of the inspection, one of the following actions is initiated;

- Waste may be returned to the producer and tracked (evidence of disposal to be produced)
- Disposed off-site and tracked
- Disposed on site based on assessment by the Site Manager.

Records of rejected loads are maintained at the site office. Random inspections of incoming loads are also undertaken and recorded.

A drive-through wheel-wash is situated on the exit route from the landfill site, the use of which is compulsory for all vehicles leaving the site.

Public waste reception area

At present all waste, other than large vehicles, are directed to the Public Reception Area, where waste is transferred into a number of large skips in designated bays. This area is managed by Council staff on an ongoing basis, assisting customers, and advising them of the waste types acceptable. These skips are transported to the working face as required. In 2010, receptacles were established in the Public Reception Area for Bio-waste/Food Waste to be deposited separately and removed off-site for recovery.

Inert Waste

Inert wastes are recovered through their use as cover material and for the construction of hard standing areas and haul-roads on the site. Separate locations are provided near the active working area for soil, fines and clean C & D waste.

Recyclables

The Civic Amenity Site (CAS) is operated by a private contractor, on behalf of Offaly County Council. Only customers wishing to deposit waste at the site enter the landfill area, over the weighbridge. Domestic customers, with recyclable waste, bop-waste and general waste may deposit these waste materials at the CAS to the front of the licensed site.

All wastes are managed by the contractor responsible for the site, with Waste Collection Permits available at the weighbridge office for all contractors removing waste from the site. Details of the authorised sites to which wastes are removed are also recorded.

Recyclables that are accepted at the site are as follows:

- Glass Bottles
- Aluminum Cans
- Timber

- Plastic Bottles
- Plastic Packaging
- Cardboard
- Paper & Newspapers
- Glossy Magazines
- Household hazardous paints/aerosols/herbicides & pesticides
- Steel cans
- Scrap Metal
- Flat Glass
- WEEE
- Green Waste
- Waste oils
- Steel
- Bio-waste – food waste
- Tetra-pak
- Clothes and Footwear
- Polystyrene
- Batteries
- Fluorescent and light bulbs
- Tyres

General waste also accepted at the site.

Summary of Results of Environmental Monitoring

Monitoring was undertaken in accordance with the requirements of the licence in relation to the following environmental media:

Surface Water

- Surface Water – quarterly monitoring of six points. Samples taken were compared to the Class A1 limit of Surface Water Regulation.
- No incidents were recorded in relation to Surface Water Monitoring in 2010.

Groundwater

- Groundwater is monitored quarterly at fourteen points, taking a level for the depth to water table and also analysing samples for parameters required under the licence. Based on the EPA Audit in July 2010 the groundwater parameters were extended to include Cyanide (total) and Fluoride in the sample analysis in accordance with the licence requirements.

Landfill Gas

- Landfill Gas is monitored monthly at eighteen points on the site, some of which are located within the waste body of the capped cell, and others along the perimeter of the site. Each monitoring episode has measured exceedances in the % Methane and/or % Carbon Dioxide at a number of sampling points each month. Incidents were reported to the Agency on each occasion with 12 monthly exceedances in 2010. A proposal in relation to this situation was submitted to the Agency in January 2011.

Gas Flare

- There were 6 incidents relating to flare operation in 2010, relation to operational issues and towards the year end due to severe weather conditions.
- The prolonged period of severe freezing weather from the 28th November 2010 to the 10th December caused intermittent operation of the Gas Flare at Derryclure Landfill Facility during the period. The flare was affected by the extremely low temperatures which resulted in frozen sample lines, frozen gas pipe sections, frozen analyser and faulty pressure regulator at the flare. Works were undertaken by both on-site trained staff and Irish Biotech Services to address the issues as they arose.

Dust

- Dust was monitored 3 times during 2010, at four locations. Two exceedences were noted. The first at DM 07 in July, and a second exceedance DM04 in August 2010 in 2010. Both were notified as incidents to the Agency.
- The monitoring location of DM07 was moved in September 2010, as per Agency approval.

Noise

- A noise survey was undertaken at pre-determined perimeter monitoring points on 6 July 2010, with one exceedance recorded. This was reported as an incident to the Agency.

Leachate

- Under the terms of the licence, the leachate lagoon temperature is monitored quarterly and sampled annually at three leachate wells and the leachate lagoon. All leachate is collected in the leachate lagoon, and tankered to Waste Water Treatment facilities.

Resource and energy consumption

	Municipal Water Supply (m³)	ESB (Kilowatt Hours)	Diesel (Gals.) For Machinery	Oil (Gals.) Machinery Hydraulic	Oil (Gals.) Machinery Engine
Total	10,060	109800	13,557	150	129

Water consumption: consists of usage by wheel-wash facility and domestic purposes.

Electricity consumption: consists of usage by the landfill offices, wheel-wash, gas flare, public lighting, leachate pumps and ground water pumps.

Energy Usage at Derryclure Landfill

The current electricity provider for Derryclure Landfill is ESB Electric Ireland. It is a Max Demand Low Voltage account. The total cost for 2010 is €19,790 inc 13.5% VAT. The total consumption for last year was 109,800 kWh which is a reduction of 2,400 kWh on the previous year. This year, Derryclure Landfill is taking part in the National Procurement Service tender along with all energy accounts in the Offaly Local Authority area and a new energy provider will be in place by July 2011. This will impact significantly on energy costs. A landfill gas feasibility analysis is also being carried out this year by the Midlands Energy Agency at Derryclure Landfill.

Diesel consumption: consists of usage by the compactor and other vehicles. Diesel deliveries are made directly to all vehicles, as no diesel is stored on site.

Volume of leachate produced

In 2010, 27,167.58 tonnes of leachate were produced on the site. All leachate was tankered off site for treatment at Waste Water Treatment facilities.

Development works undertaken during the reporting period:

- Moved into Cell 1C and continued to fill in this area of the site throughout 2010.
- The extension of the gas extraction and collection system, with the addition of three horizontal wells in Cell 1C.

- Continued work in relation to gas management from Cells 1A & 1B – with bedding in of the wells, sealing, balancing, improving cover etc.
- The establishment of a separate bio-waste/food waste management on site both in the Public Reception Area and CAS, to divert this material from landfill.
- Litter netting management system improved to increase its effectiveness in the working areas.
- Improvements to haul road access to working face
- In late 2010, the CAS footprint was extended to include a hardcore area which allows servicing vehicles to access the waste receptacles.

Procedures

A number of procedures were reviewed in 2010, namely

- Procedure 29: Working Face Management
- Procedure 44: Operating Procedure for Weighbridge – to address BMW factors to be recorded and reported to the Agency.

Summary of Incidents and Complaints

Recorded Incidents

There were twenty three incidents recorded during 2010, all of which were reported to the Agency. The breakdown of incidents is as follows:

Gas Monitoring (monthly)	12
Flare	6
Dust	2
Leachate levels	1
Noise	1
Severe weather conditions	1

All details are available for inspection in the Incident Register, which is located in the Site Manager's Office at the facility.

Recorded Complaints

There were 52 complaints were received at the Derryclure facility during 2010, all of which related to odour. The table below provides a breakdown of complaints during the year.

January	7		July	1
February	3		August	3
March	5		September	1
April	6		October	2
May	1		November	7
June	1		December	15

All details are available for inspection in the Complaints Register, which is located in the Site Manager's Office at the facility.

It should be noted that a significant increase in complaints occurred in the late part of 2010. This corresponded with a period of prolonged freezing temperatures, and also the granting of planning permission by Offaly County Council for a Waste to Energy plant adjacent to the Derryclure site.

Review of Nuisance Control

The landfill manager and site staff carry out assessments of nuisance control on a daily and weekly basis. Records of nuisances caused by litter, vermin, birds, flies, mud, dust and odours are maintained on site and are available for inspection at the site office.

Litter

The erection and maintenance of 4m high anti-litter netting has been very successful in controlling wind blown litter within the landfill site. Netting on site is managed by regular maintenance and landfill staff complete litter picks within the site as part of routine works. Compaction and covering of the waste also aids in preventing litter arising. All vehicles entering the site are required to have their loads covered to prevent any litter nuisances.

Vermin and Flies

Control of vermin on site is maintained by the management of bait boxes throughout the site. Records for same are maintained and are available on site for inspection.

Birds

There are a number of bird control measures employed on the site including a fixed Bird Stress Caller, Bangers, a hand held flare gun and a kite, all of which are operated at irregular intervals, to maximise their effectiveness.

Mud

The use of the wheel wash by all vehicles ensures the facility roads are kept free of mud. A road sweeper is also employed on a regular basis to clean access roads and hard standing areas.

Dust

A water bowser is used to suppress dust on the site, especially on roads and hard standing areas during extended periods of dry weather.

Odour

The Council is committed to the control and minimizing of odours arising from the site. Further gas extraction infrastructure was established in 2010 with a further three horizontal wells in Cell 1C. Works in relation to management and improving cover also continued throughout the year.

In early 2011, additional works in relation to the installation of vertical wells in 1C were completed. The Council continue to assess and manage the gas extraction infrastructure to minimize impacts from the site.

Noise

Noise is managed through the regular maintenance of site plant equipment, traffic management with speed restrictions and ramps, and the managed use of the bird control measures.

Septic Tank Compliance Report

Both septic tanks on site at Derryclure Landfill are holding tanks and do not percolate to ground via either a soakway or percolation area. These tanks are emptied on a frequent basis by contractor and are drawn to Tullamore WWTP.

Management of site

The management structure for Derryclure Landfill during 2010 was as follows:

Director of Services – Sean Murray

Senior Engineer - David Hogan

Executive Scientist - Marian Healy

On-site staff:

Site Manager – Basil Mannion

Site Foreman – PJ Cleary until December 22nd 2010, Gerry Condron for remainder of year.

Site Operators – Gerry Condron, Dave Mc Cabe, Brendan Monaghan, Eddie Kaye

Contracted staff – Greg Byrne and Eamonn Walsh

Note: Three staff changes in February 2010 with Sean Murray taking up the role of Director of Service, and Basil Mannion as Site Manager and Gerry Condron as Acting Site Foreman.

Staff training provided in 2010

Staff training completed in 2010 included:

- Bird Scaring Pistol Proficiency training
- Occupational First Aid training

Records of all training are maintained and are available at the site office.

EMP 2010: Schedule of Objectives and Targets for Derryclure Landfill Site for 2010

1. Conduct operation on site in accordance with the schedules and conditions of the waste license
2. Continue to monitor and reduce odour emissions/impacts from the facility
3. Completion of works to assist gas extraction system in cold weather condition.
4. Review of traffic movements on site and completing line markings.
5. Review Health & Safety on site
6. Continue to manage litter arising on the site and surrounding areas.
7. Ongoing training to be provided to all employees at the facility.
8. Review procedures for all site activities
9. Complete assessment of all signage and implement recommendations.

OPERATION	TARGET	OBJECTIVE	Review dates	Responsible Person
1. All site activities	To ensure compliance with the Waste License	Reviewed and updated operations conducted on site in accordance conditions of the Waste License	Ensured compliance with W00029-03 and the new Waste License W00029-04. Notification of Compliance issued after EPA audit in July 2010.	Site Manager
2. All activities, and particularly Cells 1A, 1B & 1C	To minimize any odour impacts from the facility	To further develop the gas management and extraction infrastructure, in consultation with the EPA	3 new horizontal wells installed. VOC assessment carried out. Landfill cover procedure implemented. Leachate risers – sealing works completed.	Executive Scientist
3. Flare System	To ensure optimum performance, particularly in extreme weather conditions	Insulation of the knock-out pot and ancillary pipe-work	Insulation carried out in 2010.	Site Manger

4 Traffic Flow Management on site	Safe and efficient traffic movements within the site	Review traffic movement on site, and complete line marking on site	Traffic movement review completed in Quarter 3 2010. Site layout of Civic Amenity Site for ease of parking and traffic flow. Revised the parking facilities at the public reception area. Haul road installed to manage traffic access to active face.	Site Manger
5. Health & Safety	Complete Health & Safety systems on site	Review all risk assessments and implement any changes required	Ongoing, review of safety statement & all risk assessments carried out, additional signage placed on haul road. The Hessian cover applicator was re-engineered.	Site Manger
6. All site activities	To ensure litter is managed on the site and surrounding areas.	The prompt removal of any litter arising. Management of litter netting and litter-picks	Revised the litter control management in 2010 with extra resources assigned. Litter wardens undertake inspection of incoming vehicles to assess litter control/covering of loads.	Site Manager
7. Training Programme	To ensure all staff are appropriately trained	Training to be provided to all staff to address roles on site	Ongoing, Safe Pass cards updated, First Aid Refresher course & Pistol training for bird scaring completed	Site Manager
8. Records Management	To ensure all records maintained in accordance with procedures	To review all procedures and current site management systems	Reviewed operational procedures.	Executive Scientist
9. Signage	To ensure all signage is reviewed and maintained	Complete an assessment of all signage on site, and implement recommendations.	Completed an assessment of all signage and implemented the recommendations with regards to the Civic Amenity Site. Reviewed and updated the haul road signs to the active face area.	Site Manger

EMP 2011: Schedule of Objectives and Targets for Derryclure Landfill Site for 2011

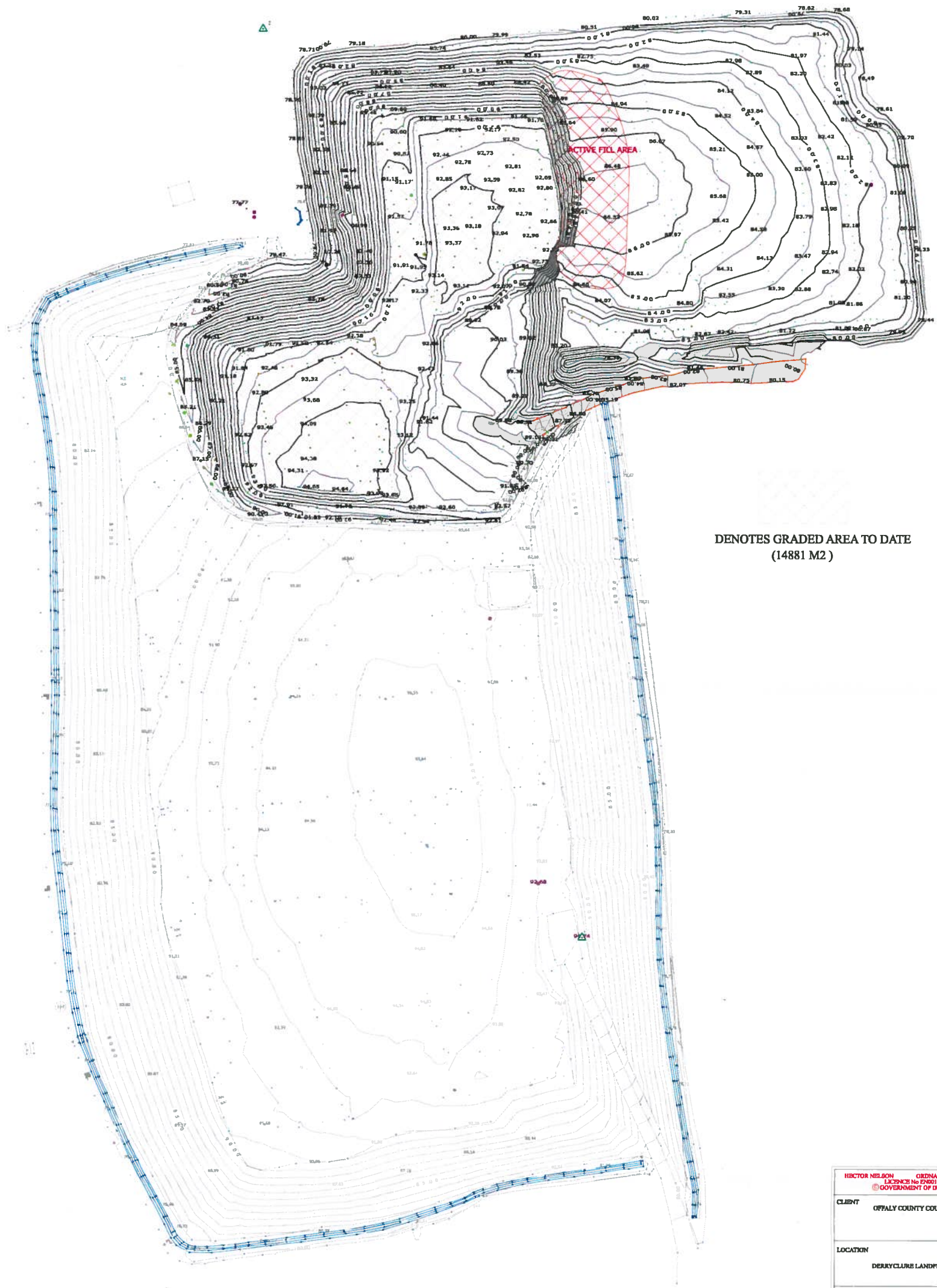
1. Conduct operation on site in accordance with the schedules and conditions of the waste license
2. Continue to monitor and reduce odour emissions/impacts from the facility
3. Completion of works to assist gas extraction system in cold weather condition.
4. To ensure the safe and efficient traffic movement within the site.
5. Continue to manage litter arising on the site and surrounding areas.
6. Ongoing training to be provided to all employees at the facility.
7. Upgrade of the wheelwash facility on site.

OPERATION	TARGET	OBJECTIVE	Review dates	Responsibility
1. All site activities	To ensure compliance with the Waste License	Conduct operations on site in accordance conditions of the Waste License	Ongoing ,2011	Site Manager
2.All activities, and particularly Cells 1A, 1B & 1C	To minimise any odour impacts from the facility	To further develop the gas management and extraction infrastructure, in consultation with the EPA Intend to install a gas extraction system on Cell 1C and conduct an extensive review of capping on site. Conduct a further VOC assessment to identify problem areas and ultimately reduce odours on site	Quarterly,2011	Executive Scientist
3.Gas Extraction System	To ensure optimum performance, particularly in extreme weather conditions	Review of adequacy of insulation of the knock-out pot and ancillary pipe-work. Install a heat tracer on the gas analyzer and analyser pipework. Assessment on pipe gradient of gas extraction system with recommendations to be carried	Quarterly 2011	Site Manger

		out. Install a more effective knockout pot at Flare inlet.		
4. Traffic Flow Management on site	Safe and efficient traffic movement within the site	Review traffic movement on site, and complete line marking on site	Quarter 3 2010	Site Manger
5. Health & Safety	Management of Safety Statement	Review all risk assessments and implement any changes required	Ongoing, 2011	Site Manger
6. All site activities	To ensure litter is managed on the site and surrounding areas.	The prompt removal of any litter arising. Review the effectiveness and location of litter netting and litter-picks	Ongoing, 2011	Site Manager
7. Training Programme	To ensure all staff are appropriately trained	Training to be provided to all staff to address roles on site	Ongoing, 2011	Site Manager
8. Wheel-wash Operation	Undertake servicing of wheel-wash facility	Servicing of wheel-wash operation facility to improve its effectiveness	Quarter 1, 2011	Site Manager

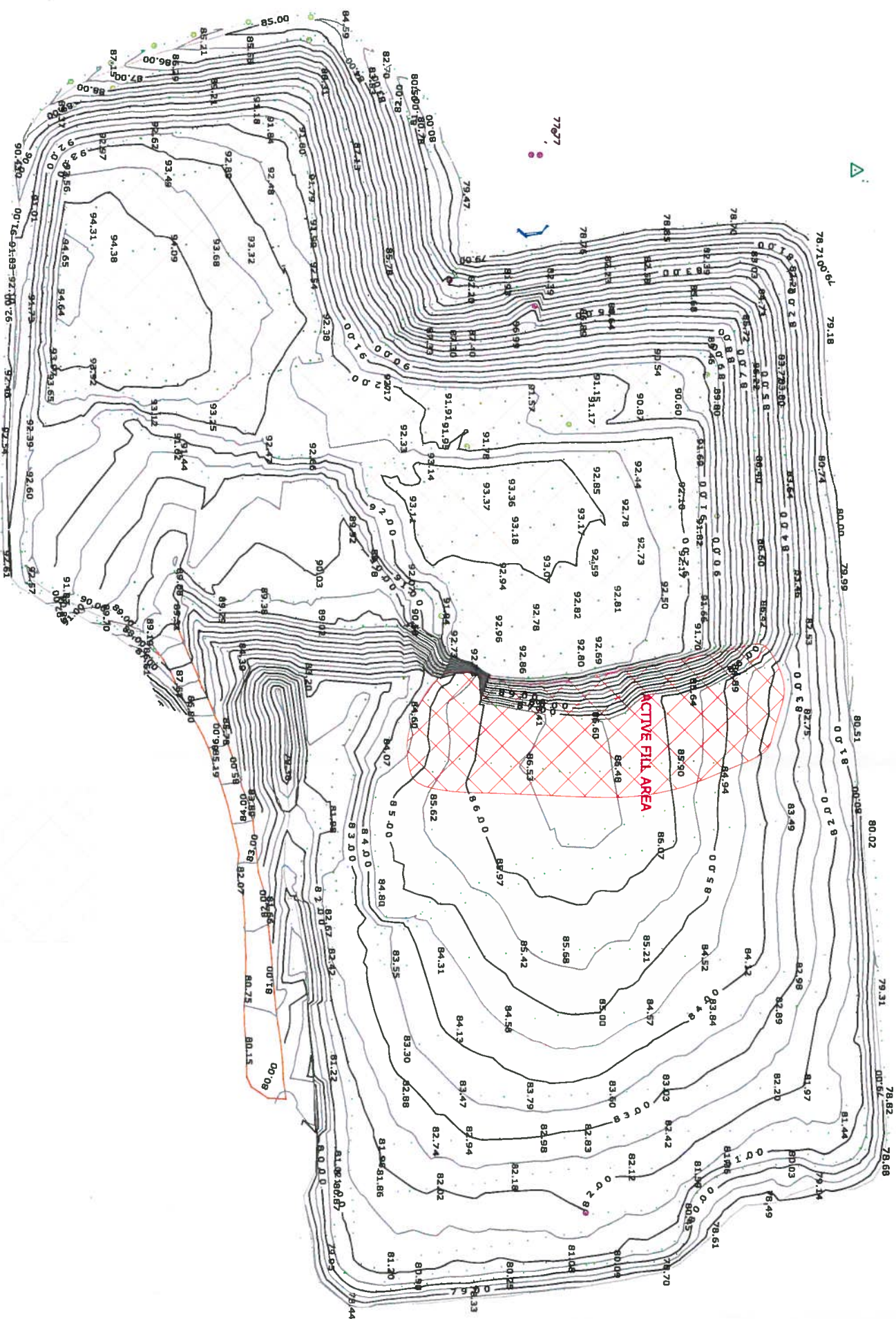
Appendix A

Site survey showing existing levels



DENOTES GRADED AREA TO DATE
(14881 M2)

HECTOR NELSON <small>LICENCE No 0001011</small> <small>GOVERNMENT OF IRELAND</small>		ORDNANCE SURVEY IRELAND <small>GOVERNMENT OF IRELAND</small>	
CLIENT			
OFFALY COUNTY COUNCIL			
LOCATION			
DERRYCLURE LANDFILL SITE			
TITLE			
UPDATE TO CELL AREAS WITH OLD CELL			
HECTOR R NELSON TOPOGRAPHIC SURVEYS CLONKEEPLY OLDCASTLE Co. WICK IRELAND TEL. 00353 49 852168 <small>hnelson@tds.com</small>			
QUARRY AND PIT SURVEYS <small>hnelson@tds.com</small>			
LEVEL: OS MALIN HEAD			
DRAWN: HRN		CHECKED:	
SCALE: 1:1500@A3		DATE: 19th APRIL 2010	
ALL RIGHTS RESERVED		REP: BIM	



DENOTES GRADED AREA TO DATE
(14881 M2)

HECTOR NELSON ORDNANCE SURVEY IRELAND ENGINEERS AND SURVEYORS © GOVERNMENT OF IRELAND			
CLIENT	OFFALOY COUNTY COUNCIL		
LOCATION	DERRYCLURE LANDFILL SITE		
TITLE	UPDATE TO CELL AREAS		
HECTOR R NELSON TOPOGRAPHIC QUARRY AND PIT SURVEYS SURVEYS CLONKERRY OLDCASTLE Co. WEAATH IRELAND TEL. 00353 49 8542168 hnrnelson@indigo.ie LEVEL: OS MALIN HEAD			
DRAWN	HRN	CHECKED	
SCALE	1:1000@A3	DATE	18th APRIL 2010
© ALL RIGHTS RESERVED		REF	BM

Appendix B

2010 PRTR submission



Environmental Protection Agency

Guidance to completing the PRTR workbook

AER Returns Workbook

Version 1.1.11

REFERENCE YEAR	2010
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1. FACILITY IDENTIFICATION

Parent Company Name	Offaly County Council
Facility Name	Derryclare Landfill
PRTR Identification Number	W0029
Licence Number	W0029-04

Waste or IPPC Classes of Activity

No.	class_name
3.5	Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment.
3.1	Deposit on, in or under land (including landfill).
3.1.1	Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule
3.1.1.1	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.
3.1.1.2	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.
3.1.3	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.
3.4	Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.
3.7	#####
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.
Address 1	Derryclare and Killeigh
Address 2	Tullamore
Address 3	Co. Offaly
Address 4	
Country	Ireland
Coordinates of Location	-6.25685 53.5597
River Basin District	IEEA
NACE Code	3821
Main Economic Activity	Treatment and disposal of non-hazardous waste
AER Returns Contact Name	Marian Healy
AER Returns Contact Email Address	mhealy@offalycoco.ie
AER Returns Contact Position	Executive Scientist
AER Returns Contact Telephone Number	057 9357403
AER Returns Contact Mobile Phone Number	
AER Returns Contact Fax Number	0579329230
Production Volume	0.0
Production Volume Units	
Number of Installations	0
Number of Operating Hours in Year	0
Number of Employees	0
User Feedback/Comments	
Web Address	

2. PRTR CLASS ACTIVITIES

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

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

Is it applicable?	
Have you been granted an exemption?	
If applicable which activity class applies (as per Schedule 2 of the regulations)?	
Is the reduction scheme compliance route being used?	

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

POLLUTANT	Name	M/C/E	METHOD		Emission Point 1	T (Total) KG/Year	QUANTITY		
			Method Code	Method Used			A (Accidental) KG/Year	F (Fugitive) KG/Year	
No Annex II									
01	Methane (CH4)	C	MAB	Total gas arising, less gas flared - Balance multiplied by 0.68 for CH4		0.0	1848669.73	0.0	1848669.73
03	Carbon dioxide (CO2)	C	MAB	Total gas arising, less gas flared - Balance multiplied by 1.97 for CO2		0.0	5355704.94	0.0	5355704.94

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

SECTION B : REMAINING PRTR POLLUTANTS

POLLUTANT	Name	M/C/E	METHOD		Emission Point 1	T (Total) KG/Year	QUANTITY	
			Method Code	Method Used			A (Accidental) KG/Year	F (Fugitive) KG/Year
No Annex II								

* 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)

POLLUTANT	Name	M/C/E	METHOD		Emission Point 1	T (Total) KG/Year	QUANTITY	
			Method Code	Method Used			A (Accidental) KG/Year	F (Fugitive) KG/Year

* 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: Please enter summary data on the quantities of methane flared and / or utilised	Derricure Landfill	T (Total) Kg/Year	M/C/E	Method Used		Facility Total Capacity m3 per hour
				Method Code	Description or Designation	
Total estimated methane generation (as per site model)		5281913.6	C	OTH	The total gas flared is estimated at 65% of the total gas arising, based on the area under extraction (vertical and horizontal) and the age and gas composition of the various sections on the site.	N/A
Methane flared		3433243.87	C	MAB	Total gas flared - multiplied by 0.68 for CH4	0.0 (Total Flaring Capacity)
Methane utilised in engines		0.0		None	None	0.0 (Total Utilising Capacity)
Net methane emission (as reported in Section A above)		1848669.73	C	MAB	Total gas arising, less gas flared	N/A

Please enter all quantities on this sheet in Tonnes

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	M/C/E	Method Used	Location of Treatment	Haz Waste		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)	
									Licence/Permit No of Next Haz Waste Name and Licence/Permit No of Recover/Disposer	Address of Next Destination Facility Non Haz Waste Address of Recover/Disposer			
Within the Country	15 01 01	No	169.34	paper and cardboard packaging	R3	M	Weighted	Onsite in Ireland	1	Greyhound Recycling, WI205- Oxygen Environmental Ltd,WL 208-02	Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland Ballymount Road, Walkinstown, Dublin, 22, Ireland		
Within the Country	15 01 01	No	27.0	paper and cardboard packaging	R3	M	Weighted	Onsite in Ireland		Irish Packaging Recycling ,WL263-01	Unit 4, Osberstown Ind Park Ireland		
Within the Country	15 01 01	No	4.0	paper and cardboard packaging	R3	M	Weighted	Onsite in Ireland		Rahab Glassco Ltd, WFP-KE- 08-0957-01	Unit 4, Osberstown Ind Park Naas Co. Kildare, 0, Ireland		
Within the Country	15 01 07	No	54.0	glass packaging	R5	M	Weighted	Onsite in Ireland		Rahab Glassco Ltd, WFP-KE- 08-0957-01	Unit 4, Osberstown Ind Park Naas Co. Kildare, 0, Ireland		
Within the Country	20 01 02	No	10.1	glass	R5	M	Weighted	Onsite in Ireland		Greyhound Recycling, WL205-1	Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland		
Within the Country	15 01 04	No	0.27	metallic packaging	R4	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland		
Within the Country	15 01 04	No	2.0	metallic packaging	R4	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland		
Within the Country	15 01 04	No	3.46	metallic packaging	R4	M	Weighted	Onsite in Ireland		Greyhound Recycling, WI205- 1	Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland		
Within the Country	15 01 04	No	4.0	metallic packaging	R4	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland		
Within the Country	20 01 40	No	25.0	metals	R4	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland		
Within the Country	20 01 40	No	54.09	metals	R4	M	Weighted	Onsite in Ireland		Greyhound Recycling, WI205- 1	Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland		
Within the Country	15 01 02	No	89.34	plastic packaging	R5	M	Weighted	Onsite in Ireland		Greyhound Recycling, WI205- 1	Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland		
Within the Country	15 01 02	No	22.0	plastic packaging	R5	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland		
Within the Country	15 01 05	No	2.14	composite packaging	R5	M	Weighted	Onsite in Ireland		Greyhound Recycling, WI205- 1	Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland Glen Abbey		
Within the Country	15 01 05	No	4.0	composite packaging	R5	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland Glen Abbey		
Within the Country	20 01 11	No	9.0	textiles	R5	M	Weighted	Onsite in Ireland		Textile Recycling Ltd, N/A Greyhound Recycling, WI205- 1	Complex, Belgard Rd, Dublin, 24, Ireland Craig Ave, Clondalkin Ind Estate, Dublin, 22, Ireland Barnan, Daingaen, Co. Offaly, 0, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland		
Within the Country	20 01 11	No	11.69	textiles	R5	M	Weighted	Onsite in Ireland		1			
Within the Country	15 01 03	No	144.21	wooden packaging	R3	M	Weighted	Onsite in Ireland		Crs Ltd, WFP138/06	Offaly, 0, Ireland Merrywell Ind Estate, Ballymount Rd Lower, Clondalkin Dublin, 22, Ireland		
Within the Country	15 01 03	No	4.0	wooden packaging	R3	M	Weighted	Onsite in Ireland		Oxygen Environmental Ltd,WL 208-02	Dublin, 22, Ireland		
Within the Country	15 01 03	No	11.0	wooden packaging	R3	M	Weighted	Onsite in Ireland		Conroy Recycling, WFP-WH- 2009-0002-01	Sonma, Mullingar Co. Westmeath, 0, Ireland		
Within the Country	15 01 03	No	6.0	wooden packaging	R3	M	Weighted	Onsite in Ireland		Enrich Environmental, MH- 2005-074	Kilcock, Co. Meath, 0, Ireland		
To Other Countries	16 06 01	Yes	1.051	lead batteries	R4	M	Weighted	Abroad		KWK Metals, WL 184-01	Cappincur Rd, Tullamore, Co. Offaly, 0, Ireland	H. J. Enthoven Ltd, Lix # BL 5598, Darley Dale Smeller, South Darley, Matlock, Derbyshire DE4 2LP, United Kingdom	Darley Dale Smeller, South Darley, Matlock, Derbyshire DE4 2LP, United Kingdom

To Other Countries	16 06 04	No	0.305 alkaline batteries (except 16 06 03)	R4	M	Weighted	Abroad	KMK Metals , WL 184-01	Cappincur Rd, Tullamore, Co. Offaly, 0, Ireland	
Within the Country	20 01 25	No	2.58 edible oil and fat	R9	M	Weighted	Onsite in Ireland	MT Oils, WP98/119	Newmarket ,, Dublin ,9, Ireland	
To Other Countries	20 01 27	Yes	paint, inks, adhesives and resins containing 8.7 dangerous substances	D10	M	Weighted	Abroad	Oxigen Environmental Ltd, WL 208-02	Estimate, Ballymount Rd Lower, Clonsalkin Dublin, 22, Ireland	ATM BV, Llc #827180, Vlasweg 12, P.W. Moerdijk, 4782, Nether lands
Within the Country	16 01 03	No	5.22 end-of-life tyres	R5	M	Weighted	Onsite in Ireland	Greyhound Recycling, WI205-1	Craig Ave, Clonsalkin Ind Estate, Dublin, 22, Ireland	
Within the Country	16 01 03	No	0.8 end-of-life tyres	R5	M	Weighted	Onsite in Ireland	Crs Ltd, WP138/06	Offaly, 0, Ireland	
Within the Country	17 08 02	No	9.12 than those mentioned in 17 08 01	R3	M	Weighted	Onsite in Ireland	Greyhound Recycling, WI205-1	Craig Ave, Clonsalkin Ind Estate, Dublin, 22, Ireland	
Within the Country	17 08 02	No	6.06 than those mentioned in 17 08 01	R3	M	Weighted	Onsite in Ireland	Crs Ltd, WP138/06	Offaly, 0, Ireland	
Within the Country	20 01 39	No	2.2 plastics	R5	M	Weighted	Onsite in Ireland	Crs Ltd, WP138/06	Offaly, 0, Ireland	
Within the Country	20 03 01	No	40.0 mixed municipal waste	D5	M	Weighted	Onsite in Ireland	Greyhound Recycling, WI205-1	Craig Ave, Clonsalkin Ind Estate, Dublin, 22, Ireland	
Within the Country	20 03 01	No	61.0 mixed municipal waste	R5	M	Weighted	Onsite in Ireland	Oxigen Environmental Ltd, WL 208-02	Dublin, 22, Ireland	
Within the Country	20 02 01	No	110.69 biodegradable waste	R3	M	Weighted	Onsite in Ireland	Greyhound Recycling, WI205-1	Craig Ave, Clonsalkin Ind Estate, Dublin, 22, Ireland	
Within the Country	20 02 01	No	40.0 biodegradable waste	R3	M	Weighted	Onsite in Ireland	Crs Ltd, WP138/06	Offaly, 0, Ireland	
Within the Country	20 02 01	No	11.0 biodegradable waste	R3	M	Weighted	Onsite in Ireland	Oxigen Environmental Ltd, WL 208-02	Lower Clonsalkin Dublin, 22, Ireland	
Within the Country	20 02 01	No	49.0 biodegradable waste	R3	M	Weighted	Onsite in Ireland	Enrich Environmental, MH-2005-074	Kilcock, Co. Meath, , 0, Ireland	
Within the Country	20 02 01	No	243.3 biodegradable waste	R3	M	Weighted	Onsite in Ireland	Enrich Environmental, MH-2005-074	Kilcock, Co. Meath, , 0, Ireland	
Within the Country	20 01 39	No	1.17 plastics	R5	M	Weighted	Onsite in Ireland	Greyhound Recycling, WI205-1	Craig Ave, Clonsalkin Ind Estate, Dublin, 22, Ireland	
Within the Country	20 01 21	Yes	fluorescent tubes and other mercury-0.11 containing waste	R4	M	Weighted	Onsite in Ireland	KMK Metals , WL 184-01	Cappincur Rd, Tullamore, Co. Offaly, 0, Ireland	Alba Service GmbH & Co KG, E56657020 Kanal Strasse 64, Rheine ,, 48432, Germany
Within the Country	19 07 03	No	27073.08 in 19 07 02	D9	M	Weighted	Onsite in Ireland	Tullamore Waste Water Treatment Plant, D0039-01	Kilcrotin , Tullamore, Co. Offaly, 0, Ireland	Kanal Strasse 64, Rheine ,, 48432, Germany
Within the Country	20 03 04	No	25.2 septic tank sludge	D9	M	Weighted	Onsite in Ireland	Tullamore Waste Water Treatment Plant, D0039-01	Kilcrotin , Tullamore, Co. Offaly, 0, Ireland	
Within the Country	20 03 99	No	69.3 municipal wastes not otherwise specified	D9	M	Weighted	Onsite in Ireland	Tullamore Waste Water Treatment Plant, D0039-01	Kilcrotin , Tullamore, Co. Offaly, 0, Ireland	
Within the Country	20 01 36	No	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighted	Onsite in Ireland	KMK Metals , WL 184-01	Cappincur Rd, Tullamore, Co. Offaly, 0, Ireland	
Within the Country	20 01 36	No	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	R4	M	Weighted	Onsite in Ireland	KMK Metals , WL 184-01	Cappincur Rd, Tullamore, Co. Offaly, 0, Ireland	
Within the Country	17 05 04	No	29561.3 in 17 05 03	R5	M	Weighted	Onsite in Ireland	Derryclare Landfill, WL29-04	Offaly, Ireland	
Within the Country	17 01 07	No	4334.33 in 17 01 06	R5	M	Weighted	Onsite in Ireland	Derryclare Landfill, WL29-04	Offaly, Ireland	

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

[Link to previous years waste data](#)

[Link to previous years waste summary data & percentage change](#)

Appendix C

Slope Stability Report



ENVIRONMENTAL BALANCE IN DESIGN AND CONSTRUCTION

SLOPE STABILITY REPORT

**DERRYCLURE LANDFILL
DERRYCLURE, TULLAMORE, CO. OFFALY**

WASTE LICENCE REGISTER W0029-04

ORIGINAL

MAY 2011





SLOPE STABILITY REPORT

**DERRYCLURE LANDFILL
DERRYCLURE, TULLAMORE, CO. OFFALY**

WASTE LICENCE REGISTER W0029-04

COPY

MAY 2011

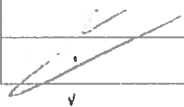

SLOPE STABILITY REPORT

DERRYCLURE LANDFILL

DERRYCLURE, TULLAMORE, CO. OFFALY

WASTE LICENCE REGISTER W0029-04

User is Responsible for Checking the Revision Status of This Document

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Client: Offaly County Council

Keywords: Derryclure, landfill, capping, slope stability, peat, 2011 AER

Abstract: Offaly County Council retained FTC to carry out a slope stability analysis of the landfill side slopes as part of the 2011 AER.

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1 INTRODUCTION

1.1 Purpose

This report presents the results of a slope stability assessment carried out for Derryclure Landfill site on behalf of Offaly County Council. The analysis is undertaken as part of the 2011 AER for the site in accordance with EPA waste licence issued to the site (reference: W0029-04).

Readers of this report are advised that the analysis has been conducted in accordance with Eurocode 7 (IS EN 1997-1) which deals with factors of safety (FOS) in a different manner to previous design codes (BS 6031 – Code of Practice for Earthworks).

A more detailed explanation of factors of safety and Eurocode 7 (IS EN 1997-1) is presented in Section 3.2 in this report.

1.2 Site Description

Derryclure Landfill is located at Derryclure, approximately 5 km south of Tullamore, Co. Offaly. The original landfill was constructed on a level area of peat bog and began receiving waste in approximately 1972. The original landfill is unlined and was closed and capped in 2006. A newer fully lined landfill was constructed to the northeast of the original landfill and is currently receiving waste.

1.3 Slope Stability Analysis Method

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

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

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

The definition of factor of safety used within SLOPE/W is:

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

Design values for use in the slope stability analysis have been derived using Eurocode 7 (IS EN 1997-1) Design Approach 3. This design approach is considered to be the most logical approach for slope stability analysis as it includes partial factors for both material properties and variable loads (for example traffic loads).

1.4 Limitations of Slope Stability Analyses

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

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

1.5 Factors controlling the stability of Landfill Slopes

The factors controlling the stability of landfill slopes are:

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

2 DESIGN CRITERIA

2.1 Slope Geometry

Using the latest topographical survey prepared by Hector Nelson Surveys Ltd., dated April 2011, typical cross-sections through the old and new waste slopes of the site were taken at the locations shown on Drawing LW11-286-02-001 Rev A, as denoted by section lines 1-1 to 4-4. The side slopes analysed were a combination of the permanently capped slopes and the most recently filled areas representing the active slopes on site. At the time of the survey, slope 1 was within the fully formed, permanently capped part of the landfill while slopes 2, 3 and 4 were within the actively filled area.

Slope 1 is approximately 17 m high, 80 m long and has a maximum slope of 1:3.2 (vertical : horizontal). Slope 2 is approximately 14 m high and 38 m long, with a maximum slope of 1:2.7. Slope 3 is approximately 13 m high and 45 m long, with an average slope of 1:3.3. Slope 4 is approximately 12 m high, 30 m long and has a maximum slope of 1:2.5 (vertical : horizontal).

All four sections are presented on Figures 3.1 to 3.4.

2.2 Geology

Previous site investigations within the current active landfill area show that this part of the site is underlain by an average thickness of 2.5 m of peat, 1.0 m of soft silt/clay, 2.5 m of sand, 4.0 m of stiff silt/clay and possible bedrock at about 10 m. Due to the level nature of the site, it is reasonable to assume that similar conditions exist beneath the original capped landfill. It is understood that the active landfill was constructed following excavation of peat and silt to a depth of around 4.0 m below ground level and the base of the cell is currently at 74 mOD. This has been taken into account in the analyses of the slopes in these areas.

The slope cross-sections were created in Slope/W assuming that some consolidation of the peat has taken place beneath the capped waste.

2.3 Waste Parameters

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

Table 2.1: Characteristic Shear Strength Parameters for Waste materials

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

The parameters shown above are typical values taken from published papers on the properties of waste. The old waste parameters are considered appropriate for the analysis of slope 1 only while parameters for fresh waste have been used for the active landfill models.

Table 2.2: Partial Factors Used to Derive Design Parameters

Set	Partial Factor		Parameter
M2	γ_c	1.25	Effective cohesion
	γ_ϕ	1.25	Effective angle of friction
	γ_γ	1	Soil density
A2	γ_Q	1.3	Traffic Loading (variable unfavourable)
R3	$\gamma_{R,e}$	1	Earth resistance

Table 2.3: Design Parameters for Waste Materials

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

2.4 Properties of the supporting soil and capping layer

Table 2.4 below shows the typical parameters used for the capping, underlying clay, sand and gravel.

Table 2.4: Characteristic Parameters for Typical Supporting Materials

Material	Clay Capping	Peat	Soft Clay / Silt	Medium dense Sand	Stiff gravelly Clay/Silt	Clay Liner
Cohesion, c' , kN/m ²	2	2	0	0	2	4
Effective Friction angle, ϕ' , °	28	30	29	32	29	27
Bulk unit weight, γ , kN/m ³	18	10.5	18	20	19	19

It should be noted that the most sensitive parameter which governs failure within this model are the geotechnical parameters assigned to the underlying peat. Parameters for peat can vary widely. Parameters used in previous slope analyses undertaken in 2004 by John Barnett & Associates were referenced from Long (2004) who indicates that friction angles vary from 31° to 68° while effective cohesion c' values vary from 3 kN/m² to 6 kN/m². The previous report and this report have therefore adopted lower bound characteristic parameters for analysis of $c'=2$ kN/m² and $\phi' = 30^\circ$ along with a bulk unit weight of 10.5 kN/m³.

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

Table 2.5: Design Parameters for Typical Supporting Materials

Material	Clay Capping	Peat	Soft Clay / Silt	Medium dense Sand	Stiff gravelly Clay/Silt	Clay Liner
Cohesion, c' , kN/m ²	1.6	1.6	0	0	1.6	3.2
Effective Friction angle, ϕ' , °	22.4	24	23.2	25.6	23.2	21.6
Bulk unit weight, γ , kN/m ³	18	10.5	18	20	19	19

2.5 Leachate levels within the waste material

Leachate levels were measured within the original landfill waste body on 5th April 2011 at four separate monitoring points (LE1, LE2, LE3, LE4, LE5 & LE6). The leachate height within the landfill was found to vary between 0.m above the base of the waste to 1.85 m above the base of the waste (77.5 to 79.4 mOD approximately). The leachate levels recorded within the new cells 1A and 1B were 0.64 m and 0.72 m approximately (74.6 and 74.7 mAOD) respectively.

The leachate levels adopted for the analyses presented in this report are considered to be typical levels using the 2011 monitoring data.

2.6 Surcharge

A surcharge of 20 kN/m² was applied to the slopes during the analyses to simulate vehicular movement. After applying a partial factor of 1.3 as per IS EN 1997-1 Design Approach 3 (variable, unfavourable action), a design load of 26 kN/m² has been applied to the models.

3 RESULTS

3.1 Slope Stability Analyses

Models were run for representative sections to assess the slope stability of the landfill waste embankment. The results of those analyses are summarised in Table 3.1 with factors of safety calculated for Bishop, Janbu and Morgenstern-Price methods. Table 3.1 gives the location of each slope, the leachate level simulated, and the length and type of the slip. Although models were undertaken for both shallow and deep-seated slips, only results for deep slips are presented here as these represent the minimum factors of safety and are therefore the most likely slips to occur.

A typical analysis carried out for each of the slopes is presented in Figures 3.1 through 3.4.

3.2 Factors of Safety

In accordance with the principals of Eurocode 7 (IS EN 1997-1), rather than using a global factor of safety as per previous design codes, the factors of safety (termed partial factors) are applied to the chosen characteristic values to obtain design values. Actions (influences) are multiplied by the safety factor, while resistances are divided by the safety factor.

In accordance with Eurocode 7 (IS EN 1997-1), geotechnical checks must be carried out to ensure that the resistance preventing a slide are greater than or equal to the actions which cause a slide, i.e.:

$$E_d \leq R_d$$

Where

E_d = Sum of design actions

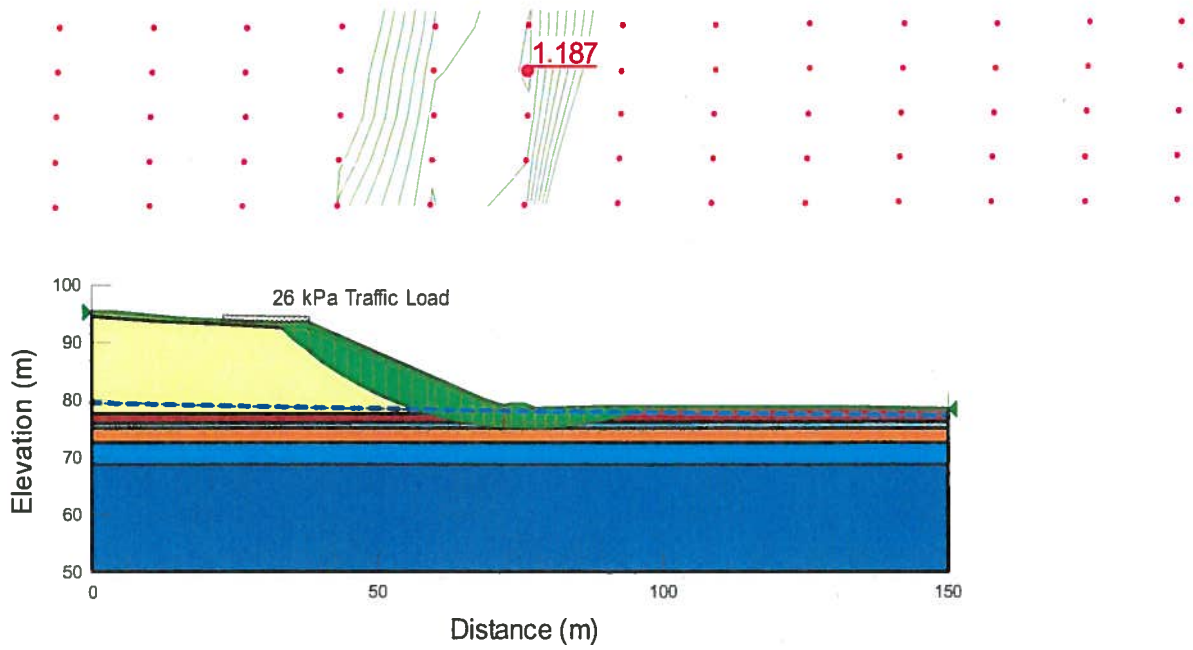
R_d = Sum of design resistances

The safety ratios for potential slope failures along the sections analysed at the site ranged from 1.01 to 1.43 and are presented on Table 3.1 below. By adopting the methods of analysis given in Eurocode 7 (IS EN 1997-1), the factor of safety against failure is **included** in the partial factors (ranging from 1.0 to 1.3 for various parameters) applied to the analysis rather than to the end result. In order to verify that this condition is met, the resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e.: An in-situ "safety ratio" of less than 1.0 indicates that the slope currently has an inadequate factor of safety against failure and therefore is potentially unstable. Ratios greater than 1.0 indicate an adequate factor of safety against failure and are considered stable.

Table 3.1: Slope Analyses Results

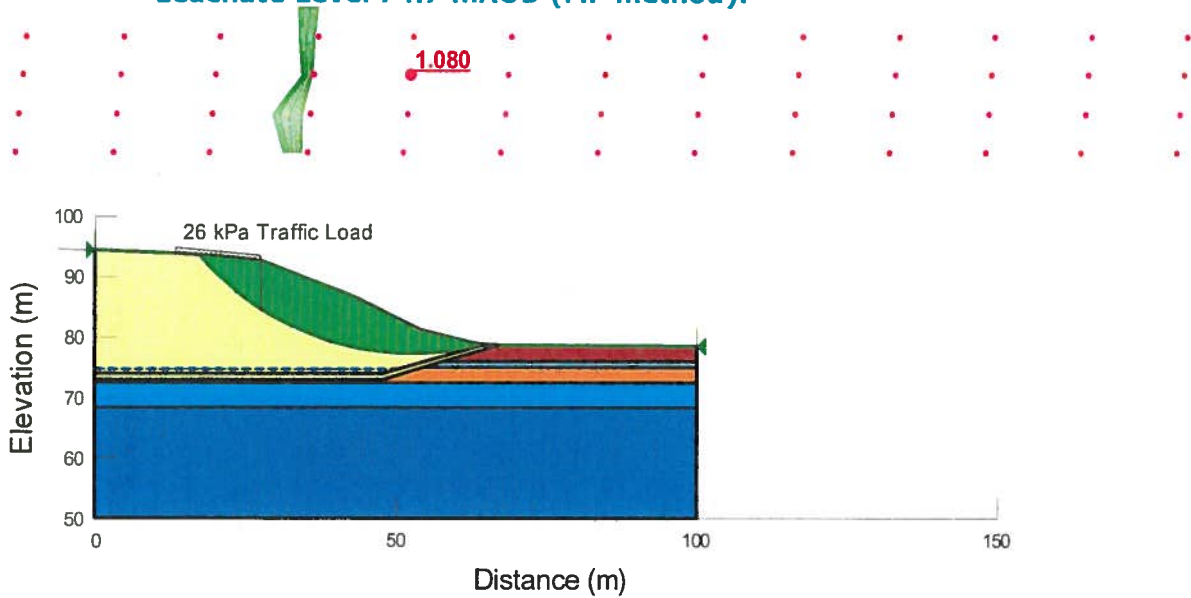
Slope Name	Waste parameters (C, γ & ϕ)	Leachate Level (mAOD)	Morgenstern-Price FoS	Bishop FoS	Janbu FoS	Slip Length (m)	Slip location
1	7.1,11,17.6	79.4	1.18	1.17	1.10	69	Deep rotational slip through cap, waste peat and silt
2	8, 9.5, 12	74.7	1.08	1.08	1.01	51	Deep rotational slip through cap and waste
3	8, 9.5, 12	74.7	1.43	1.43	1.41	36	Deep rotational slip through cap and waste
4	8, 9.5, 12	74.7	1.33	1.33	1.27	36	Deep rotational slip through cap and waste

Figure 3.1: Typical deep rotational slope failure for Slope 1 Leachate Level 79.4 mAOD (MP method).



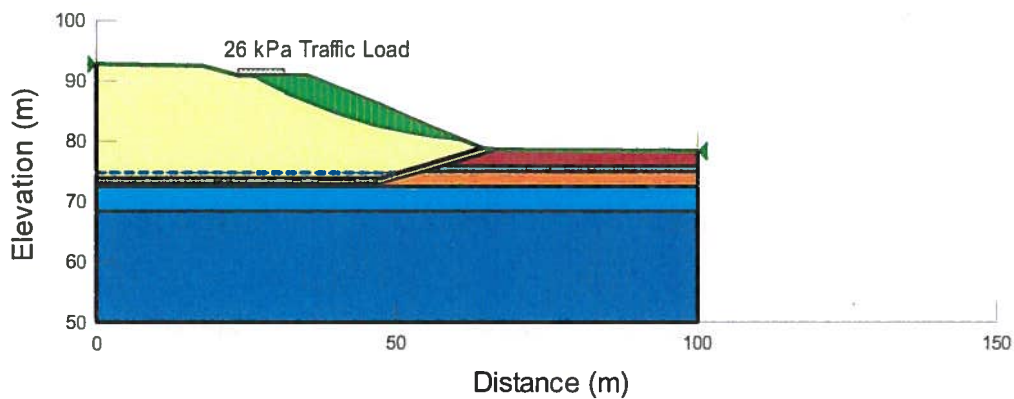
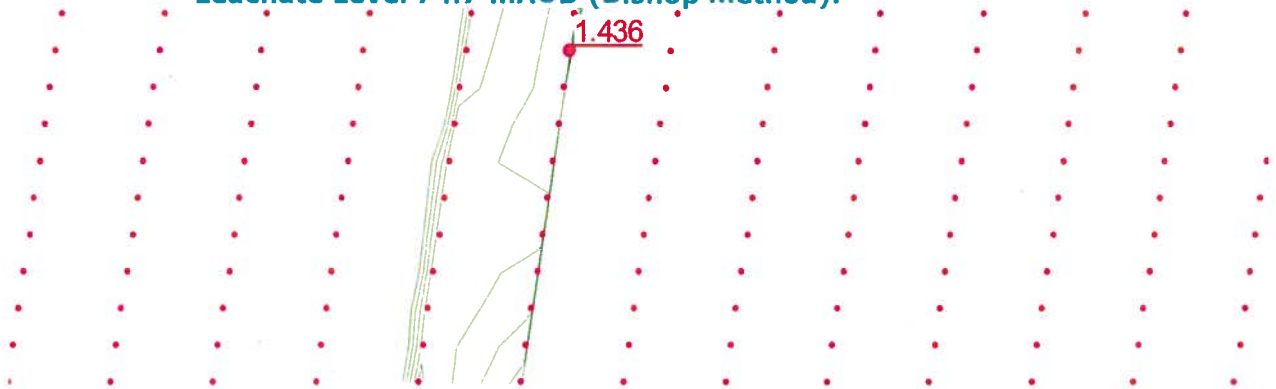
Material #: 1	Description: Clay Capping	Wt: 18	Cohesion: 1.6	Phi: 22.4
Material #: 2	Description: Waste (old)	Wt: 11	Cohesion: 7.1	Phi: 17.6
Material #: 3	Description: Peat (consolidated)	Wt: 10.5	Cohesion: 1.6	Phi: 24
Material #: 4	Description: Soft Silt/Clay	Wt: 18	Cohesion: 0	Phi: 23.2
Material #: 5	Description: M Dense Sand	Wt: 20	Cohesion: 0	Phi: 25.6
Material #: 6	Description: Stiff Clay/Silt	Wt: 19	Cohesion: 1.6	Phi: 23.2
Material #: 7	Description: Bedrock			

**Figure 3.2: Typical deep rotational slope failure for Slope 2
Leachate Level 74.7 mAOD (MP method).**



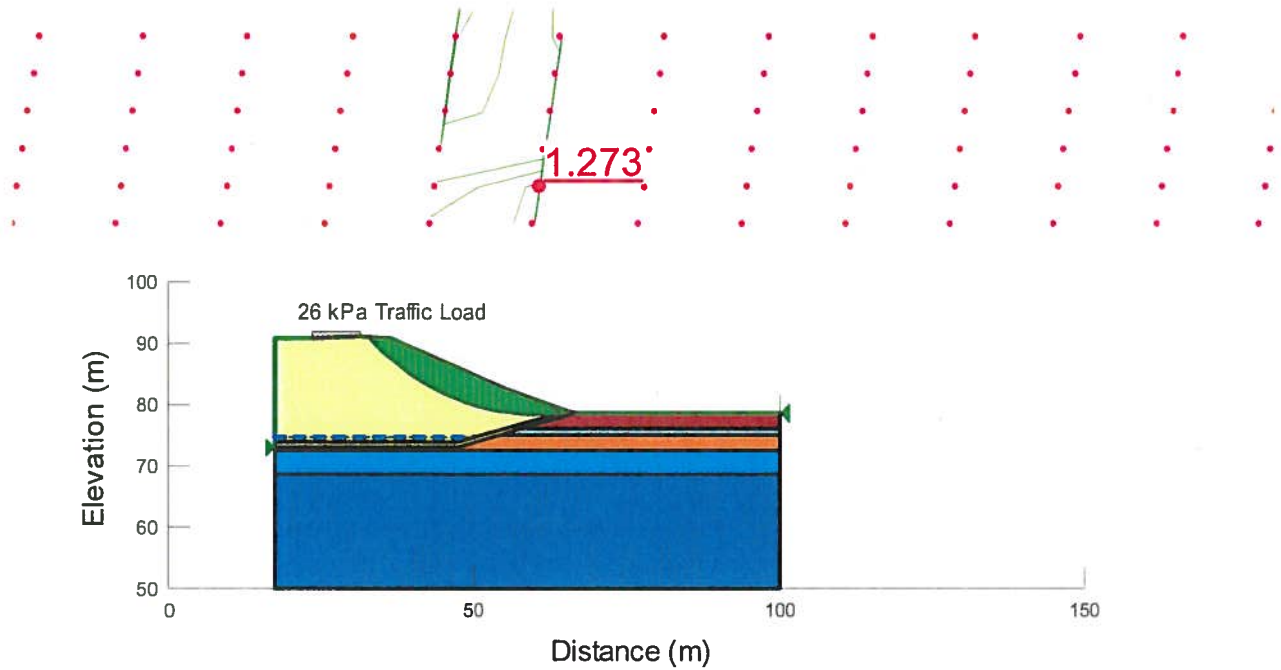
Material #: 1	Description: Waste (new)	Wt: 9.5	Cohesion: 8	Phi: 12
Material #: 2	Description: Clay Liner	Wt: 19	Cohesion: 3.2	Phi: 21.6
Material #: 3	Description: Peat (consolidated)	Wt: 10.5	Cohesion: 1.6	Phi: 24
Material #: 4	Description: Soft Silt/Clay	Wt: 18	Cohesion: 0	Phi: 23.2
Material #: 5	Description: M Dense Sand	Wt: 20	Cohesion: 0	Phi: 25.6
Material #: 6	Description: Stiff Clay/Silt	Wt: 19	Cohesion: 1.6	Phi: 23.2
Material #: 7	Description: Bedrock			

**Figure 3.3: Typical deep rotational slope failure for Slope 3
Leachate Level 74.7 mAOD (Bishop method).**



Material #: 1	Description: Waste (new)	Wt: 9.5	Cohesion: 8	Phi: 12
Material #: 2	Description: Clay Liner	Wt: 19	Cohesion: 3.2	Phi: 21.6
Material #: 3	Description: Peat (consolidated)	Wt: 10.5	Cohesion: 1.6	Phi: 24
Material #: 4	Description: Soft Silt/Clay	Wt: 18	Cohesion: 0	Phi: 23.2
Material #: 5	Description: M Dense Sand	Wt: 20	Cohesion: 0	Phi: 25.6
Material #: 6	Description: Stiff Clay/Silt	Wt: 19	Cohesion: 1.6	Phi: 23.2
Material #: 7	Description: Bedrock			

**Figure 3.4: Typical deep rotational slope failure for Slope 4
Leachate Level 74.7 mAOD (Janbu method)**



Material #: 1	Description: Waste (new)	Wt: 9.5	Cohesion: 8	Phi: 12
Material #: 2	Description: Clay Liner	Wt: 19	Cohesion: 3.2	Phi: 21.6
Material #: 3	Description: Peat (consolidated)	Wt: 10.5	Cohesion: 1.6	Phi: 24
Material #: 4	Description: Soft Silt/Clay	Wt: 18	Cohesion: 0	Phi: 23.2
Material #: 5	Description: M Dense Sand	Wt: 20	Cohesion: 0	Phi: 25.6
Material #: 6	Description: Stiff Clay/Silt	Wt: 19	Cohesion: 1.6	Phi: 23.2
Material #: 7	Description: Bedrock			

4 DISCUSSION AND CONCLUSIONS

The results of the stability analysis show safety ratio for potential deep rotational slope failures along the existing slope cross-sections modelled ranged from 1.01 to 1.43. The lower value safety ratios obtained in the analysis were calculated using the Janbu Method which is considered conservative. All slopes analysed gave factors of safety above the minimum required factor-of-safety of 1.0 in accordance with IS EN 1997-1.

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

Specific Recommendations Relating to Slope Safety

In order to maintain a long-term safety ratio of 1.0 or greater, leachate levels must be regularly monitored and pumped down (ideally within 1 m of the base of the landfill body) to prevent a build up of levels within the waste body and cause potential instability of the landfill slopes. The stability of the interim slopes on the site should be revisited prior to final capping to ensure that a minimum long term safety ratio of 1.0 can be achieved.

It is recommended that for health and safety reasons, temporary active faces are maintained at a minimum slope of 1 in 2.5 to ensure that a minimum interim factor of safety against slope failure of 1.0 is achieved.

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

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

5 REFERENCES

1. Kolsch (1995) Material values for some mechanical properties of domestic waste, Proceedings 5th Sardinia International Landfill Symposium, Vol 2, pp 711-729.
2. E Kavazanjian, JR, N Matasovic & R C Bachus (1999), Large diameter static and cyclic laboratory testing of municipal solid waste, Vol 3, Sardinia Landfill Symposium pp 437-444.
3. S Thomas, A A Aboura, J P Gourc, P Gotteland, H Billard, T Delineau, T Gisbert, J F Ouvry and M Vuillemin, (1999), Vol 3, Sardinia Landfill Symposium, pp 445-452.
4. Glover Site Investigations. Borehole Logs BH1 to BH8. Derryclure Landfill. January 2004.
5. Hector R. Nelson Topographic Surveys. Derryclure landfill Site Survey. April 2011.
6. John Barnett and Associates. Slope Stability Assessment Report. Derryclure Landfill Facility, Tullamore, Co. Offaly. November 2004. Prepared on behalf of Bord Na Mona Environmental Ltd.
7. Long, M. (2004). Report on Literature Review on Peat Strength and Constitutive Modelling of Peat with reference to Landslides. Dept. of Civil Engineering, University College Dublin. Unpublished.

Appendix 1

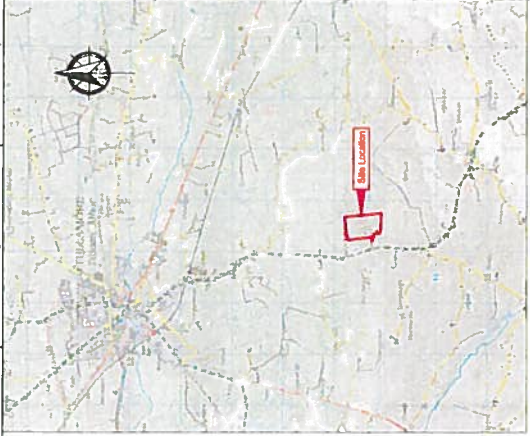
DRAWING LW11-286-02-001 Rev B:

Existing Topographic Survey showing
Section lines for Slope Stability Analysis

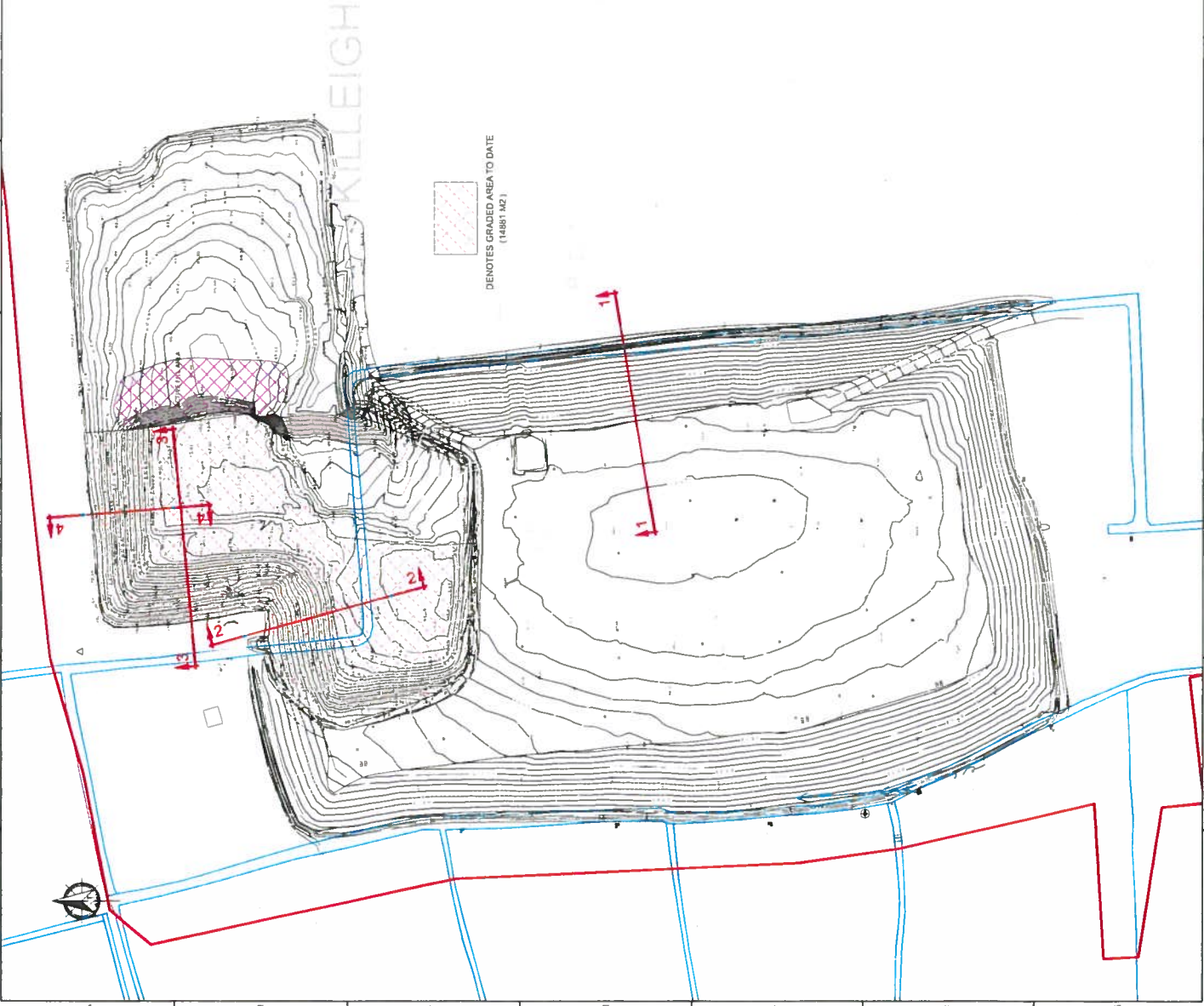


NOT FOR CONSTRUCTION PURPOSES - PRELIMINARY DIMENSIONS

Note
 Survey taken from Institute Topographic
 Survey, District of Galway, S18, April 2010
 The datum is I.T.M. 2000
 The datum is I.T.M. 2000
 The datum is I.T.M. 2000



KEY LOCATION MAP
 Scale 1:50000



ISSUE FOR INFORMATION		Section 4 Address
No.	Description	
1	Issue for Information	

Name of Client
O'FAYL COUNTY COUNCIL

Name of Job
**DEVELOPE LANDRILL
 SLOPE STABILITY**

Title of Drawing
**SITE PLAN
 SHOWING LOCATION OF SECTIONS**

Scale of Plot
 1:1000

Drawn By
 LW11-286-02-001

Check By
 B

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