TIER 2

ENVIRONMENTAL RISK ASSESSMENT

OF A

FORMER MUNICIPAL HISTORIC LANDFILL

AT

POTTLEBOY

COOTEHILL

CO. CAVAN

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1.0 INTRODUCTION

Cavan County Council conducted a Tier 1 risk assessment of the historic waste disposal site at Pottleboy, Cootehill, Co. Cavan in accordance with the requirements of Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008 in September 2009. The preliminary, risk assessment followed the guidance as per the Environmental Protection Agency (EPA) guidance document "Code of Practice: Environmental risk Assessment for Unregulated Waste Disposal Sites (COP)", which was published in April 2007. The site was ranked as being of Moderate Risk due to the SPR linkage No. 10 landfill gas migration from the site. A copy of the assessment is included in Appendix G Tier 1 Risk Assessment. In October 2014, Cavan County Council appointed Traynor Environmental Ltd to undertake a Tier 2 Environmental Risk Assessment in association with the Waste Management Section of Cavan County Council.

1.1 METHODOLOGY

The Tier 2 Environmental Risk assessment, which was carried out in accordance with the guidance in the code of practice, including an initial review of the Tier 1 Report; review of original data sources; conducting a site inspection to ascertain an understanding of historical land use; establish the local and regional hydrological and hydrogeological conditions; confirm the presence of potentially sensitive on site receptors; and identify suitable locations for the intrusive investigation programme.

Traynor Environmental Ltd subsequently designed and implemented a site investigation programme that included:

- Topographic Survey;
- Trial hole excavation and survey;
- Collection and analyses of waste and sub-soil samples;
- Installation of landfill gas/leachate monitoring wells;
- Landfill gas monitoring;
- Ecological Assessment of the Site

Traynor Environmental Ltd carried out the intrusive site investigation works in accordance with BS 10175:2001 Investigation of Potentially Contaminated Sites Code of Practice. The intrusive works were supervised by Traynor Environmental Ltd personnel in association with the Waste Management Section of Cavan County Council. The landfill gas/leachate monitoring wells were installed by S & A Construction under the direct supervision of Traynor Environmental Ltd personnel. The testing laboratory used was Alcontrol Laboratories Ltd who have United Kingdom Accreditation Service (UKAS) certification. A topographic survey was carried out by Alan Traynor Consulting Engineers Ltd. The Ecology assessment was carried out by Noreen Mc Loughlin MSc. MIEEM on behalf of Traynor Environmental Ltd. Tim Moynihan, BSc, MSc, MIEI, FGS, P.Geol, C.Eng of Malachy Walsh & Partners is the designated project manager and is deemed to be competent by the Environmental Protection Agency.

1.2 DISCLAIMER

The conclusions presented in this report are professional opinions based solely on the tasks outlined herein and the information made available to Traynor Environmental Ltd. They are intended for the purpose outlined herein and for the indicated site and project. The report is for the sole use of the Client. This report may not be relied upon by any other party without explicit agreement from Traynor Environmental Ltd. Opinions and recommendations presented herein apply to the site conditions existing at the time of the assessment. They cannot apply to changes at the site of which Traynor Environmental Ltd is not aware of and has not had the opportunity to evaluate. This report is intended for use in its entirety; no excerpt may be taken to be representative of this assessment.

1.3 DIFFICULTIES ENCOUNTERED

Please note that although extensive research was completed as part of this assessment, given the historic nature of land filling activities, some information on the phasing of land filling at the former landfill could not be established. Therefore in evaluating the landfill gas risk and completing the landfill gas assessment, a number of assumptions have been made on the phasing of filling (e.g. annual tonnages accepted) and type of material and compaction. While these limitations are identified it is considered that the overall project objective was not compromised and the conclusions and recommendations presented are valid.

2. 0 SITE DESCRIPTION

2.1 SITE LOCATION

Cootehill Historic landfill is located approximately 0.8 km from the centre of Cootehill town, in the townland of Pottleboy on local roadway L - 6088-0 Ref: Drawing No. 14.248.101 - Site Location Map in Appendix F. The land surrounding the site slopes(uphill) moderately in a North Easterly direction towards the town of Cootehill. It is bounded on the North and South by urban dwellings and to the west and east by Agricultural Land. Figure No. 1 B Location Map, shows the area used for the purpose of the landfill (marked 9) and the neighbouring site (marked 11) to the east (are outlined in blue).

Figure No. 1 A: Location of Cootehill Town in Co Cavan.

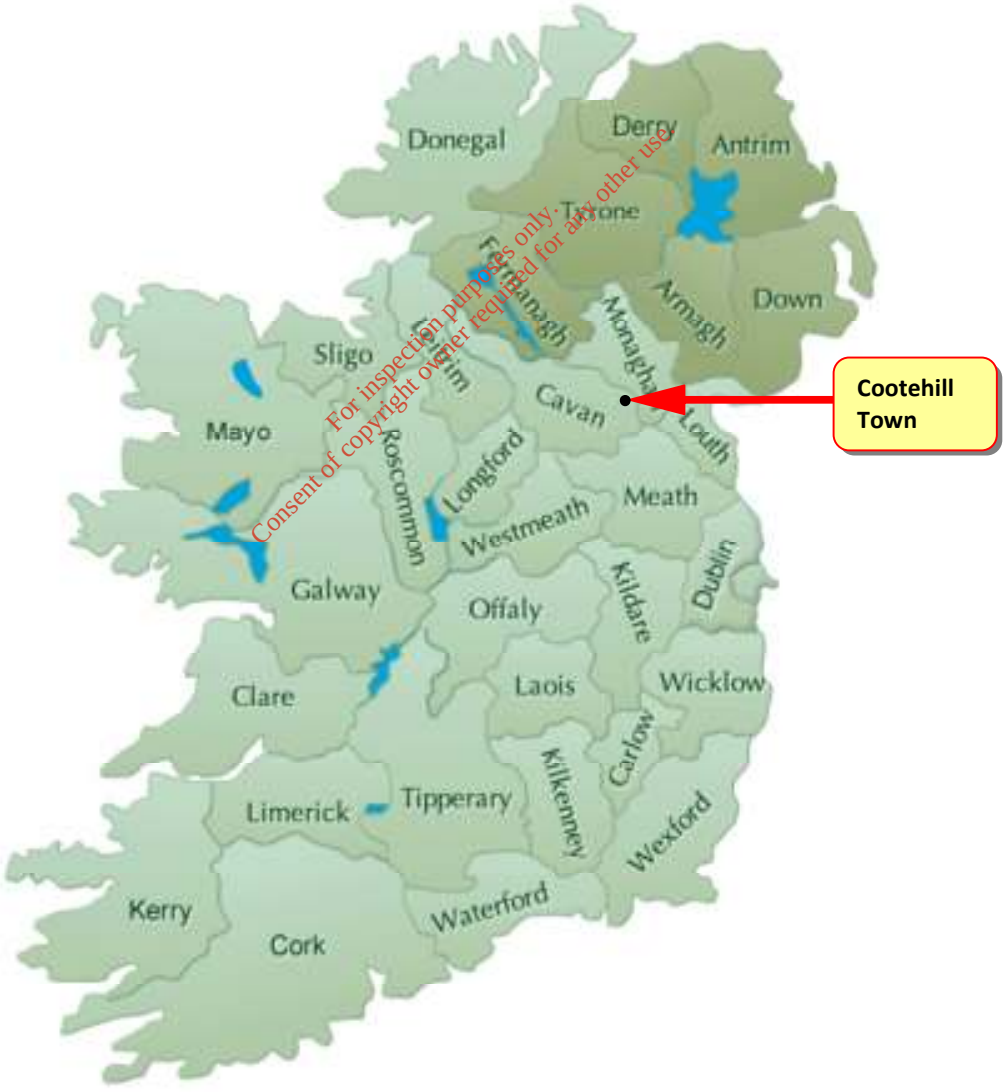


Figure No. 1 B: Location Map of Cootehill Historic Landfill and Adjoining parcel of land.

"Geological Survey of Ireland - Online Mapping. Geotechnical viewer September 2012" (OSI, No. EN0047212)

The historic landfill site located at Pottleboy in Cootehill is directly linked to a small parcel of land (marked 11 on figure no. 1 C) not in the ownership of Cavan County Council. Outlined below is the land registry information for both parcels of land (figure no. 1D & 1E). There is no fence or hedgerow delineating the boundary between the two sites. However from the Tier 2 investigation it has been established that the majority of historical waste present is located within the boundary of land owned by Cavan County Council (marked 9 on figure 1 C). The adjoining parcel of land owned by Patrick and Siobhan Shields, located to the east contained some surface waste but would be deemed insignificant. Figures No. 1C, 1D and 1E show clear boundary outlines of both parcels of land.

Figure No. 1 C: Folio Map of Cootehill historic landfill and adjoining parcel of land.

Figure No. 1 D: Land Registry Map of Cootehill historic landfill (Cavan County Council Ownership) (9)

Cavan County Council - Folio 15561 - Land Registry Information

Folio No.	15561	**Title Level**	Freehold
Plan No.	9	**Property No.**	1
Area of the Site	0.18 Ha	**Entry No.**	731
Townland	Pottleboy	**Key**	

Figure No. 1 E: Land Registry Map of site adjoining Cootehill historic landfill (Patrick & Siobhan Shields Ownership)(11)

Patrick and Siobhan Shields - Folio 6888 - Land Registry Information

Folio No.	CN6888	**Title Level**	Freehold
Plan No.	11	**Property No.**	1
Area of the Site	0.10 Ha	**No of plans in this folio**	2
Townland	Pottleboy	**Key**	

2.2 SITE LAYOUT

The main receptors close to the historic landfill site are dwelling houses and a community Crèche. Drumarket housing estates to the South and the Community Crèche to the north west of the site are both in close proximity to the site and thus lateral landfill gas migration would pose a potential risk. The housing estate and Community Crèche are served by Cootehill water supply. The landfill site encompasses an area of approximately 0.18 ha and the adjoining site to the east is 0.10 ha. The boundaries are marked by local road (L-6088-0) to the South and Southwest. The area to the West and East consist of agricultural land. The land to the Southeast is an unmaintained forested and overgrown site. The historic landfill site is currently unused and over grown with vegetation. The site is unsecured and does not currently have any fencing on the perimeter.

2.3 SURROUNDING LAND USE

The surrounding land use is a mix of both urban housing and agricultural land. Receptors R1, R2, R3, R4, R5 and R6 identified during the Tier 1 risk assessment can be seen on a sketch map located in Appendix G of this document.

- R1 - Piped Watercourse on western boundary immediate to the site boundary;
- R2 & R4 - Council Housing estate on the eastern and north western aspect of the site boundary;
- R3 - Cootehill Community Crèche on the north western boundary immediate to the site boundary;
- R5 - Open Watercourse on the north eastern aspect immediate to the site boundary;
- R6 - Possible Well on the north eastern boundary immediate to the site boundary;
- R7 - Caravans on the southern boundary immediate to the site. (2009 Cavan County Council Survey)

2.4 SITE HISTORY

It is understood that waste disposal began at the site in August 1967 (approximate date). A variety of wastes may have been deposited, including Municipal Solid Waste (MSW) and Construction and Demolition (C&D) wastes. It is thought the landfill mainly accepted municipal waste from the surrounding area. The landfill was finally closed on the 19th April 1985.

2.4.1 Review of OSI Maps and Aerial Photographs

A review of the Ordnance Survey Ireland (OSI) revealed a good selection of historical maps for the site ranging from 1888 to the present day. Colour and black/white aerial photographs were also reviewed. The following maps/aerial photographs were used to show changes of usage on the site: (Ref to Appendix F for drawings)

- Ortho 2000 - Colour aerial photography July 2000 (Drawing No. 14.248.103.);
- Ortho 1995 – Black and White aerial photography 1995 (Drawing No. 14.248.104);
- 6 inch mapping series (1:10,560) greyscale 1837-1842 (Drawing No. 14.248.105-A);
- 25 inch mapping series (1:2,500) greyscale 1888-1913 (Drawing No. 14.248.105 -B);

2.4.1.1 Landfill Pre 1970s

From review of the historical maps it is understood that the site was formerly agricultural land.

2.4.1.2 Landfill 1995

Tipping on the site had ceased by 1985. The overgrown nature of the site can be observed on aerial photography 1995 (Drawing No. 14.248.103) located in Appendix F .The site appears to have been a local and largely informal tip rather than a large organised dump.

2.4.1.3 Landfill 2000.

An Aerial photograph from 2000 (Drawing No. 14.248.103 - Appendix F), shows the site to contain large amounts of overgrown vegetation and a number of Caravans in the South east corner. There is no evidence of tipping.

Figure No. 2: OSI 2000 Map of the Historic Landfill Site.

2.5 HYDROLOGY

Historic maps from the Department of Communications, Energy and Natural Resources and the Geological Survey of Ireland were examined for hydrological information relating to the site. A site walk over was also conducted as part of the Tier 1 and Tier 2 Risk Assessments. From this combined research it has been ascertained that there is a watercourse/drain located on the north eastern boundary of both the Cavan County Council Site and the adjoining site (marked as 9 and 11 on figure No. 1 C respectively). A piped section of the same watercourse flows from east to west along the northern boundary of both sites and also along the western boundary of the Cavan County Council Landfill site.

2.6 GEOLOGY AND HYDROGEOLOGY

Traynor Environmental Ltd established the local geological and hydrogeological conditions from a review of databases maintained by the Geological Survey of Ireland (GSI), Teagasc and the site investigation findings.

2.6.1 Soils and Subsoil

The GSI and Teagasc databases indicate that the soil in the region of the site, belong to Soil Association 25 of the General Soil Map of Ireland. A Soil Association is defined as a cartographic unit, consisting of two or more soils, usually formed from the same type of parent material and associated landscape in a particular pattern. Soil Association 25 is grouped with other associations in the broad physiographic division of the Drumlin formations (Mainly wet mineral and organic soils). The principle soils of Association 25 are Gleys (50%), Acid Brown Earths (40%) and Interdrumlin Peat and Peaty Gleys (10%). These soils are derived from mostly Ordovician - Silurian shale sandstone glacial till. The subsoil in the region of the site is bedrock outcrop and subcrop. (Drawing No. 14.248.109 - Appendix F) This information and map are compiled from the Geological Survey of Ireland (GSI). The subsoil in the vicinity of the site is Till Derived chiefly from Lower Palaeozoic Rocks.

2.6.2 Bedrock Geology

The site is underlain by Silurian Metasediments and Volcanics (Drawing No. 14.248.108 - Appendix F). Bedrock was encountered at shallow depths in a number of trial holes during the Tier 2 investigation.

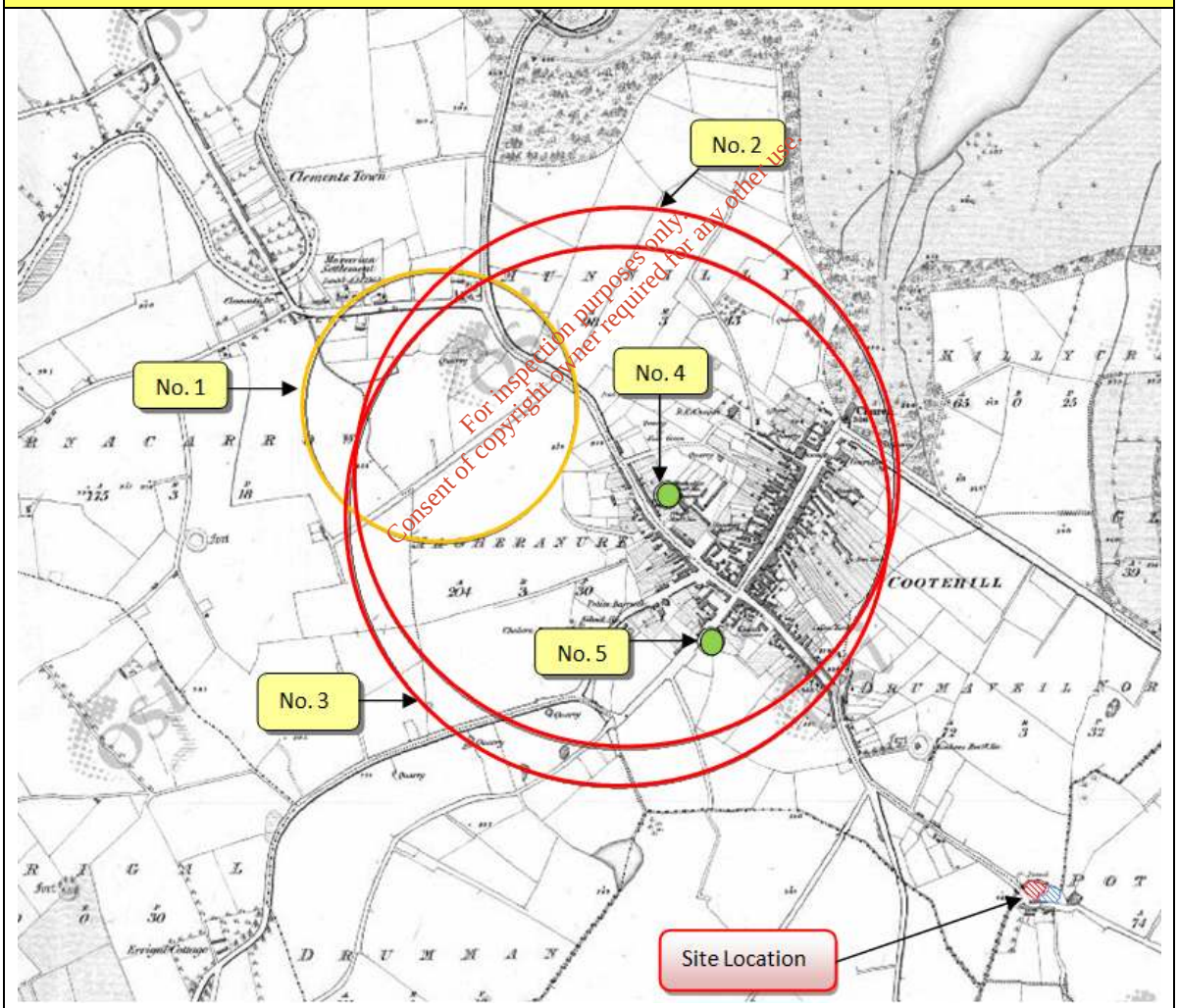
2.6.3 Hydrogeology

The GSI, EPA and the Department of the Environment, Community and Local Government (DOECLG) have developed a programme of Groundwater Protection Schemes (GPWS) with the aim of maintaining the quality and quantity of groundwater in Ireland, and in some cases improving the groundwater quality, by applying a risk assessment approach to groundwater protection and sustainable development. From the GPWS for the area it is evident that the bedrock aquifer underlying the site has a classification of “Poor Aquifer” (Pl) – Bedrock which is generally unproductive except for local zones (Drawing No. 14.248.106 - Appendix F). The Geological Survey of Ireland has classified the vulnerability of the aquifers within the region as Extreme (Rock at/near surface or Karst) and Extreme to the Northeast of the site (Drawing No 14.248.107 - Appendix F). According to the GSI Well Database, there are seven wells within 2.0 km of the site. Refer to Table 1 & 1A, Well data and location in the vicinity of Cootehill.

Table 1: Well data and location in the vicinity of Cootehill 1 - 5

Groundwater Well Data No. 1 - 5								
Well Ref. No.	**Approx Distance From Site (Km)**	**Direction away from site**	**Use**	**Yield Class**	**Yield m³/day**	**Depth (metres)**	**Depth to Rock (metres)**	**Grid Ref.**
No. 1	1.45 km	North West	Agri & Domestic	Poor	16.3	56.4	3	259570 314420
No. 2	1.2 km	North West	-	Moderate	54.5	61	6.7	259910 314290
No. 3	1.1 km	North West	Agri & Domestic	Good	65	36.6	16.5	259900 314220
No. 4	1.0 km	North West	Agri & Domestic	Poor	34.5	63	1	259990 314260
No. 5	0.75 km	North West	Agri & Domestic	Poor	34.6	105	10	260070 313990

Locations of Wells in the vicinity of Cootehill Landfill.



Map Legend: Distance of well accuracy within (m) Meters/ (km) Kilometers

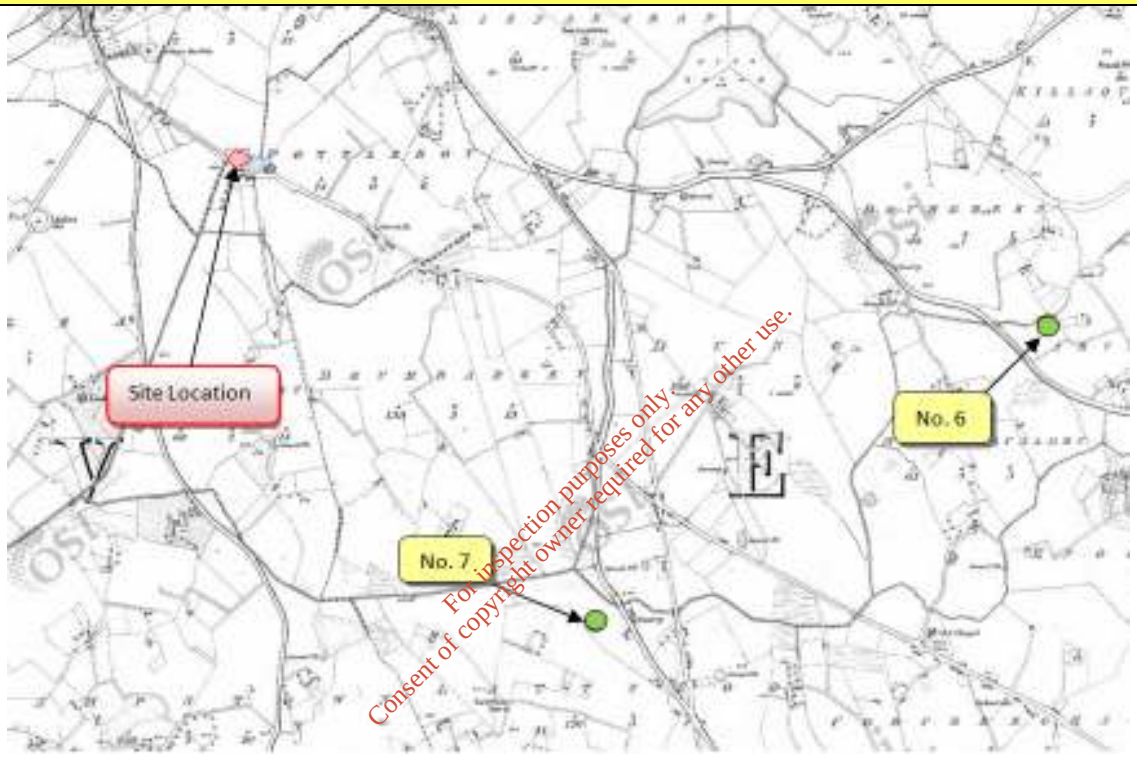
1 km	500 m	100 m	10 - 50 m

Source of Map: Geological Survey of Ireland-Online Mapping - Groundwater Public Viewer

Table 1A: Well data and location in the vicinity of Cootehill 6 - 7

Groundwater Well Data No. 6 - 7								
Well Ref. No.	Approx Distance From Site (Km)	Direction away from site	Use	Yield Class	Yield m^3/day	Depth (metres)	Depth to Rock (metres)	Grid Ref.
No. 6	1.4 km	South East	Agri & Domestic	-	-	5	5	261520 312430
No. 7	1.9 km	South East	Agri & Domestic	-	-	5	1	262600 313140

Locations of wells in the vicinity of Cootehill Landfill.



Map Legend: Distance of well accuracy within (m) Meters/ (km) Kilometers

1 km	500 m	100 m	10 - 50 m

2.6.4 Groundwater Vulnerability

The GSI vulnerability map (www.gsi.ie) indicates that the vulnerability rating within the site is Extreme (Rock at/near surface or Karst) (Drawing No 14.248.107 - Appendix F). The vulnerability mapping is based on the response matrix for landfills (as summarised in Table 2 below), which assigns a vulnerability rating depending on the characteristics of the overburden deposits, the thickness of the strata and in the case of drift aquifers, depth of the unsaturated zone. Taking account of the fact that the aquifer is a poor aquifer coupled with the vulnerability level an $R2^2$ response is recommended. The level of response depends on the different elements of risk; the vulnerability, the value of the groundwater and the contaminant loading. A response level of $R2^2$ is acceptable in principle depending on the zone and activity. All the above facts would minimise the impact on groundwater resources.

Table 2: Response Matrix for Landfills

VULNERABILITY RATING	SOURCE PROTECTION AREA		RESOURCE PROTECTION Aquifer Category					
			Regionally Important (R)		Locally Important (L)		Poor Aquifer (P)	
	Inner (SI)	Outer (SO)	Rk	Rf/Rg	Lm/Lg	L1	Pl	Pu
Extreme (E)	R4	R4	R4	R4	$R3^2$	$R2^2$	$R2^2$	$R2^1$
High (H)	R4	R4	R4	R4	$R3^1$	$R2^1$	$R2^1$	R1
Moderate (M)	R4	R4	R4	$R3^1$	$R2^2$	$R2^1$	$R2^1$	R1
Low (L)	R4	$R3^1$	$R3^1$	$R3^1$	R1	R1	R1	R1

Source of Map: www.gsi.ie - Responses Matrices for Groundwater Protection Schemes

$R2^2$ Acceptable subject to guidance in the EPA Landfill Design Manual or conditions of a waste licence.

- 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 down gradient of the site and to the projected future development of the aquifer.

3.0 SITE INVESTIGATION WORKS

3.1 TIER 1 RISK ASSESSMENT

A Tier 1 Risk assessment was carried out by Cavan County Council, which included a visual inspection, desktop study and risk classification of the site. The Tier 1 Risk assessment was carried out in June 2009. Cootehill historic landfill has a moderate risk (B) classification after the Tier 1 risk assessment. Class B, moderate risk sites are defined as sites where any of the site-specific S-P-R linkages have a score between 40% and 70%. The risk assessment methodology for Cootehill highlighted SPR linkage number 10, which has a risk score rating of 50%. The said linkage refers to lateral landfill gas migration.

Table 3: Risk Score Rating for Cootehill Historic Landfill

SPR Linkage Number	Linkage %	Risk Level
SPR 1	20	C
SPR 2	0	C
SPR 3	25	C
SPR 4	0	C
SPR 5	5	C
SPR 6	0	C
SPR 7	25	C
SPR 8	0	C
SPR 9	0	C
SPR 10	**50**	**B**
SPR 11	0	C

Table 4: Risk Classification Range of Risk Scores

Highest Risk (Class A)	Greater than or equal to 70% for any individual SPR linkage
Moderate Risk (Class B)	Between 40-70% for any individual SPR linkage
Lowest Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

3.2 OBJECTIVES

The objective of the Tier 2 Risk assessment was to collect sufficient information to allow an assessment of the environmental risk posed by the historic landfill. This was achieved by:

- Confirming Initial Conceptual Site Model;
- Delineating the lateral and vertical extent of the wastes;
- Characterising the waste;
- Assessing the risk of pollution from leachate run-off to soils, surface water and groundwater;
- Assessing the potential risk presented by landfill gas;
- Confirm the presence of Source-Pathway-Receptor linkages as identified in the Tier 1 Risk Assessment. With particular emphasis on SPR No. 10

3.3 SITE INVESTIGATION SCOPE

The site investigation comprised of four phases.

- **Phase 1 – Topographical Survey**
  Phase 1 involved the completion of a topographical survey to establish the extent of the site and the differing gradients within the site.
- **Phase 2 – Trial Holes Excavation and Logging**
  Phase 2 involved the excavation of trial holes to confirm the lateral and vertical extent of the waste, and the collection of waste/soil for characterisation purposes.
- **Phase 3 – Sampling and Analysis**
  This involved the sampling of waste/soil on site. No leachate, surface water or ground water was encountered during trial hole excavations and therefore no sampling was carried out. Surface Water samples of Pottleboy stream were taken.
- **Phase 4 – Ecological Assessment**
  Phase 4 involved an Ecological Assessment of the area surrounding the landfill.

- **Phase 5 - Landfill Gas Monitoring**
  Gas monitoring was carried out over a 6 week period from the 28th October 2014 to 27th November 2013
  Extended gas monitoring was carried out in November 2014

3.3.1 Phase 1 – Topographical Survey

The topographical survey was completed by Alan Traynor Consulting Engineers Ltd in October 2014. (Please refer to Drawing No. 14.248.110 - Appendix F). The objective was to map the entire area of the site and to estimate the total amount of waste stored on site.

3.3.2 Phase 2 – Trial Holes Excavation and Logging

The trial hole survey was carried out on the, the 22nd and 23rd October 2014.

The objectives were:

1. To assess the sub-surface conditions including depth and lateral extent of the buried wastes;
2. To identify possible leachate;
3. To identify possible Groundwater;
4. To identify possible hazardous waste;
5. Characterise any wastes on site including hazardous wastes.

The trial holes were excavated using a track mounted excavator, capable of travelling on variable terrain and with a reach of 5 – 8 metres. A total of 25 trial holes were excavated. 18 trial holes were excavated within the Cavan County Council historic landfill site. With the full permission of the land owners Patrick and Siobhan Shields, 7 trial holes were excavated in their site (site 11 of fig 1B) which is located directly east of the landfill site. The locations of the trial holes are shown on Drawing No. 14.248.115 - Appendix F. The excavation of the trial holes was supervised by Traynor Environmental Ltd and the Waste Management Section of Cavan County Council. Each trial hole was logged in accordance with BS 5930. No trial holes were excavated outside the boundary of either sites due to the close proximity of domestic dwelling, the community crèche and the presence of bedrock in the area. The trial hole logs are included in Appendix A.

3.3.3 Phase 3 - Sampling of Groundwater, Surface Water, Soils & Landfill Gas

Phase 3 involved the sampling of soil for chemical analysis. No leachate and/or groundwater was encountered during the trial hole excavations therefore no leachate sampling was carried out. Samples taken were placed in laboratory prepared containers and stored in cool dry location prior to shipment for testing. 5 No. Soil samples were taken from the following trial pits, to give a representative view of the site (TH2, TH10, TH25, TH23 and TH 20 (control).

Trial holes containing waste/no waste are listed below:-

- Trial Holes TH 16,TH17 , TH18, TH19, TH20, and TH21 contained no waste.
- Trial Holes TH1, TH2, TH3 TH4, TH5, TH6, TH7, TH8, TH9, TH10, TH11, TH12, TH13, TH14, TH15,TH22,TH23,TH24 and TH 25 contained waste.

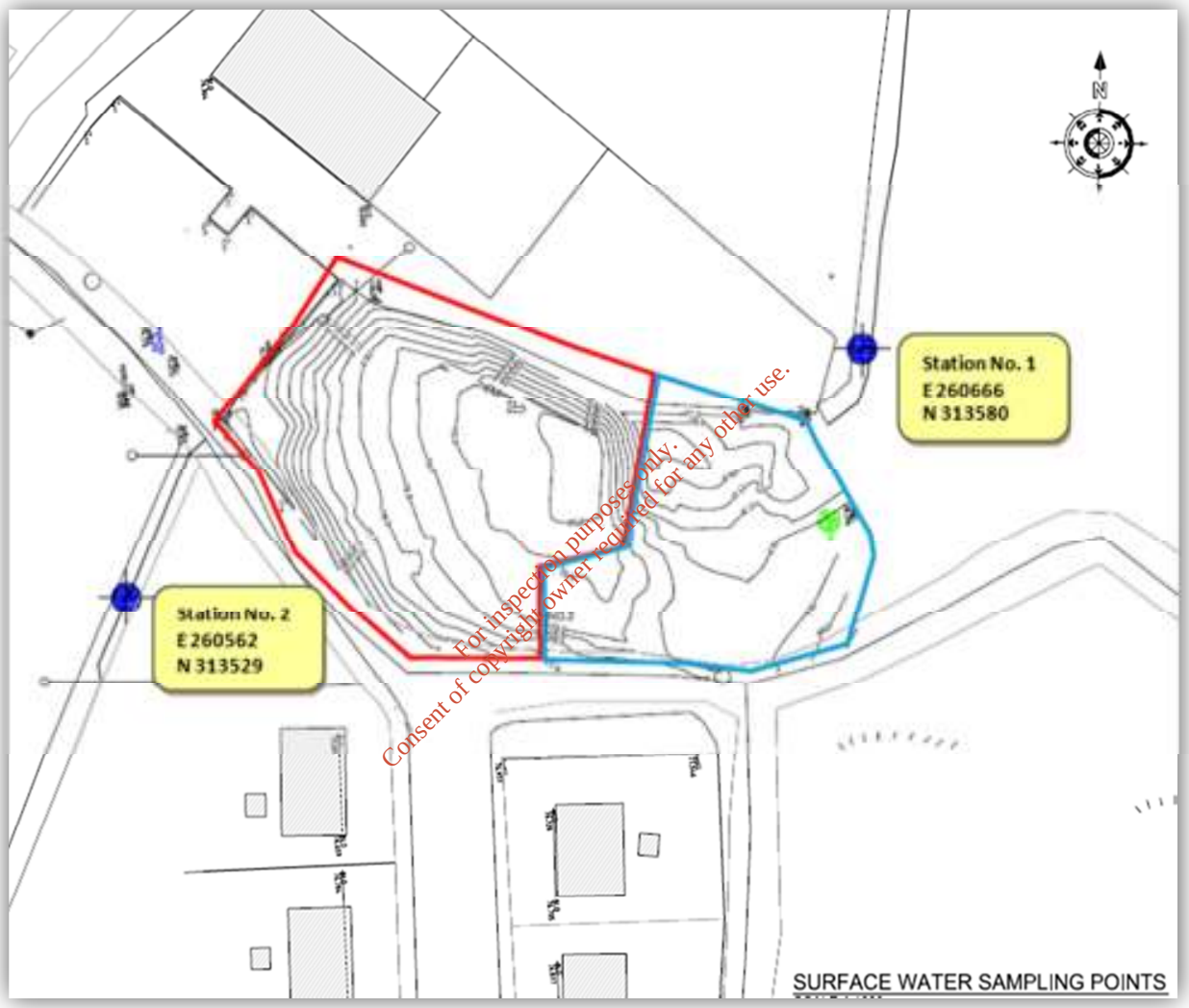
3.3.4 Phase 4 – Ecological Assessment and Q Value Ratings of Watercourse/drains

An ecological assessment was carried out on the site and Q value ratings of the watercourse/drains was used to assess the water quality upstream and downstream of the landfill site. The summary of the results from the Ecological Survey can be seen in the following table. Please also refer to the Ecological Report carried out by Noreen McLoughlin MSc MIEEM. included in Appendix B.

Table 5: Q Value -Assessment Findings.

Station	Location	Q Rating	Status	Quality
1	Main Stream(Down Stream)	Q 2-3	Moderately Polluted	Poor
2	Main Stream (Up Stream)	Q3	Moderately Polluted	Poor

Figure 3: Location of Sampling Point for Q Analysis.



The ecological assessment of the landfill site at Pottleboy was carried out using aerial photographs, ground photographs historical maps and a site survey. After consultation with National Parks and Wildlife Service website, it was ascertained that there are no designated sites adjacent to or close to the historic landfill site. The main habitats identified on the site are scrub and unimproved grassland. The boundary along the northern perimeter of the site is comprised of a treeline / hedgerow, this appears to be an original fence.

3.4 VERTICAL EXTENT OF WASTE

The main body of waste is located at the centre of the Cavan County Council site which is elevated and sloping towards all the boundaries. No waste was encountered in trial holes excavated in the adjoining site. Waste was encountered in trial holes TH1, TH2, TH3 TH4, TH5, TH6, TH7, TH8, TH9, TH10, TH11, TH12, TH13, TH14, TH15, TH 22, TH 23, TH24 and TH25 see drawing no. 14.248.115 Trial Hole Locations in appendix F. The base of the waste is defined by bed rock encountered between 0.6 m and 3.3 m below ground level throughout the sites. Full cross section drawings from two different aspects of the sites are included in appendix F (Drawing Ref 14.248.112).

Table No. 6 below outlines the depth of all trial holes and the extent in meters of waste encountered in each hole. The trial pits were monitored during excavation for the presence of leachate, odours and landfill gas. Trial holes were logged according to BS 5930:1999(Refer to Appendix A -Trial Hole Logs). A handheld GA 2000 landfill gas analyser was used to assess if landfill gas was present during excavation. The GA 2000 landfill gas analyser measures methane, carbon dioxide, oxygen, carbon monoxide, and hydrogen sulphide concentrations and has data logging capabilities

Details of the GA 2000 landfill Gas Analyser

GA 2000 landfill gas analyser		
	**Features:**	**Main Application**
	• ATEX certified • 5 gases standard • Peak CH4 recording • Simultaneous display of all gases • Storage of site and ID questions • Field proven • Standardises monitoring routines • Easy transfer of data • Optional Internal Flow • Optional Event Log • Data storage 2000 readings and 1000 IDs • 0-500ppm H2S reading • Technician Log-in	• Landfill sites • Brownfield • Site investigation

Table 6: Waste Depths in Each Trial Hole. = **Trial Holes containing Waste**

Trial Hole No.	Meters above Ordnance Datum from the top of Ground (M.O.D)	Meters above Ordnance Datum from the top of Waste Level (M.O.D)	Total Trial Hole Depth (m)	Waste start depth (m)	Waste finish depth (m)	Depth of waste (m)
TH 1	74.4	72.6	2.2	0.3	2.1	1.8
TH 2	76.7	75	3.1	0.3	2.0	1.7
TH 3	76.9	76.1	2.2	0.2	1.0	0.8
TH 4	77.4	74.6	4.0	0.2	3.0	2.8
TH 5	78.0	75.7	3.5	0.3	2.6	2.3
TH 6	78.9	77.6	2.0	0.2	1.5	1.3
TH 7	79.5	77.7	2.3	0.2	2.0	1.8
TH 8	77.6	75.1	2.7	0.2	2.7	2.5
TH 9	78.0	75.7	3.7	0.3	2.6	2.3
TH 10	79.7	77.7	3.4	0.5	2.5	2.0
TH 11	79.9	77	3.7	0.2	3.1	2.9
TH 12	79.0	76.6	3.3	0.2	2.6	2.4
TH 13	79.3	77	3.4	0.7	3.0	2.3
TH 14	80.1	79.2	3.4	0.5	2.4	1.9
TH 15	80.1	77.4	3.4	0.3	3.0	2.7
TH 16	78.5	-	0.6	None	None	n/a
TH 17	77.8	-	1.1	None	None	n/a
TH 18	76.3	-	0.6	None	None	n/a
TH 19	77.3	-	1.0	None	None	n/a
TH 20	78.2	-	1.0	None	None	n/a
TH 21	78.2	-	0.8	None	None	n/a
TH 22	79.6	77.3	4.0	0.5	2.8	2.3
TH 23	79.7	77.2	3.4	0.5	3.0	2.5
TH 24	77.8	75.7	2.7	0.5	2.6	2.1
TH 25	77.4	74.4	3.7	0.2	3.2	3.0

Please refer to Appendix F. Drawing No 14-248-115 Trial hole Locations.

3.5 LATERAL EXTENT OF THE WASTE

The most extensive quantities of waste were encountered towards the west and central area of the Cavan County Council landfill site which is elevated. The waste extends from the westerly boundary (TH 1 & TH 2) to the top of the slope (TH 14 & TH 15) in an easterly direction. The lateral extent of the waste is shown in Drawing No. 14.248.111 - Appendix F and covers an area of approximately 1700 m^2 . Using a conversation factor of 1, and an average waste depth of 2.2m it is estimated, that approximately 3740 tonnes of waste is deposited at the site.

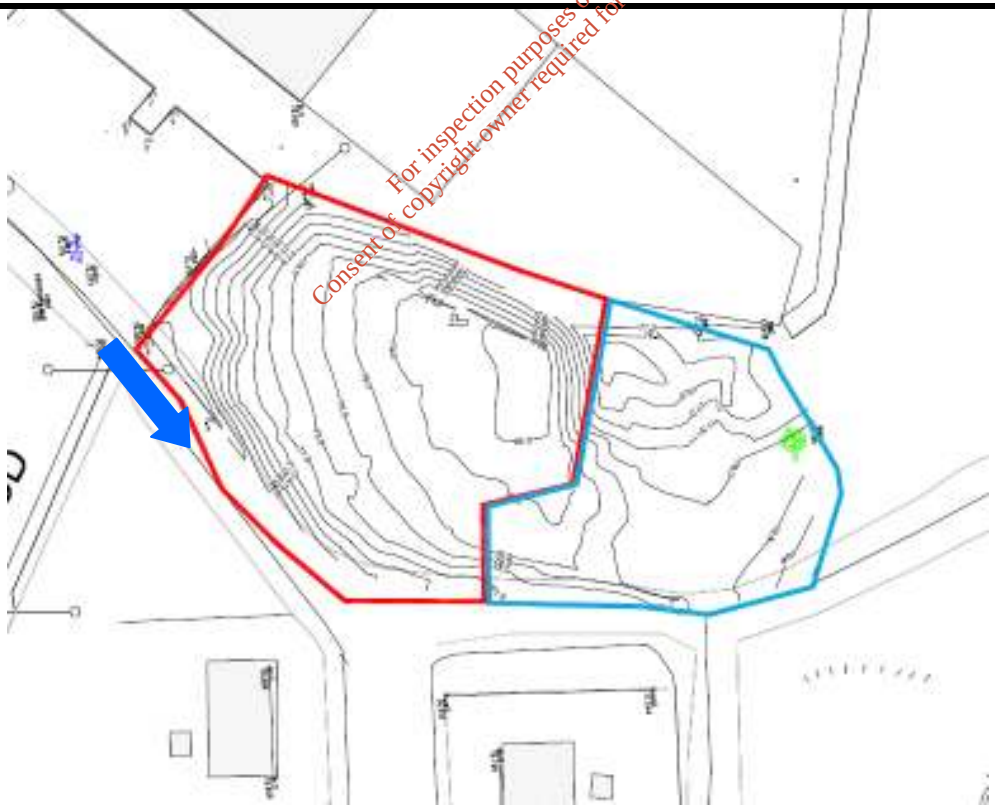
Figure No. 4 - Map showing the Location of adjoining site marked 11 as per folio map.

3.6 WASTE CHARACTERISATION

The waste comprised mainly of plastics, paper, glass, metal and textiles all of which were supported by a stony clay matrix. From soil sample results analysis it has been determined that trace amounts of hazardous waste in the form of asbestos were found in TH 10. The hazardous waste was deemed to be, Chrysotile (white asbestos), a trace amount of 1-2 fibres. A large number of animal bones were also unearthed during trial hole excavations. Photographs 2 - 20 which follow illustrate the types of waste encountered. Full trial holes assessment and logs can be found in Appendix A.

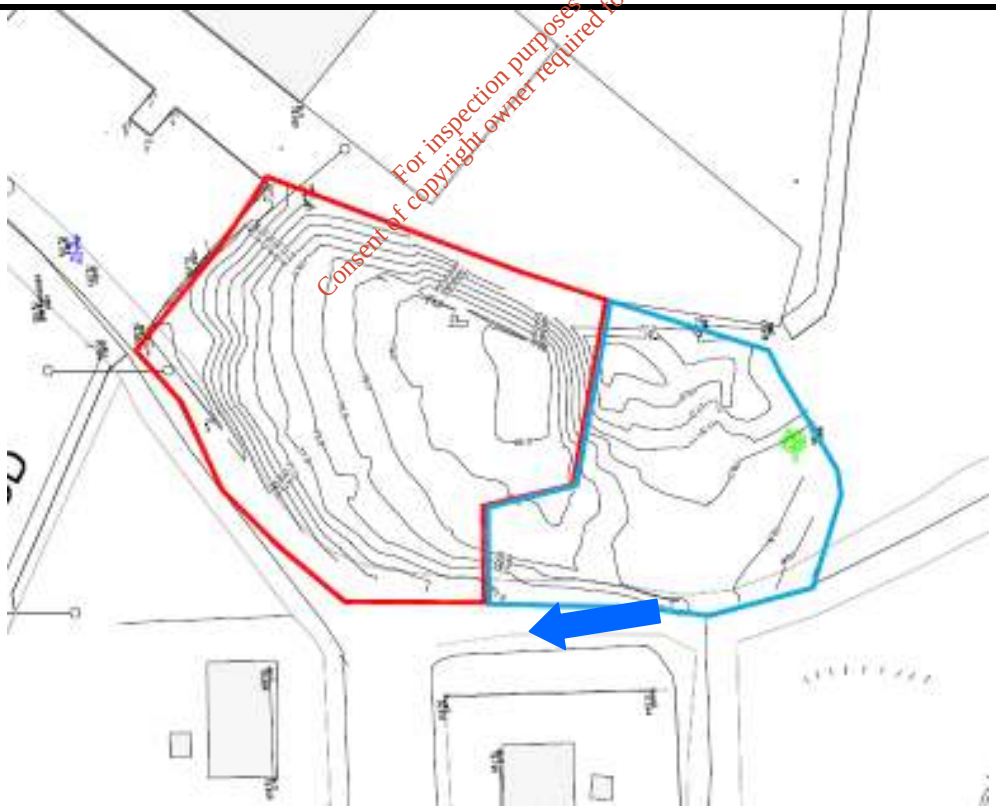
Photograph 1: Facing towards the nearest sensitive residential receptor

The blue arrow indicates direction and location of where photograph was taken.
Direction of Photo - Southeast



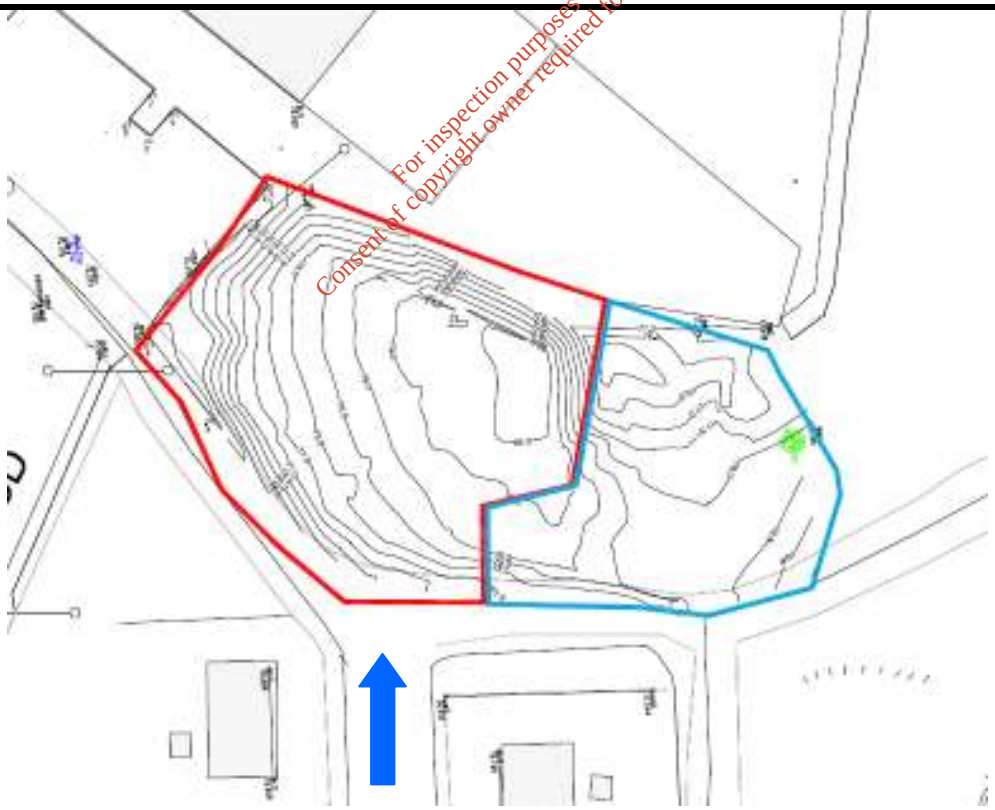
Photograph 1 A: Vegetation and hedgerow along the southern boundary.

The blue arrow indicates direction and location of where photograph was taken.
Direction of Photo - West



Photograph 1 B: View from the entrance to the Drumarket Housing Estate towards the Landfill.

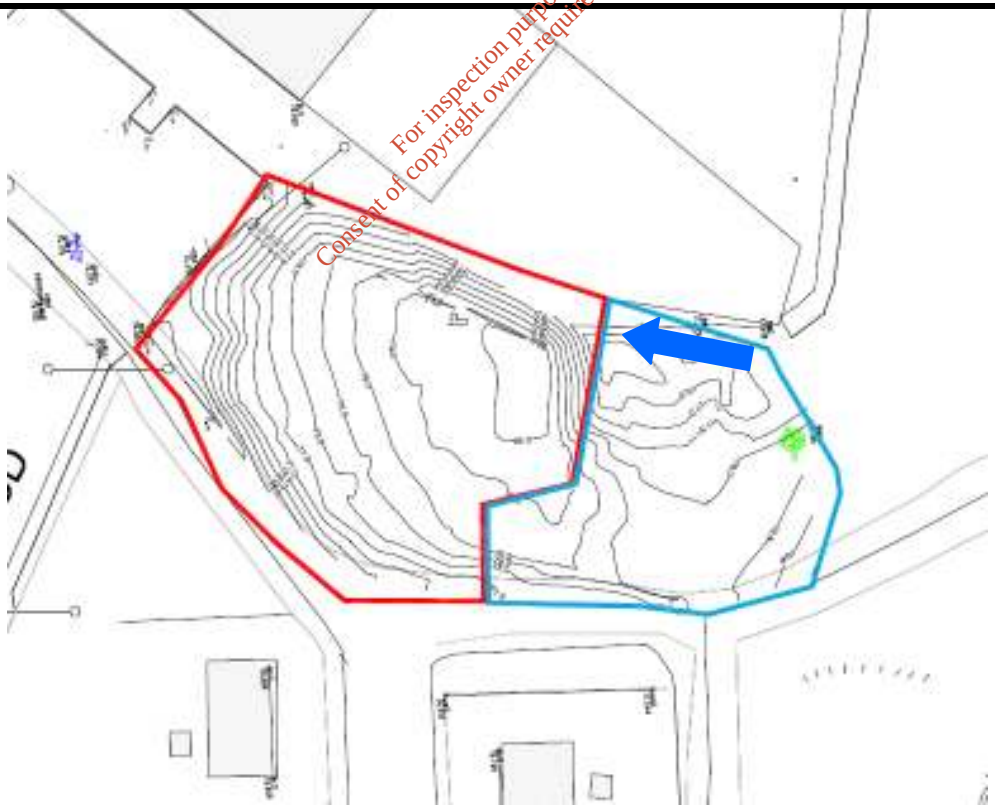
The blue arrow indicates direction and location of where photograph was taken.
Direction of Photo - North



Photograph 1 C: View of vegetation surrounding the north western boundary at the lowest area.

The blue arrow indicates direction and location of where photograph was taken.

Direction of Photo – West



Photograph 1 D: Central area of the site which is the most elevated.

The blue arrow indicates direction and location of where photograph was taken.
Direction of Photo - Southeast

Photograph 2: Waste Contained in Trial Hole 1 (TH 1).

Photograph 3: Waste Contained in Trial Hole 2 (TH 2).

Photograph 4: Waste Contained in Trial Hole 3 (TH 3).

Photograph 5: Waste Contained in Trial Hole 4 (TH 4).

Photograph 6: Waste Contained in Trial Hole 5 (TH 5).

Photograph 7: Waste Contained in Trial Hole 6 (TH 6).

Photograph 8: Waste Contained in Trial Hole 7 (TH 7).

Photograph 9: Waste Contained in Trial Hole 8(TH 8).

Photograph 10: Waste Contained in Trial Hole 9 (TH 9).

Photograph 11: Waste Contained in Trial Hole 10 (TH 10).

Photograph 12: Waste Contained in Trial Hole 11 (TH 11).

Photograph 13: Waste Contained in Trial Hole 12 (TH 12).

Photograph 14: Waste Contained in Trial Hole 13 (TH 13).

Photograph 15: Waste Contained in Trial Hole 14 (TH 14).

Photograph 16: Waste Contained in Trial Hole 15 (TH 15).

Photograph 17: Waste Contained in Trial Hole 22 (TH 22).

Photograph 18: Waste Contained in Trial Hole 23 (TH 23).

Photograph 19: Waste Contained in Trial Hole 24 (TH 24).

Photograph 20: Waste Contained in Trial Hole 25 (TH 25).

3.7 PHASE 3 - SAMPLING OF SOILS, SURFACE WATER, GROUNDWATER & LANDFILL GAS

3.7.1 Soils Sampling Results

5 no. Soil samples were taken for analysis to give a representation of the site. The analytical parameters included those specified in the EPA 2003, Landfill Manuals: Landfill monitoring (2nd edition) Table D. 1 - guideline minimum reporting values.

The soil samples were taken from trial holes TH 2, TH 10, TH 23, TH 25 and TH 20(Control) were analysed for the following:

- Organics;
- Inorganics;
- Metals;
- Mineral Oil / Oils & Greases;
- Polyaromatic Hydrocarbons (PAHs) USEPA;
- Phenols;
- Volatile Organic Compounds (VOCs);
- Asbestos.

The laboratory test results are included and summarised in Tables 7 to 14. The tables include the limits for Dutch Reference and Intervention values and each soil sample was compared to these.

The "Dutch Target and Intervention Values" environmental pollutant reference values (i.e., concentrations in environmental medium) used in environmental remediation, investigation and cleanup. Barring a few exceptions, the target values are underpinned by a risk analysis wherever possible and apply to individual substances. In most cases, "Target Values" for the various substances are related to a national Background Concentration which was determined for the Netherlands, but are considered applicable to Ireland.

The soil remediation Intervention values indicate when the functional properties of the soil for humans, plants and animals is seriously impaired or threatened. They are representative of the level of contamination above which soil contamination is deemed to exist. The Target values for soil are adjusted for the organic matter (humus) content and soil fraction.

An area of the neighbouring site (marked 11 on fig 1 B) unused for historical waste disposal located to the east of the historic landfill site was used as the control sample - TH 20. None of the Trial Holes exceeded the Dutch Reference values as included in table's no. 7- 14 which follow.

With Regard to PAH's ,The United States Environmental Protection Agency (USEPA) has designated 16 PAH compounds as priority pollutants, this is known as "Polyaromatic hydrocabons Total USEPA 16". Polyaromatic hydrocarbon (PAH) occur in oil, coal, and tar deposits, and are produced as byproducts of fuel burning (whether fossil fuel or biomass). As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. However no significant concentrations of PAH's were found in the soil samples analysed.

It should be noted that the Mineral oil >C10-C40 and Conductivity with results of 18.9 and 29.3 are significantly lower in TH20 the control than the other 4 trial hole samples tested. These values are given as a reference, but according to the principal of the Dutch Reference values no action or remediation is required until the intervention value is reached. In this case, values have not been exceeded.

Trace amounts of asbestos were found in TH 10. The hazardous waste was deemed to be, Chrysotile (white asbestos), a trace amount of 1-2 fibres. Asbestos soil sample results are contained in table No. 14. From 5 no. of samples sent to the lab for analysis, three were identified as containing trace amounts of crushed brick and construction and demolition waste e.g. concrete, therefore it was deemed necessary to carry out further testing on these three samples (Sample no. 1 (TH25), Sample no.3 (TH23), Sample no. 4 (TH10) for Hazardous Waste.

Legend:

	Result exceeds Dutch Intervention Values (Reference Value)
	Result exceeds Dutch Intervention Values (Intervention Value)
	Result does not exceed Dutch Intervention or Reference Values

Table 7: Organics - Soils Samples Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.3 TH 23	Sample No.4 TH 10	Sample No.5 TH 2	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Dissolved Organic Carbon	15.7	7.5	5.46	4.6	3.61	*n/a*	*n/a*

Table 8: Inorganics - Soils Samples Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.3 TH 23	Sample No.4 TH 10	Sample No.5 TH 2	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
pH (pH units)	5.95	7.76	8.14	7.85	8.22	*n/a*	*n/a*
Conductivity @ 20 deg.C (mS/cm)	29.30	268.00	236.00	235.00	173.00	*n/a*	*n/a*
Chloride	2.1	<2	<2	<2	<2	*n/a*	*n/a*
Fluoride	<0.5	<0.5	<0.5	<0.5	<0.5	*n/a*	*n/a*
Sulphate (Soluble)	<2	49	53.3	37	15.6	*n/a*	*n/a*
Total Dissolved Solids	26.3	200	176	173	130	*n/a*	*n/a*

Table 9: Metals - Soils Samples Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.3 TH 23	Sample No.4 TH 10	Sample No.5 TH 2	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Arsenic	0.00147	0.00117	<0.00171	0.00165	0.00147	29.0	55.0
Barium	0.00866	0.0584	0.0324	0.0559	0.0331	160.0	625.0
Cadmium	0.000403	<0.0001	<0.0001	<0.0001	<0.0001	0.8	12.0
Chromium	0.00199	0.0129	0.00926	0.00245	0.00423	100.0	380.0
Copper	0.0838	0.016	0.00955	0.00745	0.0072	36.0	190.0
Mercury Dissolved	0.0000984	0.000022	0.0000306	0.0000634	<0.00001	0.3	10.0
Molybdenum	0.000839	0.00313	0.00613	0.014	0.00524	3.0	200.0
Nickel	0.00621	0.00223	0.00206	0.00332	0.00204	35.0	210.0
Lead	0.004890	0.000542	0.00148	0.00108	0.00123	85.0	530.0
Antimony	0.00262	0.00255	0.00837	0.00577	0.0089	3.0	15.0
Selenium	0.00114	0.00176	0.000662	0.000844	0.000464	0.7	100.0
Zinc	0.117	0.00574	0.00503	0.00335	0.00536	140.0	720.0

Table 10: Mineral Oil / Oils & Greases Soil Sample Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.3 TH 23	Sample No.4 TH 10	Sample No.5 TH 2	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Mineral oil >C10-C40	18.9	136	95.4	73.6	138	*n/a*	5000

Table 11: Polyaromatic Hydrocarbons (PAHs) USEPA Soil Sample Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.3 TH 23	Sample No.4 TH 10	Sample No.5 TH 2	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
PAH Sum of 17 (mg/kg)	31.6	22.4	18.8	<10	31.6	*n/a*	*n/a*

Table 12: Phenols - Soils Samples Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.3 TH 23	Sample No.4 TH 10	Sample No.5 TH 2	*Dutch Intervention Values Reference Value (mg/kg)*	*Dutch Intervention Values Intervention Value (mg/kg)*
Total Monohydric Phenols (W)	<0.016	<0.016	<0.016	<0.016	<0.016	*n/a*	*n/a*

Table 13: Volatile Organic Compounds (VOCs) - Soils Samples Results

Parameter	Sample No. 2 TH 20 (Control)	Sample No.1 TH25	Sample No.4 TH 10	Sample No.3 TH 23	Sample No.5 TH 2	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Methyl tertiary butyl ether (MTBE)	<5	<5	<5	<5	<5	*n/a*	*n/a*
Benzene	<10	<10	<10	<10	<10	*n/a*	*n/a*
Toluene	<2	<2	<2	<2	<2	*n/a*	*320*
Ethylbenzene	<3	<3	<3	<3	<3	*n/a*	*n/a*
m,p-Xylene	<6	<6	<6	<6	<6	*n/a*	*n/a*
o-Xylene	<3	<3	<3	<3	<3	*n/a*	*n/a*
Sum of detected mpo-Xylene	<9	<9	<9	<9	<9	*n/a*	*n/a*
Sum of detected BTEX	<24	<24	<24	<24	<24	*n/a*	*n/a*

Table 14: Asbestos Soil Sample Results

Parameter	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non – Asbestos Fibre
Sample No.1 TH25	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Sample No. 2 TH 20 (Control)	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Sample No. 3 TH 23	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Sample No.4 TH 10	Not detected	Trace	Not detected	Not detected	Not detected	Not detected	Not detected
Sample No. 5 TH 2	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected

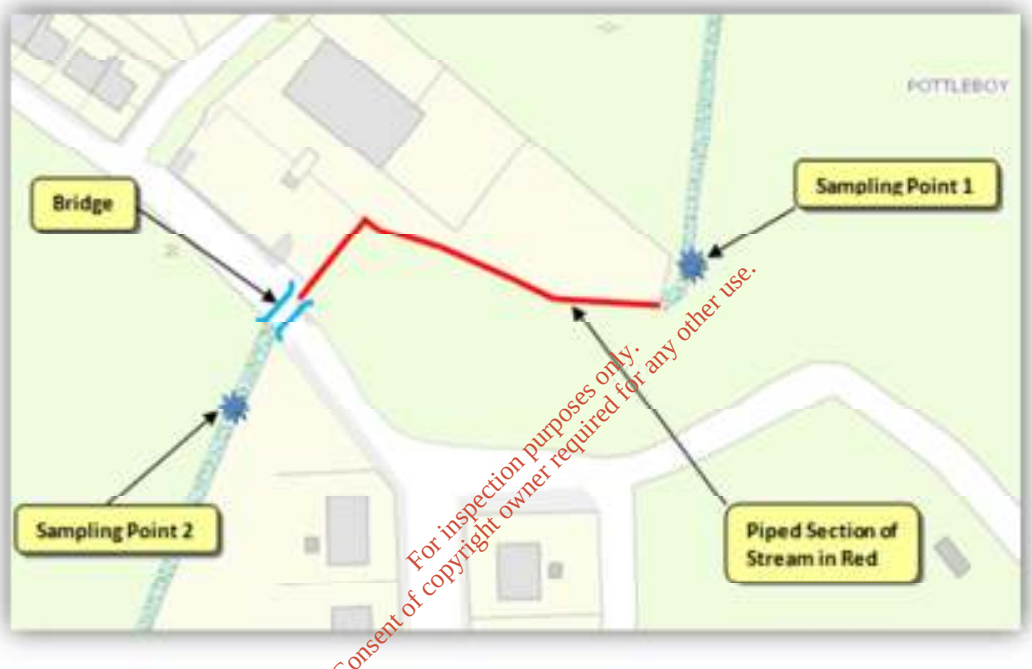
3.7.2 Groundwater Sampling

There was no groundwater encountered during trial hole excavations therefore no grounwdwater sampling took place.

3.7.3 Surface water Sampling

The watercourse/drain, which flows along the northern and western boundary of the landfill site, is piped for approximately 90-100m. The stream then remerges across the road under the bridge marked in blue on fig 5 below.

Figure No. 5 Section of Pottleboy stream that is piped.



Given that the stream is piped from upstream, bordering the site and downstream the potential for leachate to enter the steam via surface water run-off from the landfill is very low.

Surface water samples were taken in the stream at 2 No. Locations on 22th October 2014. Sample No. 1 location was located north east of the site and Sampling No.2 was taken down stream due west of the historic landfill. Detailed location of the sampling points can also be seen on Drawing No. 14.248.117

The surface water samples were collected in accordance with Traynor Environmental sampling protocols and were placed in laboratory prepared containers and stored in a cooler. Field measurement and observations recorded at the time of sampling are presented in Table 17. The samples were sent for analysis to Alcontrol Laboratories.

The samples were analysed for a range of organic and inorganic parameters that included pH, electrical conductivity, dissolved organic carbon, fluoride, chloride, sulphate, heavy metals to include(arsenic, antimony, barium, cadmium, chromium, copper, mercury, molybdenum, nickel, lead, selenium and zinc), Volatile Organic Compounds (VOC).

The laboratory test report is contained in Appendix C and the results are summarised in Tables 15-17 below. The tables include for comparative purposes the Environmental Quality Standards (EQS) published by the EPA. The EQS limits are proposed water quality standards and are derived from the EU Directive on Drinking Water Quality 80/778/EEC.

The pH results were similar at both sampling locations, pH readings were 7.99 Up Stream and 7.98 downstream. The BOD both upstream and downstream measured <1mg/l.

Results for phosphate downstream showed a marginal increase from upstream of the site, measuring 0.093 mg/l and <0.05 mg/l respectively.

All parameters analysed, were below their respective EQS or method detection limits. The results would indicate that the historic landfill is having a negligible impact on the water quality downstream of the site.

Table 15: Inorganics (mg/l) Surface water Samples Results

Parameter (mg/l)	Sample No. 1 Up Stream	Sample No. 2 Downstream	*EQS for Surface Waters*
Alkalinity, Total as CaCO3	165	165	-
BOD, unfiltered	<1	<1	-
Ammoniacal Nitrogen as N(low level)	<0.01	0.0379	*0.02 NH_3*
Free Ammonia as N	<0.01	<0.01	
Fluoride	<0.5	<0.5	*5.0mg/l*
Conductivity @ 20 deg.C	0.43	0.447	*1.0 mS/cm*
Dissolved solids, Total (meter)	330	334	-
Sulphate	68.9	68.1	*250 mg/l*
Chloride	21.3	21.1	*250 mg/l*
Phosphate (ortho) as PO4	<0.05	0.093	-
Total Oxidised Nitrogen as N	1.55	1.57	-
Cyanide, Total	<0.05	<0.05	*0.01mg/l*
pH	7.99	7.98	*6.5 and 9.5*

Table 16: Filtered (Dissolved) Metals – (mg/l) Surface water Samples Results

Parameter (mg/l)	Sample No. 1 Up Stream	Sample No. 2 Downstream	*EQS for Surface Waters*
Arsenic (diss.filt)	0.000758	0.000873	*0.025mg/l*
Boron (diss.filt)	0.0026	0.00239	*2.0mg/l*
Cadmium (diss.filt)	<0.00001	<0.00001	*0.005mg/l*
Copper (diss.filt)	0.000206	0.000269	*0.03mg/l*

Lead (diss.filt)	0.0000165	0.0000089	*0.01mg/l*
Manganese (diss.filt)	0.000143	0.000141	*0.3mg/l*
Nickel (diss.filt)	0.000278	0.000276	*0.05mg/l*
Zinc (diss.filt)	0.00081	0.000453	*0.1mg/l*
Mercury (diss.filt)	<0.000001	<0.000001	*0.001mg/l*
Calcium (diss.filt)	70.6	73.2	-
Sodium (diss.filt)	15.1	15.9	-
Magnesium (diss.filt)	8.3	8.85	-
Potassium (diss.filt)	3.82	4.2	-
Iron (diss.filt)	0.0921	0.0847	-

Table 17: Surface Water Monitoring Field Measurements

Parameter	Sample No. 1 Up Stream (mg/l)	Sample No. 2 Downstream (mg/l)
Electrical Conductivity	0.43	0.447
Apparent Colour	277	358
True Colour	193	163

3.7.4 Landfill Gas Monitoring

3.7.4.1 Introduction

Landfill gas is a complex mixture of gases formed during the decomposition of biodegradable waste. It is primarily composed of methane (64%), carbon dioxide (34%) plus trace concentrations of a range of organic gases and vapours. The typical ratio of Methane and Carbon Dioxide is 3:2. It is the methane of the landfill gas that offers the potential for the gas to be exploited for its energy content. Methane is flammable and an asphyxiant, Carbon dioxide is an asphyxiant and both are greenhouse gases. The rate of landfill gas production is influenced by a number of factors including the types of wastes deposited, the moisture content, temperature, pH and density of wastes, the infill rate and degree of compaction. Landfill gas is produced in significant quantities during the first ten years of a landfills life, with a typical annual production rate of $10m^3$ of gas produced per tonne of organic deposited waste. (ref EPA Landfill Manuals - Restoration and Aftercare 1999)

Due to differences in pressure and density, landfill gases migrate through the top surface or through cracks that may be present in capping materials or because of diffusion through permeable strata bordering the site. On sites with no cap or landfill gas control system, landfill gas may vent across the whole surface area of the landfill. Some localised hot spots may be identified by patches of dead or dying vegetation as migration of these gases takes effect on the plants. Vegetation affected by landfill gas typically exhibits wilting and yellowing of leaves (chlorosis), premature leaf loss and stunted growth of roots and shoots. Severely affected vegetation will eventually die. There was no evidence during the site investigation, of vegetation being effected in any way at the Cootehill Historic Landfill.

3.7.4.2 Production and Composition of Landfill Gas

There are four main reasons for the occurrence of low levels of landfill gas production.

1. Initial infilling of waste into a landfill cell;
2. Post - Closure;
3. Filling with Low Levels of Biodegradable Waste;
4. Inadequate Management of the Gas Field and Landfill Gas Infrastructure

[(1)]"Landfill sites accepting biodegradable waste generate landfill gas during waste decomposition. Generation rates as well as the composition of landfill gas vary throughout the life of the landfill. The waste decomposition process involves several stages during which different groups of bacteria break down complex organic substances such as carbohydrates, proteins and lipids into successively simpler compounds.

In the beginning of the degradation process, bacteria consume any oxygen contained within the waste and release mainly carbon dioxide, water and heat. Methane production (methanogenesis) only starts after anaerobic conditions have been established in the waste, typically approximately 3 to 6 months after waste placement (EPA, 2010). During peak landfill gas production the bulk gas consists typically of 50 to 60% by volume methane and 40 to 50% by volume carbon dioxide. After all biodegradable substrate has been consumed, landfill gas production slows and the gas composition in the waste returns to atmospheric conditions.

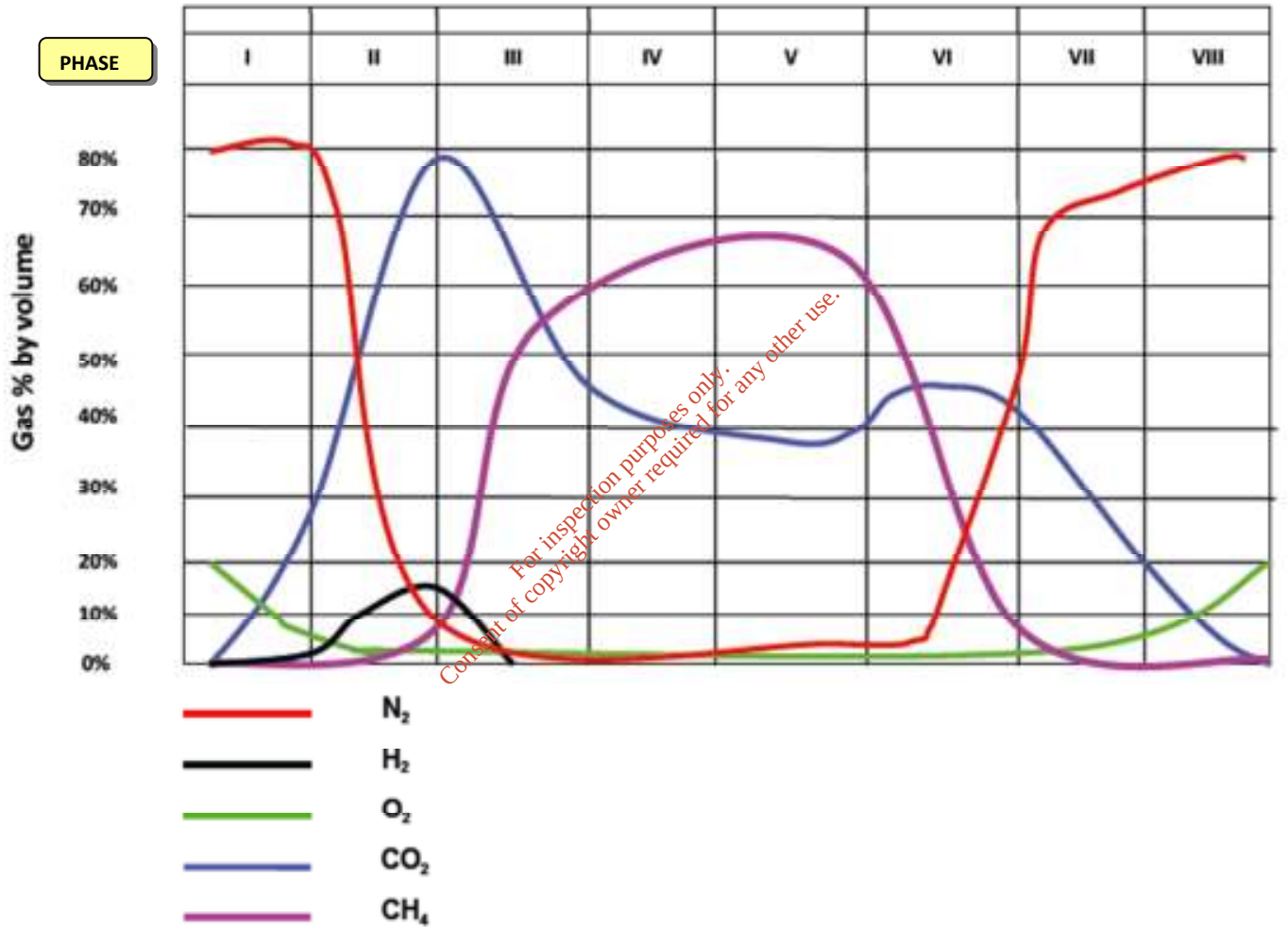
On average, there is approximately 150-250 kg of decomposable organic matter in every tonne of household waste. Under oxygen-restricted conditions, bacterial degradation of organic matter takes place through four phases yielding landfill gas. The time line for this differs depending mainly on the nature of waste being infilled and the life span of the Landfill.

Christian and Kjedsen (1989) identified eight distinct phases in the evolution of landfill gas (Figure No. 6). The duration of each of these phases is highly variable. Apart from the initial aerobic decomposition, which may be complete in days to months, the remaining phases have durations measured in years, decades or even centuries for the final phases.

The eight phases are described as follows:

- Phase I - ***Aerobic***
- Phase II - ***Acid***
- Phase III - ***Initial methanogenic***
- Phase IV - ***Stable methanogenic***
- Phase V - ***Air intrusion***
- Phase VI - ***CH4 oxidation***
- Phase VII - ***CO2***
- Phase VIII - ***Soil air***

Figure No. 6 Changes in the Production and Composition of Landfill Gas over Time



[2] **Source: (Christiansen and Kjedsen 1989)**

[3]"**Phase I**: *Aerobic* – follows waste deposition in which the residual oxygen is used up. This phase typically lasts for a few days to a number of months, depending on local factors such as temperature and moisture availability. Preliminary changes in environmental components occur in order to create favourable conditions for biochemical decomposition.

Phase II: *Acid* – populations of facultative and fermentative anaerobic bacteria develop, producing volatile (aliphatic) acids, CO2 and H2, displacing the remaining N2 entrained with the waste. This phase may last from weeks to years, depending on conditions.

Phase III: *Initial methanogenic* – microbial respiration reduces oxygen concentrations to extremely low values, allowing populations of methanogenic bacteria to develop, producing CH4. Concentrations of H2 and CO2 start to fall.

Phase IV: *Stable methanogenic* – the remaining H2 is used in the reduction of CO2 to CH4 and H2O. Phase IV may begin within months to years after waste deposition and last for decades. Typical landfill gas collected in this phase consists of 40–65% by volume of CH4 with most of the balance made up by CO2.

Phase V: *Air intrusion* – the rate of methanogenic activity begins to fall as substrate is used up, resulting in air beginning to enter the waste. Lower rates of gas formation lead to relatively faster washout of CO2, so that its concentration falls relative to that of CH4.

Phase VI: *CH4 oxidation* – rates of methanogenesis have now fallen to low levels, allowing the rate of air ingress to increase, so that surface layers of waste and the capping material now become aerobic (oxygen rich). Methane concentration in landfill gas decreases while that of CO2 increases steadily.

Phase VII: *CO2* – return of aerobic conditions. At this stage, the rate of landfill gas formation has almost ceased because of substrate limitation; anaerobic decomposition becomes inhibited by the ingress of O2 in the air. This allows the aerobic decomposition of solid organic matter resistant to anaerobic decomposition.

Phase VIII: *Soil air* – the final phase occurs when degradable organic matter has been oxidised and the landfill gas resembles that of typical soil air."

From the comprehensive gas monitoring program and review of the results (tables 21 - 29) with particular reference to methane and carbon dioxide, Cootehill historic landfill falls into the **phase VII**. When waste deposition has discontinued at the site, rates of landfill gas production significantly decrease and is slowly replaced by air in the waste body. Consequently the composition of gases within the waste body gradually assume that of atmosphere air. This is demonstrated on the graph in figure No. 6 above. Extractable volumes of landfill gas become insignificant and levels of methane significantly decrease, as landfall gas mix with air in the waste body.

3.7.4.3 Landfill Gas Safety

The flammability, toxicity and asphyxiate characteristics of landfill gas require personnel involved in the monitoring, operation, construction or any other aspect of a gas management system to be adequately trained. Traynor Environmental Consultants are highly trained and experienced in all aspects of landfill gas monitoring at historic landfill sites such as Cootehill Historic Landfill. Traynor Environmental take into account all Health and Safety considerations.

3.7.4.4 Standpipe Installation for Landfill Gas Monitoring

A total of 9 landfill gas monitoring wells were strategically located around the site as indicated on drawing no 14.248.113 of Appendix F. Gas Wells GW5 and GW6 were placed in the centre of the site where a high percentage of waste was encountered during the site investigation works. GW7, GW8 and GW9 were located on the northern and western boundary of the site adjacent to the community Crèche. GW2, GW3 and GW4 were located along the eastern edge of the landfill site which also defines the edge of the waste. GW 1 was located outside the waste body in the most easterly aspect of the neighbouring site (marked 11 on figure 1 B) and was be monitored for landfill gas as a control.

Each trial pit was dug to approximately 3.5m – 4m. Pea gravel was then filled into the base of each trial pit to a depth of 100mm. A 150mm diameter perforated pipe was inserted into each trial pit and the hole carefully back filled around the pipe with the excavated waste/soil material to within 500mm of the grounds surface.

37mm diameter plastic standpipes were then inserted into the larger 150mm land drain and backfilled with pea gravel and capped at the surface of the ground with expandable foam to form an air tight seal. These smaller 37mm pipes are perforated to within 500mm of the surface to allow gas to pass into the pipe. The top of the 37mm diameter pipe is capped off with removable stop-ends to facilitate gas monitoring. Refer to figure no. 8 Landfill gas standpipe construction.

A photographic record of the gas monitoring standpipes is included in Appendix D of this report.

3.7.4.5 Monitoring Locations

The locations of the Gas Monitoring Wells are presented in table No. 18 and Figure No. 7 below.

Table No. 18 Gas Monitoring Stand Pipe Locations

Gas Monitoring Well	Location	Grid Reference	Depth of Standpipe	Waste Present
GW 1	Eastern Boundary	E 260646 , N 313539	1.00m	No
GW 2	Southern Boundary	E 260624 , N 313527	2.70m	Yes
GW 3	Central area of the Site	E 260629 , N 313546	3.40m	Yes
GW 4	South Western Boundary	E 260606 , N 313530	3.70m	Yes
GW 5	Central area of the Site	E 260613 , N 313547	4.00m	Yes
GW 6	Central area of the Site	E 260606 , N 313549	3.70m	Yes
GW 7	Northern Boundary	E 260614 , N 313561	2.30m	Yes
GW 8	Western Boundary	E 260582 , N 313556	2.20m	Yes
GW 9	Northern west Boundary	E 260594 , N 313570	2.20m	Yes

Figure No. 7 Gas Monitoring Stand Pipe Locations

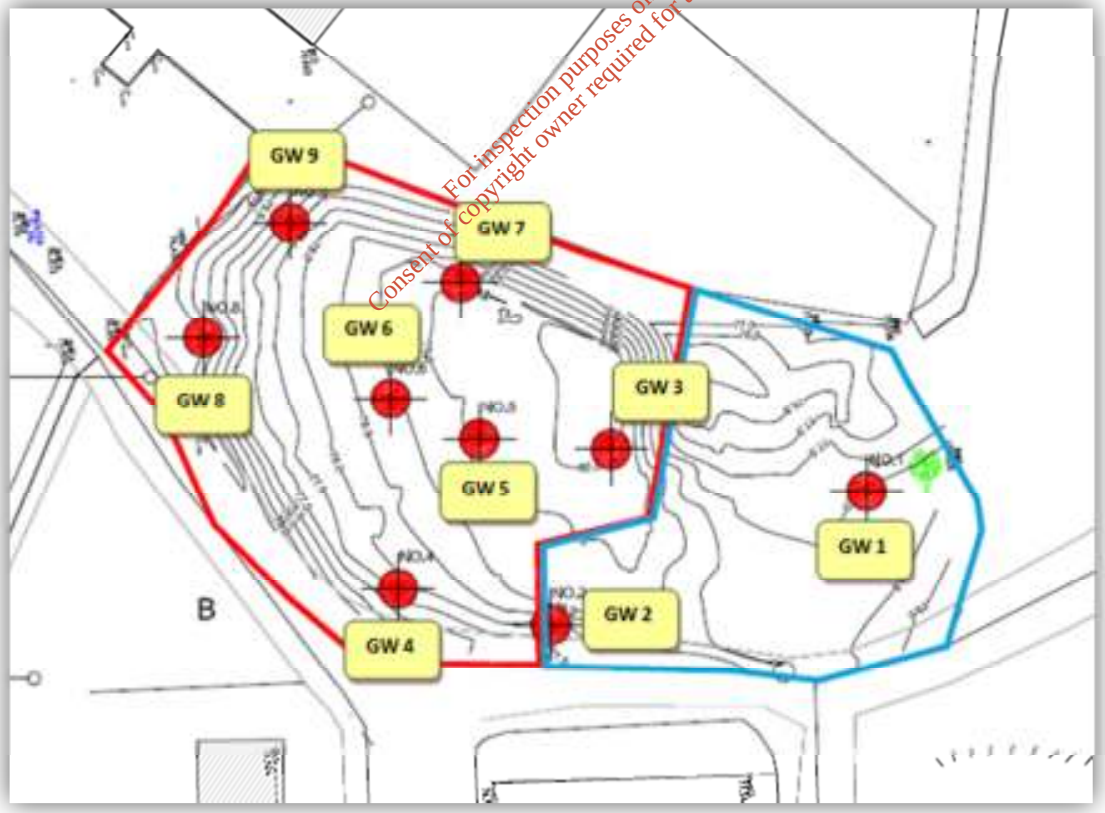
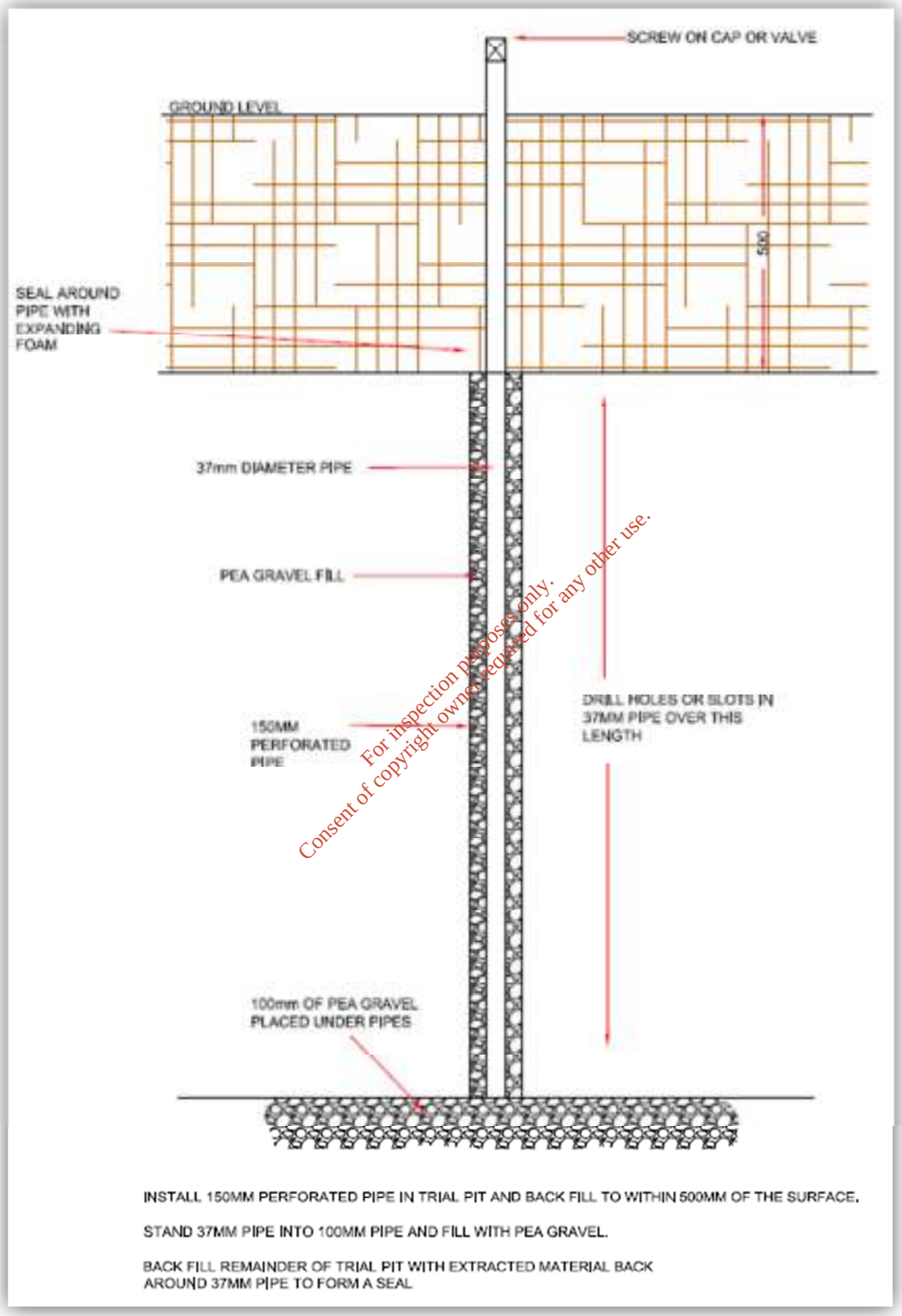


Figure No. 8: Landfill Gas Standpipe Construction



3.7.4.6 Landfill Gas Monitoring

Based on the findings of the Tier 1 Risk Assessment, it was recommended by the project manager Tim Moynihan that a programme of landfill gas monitoring should be undertaken. A comprehensive regime of landfill gas monitoring was completed on site. Landfill gas was monitored on 15 No. occasions between 28th October 2014 and the 27th November 2014. Readings were collected using a GA 2000 landfill gas analyser. This analysis has been undertaken using the information from the Environmental Protection Agency (EPA) Landfill Manuals - Landfill Monitoring 2nd Edition 2003, to estimate the current rate of gas generation from the waste material.

The Following Parameters were recorded during each monitoring event:

- Stable and peak methane;
- Carbon Dioxide;
- Oxygen;
- Hydrogen Sulphide;
- Carbon Monoxide;
- Barometric Pressure;
- Balance of gases;

Reference was made to the Environment Protection Agency landfill Manual - "Landfill Monitoring 2nd Edition 2003 to determine an appropriate number and location for the landfill monitoring points, however as the history and the precise extent of the landfill was unknown we have used best judgement in determining the most appropriate locations.

The 15 scheduled Monitoring events that have been completed by Traynor Environmental Ltd are as follows:

Table No. 19 Summary of Gas Monitoring Events

No.	Landfill Gas Monitoring Event	Date
M 1	Event Number 1	28/10/2014
M 2	Event Number 2	30/10/2014
M 3	Event Number 3	06/11/2014
M 4	Event Number 4	11/11/2014
M 5	Event Number 5	12/11/2014
M 6	Event Number 6	14/11/2014
M 7	Event Number 7	17/11/2014
M 8	Event Number 8	18/11/2014
M 9	Event Number 9	19/11/2014
M 10	Event Number 10	20/11/2014
M 11	Event Number 11	21/11/2014
M 12	Event Number 12	24/11/2014
M 13	Event Number 13	25/11/2014
M 14	Event Number 14	26/11/2014
M 15	Event Number 15	27/11/2014

Atmospheric pressure was monitored in order to aid understanding of gas pressure readings within the waste body. Rapid drops in atmospheric pressure can cause the pressure of landfill gas to rise significantly above that of ambient atmospheric pressure, resulting in possible migration. In addition a separate exercise involving continuous sampling at each gas location for a 15 minute period was also completed on three occasions, 13th, 16th and 22nd November 2014. For analysis of these results refer to table and graphs of this extended gas monitoring in Appendix E (Extended Gas Monitoring Results and Graphs). The main objective of the extended gas monitoring was to reaffirm the findings of the Tier 2 assessment; that there is no immediate or long term risk from the low levels of landfill gas migration to offsite receptors.

3.7.4.7 Landfill Gas Monitoring Methodology

The landfill gas detector used during the survey was the GA 2000 landfill gas analyser. The GA 2000 landfill gas analyser measures methane, carbon dioxide, oxygen, carbon monoxide, and hydrogen sulphide concentrations and has data logging capabilities. The meter was calibrated before use. Refer to full calibration certificates for the GA 2000 landfill gas analyser in Appendix H of this Report.

An extensive gas monitoring survey was completed for all of the permanently installed gas monitoring wells. Methane and Carbon Dioxide results concentrations expressed as a percentage in volume (% v/v) were expressed relative to the EPA 1997 threshold values outlined in the document 'Landfill Manuals – Landfill Operational Practices' (EPA, 1997) Gas monitoring results together with the relevant assessment criteria are presented in Tables 21 – 29 of this Tier 2 risk assessment. All gas monitoring results are included in Appendix E.

3.7.4.8 Landfill Gas Monitoring Results

GW 1 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.2 % v/v were recorded with a peak of 0.3 %v/v on 28.10.14. Carbon Dioxide concentrations ranged from 0 % v/v to 0.9% v/v recorded on the 21.11.14 and 30.11.14 respectively. Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

GW 2 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.2 % v/v. Carbon Dioxide concentrations ranged from 0.2% v/v to 8.9% v/v recorded on the 06.11.14, 20.11.14 and 17.11.14. Hydrogen Sulphide was detected at a concentration of 0.5ppm on 1 occasion (11/07/2013). Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

GW 3 Monitoring

Stable methane concentrations ranged from 0.2% v/v to 1.3 % v/v. Carbon Dioxide concentrations ranged from 4.9% v/v to 10.8% v/v. were detected on 25.11.14 and 06.11.14 respectively. A carbon dioxide range such as this reaffirms that Cootehill Historic Landfill is in phase VII of the graph located in section 3.7.4.2 of this report. Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

GW 4 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.3 % v/v. Carbon Dioxide concentrations ranged from 0.3 % v/v to 4.7% v/v. were detected on the 20.11.14, 28.11.14 and 17.11.14. Sulphide and Carbon Monoxide were not detected during sampling.

GW 5 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.2% v/v. Carbon Dioxide concentrations ranged from 0.0 % v/v to 6.1% v/v recorded on the following dates 30.11.14, 06.11.14, 14.11.14 and 17.11.14. Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

GW 6 Monitoring

Stable methane concentrations ranged from 0.0% v/v to 0.2% v/v. Carbon Dioxide concentrations ranged from 0.4 % v/v to 7.9% v/v. were recorded on the following dates 20.11.14 and 06.11.14 respectively.

GW 7 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 1.3% v/v. Carbon Dioxide concentrations ranged from 0.2 % v/v to 7.2% v/v recorded on the following dates 11.11.14, and 21.11.14. Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

GW 8 Monitoring

Stable methane concentrations ranged from 0.2% v/v to 11.5% v/v. Carbon Dioxide concentrations ranged from 3.2 % v/v to 6.8% v/v recorded on the following dates 28.10.14, and 18.11.14, 21.11.14. Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

GW 9 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.8% v/v. Carbon Dioxide concentrations ranged from 1.2 % v/v to 3.9% v/v recorded on the following dates 28.10.14, and 27.11.14,. Hydrogen Sulphide and Carbon Monoxide were not detected during sampling.

These low levels of landfill gas, reflect the positioning of Cootehill Historic Landfill in phase VII of the evolution of landfill gas production within a landfill (refer to graph in Figure No. 6 - production and Composition of Landfill Gas). According to the EPA Landfill Manuals (Landfill Monitoring 2nd Edition) the trigger levels for emissions of methane and carbon dioxide in boreholes outside the main body of waste are 1% v/v for methane and 1.5% v/v for Carbon dioxide. In total 8 No. gas wells (GW 2 – GW 9) were installed within the footprint of the historic landfill with 1 No. gas well (GW 1) installed outside the footprint of the landfill (refer to figure No. 7 Gas Monitoring Stand Pipe Locations). The landfill gas results for GW 2 – GW 9 (excluding GW 8) would indicate that methane and carbon dioxide concentrations are low and would be indicative of a landfill in the final stages of gas production. When results for GW 2, GW 4, GW 5, GW 6 and GW 9 are compared and contrasted against the trigger level emissions for methane and carbon dioxide (concentrations outside the waste body 1% v/v for methane and 1.5% v/v for Carbon dioxide) it is evident that on no monitoring event for the aforementioned wells was this combination trigger level reached. GW 3 and GW 7 exceeded the trigger level emission on one monitoring event (being cognizant of the fact that both wells were located within the waste body). GW 8 had somewhat elevated levels of methane gas when compared and contrasted to methane gas results for GW 2 – GW 9. This elevated level of methane gas production was most evident in the first 5 monitoring

events and steadily decreased over the remaining 10 monitoring events. The trigger level emission for GW 8 was exceeded on 11 monitoring events with the remaining 4 monitoring events below the trigger level. The elevated methane gas results obtained for GW 8 could be indicative of a landfill gas pocket within the waste body. GW 1 which was located outside the main waste body had negligible levels of methane and carbon dioxide and did not exceed the trigger level. This would indicate that landfill gas was not migrating laterally in an easterly direction to the land parcel immediate to the landfill. GW 1 levels of methane gas would be comparable to methane gas levels obtained in GW 2, GW 4, GW 5, GW 6 and GW 9. GW 9 located close to the community crèche (deemed the most immediate receptor) had nominal levels of methane and carbon dioxide with no exceedances of the trigger level.

3.7.4.9 Extended Gas Monitoring

The main objective of the extended gas monitoring was to reaffirm that there is no immediate or long term risk from landfill gas to offsite receptors from Cootehill historic landfill. Extended gas monitoring (15 minutes per location) was completed at all No. 9 gas monitoring wells on the 13.11.14, 16.11.14 & 22.11.14 (refer to table for results and graphs in appendix E). Overall the following patterns for methane and Carbon Dioxide can be observed.

Methane

- Concentrations remained low and did not increase - GW1, GW2, GW4, GW5, GW 6 & GW 9.
- Concentrations decreased as monitoring progressed – GW8.
- Methane levels in GW3 and GW7 were low and variable with an overall peak of 1.3 %v/v

Carbon Dioxide

- Concentrations remained the constant – GW1.
- Concentrations fluctuated throughout all 15 monitoring events – GW2.
- Carbon Dioxide ranged from 4.9%v/v to 10.8%v/v in GW3
- Concentrations decreased very slightly over time – GW4.
- An insignificant increase and decrease was seen but overall concentrations remained more or less the same – GW5.
- Levels increased slightly but concentrations decreased back to lower than initial readings GW6
- Concentrations decreased very slightly overtime and increased back to initial levels recorded– GW7.
- Concentrations increased over time as gas composition in the waste returns to atmospheric conditions – GW8.
- Concentrations increased over time as gas composition in the waste returns to atmospheric conditions – GW9.

Landfill gas levels recorded at Cootehill Historic Landfill site are deemed insignificant and the risk to nearby receptors would be nominal. Through detailed monitoring of the site it has been ascertained that low levels of gas are occurring at GW 8 but have gradually decreased over the 15 monitoring events. Additional gas monitoring points outside of the landfill footprint would not be required as results for GW 2 – GW 9 (excluding GW 8) would indicate insignificant gas levels.

Table No. 20 Landfill Gas Trigger Levels for Boreholes Outside of the Waste Body

Parameter	Trigger concentration
Methane	Greater than or equal to 1% v/v or
Carbon Dioxide	Greater than or equal to 1.5% v/v

Table No. 21 - Landfill Gas Monitoring Results - GW 1

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 1	M1	28.10.14	0.2	2	0.3	0.3	19.7	79.7	0	0	1001
	M2	30.10.14	0.2	3	0.2	0.9	19.1	79.8	0	0	1001
	M3	06.11.14	0.1	2	0.2	0.8	19.1	79.8	0	0	980
	M4	11.11.14	0.2	3	0.2	0.6	18.9	80.2	0	0	979
	M5	12.11.14	0.1	1	0.1	0.2	19.6	80.1	0	0	979
	M6	14.11.14	0.1	2	0.1	0.1	20.3	79.5	0	0	983
	M7	17.11.14	0.1	2	0.1	0.3	19.6	79.9	0	0	999
	M8	18.11.14	0.1	2	0.1	0.1	19.3	80.5	0	0	1003
	M9	19.11.14	0.1	2	0.1	0.1	19.4	80.4	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.1	20	80	0	0	1016
	M11	21.11.14	0.1	2	0.1	0	19.9	79.8	0	0	1005
	M12	24.11.14	0.1	1	0.1	0.1	16.3	80.1	0	0	1016
	M13	25.11.14	0.1	2	0.1	0.1	19.9	79.8	0	0	1014
	M14	26.11.14	0.1	2	0.1	0.4	19.7	79.5	0	0	1014
	M15	27.11.14	0.2	3	0.2	0.2	19.7	79.9	0	0	993

Table No. 22 - Landfill Gas Monitoring Results - GW 2

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 2	M1	28.10.14	0.2	3	0.2	2.4	16.4	81	0	0	1001
	M2	30.10.14	0.1	2	0.2	4.8	15.2	79.9	0	0	1001
	M3	06.11.14	0.2	3	0.2	0.2	19.7	79.9	0	0	980
	M4	11.11.14	0.2	4	0.2	0.4	19.1	80.2	0	0	979
	M5	12.11.14	0.2	3	0.2	2.8	17.2	79.8	0	0	979
	M6	14.11.14	0.1	2	0.1	1.6	18	80.2	0	0	983
	M7	17.11.14	0.1	2	0.1	8.9	7.3	83.6	0	0	999
	M8	18.11.14	0.1	2	0.1	3.2	16	80.6	0	0	1003
	M9	19.11.14	0.1	2	0.1	7	9.6	83.7	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.2	19.8	79.8	0	0	1016
	M11	21.11.14	0.1	1	0.1	4.3	14.5	81	0	0	1005
	M12	24.11.14	0.1	2	0.1	2.7	15.7	79.6	0	0	1016
	M13	25.11.14	0.1	2	0.1	1.5	18.2	80.2	0	0	1014
	M14	26.11.14	0.1	1	0.1	2.7	17.1	80	0	0	1014
	M15	27.11.14	0.1	2	0.1	1.4	18.4	80.1	0	0	992

Table No. 23 - Landfill Gas Monitoring Results - GW 3

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 3	M1	28.10.14	1.3	24	1.3	7.6	13.8	77.3	0	0	1001
	M2	30.10.14	0.6	11	0.6	9.2	12	78.3	0	0	1001
	M3	06.11.14	0.4	14	0.7	10.8	9.9	78.5	0	0	979
	M4	11.11.14	0.4	8	0.5	8.9	12.8	77.8	0	0	979
	M5	12.11.14	0.3	6	0.3	8.1	13.5	78	0	0	979
	M6	14.11.14	0.6	11	0.6	9.3	10.5	79.5	0	0	983
	M7	17.11.14	0.7	13	0.7	8.2	12.2	78.9	0	0	999
	M8	18.11.14	0.6	11	0.6	8.1	12.9	78.4	0	0	1003
	M9	19.11.14	0.5	10	0.6	7.5	13.4	78.5	0	0	1007
	M10	20.11.14	0.5	10	0.6	6.2	14.9	78.2	0	0	1015
	M11	21.11.14	0.6	12	0.6	6.1	14.4	78.8	0	0	1005
	M12	24.11.14	0.3	6	0.4	7.3	13	79.2	0	0	1016
	M13	25.11.14	0.4	8	0.4	4.9	15.5	79.1	0	0	1014
	M14	26.11.14	0.4	8	0.4	4.9	15.8	78.8	0	0	1014
	M15	27.11.14	0.2	3	0.2	6.9	13.8	79.1	0	0	992

Table No. 24 - Landfill Gas Monitoring Results - GW 4

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 4	M1	28.10.14	0.2	3	0.2	4.7	15.8	79.2	0	0	1001
	M2	30.10.14	0.1	2	0.1	5	14.3	80.6	0	0	1001
	M3	06.11.14	0.1	2	0.2	1.4	18.8	79.6	0	0	979
	M4	11.11.14	0.2	3	0.2	1.5	18.2	80.2	0	0	979
	M5	12.11.14	0.1	1	0.1	1.8	17.9	80.3	0	0	979
	M6	14.11.14	0.1	1	0.1	3.5	17.1	79.3	0	0	983
	M7	17.11.14	0.1	1	0.1	4.7	13.3	81.8	0	0	999
	M8	18.11.14	0.1	2	0.1	2.3	16.9	80.6	0	0	1003
	M9	19.11.14	0.1	1	0.1	3.1	17.2	79.5	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.3	19.8	79.7	0	0	1016
	M11	21.11.14	0.3	4	0.3	3.8	15.7	80.4	0	0	1005
	M12	24.11.14	0.1	2	2	4.2	15.2	79.9	0	0	1017
	M13	25.11.14	0.1	2	0.1	4	15.5	80.3	0	0	1014
	M14	26.11.14	0.1	1	0.1	3.6	16.3	79.9	0	0	1014
	M15	27.11.14	0.1	1	0.1	1.3	18.6	79.8	0	0	992

Table No. 25 - Landfill Gas Monitoring Results - GW 5

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 5	M1	28.10.14	0.2	3	0.2	2.2	15.4	82.2	0	0	1001
	M2	30.10.14	0.1	2	0.2	0	19.8	80	0	0	1001
	M3	06.11.14	0.1	2	0.2	0	19.8	79.9	0	0	979
	M4	11.11.14	0.2	4	0.2	0.4	19.2	80.1	0	0	979
	M5	12.11.14	0.1	1	0.1	0.4	19.9	79.6	0	0	979
	M6	14.11.14	0.1	1	0.1	0	19.9	79.9	0	0	983
	M7	17.11.14	0.1	2	0.1	6.1	10	83.9	0	0	999
	M8	18.11.14	0.2	3	0.2	1	17.6	81.1	0	0	1003
	M9	19.11.14	0.1	2	0.1	2.9	15	81.8	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.6	19.1	80.1	0	0	1016
	M11	21.11.14	0.1	2	0.1	4.4	14.1	81.3	0	0	1005
	M12	24.11.14	0.1	2	0.2	1.6	16.1	80	0	0	1016
	M13	25.11.14	0.1	1	0.1	0.3	19.4	80.1	0	0	1014
	M14	26.11.14	0.1	1	0.1	0.2	19.9	79.9	0	0	1014
	M15	27.11.14	0.1	1	0.1	4.5	11.4	83.9	0	0	992

Table No. 26 - Landfill Gas Monitoring Results - GW 6

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 6	M1	28.10.14	0.2	3	0.2	4.2	15.8	79.8	0	0	1001
	M2	30.10.14	0.1	2	0.1	5.5	14.8	79.6	0	0	1001
	M3	06.11.14	0.1	3	0.2	7.9	11.9	80.1	0	0	979
	M4	11.11.14	0.2	3	0.2	0.8	19.2	79.8	0	0	979
	M5	12.11.14	0	0	0.1	2.1	18.2	79.6	0	0	979
	M6	14.11.14	0.1	2	0.1	6.9	9.9	83	0	0	983
	M7	17.11.14	0.1	2	0.1	1.7	18.8	79.4	0	0	999
	M8	18.11.14	0.1	2	0.2	1.9	17.8	80	0	0	1003
	M9	19.11.14	0.1	2	0.1	3.8	16.3	79.8	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.4	19.8	79.6	0	0	1016
	M11	21.11.14	0.1	1	0.1	4.7	13.8	81.3	0	0	1005
	M12	24.11.14	0.2	1	0.2	0.6	16.3	80.3	0	0	1016
	M13	25.11.14	0.1	1	0.1	5	12.6	82.2	0	0	1014
	M14	26.11.14	0.1	1	0.1	3.6	15	81.4	0	0	1014
	M15	27.11.14	0.1	2	0.1	2	17	80.7	0	0	992

Table No. 27 - Landfill Gas Monitoring Results - GW 7

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 7	M1	28.10.14	0.2	3	0.2	2.6	18.9	79.2	0	0	1002
	M2	30.10.14	1	20	1	1.5	18.7	78.7	0	0	1000
	M3	06.11.14	1.3	18	1.3	4.8	14.7	79.1	0	0	979
	M4	11.11.14	0.2	3	0.6	0.2	19.6	79.8	0	0	979
	M5	12.11.14	0.1	1	0.1	2.6	18.2	79.1	0	0	979
	M6	14.11.14	0.1	2	0.1	4.6	15.4	79.8	0	0	983
	M7	17.11.14	0.1	2	0.1	0.7	18.9	80.1	0	0	999
	M8	18.11.14	0.1	2	0.1	3.7	16.4	79.6	0	0	1003
	M9	19.11.14	0.1	2	0.1	3.9	16.4	79.5	0	0	1007
	M10	20.11.14	0.1	2	0.1	1.1	19.1	79.5	0	0	1016
	M11	21.11.14	0.1	1	0.1	7.2	13.2	79.4	0	0	1004
	M12	24.11.14	0.1	1	0.1	1.8	16.9	80.6	0	0	1017
	M13	25.11.14	0.1	2	0.1	1.6	18.4	79.8	0	0	1014
	M14	26.11.14	0.2	3	0.2	0.9	19.3	79.6	0	0	1014
	M15	27.11.14	0.1	1	0.1	1.8	18.3	79.8	0	0	992

Table No. 28 - Landfill Gas Monitoring Results - GW 8

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 8	M1	28.10.14	11.5	>>>	11.5	3.2	15.3	76.2	0	0	1002
	M2	30.10.14	8.8	>>>	8.8	3.9	15.1	72.1	0	0	1001
	M3	06.11.14	4	78	4	5.2	14.1	76.6	0	0	979
	M4	11.11.14	2.7	53	2.7	5.6	14.5	77.2	0	0	979
	M5	12.11.14	2.5	50	2.5	5.7	14.2	77.6	0	0	979
	M6	14.11.14	1.9	37	1.9	6.2	12.7	79.2	0	0	984
	M7	17.11.14	1.6	32	1.7	6.7	12.7	78.9	0	0	999
	M8	18.11.14	1.4	28	1.5	6.8	12.1	79.6	0	0	1003
	M9	19.11.14	1.2	23	1.2	6.3	13	79.5	0	0	1007
	M10	20.11.14	1.2	24	1.2	6.6	12.9	79.2	0	0	1016
	M11	21.11.14	1.2	23	1.2	6.8	12.6	79.4	0	0	1005
	M12	24.11.14	0.2	3	0.2	3.7	16.1	79.8	0	0	1017
	M13	25.11.14	0.8	15	0.8	5.9	14.9	78.4	0	0	1014
	M14	26.11.14	0.8	15	0.8	5.9	15	78.3	0	0	1014
	M15	27.11.14	0.7	13	0.7	6.1	15	78.2	0	0	992

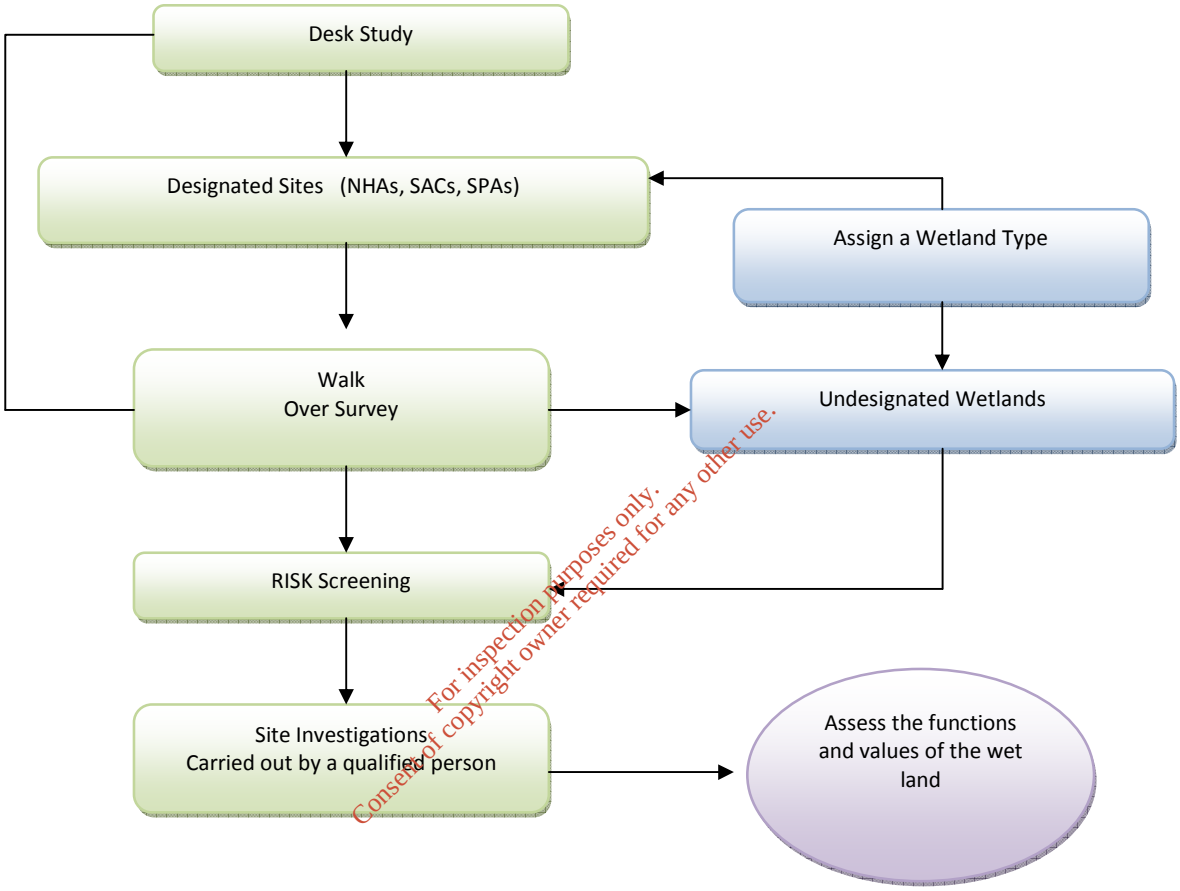
Table No. 29 - Landfill Gas Monitoring Results - GW 9

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 9	M1	28.10.14	0.3	6	0.3	1.2	18.6	79.8	0	0	1002
	M2	30.10.14	0.8	15	0.8	1.3	18.7	79.3	0	0	1000
	M3	06.11.14	0.3	7	0.4	1.8	19	78.8	0	0	979
	M4	11.11.14	0.5	12	1	2.8	16.9	79.6	0	0	979
	M5	12.11.14	0.4	8	0.4	2.6	17.8	79.1	0	0	979
	M6	14.11.14	0.3	6	0.3	2.1	18.2	79.2	0	0	983
	M7	17.11.14	0.5	9	0.5	3.3	16.4	79.6	0	0	999
	M8	18.11.14	0.4	8	0.4	2.9	16.3	80.3	0	0	1003
	M9	19.11.14	0.3	5	0.3	3.8	15.2	80.4	0	0	1007
	M10	20.11.14	0.5	9	0.5	2.5	17.1	79.9	0	0	1016
	M11	21.11.14	0.4	8	0.4	3.6	15.2	80.7	0	0	1005
	M12	24.11.14	0.5	10	0.5	6	14.7	78.7	0	0	1017
	M13	25.11.14	0.4	7	0.4	2.2	18.1	79.4	0	0	1014
	M14	26.11.14	0.1	1	0.1	2	18.6	79.2	0	0	1014
	M15	27.11.14	0.1	2	0.1	3.9	17.1	78.9	0	0	992

3.8 ECOLOGICAL ASSESSMENT OF SITE

An ecological survey of the historic landfill site at Cootehill was carried out in November 2014 by Noreen McLoughlin, MSc. MIEEM on behalf of Traynor Environmental Ltd.

Figure No 9: Code of practice for Ecological Survey site investigations.



3.8.1 Survey Methods

Prior to the site visit, the websites of the National Parks and Wildlife Service (NPWS), the National Biodiversity Data Centre and the EPA were consulted for information on nature conservation areas (SAC, NHA, PNHA, SPA) and records of notable species within the area.

An initial desktop ecological assessment of the landfill site at Pottleboy was carried out using aerial photographs, ground photographs and historical maps. There is a small stream located in the vicinity of the site, however that portion of the stream along the boundary of the landfill is piped.

The ecological survey of the site included a Q assessment of the Pottleboy stream that runs along the northern and western perimeter of the site. Two biological water samples were taken for the purpose of Q value rating, the locations of which are listed in Table 30.

Table 30: Location of Q Value Rating Surface Water Sampling

Station No.	Location	Grid Reference	Q Rating
1	40m downstream of landfill	E 260666, N 313580	Q 2-3 (Poor)
2	18m upstream of landfill	E 260562, N 313529	Q 3 (Poor)

Refer to Appendix B for the full ecological report of the historic landfill site.

The EPA recommends that for a standard Q assessment, a two minute kick sample and stone wash is undertaken. At each station, the surrounding habitats were noted along with other parameters such as water flow, stream depth and the predominance of vegetation. Where possible, at each station a two minute kick sample was taken with a Freshwater Biological Association approved hand held sweep net with a mesh diameter of 500µm. If a kick sample was not suitable, then a two-minute sweep sample of the in-stream vegetation was taken instead. The samples were retained in plastic containers at the sampling site. Samples were removed and later assessed by determining the abundances of various indicator groups of macro-invertebrates that were obtained in the sweep. Based on the relative abundance of these indicator species, a biotic index (Q rating) was determined for the sites in accordance with the biological assessment procedure used by the Environmental Protection Agency. All indicator species are assigned to one of five different groups based on their tolerance to pollution. Group A are the most sensitive invertebrates and Group E are the least sensitive.

3.8.2 Description of the Existing Environment

The site in question is located in the townland of Pottleboy, on the southeastern outskirts of Cootehill town, approximately 0.8 km south east of the town centre. It is located in an area that is surrounded both agricultural and residential land, some of which has been developed since 2005. The OSI (Ordinance Survey of Ireland) 6 inch maps for Cootehill, drawn between 1829 and 1842, depict the site of the landfill part of a Farm holding. The landfill site encompasses an area of approximately 0.18 ha and the adjoining site to the east is 0.10 ha. Since the closure of the landfill it has been capped with soil and it has re-vegetated.

Designated Areas and Habitats

There are no Natura 2000 sites within 10km of this proposed development. The closest Natural Heritage Area to the site is the Dromore Lakes (pNHA 000001). This is located approximately 1km north of the landfill site. The main vegetated habitats on the site of the disused landfill include hedgerows, treelines, scrub and un-improved grassland. Site boundaries consist of hedgerows and tree lines and species such as Common (ash) Fraxinus excelsior, (hawthorn) Crataegus monogyna, (sycamore) Acer pseudoplatanus and (Leyland Cypress), Cupressus x leylandii occur. Scrub areas within the site are dominated by (gorse) Ulex europaeus and (bramble) Rubus fruticosus agg. Aerial photographs from Ordnance Survey Ireland 2000 show that the vegetative cover has been established for years.

Figure No. 10 - Ordnance Survey Ireland Map showing the vegetation cover on the site in 2000

Pottleboy Stream

The Pottleboy Stream is a small stream that flows in a southerly direction along the northern and western boundaries of the landfill, before it flows under the road. From an inspection of the historical maps of the area, it seems that the Pottleboy Stream rises in the townland of Pottleboy, approximately 350m north of the landfill site. It then flows mostly through agricultural land in a southerly direction for approximately 1.3km, until it reaches the Annalee River in the townland of Campstown.

3.8.3 Ongoing Impacts and Assessment

The site is dominated by scrub and hedgerow habitats. Habitat like this in a residential / urban area would be considered useful for biodiversity, as it provides shelter, nesting and feeding sites for local populations of small passerine birds and mammals. Ecological connectivity between this area and the open countryside would still exist due to the agricultural land located both east and west of the landfill. Habitats have not become fragmented due to disturbance and development. Wildlife corridors exist, directly linking the landfill site and the surrounding countryside.

Sites such as this are frequently colonised by invasive species. One of the most common invasive species in Ireland is now Japanese knotweed Fallopia japonica. It can be spread vegetatively by tiny sections of root or stem, therefore it can colonise areas very rapidly, especially areas that have been recently disturbed. There was no evidence of invasive species on the site. Weeds found are commonly found through Ireland.

4.0 REFINEMENT OF CONCEPTUAL SITE MODEL (CSM)

4.1 DESCRIPTION

A conceptual model is a means of understanding the manner in which a system, which is used for a waste related activity is likely to behave. A conceptual model can be defined as follows ' A textual or graphical representation of the relationship(s) and receptor(s) developed on the basis of hazard identification and refined during subsequent phases of risk assessment.

The Code of Practice requires the Conceptual Site Model (CSM) developed during Tier 1 to be refined after completion of the Tier 2 site investigations. A drawing of the initial conceptual site model is included in Appendix F (Drawing No. Ref 14.248.100). The CSM will be used as the basis for all subsequent risk assessments. It is used to identify all possible sources(s), pathways (P) and receptors (R) as well as the processes that are likely to occur along each of the source-pathway-receptor (S-P-R) Linkages and uncertainties. Where a site is deemed to pose a high or moderate risk to the environment or human health then a Quantitative Risk Assessment (QRA) should then be undertaken. A detailed Quantitative Risk Assessment will be carried out during the Tier 3 Risk Assessment phase of the project.

Traynor Environmental Ltd, using the information obtained in the site investigation, refined the Tier 1 CSM. The most recently landfilled waste is estimated to be from 1985, with much of the waste emanating from the 1970s and early 1980s. The waste is covered by a thin layer of topsoil. The principle soils of Association 25 are Gleys (50%), Acid Brown Earths (40%) and Interdrumlin Peat and Peaty Gleys (10%). It is likely that most of the rainfall reaching the base of the waste ultimately discharges along the top of the rock with some percolation into the rock at joints.

Landfill gas generation at the site is low as detailed in section 3.7.4 of this document. Due to the free draining nature of the waste, the residual landfill gas can vent freely to the atmosphere. A drawing of the revised conceptual site model for the site is included in Appendix F (Drawing No. Ref: 14.248.116).

4.2 SOURCE/HAZARDS

4.2.1 Waste Types

The waste comprised mainly of plastics, paper, glass, metal and textiles all of which were supported by a stony clay matrix.
From soil sample analysis it has been determined that trace amounts of hazardous waste in the form of asbestos were found in TH 10. The waste type is deemed as Chrysotile (white asbestos), a trace amount which typically contains small amounts of 1-2 fibres. The nature of waste observed is typical of municipal waste that has been buried for more than 20 years and which has undergone considerable biodegradation.

4.2.2 Waste Area

The trial hole investigation showed the thickness of the waste ranged from 0.8 m to 3.0 m across the Cavan County Council landfill site area where waste was encountered. The area covered by the waste body is approximately 1700 m^2. It is estimated, that approximately 3740 tonnes of waste is deposited at the site.

The north eastern extent of the waste body is defined by a steep slope leading towards the boundary with the adjoining site to the east. The main body of waste is located in the central area of the site extending to the western and north western boundary. The western and north western aspect of the waste body is defined by a small wooden fence at the Community Crèche Car Park and palisade fence which delineates the boundary between the landfill and the play yard attached to the crèche. Towards the eastern aspect of the site no historical waste was encountered, however there were nominal quantities of waste on the surface of the ground due to wind movement. Bed rock was encountered in trial holes dug at the base of the slope along the boundary dividing the landfill site with the neighbouring site. Refer to photograph no 21 and 22 of TH16 and TH17 respectively. Drawing No. 14.248.111 - Appendix F outlines the main area of the site were waste was encountered. (Highlighted area hatched in red)

4.2.3 Leachate

Leachate can be described as any liquid material that drains from land or stockpiled material and contains significantly elevated concentrations of undesirable material derived from the material that it has passed through. In the case of a landfill the leachate picks up soluble materials that originate from or are produced by the degradation of the landfill waste. The composition of the leachate will vary depending on the overall composition of the waste. Factor which influence the generation of leachate are listed below.

- meteorological conditions at the site
- waste composition (% of biodegradable waste)
- waste density
- overall depth of the landfill
- moisture content
- speed of liquid movement
- waste age
- the existence of any lining system

No leachate was encountered at Cootehill historic landfill site during trial hole investigation. From trial hole investigations bed rock was reached at a shallow depth in some parts of the landfill (0.6m). It is likely that any of the rainfall which may reach the base of the waste ultimately discharges along or through the bed rock. The Pottleboy stream runs adjacent/immediate to the landfill site along the northern and western boundary, however this section of the stream is piped. From analysis of surface water taken both up steam and downstream of the landfill site no evidence of leachate migration was found. Refer to table's No. 15 to 17

Photograph 21: Shallow Bedrock located in TH 16

Photograph 22: Shallow Bedrock located in TH 17

4.2.4 Landfill Gas

The landfill gas monitoring which has been carried out, has established that the waste is a source of low levels of landfill gas. Gas monitoring was carried out on 9 No. gas monitoring wells, specially constructed for this type of gas monitoring. Concentrations of methane and carbon dioxide were measured but are considered low, relative to amounts documented for similar historic landfill sites register with the EPA. This is consistent with the type of waste observed, its age and relatively shallow thickness.

From analysis of the gas monitoring results Gas Well No. 8 (GW8) showed the highest levels for both methane (CH_4 - 11.5 % v/v) and carbon dioxide was also elevated (CO_2 - 6.8 % v/v) while containing the lower quantities of oxygen (O_2). Low quantities of methane were also detected in GW 3, GW 7 and GW 9. Negligible amounts of methane concentrations were evident in all of the other gas well monitoring locations. Gas Well No. 3 contained the highest quantities of CO_2 with levels ranged from 4.9% to 10.8%. Low quantities of CO_2 were evident in GW 1 and GW 5. In general the CO_2 results fluctated greatly in each location.

4.3 MIGRATION PATHWAYS

4.3.1 Groundwater Vulnerability

The GSI has categorised the aquifer vulnerability of the area occupied by the site and the general region, as Extreme (Rock at/near surface or Karst). The site investigation data confirmed bedrock on the site at shallow depths (0.6m amd 1.0m). The waste is not saturated and no water/groundwater and/or leachate were encountered in any of the trial holes. The majority of the waste is underpinned by the bedrock which would allow the downward movement of any leachate resulting in preferential flow to groundwater. Leachate would have discharged from the waste body over time. Installation of groundwater boreholes would indicate whether there is any residual localised impact on the groundwater.

4.3.2 Groundwater Flow Regime

The bedrock aquifer is characterised by the GSI as a Poor Aquifer (Pl) – Bedrock which is generally unproductive except for local zones. This means that groundwater flow paths are short probably 10s to 100s of metres.

4.3.3 Landfill Gas Pathways

The main pathway considered for landfill gas migration is through the subsoil and laterally. There are no underground services, such as pipelines, drainage systems or manholes which can be potential pathways for landfill gas migration. The watercourse (Pottleboy stream) adjoining the landfill site is piped for approximately 90 - 100m. The stoney matrix clay cover material over the waste is free draining and landfill gas vents freely to atmosphere, both vertically and laterally. As stated previously from the gas wells established on the site for monitoring purposes, GW 8 showed low levels of landfill gas. Stable methane for all 9 no. gas wells monitored, concentrations ranged from 0.1% v/v to 11.5 % v/v. Carbon Dioxide concentrations ranged from 1.2% v/v to 10.8% v/v. Hydrogen sulphide or Carbon Monoxide were not detected on any of the 15 monitoring events. Therefore the likelihood of risk to nearby receptors from the lateral migration of landfill gas is considered very low.

4.4 MIGRATION RECEPTORS

4.4.1 Leachate migration Receptors

Human Presence

According to the GSI Well Database, there are seven wells within 2.0 km of the site. However due to no evidence of leachate present at the site, the potential risk to these wells is negligible.

Aquifer Category

This is one of the most likely targets in the case of leachate migration. The bedrock aquifer for the Cootehill historic landfill site is classified as Poor aquifer (Pl), according to the national geological survey of Ireland.

Protected Areas

Protected areas which must be considered are those which are designated under the Water Framework Directive, Birds Directive, Habitats directive, Wildlife Act, Freshwater Fish Directive, Bathing Waters Directive. From the Ecological survey carried out by Noreen McLoughlin, MSc. MIEEM on behalf of Traynor Environmental Ltd no Natura 2000 sites have been identified with 10 km of the landfill site.

Public Water Supplies

Public water supplies are considered an important factor due to the risk to public health. Proximity to the landfill will be a major factor in the associated risk. No public water supplies have been identified in the vicinity of the landfill site at Pottleboy, Cootehill. The current source of potable water for Cootehill town is form Coragh Lough located 1.3km northeast of the landfill site.

Surface water Bodies.

The proximity to surface water bodies such as lakes, rivers, estuarine and coastal water is also an important factor when considering leachate migration. The Pottleboy Stream is a small stream that flows in a southerly direction along the northern and western boundaries of the landfill. However the section of this stream immediately bordering the landfill is piped.

4.4.2 Landfill gas Migration Receptors

Human Presence

Human presence is considered to be the principal sensitive receptor with respect to landfill gas migration. This is due to the potential for the accumulation of higher than normal levels of gas, in confined spaces such as basements, schools or houses. The historic landfill in Cootehill is situated in close proximity to both residential and public buildings on the outskirts of the town. The Community Crèche on the Northern aspect of the site is immediate to the boundary of the site and thus lateral landfill gas migration would pose a potential risk. Since July 1998, all new dwellings and long stay buildings are required to

incorporate some degree of radon preventative measures at the time of construction in accordance with the revised Building Regulations 1997. It can be seen from ordnance survey data that the Community Crèche development bordering the site was constructed after the year 2000. Therefore the radon protection measures build into this development offers a degree of protection in the unlikely event of any landfill gas migration. From analysis of ordnance survey maps and planning records from Cavan County Council, the Drumarket house estate located due south of the landfill site appears to be have been built prior to the year 2000.

The risk posed by landfill gas to off-site receptors is considered to be negligible. Low levels of landfill gas were detected in GW GW 8 and levels recorded in GW 1, GW 2, GW 3 GW 4, GW 4, GW 5, GW 6, GW 7 and GW 9 were negligible. GW 8 and GW 9 are located in close proximity to the car park adjoining the north-western boundary. GW 2 and GW 4 are the closest gas monitoring point to residential properties located due south of the site. Results of monitoring carried out at GW 5 and GW 6, located in the centre of the waste body, were also negligible. (Drawing 14.248.113 Gas Monitoring Locations - Appendix F) Flammability and explosion risk, from outdoor exposure to landfill gas is therefore also negligible.

4.5 RISK ASSESSMENT

4.5.1 Quantitative risk assessment

The key points to note about the conceptual gas model for the former landfill are out lined below:

- Filling/Tipping appears to have taken place predominantly to the central area of the Cavan County Council Landfill site.
- The landfill material has been in place for >20 years
- The highest landfill gas levels were recorded in GW 8 located on the periphery of the waste body.
- GW 3 and GW 9 also showed very low levels of landfill gas but were deemed negligible as they were only .
- The Landfill is in phase VII of the decomposition process. This is demonstrated in Figure No. 6 - section 3.7.4.2
- The landfill has no engineered capping layer and there is no landfill gas collection or venting system installed.
- The site investigation indicates that the landfill material is variable but predominantly consists of domestic house-hold refuse.
- Trace amounts of hazardous waste in the form of asbestos were found in TH 10..
- The landfill is relatively shallow in relation to its plan area. This is due to the bed rock level in the site.
- Gas generated is most likely venting through the cover soils in a diffuse manner both vertically and latterally.
- There are currently no potential pathways in the form of buried services on the site, for gas migration.
- There was no evidence to suggest migration outside the boundary of the site of landfill gas.

4.5.2 Risk Classification

Table No. 31 Tier 2 Risk Classification

Risk Classification	Class	Range of Risk Scores
High Risk	Class A	Greater than or equal to 70% for any individual SPR Linkage
Moderate Risk	Class B	Between 40-70% for any individual SPR linkage
Low Risk	Class C	Less than or equal to 40% for any individual SPR linkage.

The risk classification assigned to the site of Moderate (Class B), at this stage represents the intrinsic risk that the site poses to the environment and nearby receptors. It does not take account of any mitigation measures that may be put in place nor any proposed measures.

4.5.3 SPR Linkage

The Code of Practice (COP) provides a scoring matrix where points are assigned, based on a source-pathway receptor (SPR) model, to assess risk. There are eleven (11) possible SPRs, which are based on a range of hazard sources (leachate, landfill gas) pathways (soils, surface water and groundwater) and receptors (humans, ecosystems, groundwater supplies). Each one of the eleven possible linkages will be scored separatly.

The point scores for the individual parameters are derived from the Tables in the Code of Practice Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA 2007). The scores are normalised to 1 -100. High risk sites are those with a score =>70 for any one SPR. Moderate risks are sites scoring between 40 - 70. Low risk sites, which are considered not to pose a significant risk to the environment or human health, are those with a score below 40. In the Tier 1 assessment the Cootehill site score was 50.

With regard to the risk ranking; SPR Linkage number 10 highlights landfill gas migration to Humans.

Through site investigations it has been ascertained that the area of the site infilled with waste is similar to the approximation made during the Tier 1 Risk Assessment, which would result in no change to the risk rating. The waste footprint for Cootehill is < 1 hectare and thus the scoring matrix assigns a value of 5 for both municipal and industrial waste.

4.6 RISK SCREENING & PRIORITISATION CALCULATIONS AFTER TIER 2 RISK ASSESSMENT

Table 1a LEACHATE: Source/hazard Scoring Matrix			
Waste Type	**Waste Footprint (ha)**		
	≤ 1ha	> 1 ≤ 5ha	≥ 5ha
C&D	0.5	1	1.5
Municipal	5	7	10
Industrial	5	7	10
Pre 1977 sites	1	2	3
		1a =	**5**

Table 1b LANDFILL GAS: Source/hazard Scoring Matrix			
Waste Type	**Waste Footprint (ha)**		
	≤ 1ha	> 1 ≤ 5ha	≥ 5ha
C&D	0.5	0.75	1
Municipal	5	7	10
Industrial	3	5	7
Pre 1977 sites	0.5	0.75	1
		1b =	**5**

Table 2a LEACHATE MIGRATION: Pathways	
Groundwater Vulnerability (Vertical Pathway)	**Points**
Extreme Vulnerability	3
High Vulnerability	2
Moderate Vulnerability	1
Low Vulnerability	0.5
High – Low Vulnerability	2
2a =	**3**

Table 2b LEACHATE MIGRATION: Pathways	
Groundwater Flow Regime (Horizontal Pathway)	**Points**
Karstified Groundwater Bodies (Rk)	5
Productive Fissured Bedrock Groundwater Bodies (Rf & Lm)	3
Gravel Groundwater Bodies (Rg & Lg)	2
Poorly Productive Bedrock Groundwater Bodies (Ll, Pl, Pu)	1

2b =	**1**

Table 2c LEACHATE MIGRATION: Pathways	
Surface Water Drainage (Surface Water Pathway)	**Points**
Is there direct connection between drainage ditches associated with the waste body and adjacent surface water body? Yes	2
If no direct connection.	1

2c =	**1**

Table 2d LANDFILL GAS: Pathways	
Landfill Gas Lateral Migration Potential	**Points**
Sand and Gravel, Made ground, urban, karst	3
Bedrock	2
All other Tills (including limestone, sandstone etc – moderate permeability)	1.5
All Namurian or Irish Sea Tills (low permeability)	1
Clay, Alluvium, Peat	1

2d =	**3**

Table 2e LANDFILL GAS: Pathways (receptor above source)	
Landfill Gas Lateral Migration Potential	**Points**
Sand and Gravel, Made ground, urban, karst	3
Bedrock	2
All other Tills (including limestone, sandstone etc – moderate permeability)	1.5
All Namurian or Irish Sea Tills (low permeability)	1
Clay, Alluvium, Peat	1
(As Table 2e applies to situations where buildings, structures or other enclosed spaces are present above the waste body a value of 0 has been assigned)	

2e =	**0**

Table 3a LEACHATE MIGRATION: Receptor	
Human Presence (presence of a house indicates potential private wells)	**Points**
On or within 50m of the waste body	3
Greater than 50m but less than 250m	2
Greater than 250m but less than 1km	1
Greater than 1km of the waste body	0

3a =	**3**

Table 3b LEACHATE MIGRATION: Receptors	
Protected Areas (SWDTE & GWDTE)	**Points**
Within 50m of the waste body	3
Greater than 50m but less than 250m of the waste body	2
Greater than 250m but less than 1km of the waste body	1
Greater than 1km of the waste body	0
Undesignated sites within 50m of the waste body	1
Undesignated sites greater than 50m but less than 250m of the waste body	0.5
Undesignated sites greater than 250m of the waste body	0

3b =	**0**

Table 3c LEACHATE MIGRATION: Receptors	
Aquifer Category (resource potential)	**Points**
Regionally Important Aquifers (Rk, Rf, Rg)	5
Locally Important Aquifers (Ll, Lm, Lg)	3
Poor Aquifer (Pl, Pu)	1

3c =	**1**

Table 3d LEACHATE MIGRATION: Receptors	
Public Water Supplies (other than private wells)	**Points**
Within 100m of the site boundary	7
Greater than 100m but less than 300m or within the in inner SPA for GW supplies	5
Greater than 300m but less than 1km or within outer SPA for GW supplies	3
Greater than 1km (karst aquifer)	3
Greater than 1km (no karst)	0

3d =	**0**

Table 3e LEACHATE MIGRATION: Receptors	
Surface Water Bodies	**Points**
Within 50 of the site boundary	3
Greater than 50m but les than 250m of the site boundary	2
Greater than 250m but less than 1km	1
Greater than 1km	0

3e =	**3**

Table 3f LANDFILL GAS: Receptors	
Human Presence	**Points**
On site or within 50m of site boundary	5
Greater than 50 but less than 150m of site	3
Greater than 150m but less than 250m of the site	1
Greater than 250m of the site	0.5

3f =	**5**

Prior to the Tier 2 Risk Assessment after Tier 1 Assessment

Risk Equation	SPR Values	Max Score	Linkages	Normalised Scores (%)
SPR 1 = 1a x (2a + 2b + 2c) x 3e	60	300	Leachate → Surface Water	20.0
SPR 2 = 1a x (2a + 2b + 2c) x 3b	0	300	Leachate → SWDTE	0.00
SPR 3 = 1a x (2a + 2b) x 3a	60	240	Leachate → human Presence	25.0
SPR 4 = 1a x (2a + 2b) x 3b	0	240	Leachate → GWDTE	0.00
SPR 5 = 1a x (2a + 2b) x 3c	20	400	Leachate → Aquifer	5.00
SPR 6 = 1a x (2a + 2b) x 3d	0	560	Leachate → Surface Water	0.00
SPR 7 = 1a x (2a + 2b) x 3e	60	240	Leachate → SWDTE	25.0
SPR 8 = 1a x 2c x 3e	0	60	Leachate → Surface Water	0.00
SPR 9 = 1a x 2c x 3b	0	60	Leachate → SWDTE	0.00
SPR 10 = 1b x 2d x 3f	75	150	Landfill Gas → Human Presence	50.0
SPR 11 = 1b x 2e x 3f	0	250	Landfill Gas → Human Presence	0.00

Risk Classification	Score Range
High Risk (Class A)	Greater than or equal to 70% for any individual SPR linkage
Moderate Risk (Class B)	Between 40% and 70% for any individual SPR linkage
Low Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

Overall Risk	Moderate Risk (Class B)

The site was classified as Class B - Moderate Risk, after the Tier 1 risk assessment.

<u>After</u> The Tier 2 Risk Assessment

Risk Equation	SPR Values	Max Score	Linkages	Normalised Scores (%)
SPR 1 = 1a x (2a + 2b + 2c) x 3e	60	300	Leachate → Surface Water	20.0
SPR 2 = 1a x (2a + 2b + 2c) x 3b	0	300	Leachate → SWDTE	0.00
SPR 3 = 1a x (2a + 2b) x 3a	60	240	Leachate → human Presence	25.0
SPR 4 = 1a x (2a + 2b) x 3b	0	240	Leachate → GWDTE	0.00
SPR 5 = 1a x (2a + 2b) x 3c	20	400	Leachate → Aquifer	5.00
SPR 6 = 1a x (2a + 2b) x 3d	0	560	Leachate → Surface Water	0.00
SPR 7 = 1a x (2a + 2b) x 3e	60	240	Leachate → SWDTE	25.0
SPR 8 = 1a x 2c x 3e	0	60	Leachate → Surface Water	0.00
SPR 9 = 1a x 2c x 3b	0	60	Leachate → SWDTE	0.00
SPR 10 = 1b x 2d x 3f	75	150	Landfill Gas → Human Presence	50.0
SPR 11 = 1b x 2e x 3f	0	250	Landfill Gas → Human Presence	0.00

Risk Classification	Score Range
High Risk (Class A)	Greater than or equal to 70% for any individual SPR linkage
Moderate Risk (Class B)	Between 40% and 70% for any individual SPR linkage
Low Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

Overall Risk	**Moderate Risk (Class B)**

After the Tier 2 risk assessment the classification for the historic landfill remains the same, **Class B - Moderate Risk.**

5.0 CONCLUSIONS

5.1 RISK CATEGORY

The Tier 2 Risk Assessment process has resulted in the risk rating for the historic landfill remaining the same which is, Moderate Risk (Class B). SPR Linkage number 10 has been proven and thus risk rating assigned accordingly as **Moderate**. As part of the Tier 2 risk assessment the intrusive site investigation works have confirmed the area were the waste was deposited is the same as previously predicted, accounting for approximately 1700m^2 . This represents approximately 3740 tonnes of waste deposited at the site. This has resulted in no change to the SPR linkages after the tier two.

The linkage scores have not changed therefore the overall risk rating of the site after the Tier 2 Risk Assessment is **Moderate Risk.**

5.2 GROUNDWATER

There was no groundwater encountered at the site.

5.3 SURFACE WATER

Pottleboy stream is located along the northern and western boundaries of the landfill, before it flows under the road however the section of the stream adjoining the landfill is piped therefore the landfill is not having an impact on any surface water quality. It then flows mostly through agricultural land in a southerly direction for approximately 1.3km, until it reaches the Annalee River in the townland of Campstown.

6.0 REFERENCES

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