**ATTACHMENT D.1**

# TIER 2 RISK ASSESSMENT

## APPLICATION TO THE EPA FOR A CERTIFICATE OF AUTHORISATION

**FORMER MUNICIPAL HISTORIC LANDFILL**

**DUNAREE**

**KINGSCOURT**

**CO. CAVAN**



**Prepared By:**

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Creeny
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Co. Cavan

Traynor Environmental Ltd.

**APRIL 2014**

# TIER 2

# ENVIRONMENTAL RISK ASSESSMENT

# OF A

# FORMER MUNICIPAL HISTORIC LANDFILL

# AT

# DUNAREE

# KINGSCOURT

# 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 Dunaree, Kingscourt, 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 High 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 2012, 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

Kingscourt Historic landfill is located approximately 0.6 km from Kingscourt town, in the townland of Dunaree on local roadway (L-3536-0). Ref: Drawing No. 13.1210.101 - Site Location Map in Appendix F. The land surrounding the site slopes moderately in a North Easterly direction towards the town of Kingscourt. It is bounded on three sides by urban dwellings and buildings. Figure No. 1 B Location Map, shows the area potentially used for the purpose of the landfill, and is highlighted in blue shading.

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

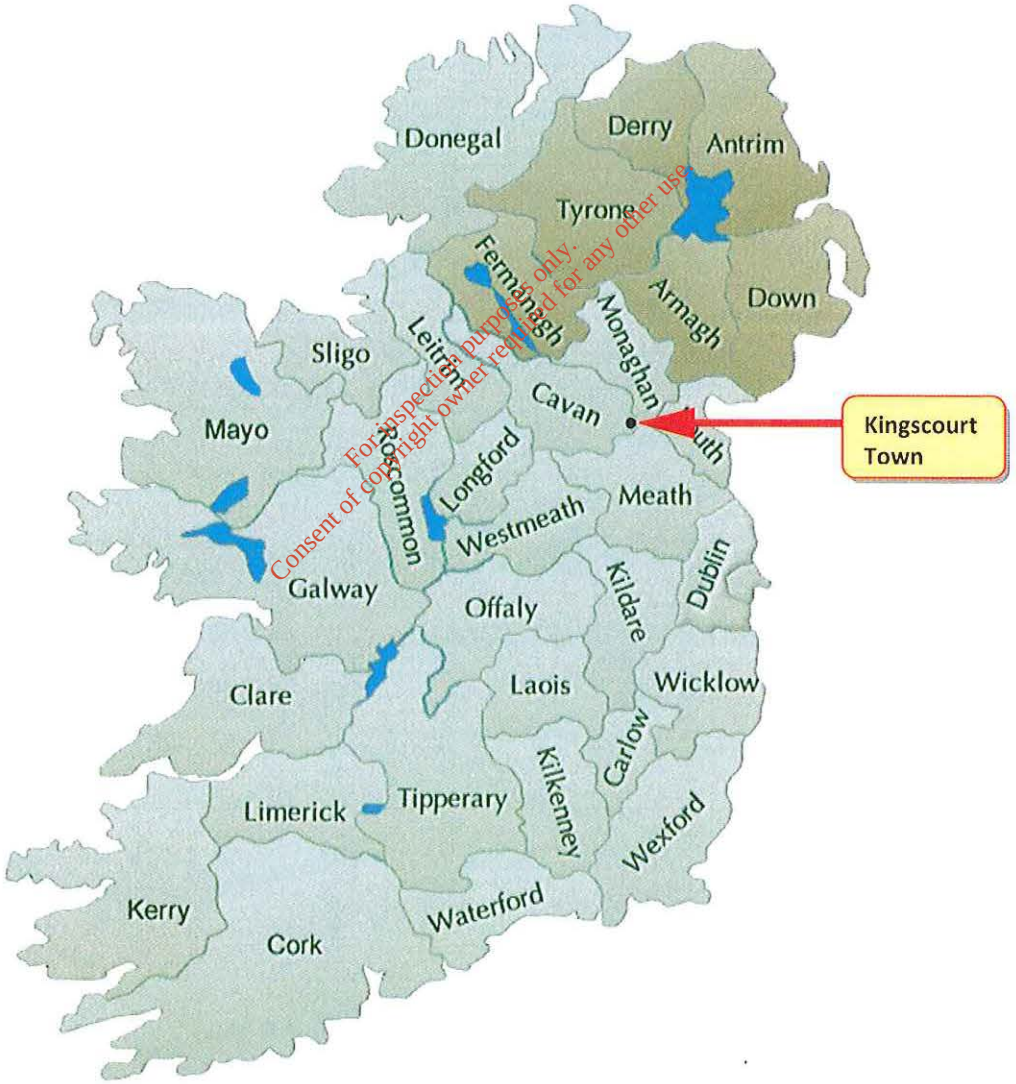


**Figure No. 1 B: Location Map of Kingscourt historic landfill.**

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



## 2.2 SITE LAYOUT

The main receptors in close proximity to the site are dwelling houses. Housing estates on the Northern, Southern and Western aspect of the site are immediate to the site and thus lateral landfill gas migration would pose a potential risk. The housing estates are served by kingscourt water supply. The site encompasses an area of approximately 1.2 hectares. The land surrounding the site slopes moderately in a north easterly direction towards the town of Kingscourt. The boundaries are marked by local road L-3536-0 to the Northwest. The area to the West and East consist of domestic dwellings. The land to the Southeast is an undeveloped construction site. The site is currently used as a storage yard by Cavan County Council. The site is secure and delineated by palisade fencing on the northern, southern, and south-eastern perimeter.

## 2.3 SURROUNDING LAND USE

The surrounding land use is predominantly urban housing and a small number of industrial units. Receptors R1, R2, R3, and R4 identified during the Tier 1 risk assessment can be seen on a sketch map located in Appendix G of this document.

- R1 - Commerical premises and housing estrate on the nothern asepect approx. 30m from the site boundary;
- R2 - Housing estate on the south western aspect immediate to the site boundary;
- R3 - Housing estate on the western aspect approx. 30m from the site boundary;
- R4 - Housing estate on the north eastern aspect immediate to the site boundary;

## 2.4 SITE HISTORY

It is understood that waste disposal began at the site in January 1970 (approximate date). A variety of wastes may have been deposited, including Municipal Solid Waste (MSW) and Construction and Demolition (C&D) wastes. The landfill mainly accepted municipal waste from the surrounding area. The landfill was finally closed on the 28th March 1991.

### 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 significant changes of usage on the site: (Ref to Appendix F for drawings)

- Ortho 2000 - Colour aerial photography July 2000 (Drawing No. 13.120.103.);
- Ortho 1995 – Black and White aerial photography 1995 (Drawing No. 13.120.104);
- 6 inch mapping series (1:10,560) greyscale 1837-1842 (Drawing No. 13.120.105-A);
- 25 inch mapping series (1:2,500) greyscale 1888-1913 (Drawing No. 13.120.105 -B);

#### 2.4.1.1 Landfill Pre 1970s

It is understood that the site was formerly a quarry. Historical evidence demonstrates that there was a quarry at the site as far back as 1837 and possibly longer.

#### 2.4.1.2 Landfill 1995

Tipping on the site had ceased by 1991. The outline of the landfill and its waste material can be observed on aerial photography 1995 (Drawing No. 13.120.104) 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. 13.120.103 - Appendix F), shows the site to contain large amounts of overgrown vegetation and outcropping rock. There is no evidence of tipping.

## 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 Risk Assessment. From this combined research it has been ascertained that there are no open drains or watercourses located on the site or its boundaries.

## 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 27 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 27 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 27 are Gleys (85%) and Interdrumlin Peat and Peaty Gleys (15%). These soils are derived from mostly Upper Carboniferous limestone and shale - sandstone glacial till. The subsoil in the region of the site is bedrock outcrop and subcrop. (Drawing No. 13.120.109 - Appendix F) This information and map are compiled from the Geological Survey of Ireland (GSI). The subsoil to the Northwest 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. 13.120.108 - Appendix F), large areas of outcropping rock are visible through the site and it has a history of being a quarry.

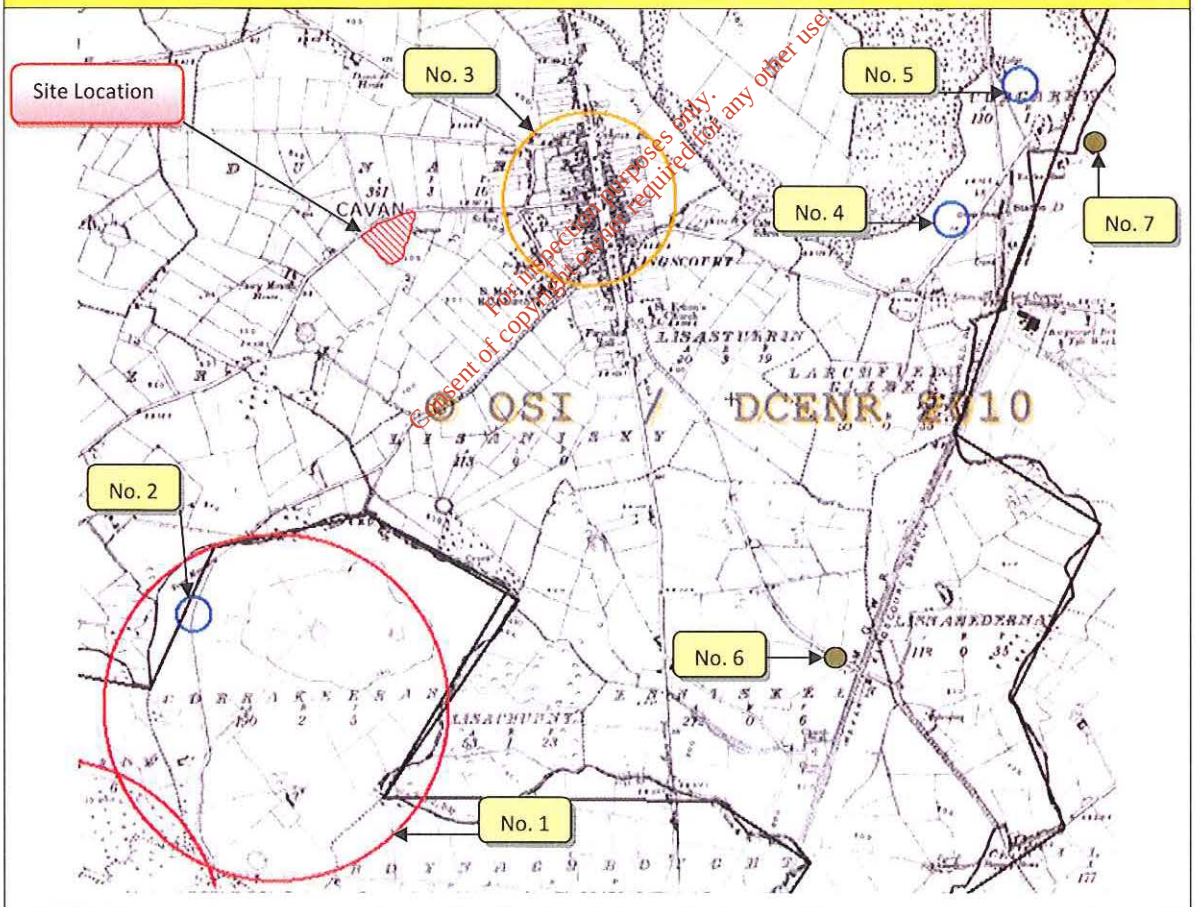
### 2.6.3 Hydrogeology

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" – Bedrock which is generally unproductive except for local zones (Drawing No. 13.120.106 - 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 Northwest of the site (Drawing No 13.120.107 - Appendix F). According to the GSI Well Database, there are seven wells within 2.0 km of the site. Refer to Table 1, Well data and location in the vicinity of Kingscourt.

**Table 1: Well data and location in the vicinity of Kingscourt**

| Groundwater Well Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 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. 1 | 1.4 km | South West | Domestic use only | Poor | 38.2 | 16.2 | 4.6 | 277862 294842 |
| No. 2 | 1.2 km | South West | Public Supply (Co. Co) | - | - | 12.8 | - | 277400 294670 |
| No. 3 | 0.8 km | East | AGRI and Domestic | Good | - | 12.2 | 7.9 | 278297 295865 |
| No. 4 | 1.65 km | East | Public Supply (Co. Co) | Failure | 10 | 99 | 2 | 279556 295839 |
| No. 5 | 1.9 km | North East | Agri and Domestic | - | - | 2.6 | - | 279796 296149 |
| No. 6 | 1.8 km | South East | Public Supply (Co. Co) | Poor | 10 | 91.4 | 7.5 | 279253 294536 |
| No. 7 | 2.0 km | North East | Industrial | Excellent | 7200 | 40 | 18.3 | 280010 296016 |

**Locations of wells in the vicinity of Kingscourt 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

### 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 13.120.107 - 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.

- Groundwater control measures such as cut-off walls or interceptor drains may be necessary to control high water table or the head of leachate may be required to be maintained at a level lower than the water table depending on site conditions.

## 3.0 SITE INVESTIGATION

### 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 September 2009. Kingscourt historic landfill has a high risk (A) classification after the Tier 1 risk assessment. High risk sites are sites where any of the Source-Pathway-Receptor (SPR) linkages have a score greater than or equal to 70%. The risk assessment methodology for Kingscourt highlighted SPR linkage number 10 which has a risk score rating of 70%. The said linkage refers to lateral landfill gas migration.

**Table 3: Risk Score Rating for Kingscourt Historic Landfill**

| SPR Linkage Number | Linkage % | Risk Level |
|---|---|---|
| 1 | 9.33 | C |
| 2 | 0 | C |
| 3 | 35 | C |
| 4 | 0 | C |
| 5 | 7 | C |
| 6 | 0 | C |
| 7 | 11.67 | C |
| 8 | 0 | C |
| 9 | 0 | C |
| 10 | 70 | A |
| 11 | 42 | B |

| | |
|---|---|
| A | High Risk |
| B | Moderate Risk |
| C | Low Risk |

## 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 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.
- **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 an 8 week period from the 11th July 2013 to 26th August 2013
  Extended gas monitoring was carried in October 2013

### 3.3.1 Phase 1 – Topographical Survey

The topographical survey was completed by Alan Traynor Consulting Engineers Ltd in June 2013. (Please refer to Drawing No. 13.120.110 - 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 over two days, the 30th and 31st May 2013.
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. The locations of the trial holes are shown on Drawing No. 13.120.115 - 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. The trial hole logs are included in Appendix A.

The site was divided into equal sections. A total of 32 trial holes were excavated. All of the trial holes were excavated within the boundary of the historic landfill site. No trial holes were excavated outside the boundary of the landfill site due to the close proximity of domestic dwelling, industrial units and the presence of bedrock in the area.



### 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. It was not possible to sample every trial hole for soil analysis, therefore soil samples were taken to give a representative view of the site. Trial holes containing waste/no waste are listed below.

- Trial Holes TH2 , TH3, TH8, TH9, TH11, TH13, TH16, TH17, TH18, TH19, TH20, TH21, TH22, TH23, TH25, TH 26, TH27, TH28, TH29, TH30, TH31, & TH32 contained no waste.
- Trial Holes TH1, TH4, TH5 TH6, TH7, TH10, TH12, TH14, TH15, and TH24 contained waste.
- Soil samples were taken from Trial Holes TH10, TH14 and TH 20 (control)

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

An ecological assessment was carried out on the site. No watercourses or drains were encountered on, or in the vicinity of the site. For this reason it was not possible to carry out Q value ratings which are used for the assessing of the water quality up and down stream of the landfill site. No water table was encountered on the site. The Ecological Report carried out by Noreen McLoughlin MSc MIEEM. is included in Appendix B.

The ecological assessment of the landfill site at Dunaree was carried out using aerial photographs, ground photographs and historical maps. After consultation with National Parks and Wildlife Service website it was ascertained that there are no designated sites adjacent to or close to the site of the old landfill. The main habitats identified on the site are hedgerows, tree lines, scrub and un-improved grassland. These are predominantly located on the lower area of the site towards the northern boundary and also along the boundary of the site.

## 3.4 VERTICAL EXTENT OF WASTE

The main body of waste is located at the most elevated area of the site along the south eastern boundary. Waste was encountered in trial holes TH1, TH4, TH5 TH6, TH7, TH10, TH12, TH14, TH15, and TH24 see drawing no. 132.120.115 Trial Hole Locations in appendix F. The base of the waste is defined by bed rock encountered between 1.0 m and 4.6 m throughout the site. Full cross section drawings from two different aspects of the site are also included in appendix F (Drawing Ref 13.120.112)

Table No. 4 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 and odours. 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**

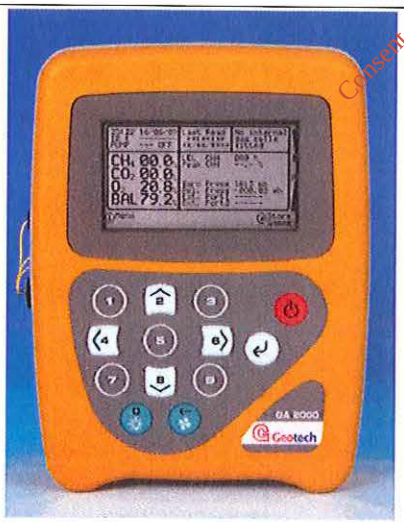
| GA 2000 landfill gas analyser | |
|---|---|
|  | **Features:** |
| | • ATEX certified<br>• 5 gases standard<br>• Peak CH4 recording<br>• Simultaneous display of all gases<br>• Storage of site and ID questions<br>• Field proven<br>• Standardises monitoring routines<br>• Easy transfer of data<br>• Optional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

Table 4: 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 | 149.3 | 147.3 | 4.00 | 2.00 | 4.00 | 2.00 |
| TH 2 | 150.0 | - | 4.00 | n/a | n/a | n/a |
| TH 3 | 149.7 | - | 3.00 | n/a | n/a | n/a |
| TH 4 | 150.3 | 147.9 | 4.40 | 2.40 | 4.40 | 2.00 |
| TH 5 | 150.0 | 149.6 | 3.70 | 0.40 | 3.70 | 3.30 |
| TH 6 | 150.5 | 150.4 | 4.60 | 0.10 | 4.60 | 4.50 |
| TH 7 | 151.5 | 150.6 | 3.60 | 0.90 | 3.60 | 2.70 |
| TH 8 | 152.5 | - | 1.00 | n/a | n/a | n/a |
| TH 9 | 152.0 | - | 1.40 | n/a | n/a | n/a |
| TH 10 | 150.0 | 149.2 | 4.00 | 0.80 | 4.00 | 3.20 |
| TH 11 | 150.0 | - | 4.00 | n/a | n/a | n/a |
| TH 12 | 149.7 | 148.2 | 3.90 | 1.50 | 3.90 | 2.40 |
| TH 13 | 149.5 | - | 2.70 | n/a | n/a | n/a |
| TH 14 | 150.0 | 149.0 | 3.30 | 1.00 | 3.30 | 2.30 |
| TH 15 | 150.0 | 148.8 | 3.00 | 1.20 | 3.00 | 1.80 |
| TH 16 | 148.5 | - | 1.50 | n/a | n/a | n/a |
| TH 17 | 149.5 | - | 2.60 | n/a | n/a | n/a |
| TH 18 | 144.0 | - | 1.80 | n/a | n/a | n/a |
| TH 19 | 146.5 | - | 2.00 | n/a | n/a | n/a |
| TH 20 | 147.5 | - | 4.00 | n/a | n/a | n/a |
| TH 21 | 143.0 | - | 2.00 | n/a | n/a | n/a |
| TH 22 | 143.5 | - | 3.00 | n/a | n/a | n/a |
| TH 23 | 150.0 | - | 1.20 | n/a | n/a | n/a |
| TH 24 | 150.5 | 149.5 | 3.00 | 1.00 | 3.00 | 2.00 |
| TH 25 | 150.0 | - | 3.20 | n/a | n/a | n/a |
| TH 26 | 148.0 | - | 2.80 | n/a | n/a | n/a |
| TH 27 | 150.7 | - | 1.20 | n/a | n/a | n/a |
| TH 28 | 142.0 | - | 2.60 | n/a | n/a | n/a |
| TH 29 | 138.3 | - | 1.60 | n/a | n/a | n/a |
| TH 30 | 140.0 | - | 2.60 | n/a | n/a | n/a |
| TH 31 | 140.1 | - | 2.80 | n/a | n/a | n/a |
| TH 32 | 140.5 | - | 1.20 | n/a | n/a | n/a |

Please refer to Appendix F. Drawing No 13-120-115 Trial hole Locations.

## 3.5 LATERAL EXTENT OF THE WASTE

Waste was encountered in 10 of the 32 trial holes excavated. The site is bordered by housing estates on the Northern, Southern and Western boundary and an undeveloped site on the south-eastern boundary. The site is secure and delineated by palisade fencing on the northern, southern, and south-eastern perimeter.

There was no waste encountered in the trial holes (TH 29, TH 30, TH 31, TH 32) excavated in the Council storage yard which is located in the most northerly aspect of the site. The most extensive quantities of waste were encountered towards the South East of the site on the upper level. The waste extends from the eastern boundary (TH 6) to the top of the slope (TH 12) in a northerly direction towards the Council storage yard. Negligible quantities of waste were found outside this area.

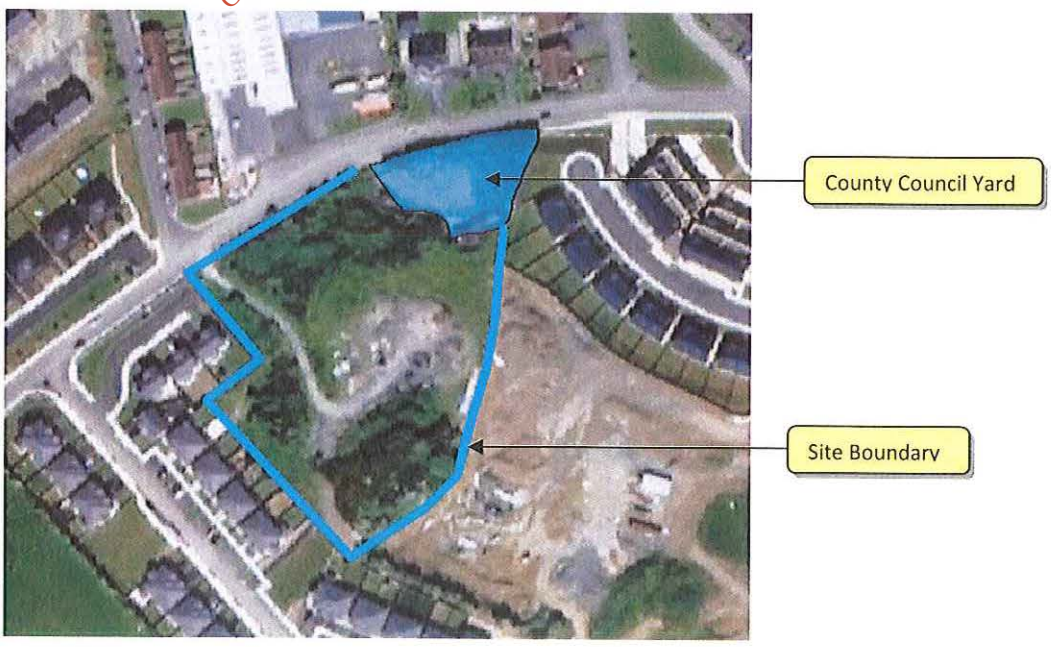
The lateral extent of the waste is shown in Drawing No. 13.120.111 - Appendix F and covers an area of approximately 2300 $m^2$. It is estimated, that approximately 6000 tonnes of waste is deposited at the site.

## 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. Datable material in the form of a newspaper article was unearthed during the trial hole excavations and was from the 23rd of September 1988. See photographic evidence. Photograph No. 12 on page 31 gives a clear indication of the longevity of dumping at the site. There was no evidence of any potentially hazardous waste on site which was apparent by the absence of oils, staining, odours, asbestos sheeting etc. Photographs 2. 11 which follow (pages 21 - 30) illustrate the types of waste encountered. Full trial holes assessment and logs can be found in Appendix A.

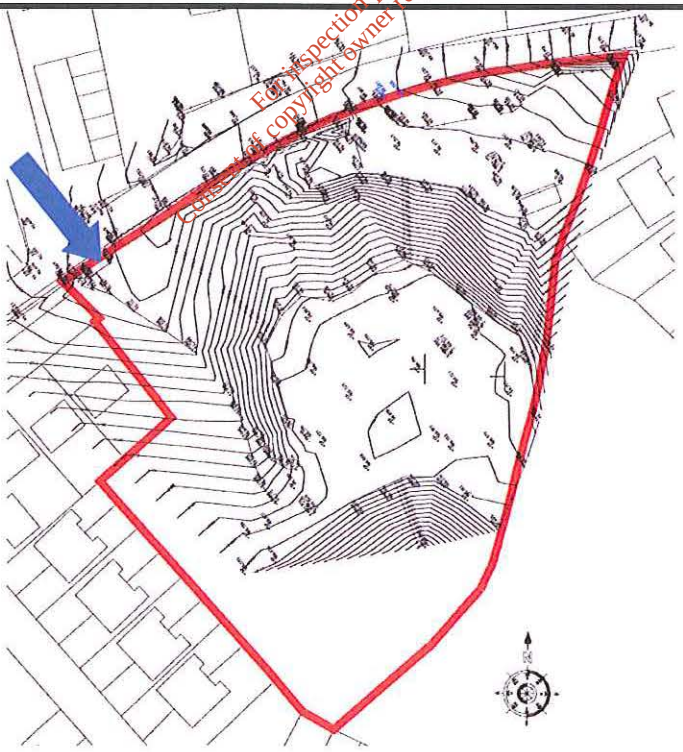


**Map showing the Location of County Council Storage Yard - hatched in blue.**



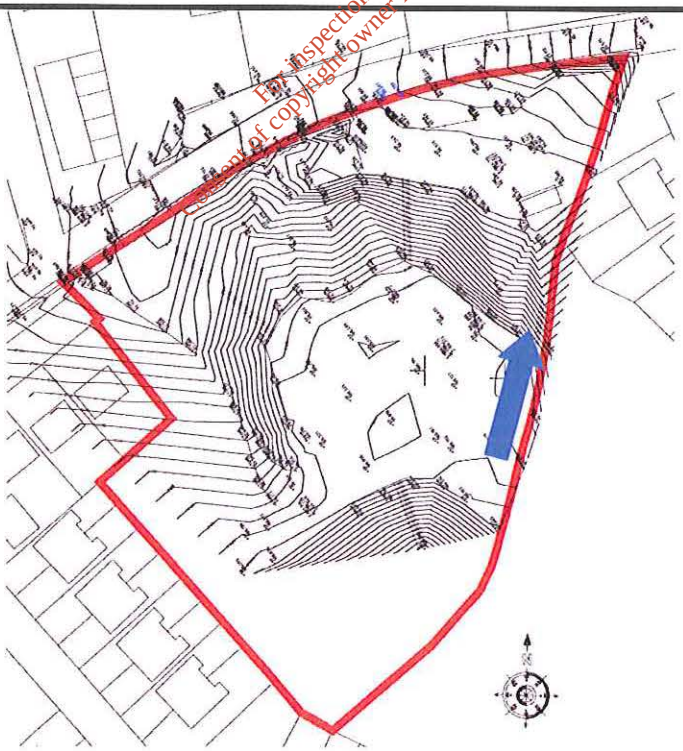
Photograph 1: Overgrown Vegetation at existing entrance to the site.

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

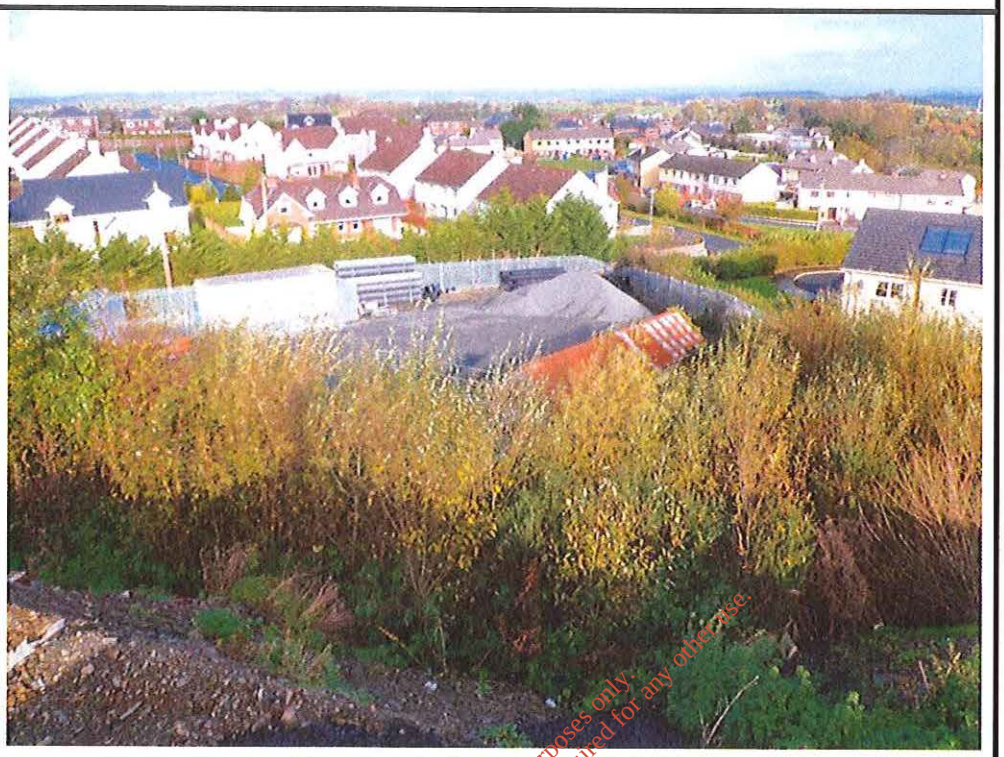


Photograph 1 A: Overgrown Vegetation along the eastern boundary.

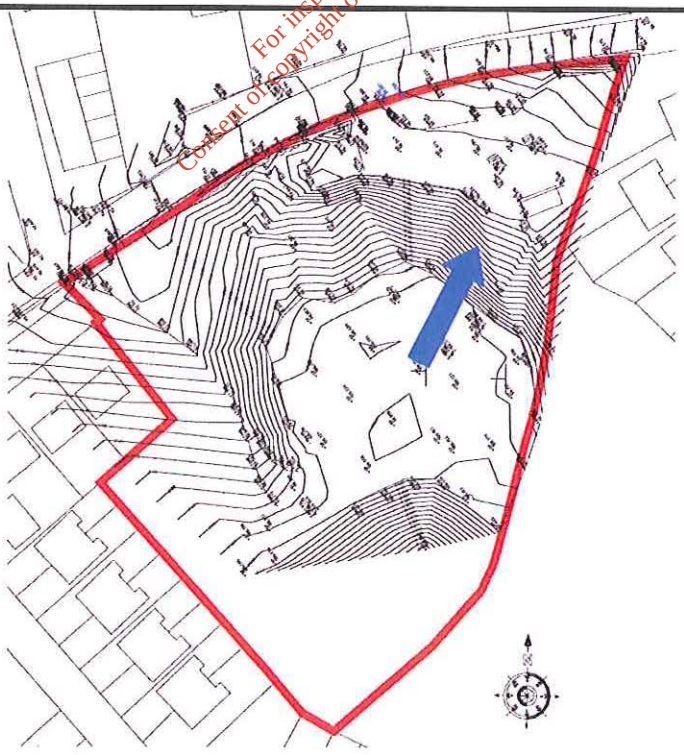
The blue arrow indicates direction and location of where photograph was taken.
Direction of Photo - Northeast



Photograph 1 B: View from the upper level of the site down to the Council Yard on the lower northern aspect of the site.

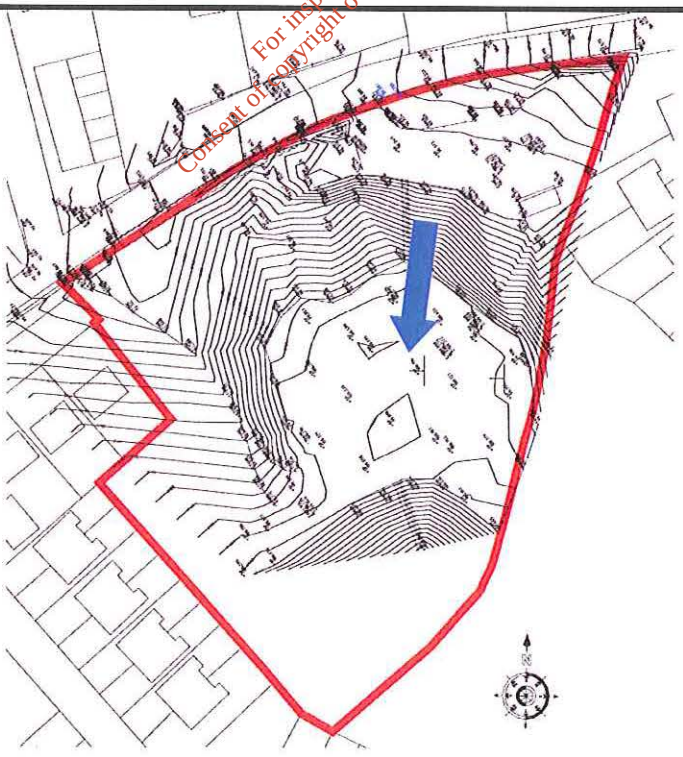


The blue arrow indicates direction and location of where photograph was taken.
Direction of Photo: Northeast



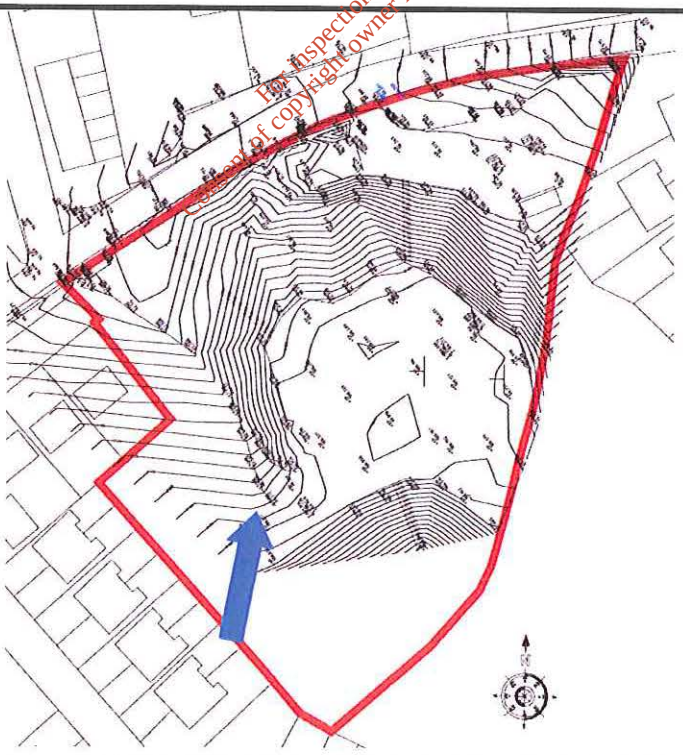
Photograph 1 C: View of vegetation surrounding the outcropping rock at the most elevated area towards the south of the site.

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



Photograph 1 D: Vehicle access to the upper area of the site via a steep gravel road.

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



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



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

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

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

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

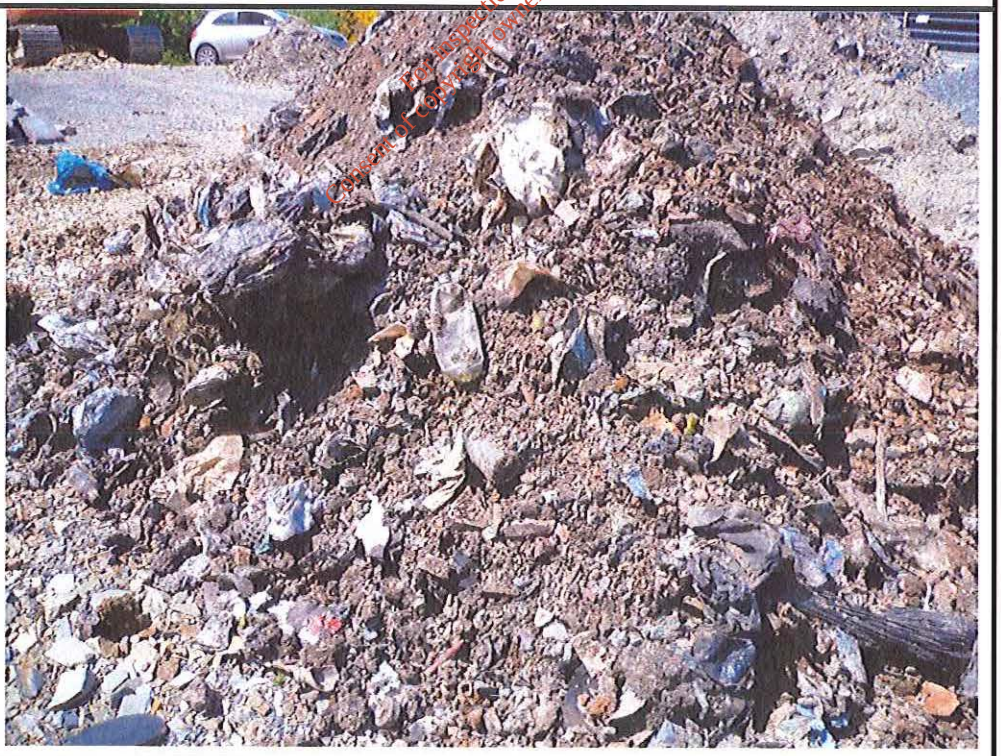
Photograph 7: Waste Contained in Trial Hole 10 (TH 10).

Photograph 8: Waste Contained in Trial Hole 12 (TH 12).

Photograph 9: Waste Contained in Trial Hole 14 (TH 14).

Photograph 10: Waste Contained in Trial Hole 15 (TH 15).

Photograph 11: Waste Contained in Trial Hole 24 (TH 24).



Photograph 12: Dateable Material – Newspaper Article.



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

### 3.7.1 Soils Sampling Results

3 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 10, TH 14 and TH 20(Control) were analysed for the following:

- Inorganics;
- Metals;
- Mineral Oil / Oils & Greases
- Extractable Petroleum Hydrocarbons (EPH)
- Polyaromatic Hydrocarbons (PAHs)
- Volatile Organic Compounds (VOCs)

The laboratory test results are included and summarised in Tables 5 and 10. The tables include the limits for Dutch Reference and Intervention values and each soil sample was compared to these. High Levels of some metals such as iron and magnesium could be related to geology, rock type, and/or parent material in the area.

Dutch Standards are 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 that was determined for the Netherlands.

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 a serious case of 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 site unused for waste disposal along the left side (as you enter the site)/ north east of the access road TH 20 was used as the control sample . TH 10 and TH 14 did not exceed the Dutch Reference values listed in table's no. 5- 10 with the exception of copper in TH14, which had a reading of (36 mg/kg). The Dutch Reference Value for copper is 36 mg/kg.

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 dangerous compounds were found in the soil samples analysed.

It should be noted that the copper in TH 14 with a result of 39(mg/kg) is only marginally above the Dutch Reference value. 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, for copper the intervention value is 190 (mg/kg). When analysing the results this should also be considered for exceedances measured in Nickel and Zinc.

**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 5: Inorganics - Soils Samples Results**

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Ammoniacal Nitrogen, exchangeable as $NH_4$ | 22.8 | <15 | 28.6 | n/a | n/a |
| Ammoniacal Nitrogen as N | 17.8 | <15 | 22.3 | n/a | n/a |
| pH (pH units) | 8.34 | 9.06 | 8.63 | n/a | n/a |
| Alkalinity, Total as CaCO3 | 218 | 244 | 249 | n/a | n/a |
| Conductivity @ 20 deg.C (mS/cm) | 2 | 2.31 | 2.14 | n/a | n/a |

Table 6: Metals - Soils Samples Results

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Copper | 27.5 | 31.9 | 39 | 36.0 | 190 |
| Iron | 43000 | 35200 | 46500 | *n/a* | *n/a* |
| Lead | 25.8 | 19.5 | 34.6 | 85.0 | 530 |
| Manganese | 804 | 690 | 661 | *n/a* | *n/a* |
| Mercury | <0.14 | <0.14 | <0.14 | 0.3 | 10.0 |
| Nickel | 58.2 | 50.4 | 53.4 | 35.0 | 210 |
| Phosphorus | 648 | 673 | 846 | *n/a* | *n/a* |
| Zinc | 140 | 102 | 138 | 140 | 720 |
| Sodium | 111 | 174 | 138 | *n/a* | *n/a* |
| Magnesium | 12600 | 12800 | 11500 | *n/a* | *n/a* |
| Potassium | 1370 | 1550 | 1580 | *n/a* | *n/a* |



Table 7: Mineral Oil / Oils & Greases Soil Sample Results

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Mineral oil >C10-C40 | 30.4 | 377 | 70.3 | *n/a* | 5000 |

Table 8: Extractable Petroleum Hydrocarbons (EPH) Soil Sample Results

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Interpretation | Bitumen/Tar | Bitumen/Tar | Bitumen/Tar | *n/a* | *n/a* |
| EPH Range >C10 - C40 | 365 | 1520 | 325 | *n/a* | *n/a* |

**Table 9: Polyaromatic Hydrocarbons (PAHs) USEPA Soil Sample Results**

| Parameter | Sample Control TH20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Naphthalene (%) | 99.5 | 90.9 | 96.4 | *n/a* | *n/a* |
| Acenaphthylene | <0.012 | <0.012 | 0.0164 | *n/a* | *n/a* |
| Acenaphthene | 0.0109 | <0.008 | <0.008 | *n/a* | *n/a* |
| Fluorene | <0.010 | <0.010 | <0.010 | *n/a* | *n/a* |
| Phenanthrene | 0.107 | 0.0272 | 0.125 | *n/a* | *n/a* |
| Anthracene | 0.0341 | <0.016 | 0.0433 | *n/a* | *n/a* |
| Fluoranthene | 0.494 | 0.0425 | 0.496 | *n/a* | *n/a* |
| Pyrene | 0.450 | 0.0488 | 0.467 | *n/a* | *n/a* |
| Benz(a)anthracene | 0.286 | 0.027 | 0.306 | *n/a* | *n/a* |
| Chrysene | 0.281 | 0.0183 | 0.285 | *n/a* | *n/a* |
| Benzo(b)fluoranthene | 0.367 | 0.0457 | 0.402 | *n/a* | *n/a* |
| Benzo(k)fluoranthene | 0.183 | 0.0159 | 0.175 | *n/a* | *n/a* |
| Benzo(a)pyrene | 0.349 | 0.0495 | 0.421 | *n/a* | *n/a* |
| Indeno(1,2,3-cd)pyrene | 0.228 | 0.0337 | 0.240 | *n/a* | *n/a* |
| Dibenzo(a,h)anthracene | 0.0549 | <0.023 | 0.0603 | *n/a* | *n/a* |
| Benzo(g,h,i)perylene | 0.307 | 0.076 | 0.318 | *n/a* | *n/a* |
| Polyaromatic hydrocarbons, Total USEPA 16 | 3.170 | 0.385 | 3.360 | *n/a* | 40 |

**Table 10: Volatile Organic Compounds (VOCs) Soil Sample Results**

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Dichlorodifluoromethane | 0.102 | 0.112 | 0.104 | *n/a* | *n/a* |
| Chloromethane | <0.007 | <0.140 | <0.007 | *n/a* | *n/a* |
| Vinyl Chloride | <0.010 | <0.200 | <0.010 | *n/a* | *n/a* |
| Bromomethane | <0.013 | <0.260 | <0.013 | *n/a* | *n/a* |
| Chloroethane | <0.014 | <0.280 | <0.014 | *n/a* | *n/a* |
| Trichlorofluorormethane | <0.006 | <0.120 | <0.006 | *n/a* | *n/a* |
| 1.1-Dichloroethene | <0.010 | <0.200 | <0.010 | - | 0.3 |
| Carbon Disulphide | <0.007 | <0.140 | <0.007 | *n/a* | *n/a* |
| Dichloromethane | <0.010 | <0.200 | <0.010 | - | 3.9 |
| Methyl Tertiary Butyl Ether | <0.011 | <0.220 | <0.011 | *n/a* | *n/a* |
| trans-1-2-Dichloroethene | <0.011 | <0.220 | <0.011 | *n/a* | *n/a* |
| 1.1-Dichloroethane | <0.008 | <0.160 | <0.008 | - | 15 |
| cis-1-2-Dichloroethene | <0.005 | <0.100 | <0.005 | *n/a* | *n/a* |
| 2.2-Dichloropropane | <0.012 | <0.240 | <0.012 | *n/a* | *n/a* |
| Bromochloromethane | <0.014 | <0.280 | <0.014 | *n/a* | *n/a* |
| Chloroform | <0.008 | <0.160 | <0.008 | - | 5.6 |
| 1.1.1-Trichloroethane | <0.007 | <0.140 | <0.007 | - | 15 |
| 1.1-Dichloropropene | <0.011 | <0.220 | <0.011 | *n/a* | *n/a* |
| Carbontetrachloride | <0.014 | <0.280 | <0.014 | *n/a* | *n/a* |
| 1.2-Dichloroethane | <0.005 | <0.100 | <0.005 | - | 6.4 |
| Benzene | <0.009 | <0.180 | <0.009 | *n/a* | *n/a* |

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Trichloroethene | <0.009 | <0.180 | <0.009 | - | 2.5 |
| 1.2-Dichloropropane | <0.012 | <0.240 | <0.012 | n/a | n/a |
| Dibromomethane | <0.009 | <0.180 | <0.009 | n/a | n/a |
| Bromodichloromethane | <0.007 | <0.140 | <0.007 | n/a | n/a |
| cis-1-3-Dichloropropene | <0.014 | <0.280 | <0.014 | n/a | n/a |
| Toluene | <0.005 | <0.100 | <0.005 | n/a | 320 |
| trans-1-3-Dichloropropene | <0.100 | <2 | <0.100 | n/a | n/a |
| 1.1.2-Trichloroethane | <0.010 | <0.200 | <0.010 | n/a | n/a |
| 1.3-Dichloropropane | <0.007 | <0.140 | <0.007 | n/a | n/a |
| Tetrachloroethene | <0.005 | <0.100 | <0.005 | - | 8.8 |
| Dibromochloromethane | <0.013 | <0.260 | <0.013 | n/a | n/a |
| 1.2-Dibromoethane | <0.012 | <0.240 | <0.012 | n/a | n/a |
| Chorobenzene | <0.005 | <0.100 | <0.005 | n/a | n/a |
| 1.1.1.2-Tetrachloroethane | <0.010 | <0.200 | <0.010 | n/a | n/a |
| Ethylbenzene | <0.004 | <0.080 | <0.004 | n/a | n/a |
| p/m-Xylene | <0.014 | <0.280 | <0.014 | n/a | n/a |
| o-Xylene | <0.010 | <0.200 | <0.010 | n/a | n/a |
| Styrene | <0.010 | <0.200 | <0.010 | n/a | n/a |
| Bromoform | <0.010 | <0.200 | <0.010 | n/a | n/a |
| Isopropylbenzene | <0.005 | <0.100 | <0.005 | n/a | n/a |
| 1.1.2.2-Tetrachloroethane | <0.010 | <0.200 | <0.010 | n/a | n/a |
| 1.2.3-Trichloropropane | <0.017 | <0.340 | <0.017 | n/a | n/a |

| Parameter | Sample Control TH 20 | Sample No.2 TH 10 | Sample No.3 TH14 | Dutch Intervention Values Reference Value (mg/kg) | Dutch Intervention Values Intervention Value (mg/kg) |
|---|---|---|---|---|---|
| Bromobenzene | <0.010 | <0.200 | <0.010 | n/a | n/a |
| Propylbenzene | <0.011 | <0.220 | <0.011 | n/a | n/a |
| 2-Chlorotoluene | <0.009 | <0.180 | <0.009 | n/a | n/a |
| 1.3.5-Trimethylbenzene | <0.008 | <0.160 | <0.008 | n/a | n/a |
| 4-Chlorotoluene | <0.012 | <0.240 | <0.012 | n/a | n/a |
| tert-Butylbenzene | <0.012 | <0.240 | <0.012 | n/a | n/a |
| 1.2.4-Trimethylbenzene | <0.009 | <0.180 | <0.009 | n/a | n/a |
| sec-Butylbenzene | <0.010 | <0.200 | <0.010 | n/a | n/a |
| 4-Isopropyltoluene | <0.011 | <0.220 | <0.011 | n/a | n/a |
| 1.3-Dichlorobenzene | <0.006 | <0.120 | <0.006 | n/a | n/a |
| 1.4-Dichlorobenzene | <0.005 | <0.100 | <0.005 | n/a | n/a |
| n-Butylbenzene | <0.010 | <0.200 | <0.010 | n/a | n/a |
| 1.2-Dichlorobenzene | <0.012 | <0.240 | <0.012 | n/a | n/a |
| 1.2-Dibromo-3-chloropropane | <0.014 | <0.280 | <0.014 | n/a | n/a |
| Tert-amyl methyl ether | <0.015 | <0.300 | <0.015 | n/a | n/a |
| 1.2.4-Trichlorobenzene | <0.006 | <0.120 | <0.006 | n/a | n/a |
| Hexachlorobutadiene | <0.012 | <0.240 | <0.012 | n/a | n/a |
| Naphthalene | <0.013 | <0.260 | <0.013 | n/a | n/a |
| 1.2.3-Trichlorobenzene | <0.006 | <0.120 | <0.006 | n/a | n/a |

### 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

There was no surface water encountered at the site therefore no surface water sampling took place.

### 3.7.4 Landfill Gas Monitoring

#### 3.7.4.1 Introduction

Landfill gas is the 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 content 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, 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 10m3 of gas produced per tonne of deposited waste.



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. From the low levels of landfill gas deselected at the site, in particular those outside the main area of waste (gas well No 4, 5, 6 Drawing Ref: 13.120.113 - Appendix F) lateral gas migration is not thought to be a concern.

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 site investigation of vegetation being effected in any way at Kingscourt 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 graph differs depending mainly on the nature of waste being infilled and the life span of the Landfill.

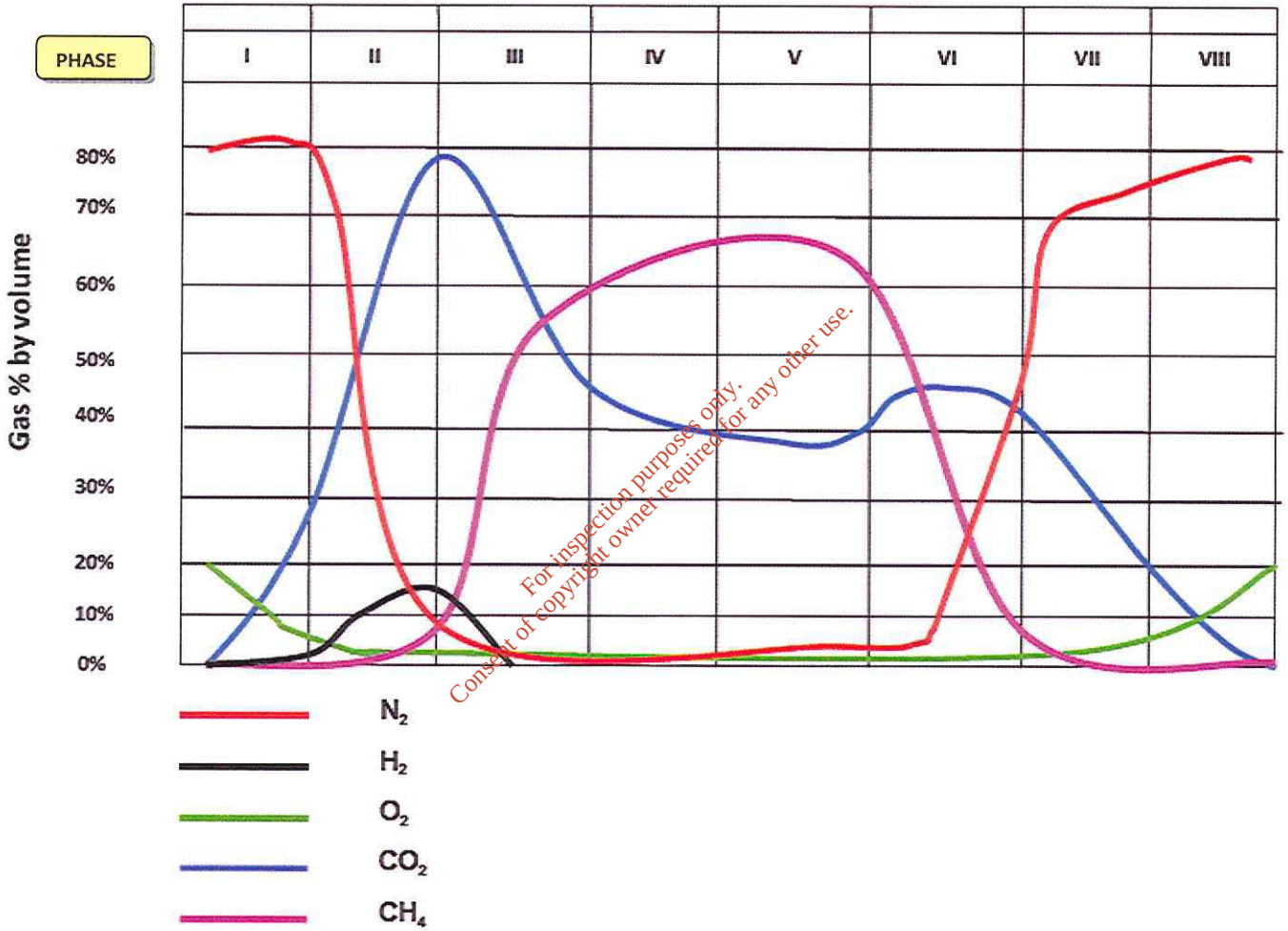
Christian and Kjedsen (1989) identified eight distinct phases in the evolution of landfill gas (Figure No.2). The duration of each of these phases is highly variable. Apart from the initial aerobic decomposition, which may be complete in days to months, the remaining phases have durations measured in 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. 2 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 site investigation works carried out, Kingscourt 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. 2 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 Kingscourt Historic Landfill. Traynor Environmental takes into account all Health and Safety considerations.

### 3.7.4.4 Standpipe Installation for Landfill Gas Monitoring

Six trial pits were strategically located around the site. Gas Wells (GW) 1 – 3 were placed in the main waste body located to the Southeast of the site. GW4 was located on the Western boundary of the site adjacent to a residential housing estate where a small amount of waste was encountered. GW5 and GW6 were located in the lower yard area to the North of the site which is currently used as a storage area by Cavan County Council; no waste was encountered in GW5 and GW6.

GW4, GW5 and GW6 was used to assess whether there was any mitigation of gas away from the main waste body located to the Southeast of the site.

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 100mm diameter slotted land drain 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 100mm 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 have been bored to within 500mm of the surface to allow gas to pass into the pipe ensuring that the pipe which is above the surface of the ground is not bored but capped off with removable stop-ends to facilitate gas monitoring.

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

### 3.7.4.5 Monitoring Locations

The locations of the Gas Monitoring Wells are presented in table No. 12 and Figure No. 3 below.

**Table No. 11 Gas Monitoring Stand Pipe Locations**

| Gas Monitoring Well | Location | Grid Reference | Depth of Standpipe | Waste Present |
|---|---|---|---|---|
| GW 1 | Southeast of Site | E 277998, N 295715 | 4.00m | Yes |
| GW 2 | Southeast of Site | E 278001, N 295755 | 3.80m | Yes |
| GW 3 | Southeast of Site | E 277986, N 295755 | 4.10m | Yes |
| GW 4 | Western Boundary | E 277959, N 295714 | 3.70m | No |
| GW 5 | North of Site | E 277954, N 295796 | 2.70m | No |
| GW 6 | North of Site | E 278021, N 295797 | 1.50m | No |

**Figure No. 3 Gas Monitoring Stand Pipe Locations**

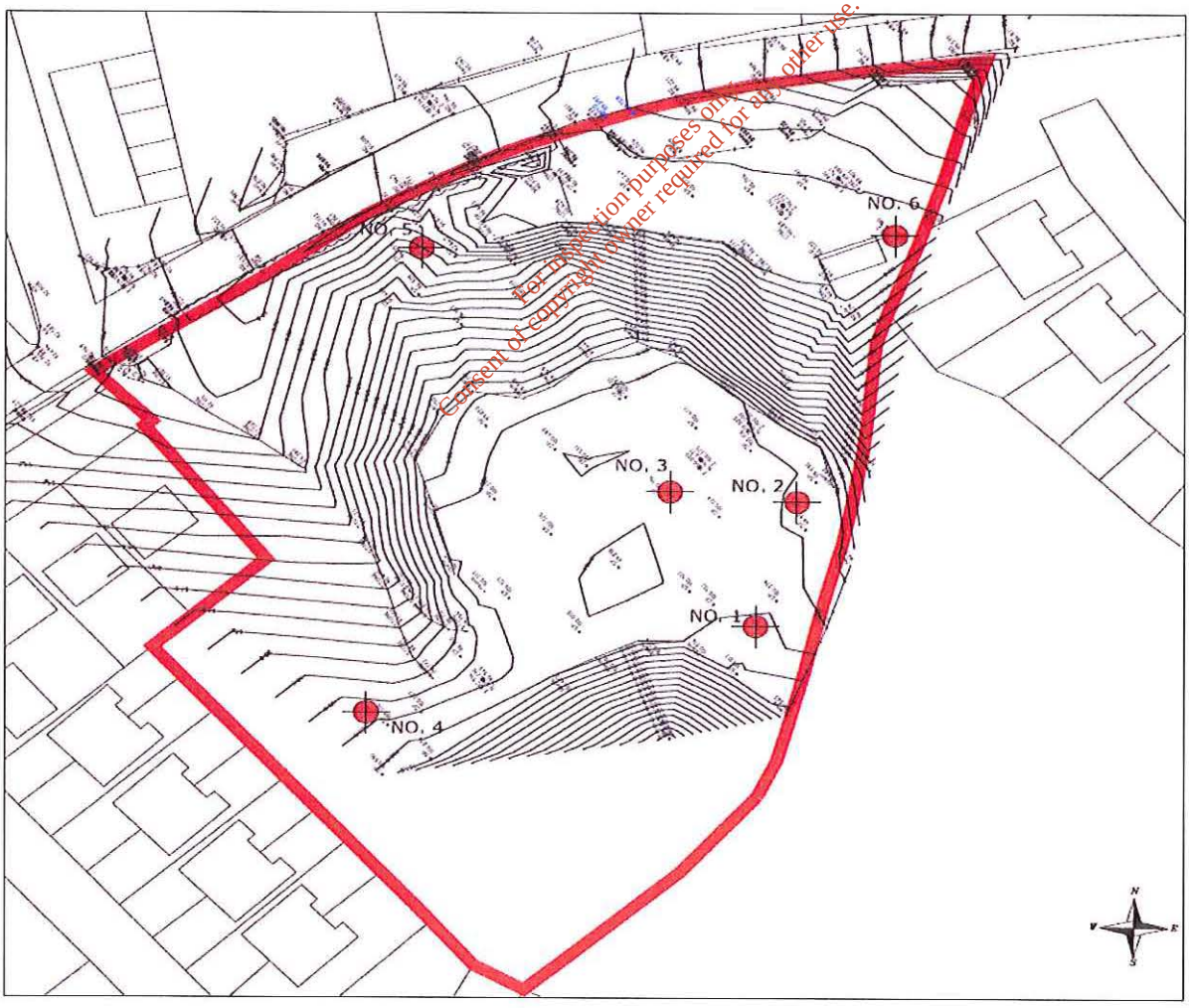
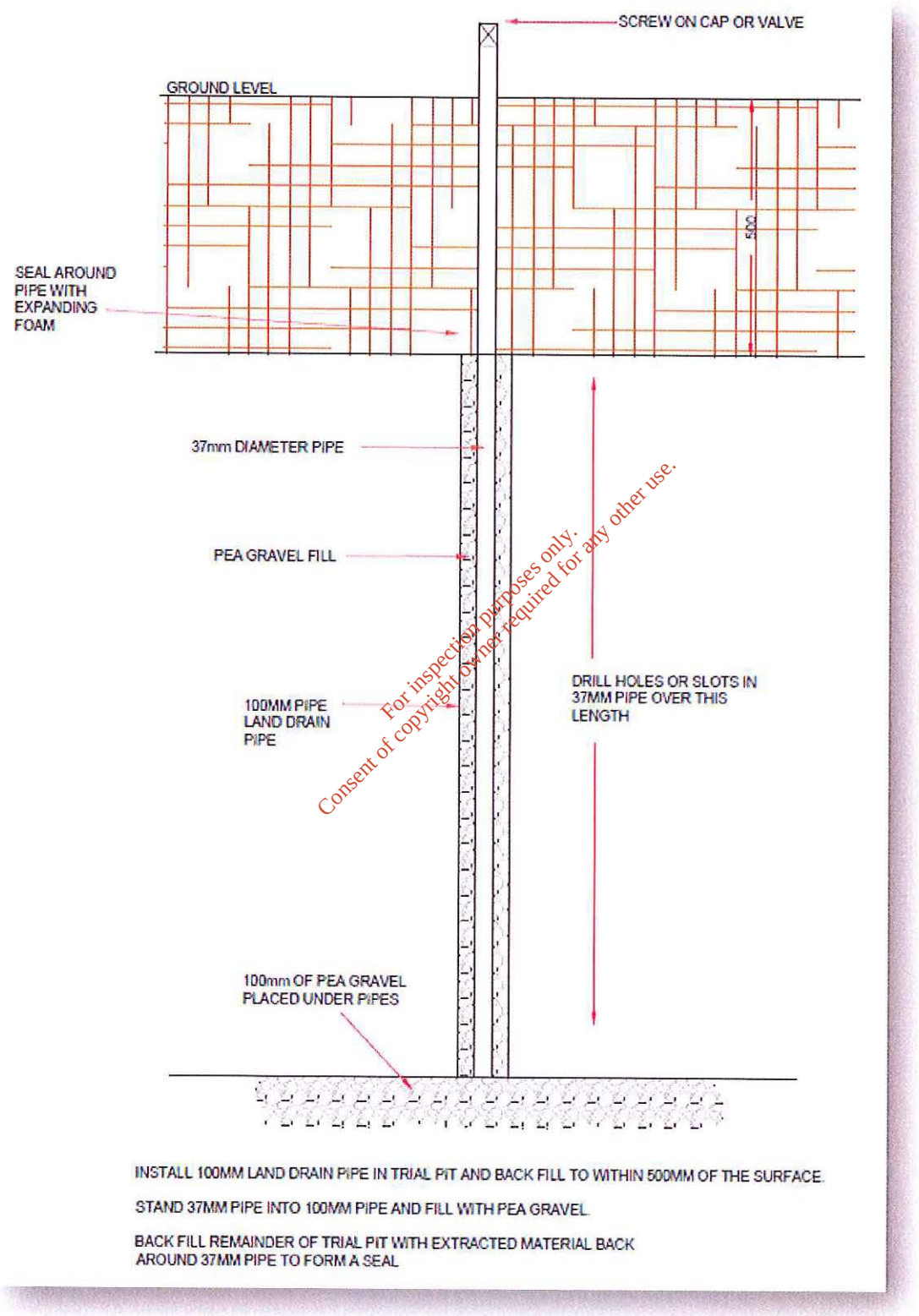


**Figure No. 4: Landfill Gas Standpipe Construction**



### 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 14 No. occasions between 11th July 2013 and the 26th August 2013. 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 14 scheduled Monitoring events that have been completed by Traynor Environmental Ltd are as follows:



**Table No. 12 Summary of Gas Monitoring Events**

| No. | Landfill Gas Monitoring Event | Date |
|---|---|---|
| M 1 | Event Number 1 | 11/07/2013 |
| M 2 | Event Number 2 | 16/07/2013 |
| M 3 | Event Number 3 | 18/07/2013 |
| M 4 | Event Number 4 | 22/07/2013 |
| M 5 | Event Number 5 | 26/07/2013 |
| M 6 | Event Number 6 | 29/07/2013 |
| M 7 | Event Number 7 | 02/08/2013 |
| M 8 | Event Number 8 | 06/08/2013 |
| M 9 | Event Number 9 | 09/08/2013 |
| M 10 | Event Number 10 | 12/08/2013 |
| M 11 | Event Number 11 | 16/08/2013 |
| M 12 | Event Number 12 | 21/08/2013 |
| M 13 | Event Number 13 | 23/08/2013 |
| M 14 | Event Number 14 | 26/08/2013 |

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 15min period was also completed on the 10th October 2013. 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 of landfill gas migration to offsite receptors from Kingscourt historic landfill.

### 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 13 - 18 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 0.05% v/v to 0.4 % v/v. Carbon Dioxide concentrations ranged from 1.4 % v/v to 8.6% v/v. Hydrogen sulphide was detected at a concentration of 1ppm on 2 occasions (11/07/2013 and 18/07/2013). Carbon Monoxide was detected on 5 occasions (11/07/2013, 18/07/2013, 22/07/2013, 26/07/2013 and 29/07/2013) at a concentration of 0.5ppm.

#### *GW 2 Monitoring*

Stable methane concentrations ranged from 1.8% v/v to 3.8 % v/v. Carbon Dioxide concentrations ranged from 5.55% v/v to 9.25% v/v. Hydrogen sulphide was detected at a concentration of 0.5ppm on 1 occasion (11/07/2013). Carbon Monoxide was detected on 6 occasions (11/07/2013, 16/07/2013, 18/07/2013, 22/07/2013, 26/07/2013 and 29/07/2013) at concentrations of 4ppm, 1ppm, 3ppm, 2ppm, 1ppm, and 1.5ppm.

### *GW 3 Monitoring*

Stable methane concentrations ranged from 0.05% v/v to 0.9 % v/v. Carbon Dioxide concentrations ranged from 1.05% v/v to 11.05% v/v. A carbon dioxide range such as this reaffirms that Kingscourt Historic Landfill is in phase VII of the graph located in section 3.7.4.2 of this report. Hydrogen sulphide was detected on 2 occasions (11/07/2013 and 18/07/2013) at concentrations of 0.5 ppm and 1ppm. Carbon Monoxide was detected on 4 occasions (11/07/2013, 18/07/2013, 22/07/2013 and 09/08/2013) at concentrations of 2.5ppm, 2ppm, 1ppm, and 0.5ppm.

### *GW 4 Monitoring*

Stable methane concentrations ranged from 0.0% v/v to 0.3 % v/v. Carbon Dioxide concentrations ranged from 1.5 % v/v to 3.45% v/v. Hydrogen sulphide was detected on 1 occasion (18/07/2013) at a concentration of 0.5 ppm. Carbon Monoxide was detected on 6 occasions (11/07/2013, 16/07/2013, 18/07/2013, 22/07/2013, 26/07/2013 and 09/08/2013) at concentrations of 2ppm, 1ppm, 1ppm, 1ppm, 0.5ppm and 0.5ppm.

### *GW 5 Monitoring*

Stable methane concentrations ranged from 0.05% v/v to 0.3% v/v. Carbon Dioxide concentrations ranged from 0.3 % v/v to 3.1% v/v. Hydrogen sulphide was detected at a concentration of 1ppm on 1 occasion (11/07/2013). Carbon Monoxide was detected on 4 occasions (18/07/2013, 22/07/2013, 26/07/2013 and 29/07/2013) at a concentration of 0.5ppm.

### *GW 6 Monitoring*

Stable methane concentrations ranged from 0.0% v/v to 0.25% v/v. Carbon Dioxide concentrations ranged from 0.2 % v/v to 3.25% v/v. Hydrogen sulphide was detected at a concentration of 0.5 ppm on 1 occasion (18/07/2013). Carbon Monoxide was detected on 3 occasions (11/07/2013, 18/07/2013, and 22/07/2013) at concentrations of 1ppm, 1ppm and 0.5ppm.



These low levels of landfill gas, reflect the positioning of Kingscourt Landfill in phase VII on the graph in Figure No. 2 (Production and Composition of Landfill Gas). These are also known as the (IV) Methane fermentation and (V) maturation phase. 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. From analysis of the landfill gas results it is clear that methane concentrations in all but one (GW No. 2) of the gas monitoring wells are below this level.

### 3.7.4.9 Extended Gas Monitoring

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 of landfill gas migration to offsite receptors from Kingscourt historic landfill. Extended gas monitoring (15 minutes per location) was completed at all No. 6 gas monitoring wells (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, GW4, GW5, GW6.
- Increased very slightly and decreased back to almost same level – GW2.
- Concentrations increased very slightly over time - GW3

Carbon Dioxide

- Concentrations decreased overtime and increased back to almost same level – GW1.
- A insignificant increase and decrease was seen but overall concentrations remained more or less the same – GW2.
- Concentrations increased over time – GW3.
- Concentrations decreased very slightly overtime and increased back to initial levels recorded – GW4.
- Concentrations remained the same – GW5.
- Concentrations decreased very slightly over time – GW6.

Landfill gas levels recorded at the Kingscourt site are not significant to cause risk to any of the receptors identified. Through detailed monitoring of the site it has been ascertained that the lateral migration of landfill gas is not occurring.

The results of the gas monitoring indicate that outside the gas body the levels of Methane detected were below the Trigger Levels recommended in table 7.1 of the Landfill Monitoring Manual, however the levels of Carbon dioxide exceeded the recommended Levels on a number of occasions, this would suggest that monitoring should continue in accordance with the Manual, however due to the limited site area and the proximity of the monitoring points outside the site fill area the levels of Carbon dioxide were not sufficient to cause a risk to adjoining properties. As part of the tier 3 additional gas monitoring points may be installed further from the filled area to check that landfill gas readings are below trigger levels set out in the Landfill Monitoring Manual.

Table No 13: Landfill Gas Monitoring Results - GW 1

| Monitoring Well I.D | Monitoring Event | Monitoring Date | Stable Methane ($CH_4$) | Peak Methane $CH_4$ | Carbon Dioxide ($CO_2$) | Oxygen ($O_2$) | Balance | Carbon Monoxide (CO) | Hydrogen Sulphide $H_2S$ | Barometric Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Units | % vol/vol | % vol/vol | % vol/vol | % vol/vol | % vol/vol | ppm | ppm | mb |
| GW 1 | M1 | 11/07/2013 | 0.4 | 0.4 | 5.45 | 10.55 | 83.55 | 0.5 | 1 | 1012 |
| | M2 | 16/07/2013 | 0.35 | 0.35 | 7.15 | 10.15 | 82.15 | 0 | 0 | 1009 |
| | M3 | 18/07/2013 | 0.25 | 0.35 | 6 | 12.9 | 80.75 | 0.5 | 1 | 1012 |
| | M4 | 22/07/2013 | 0.05 | 0.1 | 1.4 | 19 | 79.45 | 0.5 | 0 | 998 |
| | M5 | 26/07/2013 | 0.05 | 0.1 | 7.2 | 10.8 | 81.6 | 0.5 | 0 | 995.5 |
| | M6 | 29/07/2013 | 0.25 | 0.25 | 7 | 12.25 | 80.45 | 0.5 | 0 | 991.5 |
| | M7 | 02/08/2013 | 0.1 | 0.15 | 5.25 | 14.75 | 79.85 | 0 | 0 | 1006 |
| | M8 | 06/08/2013 | 0.1 | 0.1 | 6.75 | 12.85 | 80.15 | 0 | 0 | 999 |
| | M9 | 09/08/2013 | 0.15 | 0.15 | 3.9 | 11 | 84.85 | 0 | 0 | 1004 |
| | M10 | 12/08/2013 | 0.2 | 0.2 | 1.95 | 12.6 | 85.1 | 0 | 0 | 1002 |
| | M11 | 16/08/2013 | 0.1 | 0.1 | 8.6 | 10.15 | 80.45 | 0 | 0 | 997 |
| | M12 | 21/08/2013 | 0.2 | 0.2 | 2.8 | 12.1 | 84.9 | 0 | 0 | 1002 |
| | M13 | 23/08/2013 | 0.1 | 0.2 | 4.65 | 16.45 | 78.65 | 0 | 0 | 996 |
| | M14 | 26/08/2013 | 0.1 | 0.1 | 4.05 | 16.3 | 79.55 | 0 | 0 | 1006 |

## Table No 14: Landfill Gas Monitoring Results - GW 2

| Monitoring Well I.D | Monitoring Event | Monitoring Date | Stable Methane ($CH_4$) | Peak Methane $CH_4$ | Carbon Dioxide ($CO_2$) | Oxygen ($O_2$) | Balance | Carbon Monoxide (CO) | Hydrogen Sulphide $H_2S$ | Barometric Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Units | % vol/vol | % vol/vol | % vol/vol | % vol/vol | % vol/vol | ppm | ppm | mb |
| GW 2 | M1 | 11/07/2013 | 2.8 | 2.8 | 6.3 | 0.75 | 90.1 | 4 | 0.5 | 1012 |
| | M2 | 16/07/2013 | 3 | 3 | 6.7 | 0.6 | 89.6 | 1 | 0 | 1009 |
| | M3 | 18/07/2013 | 2.55 | 2.55 | 6.9 | 0.6 | 89.85 | 3 | 0 | 1012 |
| | M4 | 22/07/2013 | 2.05 | 2.05 | 9.25 | 0.95 | 87.75 | 2 | 0 | 998 |
| | M5 | 26/07/2013 | 2.4 | 2.4 | 7.9 | 0.4 | 89.2 | 1 | 0 | 995 |
| | M6 | 29/07/2013 | 2.75 | 2.75 | 7.15 | 0.75 | 89.35 | 1.5 | 0 | 992 |
| | M7 | 02/08/2013 | 3.15 | 3.2 | 6 | 1.9 | 88.85 | 0 | 0 | 1005 |
| | M8 | 06/08/2013 | 3 | 3 | 6.45 | 0.2 | 90.25 | 0 | 0 | 999 |
| | M9 | 09/08/2013 | 1.8 | 1.8 | 6.65 | 1 | 90.4 | 0 | 0 | 1004 |
| | M10 | 12/08/2013 | 2.35 | 2.45 | 6.55 | 0.4 | 90.6 | 0 | 0 | 1002 |
| | M11 | 16/08/2013 | 3 | 3 | 6.25 | 0.55 | 90.1 | 0 | 0 | 997 |
| | M12 | 21/08/2013 | 1.8 | 1.8 | 5.55 | 3.05 | 89.55 | 0 | 0 | 1002.5 |
| | M13 | 23/08/2013 | 3.8 | 3.8 | 6.3 | 0.05 | 89.75 | 0 | 0 | 996 |
| | M14 | 26/08/2013 | 3 | 3 | 6.05 | 2.45 | 88.4 | 0 | 0 | 1006 |

**Table No 15: Landfill Gas Monitoring Results - GW 3**

| Monitoring Well I.D | Monitoring Event | Monitoring Date | Stable Methane ($CH_4$) | Peak Methane $CH_4$ | Carbon Dioxide ($CO_2$) | Oxygen ($O_2$) | Balance | Carbon Monoxide (CO) | Hydrogen Sulphide $H_2S$ | Barometric Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Units | % vol/vol | % vol/vol | % vol/vol | % vol/vol | % vol/vol | ppm | ppm | mb |
| GW3 | M1 | 11/07/2013 | 0.35 | 0.35 | 2.6 | 12.8 | 84.25 | 2.5 | 0.5 | 1012 |
| | M2 | 16/07/2013 | 0.15 | 0.2 | 1.6 | 17.9 | 80.25 | 0 | 0 | 1009 |
| | M3 | 18/07/2013 | 0.2 | 0.2 | 1.9 | 17.05 | 80.85 | 2 | 1 | 1012.5 |
| | M4 | 22/07/2013 | 0.1 | 0.1 | 1.05 | 19.05 | 79.75 | 1 | 0 | 998 |
| | M5 | 26/07/2013 | 0.05 | 0.1 | 1.9 | 17.95 | 80.05 | 0 | 0 | 995 |
| | M6 | 29/07/2013 | 0.15 | 0.2 | 1.9 | 17.4 | 80.55 | 0 | 0 | 992.5 |
| | M7 | 02/08/2013 | 0.15 | 0.2 | 5.35 | 11.4 | 83.05 | 0 | 0 | 1005 |
| | M8 | 06/08/2013 | 0.25 | 0.25 | 5.3 | 11.55 | 82.85 | 0 | 0 | 999 |
| | M9 | 09/08/2013 | 0.2 | 0.2 | 7.6 | 5.65 | 86.4 | 0.5 | 0 | 1004 |
| | M10 | 12/08/2013 | 0.9 | 0.9 | 11.05 | 1.95 | 86 | 0 | 0 | 1003 |
| | M11 | 16/08/2013 | 0.5 | 0.5 | 7.5 | 3.4 | 88.5 | 0 | 0 | 997 |
| | M12 | 21/08/2013 | 0.1 | 0.15 | 1.9 | 17 | 80.95 | 0 | 0 | 1002.5 |
| | M13 | 23/08/2013 | 0.15 | 0.15 | 2.7 | 15.95 | 81.15 | 0 | 0 | 996 |
| | M14 | 26/08/2013 | 0.2 | 0.2 | 4.7 | 12.95 | 82.1 | 0 | 0 | 1006 |

**Table No 16: Landfill Gas Monitoring Results - GW 4**

| Monitoring Well I.D | Monitoring Event | Monitoring Date | Stable Methane ($CH_4$) | Peak Methane $CH_4$ | Carbon Dioxide ($CO_2$) | Oxygen ($O_2$) | Balance | Carbon Monoxide (CO) | Hydrogen Sulphide $H_2S$ | Barometric Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Units | % vol/vol | % vol/vol | % vol/vol | % vol/vol | % vol/vol | ppm | ppm | mb |
| GW 4 | M1 | 11/07/2013 | 0.3 | 0.3 | 1.95 | 14.6 | 82.55 | 2 | 0 | 1012 |
| | M2 | 16/07/2013 | 0.25 | 0.25 | 2.55 | 17.7 | 79.45 | 1 | 0 | 1009 |
| | M3 | 18/07/2013 | 0.25 | 0.25 | 2.35 | 17.25 | 80.1 | 1 | 0.5 | 1012 |
| | M4 | 22/07/2013 | 0.1 | 0.1 | 2.1 | 18.4 | 79.35 | 1 | 0 | 998 |
| | M5 | 26/07/2013 | 0 | 0.1 | 3.45 | 17.05 | 79.4 | 0.5 | 0 | 995 |
| | M6 | 29/07/2013 | 0.2 | 0.15 | 2.35 | 17.75 | 79.7 | 0 | 0 | 992 |
| | M7 | 02/08/2013 | 0.05 | 0.15 | 2.65 | 17.3 | 79.7 | 0 | 0 | 1005 |
| | M8 | 06/08/2013 | 0.15 | 0.15 | 3 | 17.3 | 79.55 | 0 | 0 | 999 |
| | M9 | 09/08/2013 | 0.1 | 0.1 | 2.7 | 17.4 | 79.75 | 0.5 | 0 | 1004 |
| | M10 | 12/08/2013 | 0.1 | 0.2 | 2 | 18.75 | 79.05 | 0 | 0 | 1004 |
| | M11 | 16/08/2013 | 0.1 | 0.1 | 1.55 | 19 | 79.25 | 0 | 0 | 997 |
| | M12 | 21/08/2013 | 0.1 | 0.1 | 1.5 | 18.95 | 79.35 | 0 | 0 | 1003 |
| | M13 | 23/08/2013 | 0.15 | 0.15 | 2.85 | 17.6 | 79.35 | 0 | 0 | 996 |
| | M14 | 26/08/2013 | 0.1 | 0.1 | 2.8 | 17.35 | 79.65 | 0 | 0 | 1006 |

## Table No 17: Landfill Gas Monitoring Results - GW 5

| Monitoring Well I.D | Monitoring Event | Monitoring Date | Stable Methane ($CH_4$) | Peak Methane $CH_4$ | Carbon Dioxide ($CO_2$) | Oxygen ($O_2$) | Balance | Carbon Monoxide (CO) | Hydrogen Sulphide $H_2S$ | Barometric Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Units | % vol/vol | % vol/vol | % vol/vol | % vol/vol | % vol/vol | ppm | ppm | mb |
| GW5 | M1 | 11/07/2013 | 0.3 | 0.3 | 0.3 | 16.15 | 83.1 | 0 | 0.5 | 1012 |
| | M2 | 16/07/2013 | 0.15 | 0.15 | 2.65 | 15.8 | 81.35 | 0 | 0 | 1010 |
| | M3 | 18/07/2013 | 0.15 | 0.2 | 0.6 | 18.25 | 80.85 | 0.5 | 0 | 1013 |
| | M4 | 22/07/2013 | 0.05 | 0.1 | 0.95 | 19.4 | 79.5 | 0.5 | 0 | 999.5 |
| | M5 | 26/07/2013 | 0.1 | 0.1 | 2.2 | 17.25 | 80.4 | 0.5 | 0 | 996 |
| | M6 | 29/07/2013 | 0.15 | 0.2 | 0.6 | 18.75 | 80.5 | 0.5 | 0 | 991.5 |
| | M7 | 02/08/2013 | 0.1 | 0.1 | 2.2 | 17.3 | 80.2 | 0 | 0 | 1006 |
| | M8 | 06/08/2013 | 0.1 | 0.1 | 1.6 | 18.85 | 79.35 | 0 | 0 | 1000 |
| | M9 | 09/08/2013 | 0.1 | 0.1 | 2.35 | 16.9 | 80.5 | 0 | 0 | 1006 |
| | M10 | 12/08/2013 | 0.2 | 0.2 | 1.6 | 18.75 | 79.55 | 0 | 0 | 1004 |
| | M11 | 16/08/2013 | 0.1 | 0.1 | 3.1 | 15.45 | 81.25 | 0 | 0 | 998 |
| | M12 | 21/08/2013 | 0.1 | 0.1 | 2.3 | 16.9 | 80.5 | 0 | 0 | 1004 |
| | M13 | 23/08/2013 | 0.1 | 0.1 | 1.9 | 18.1 | 79.8 | 0 | 0 | 997 |
| | M14 | 26/08/2013 | 0.1 | 0.1 | 2.05 | 17.85 | 79.9 | 0 | 0 | 1007 |

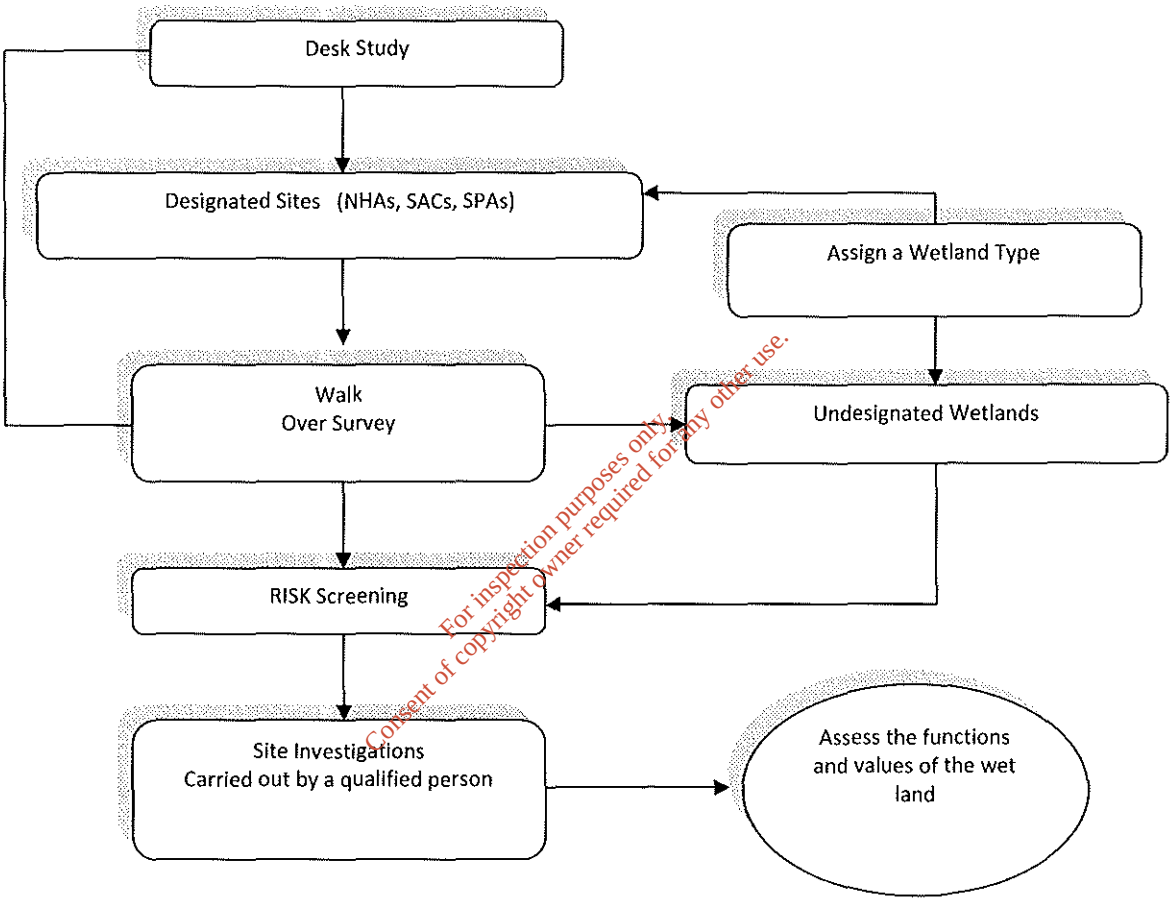
## Table No 18: Landfill Gas Monitoring Results - GW 6

| Monitoring Well I.D | Monitoring Event | Monitoring Date | Stable Methane ($CH_4$) | Peak Methane $CH_4$ | Carbon Dioxide ($CO_2$) | Oxygen ($O_2$) | Balance | Carbon Monoxide (CO) | Hydrogen Sulphide $H_2S$ | Barometric Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Units | % vol/vol | % vol/vol | % vol/vol | % vol/vol | % vol/vol | ppm | ppm | mb |
| GW6 | M1 | 11/07/2013 | 0.25 | 0.25 | 0.3 | 16.15 | 83.2 | 1 | 0 | 1012 |
| | M2 | 16/07/2013 | 0.15 | 0.15 | 0.3 | 19.85 | 79.6 | 0 | 0 | 1010 |
| | M3 | 18/07/2013 | 0.1 | 0.2 | 0.2 | 16.8 | 82.6 | 1 | 0.5 | 1012.5 |
| | M4 | 22/07/2013 | 0.05 | 0.05 | 3.25 | 13.85 | 82.85 | 0.5 | 0 | 999.5 |
| | M5 | 26/07/2013 | 0 | 0.1 | 0.85 | 19.35 | 79.7 | 0 | 0 | 996 |
| | M6 | 29/07/2013 | 0.1 | 0.2 | 2.2 | 18.05 | 79.65 | 0 | 0 | 992 |
| | M7 | 02/08/2013 | 0.1 | 0.15 | 1.3 | 16.9 | 81.65 | 0 | 0 | 1007 |
| | M8 | 06/08/2013 | 0.1 | 0.1 | 0.75 | 19.3 | 79.75 | 0 | 0 | 1000 |
| | M9 | 09/08/2013 | 0.1 | 1.5 | 1.45 | 17.2 | 81.15 | 0 | 0 | 1006 |
| | M10 | 12/08/2013 | 0.1 | 0.2 | 0.75 | 19.45 | 79.45 | 0 | 0 | 1004 |
| | M11 | 16/08/2013 | 0.1 | 0.1 | 0.6 | 19.55 | 79.55 | 0 | 0 | 998 |
| | M12 | 21/08/2013 | 0.1 | 0.2 | 0.25 | 20.05 | 79.45 | 0 | 0 | 1004 |
| | M13 | 23/08/2013 | 0.1 | 0.15 | 0.75 | 19.6 | 79.45 | 0 | 0 | 997 |
| | M14 | 26/08/2013 | 0.05 | 0.1 | 1.05 | 17.6 | 81.2 | 0 | 0 | 1007 |

## 3.8 ECOLOGICAL ASSESSMENT OF SITE

An ecological survey of the historic landfill site at Kingscourt was carried out in August 2013 by Noreen McLoughlin, MSc. MIEEM on behalf of Traynor Environmental Ltd.

**Figure No 5: 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 Dunaree was carried out using aerial photographs, ground photographs and historical maps. There are no rivers, streams or drainage ditches within or adjacent to the site and thus no biological sampling was carried out.

### 3.8.2 Description of the Existing Environment

The site in question is located in the townland of Dunaree, on the western outskirts of Kingscourt town, approximately 0.6 km west of the town centre. It is located in an area that is predominantly surrounded by residential land, much of which has been developed since 2005. The OSI (Ordinance Survey of Ireland) 6 inch maps for Kingscourt, drawn between 1829 and 1842, depict the site of the landfill as a quarry. Upon cessation of quarrying, the area was gradually filled in again with waste until 1991. The site is approximately 1.2 hectares in area. Since the closure of the landfill it has been capped with soil and it has re-vegetated.

#### Designated Areas and Habitats

There are no designated sites adjacent to or close to the site of the old landfill. The main vegetated habitats on the site of the disused landfill occur on the lower area of the site, adjacent to the road. These habitats 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. Outcropping of rock occurs in various locations around the site.

The upper section of the site, further from the road, currently is devoid of any vegetation. Aerial photographs from Ordnance Survey Ireland 2000 show that this area was then significantly more covered with vegetation, and there was a much less division of habitat corridors.



**Figure No. 6 - Ordnance Survey Ireland Map showing the vegetation cover in the site in 2000**

### 3.8.3 Ongoing Impacts and Assessment

The lower part of the site closer to the road, is dominated by scrub and hedgerow habitats. A habitat like this in a residential / urban area would be considered of local importance for biodiversity, as it would provide shelter, nesting and feeding sites for local populations of small passerine birds and mammals. However, little ecological connectivity between this area and the open countryside now exists. Habitats have become fragmented due to disturbance and development.

The upper site that is devoid of vegetation has no ecological value, although its open nature may provide some foraging opportunities for birds of prey hunting small mammals.

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 should 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 13.120.100). The CSM will be used to 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 CSM in the Tier 1 Assessment. The most recently landfilled waste is known to be form 1988, with much of the waste emanating from the 1970s and 1980s. The waste is covered by a thin layer of relatively impermeable soil and finished in some areas of the site with a another thin layer of gravel (areas used for council storage). The principle soils of Association 27 found in this area are Gleys (85%) and Interdrumlin Peat and Peaty Gleys (15%). It is likely that most of the rainfall reaching the base of the waste ultimately discharges through the bed rock.



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 and fissured bedrock, 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: 13.120.116).

### 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. Datable material in the form of a newspaper article was unearthed during the trial hole excavation and was from the year 1988.. There was no evidence of any potentially hazardous waste e.g. oils, asbestos, batteries, staining or odours. 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 0.50m to 4.60m across the site area where waste was encountered. The area covered by the waste body is estimated to be 2300 $m^2$. It is estimated, that approximately 6000 tonnes of waste is deposited at the site.

The northern and western extent of the waste body are defined by a steep slope leading towards the Rocks Road which borders the site to the north and the access road leading into the site to the west. The most southerly aspect of the waste body is defined by a rock face. Along the south-eastern boundary the waste is defined by the palisade fence which delineates the boundary of the site. Towards the northern aspect of the site no waste was encountered. This area is used as a council storage yard and bed rock was encountered in trial holes dug at the base of the slope leading to the main body of waste. Drawing No. 123.120.111 - 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.

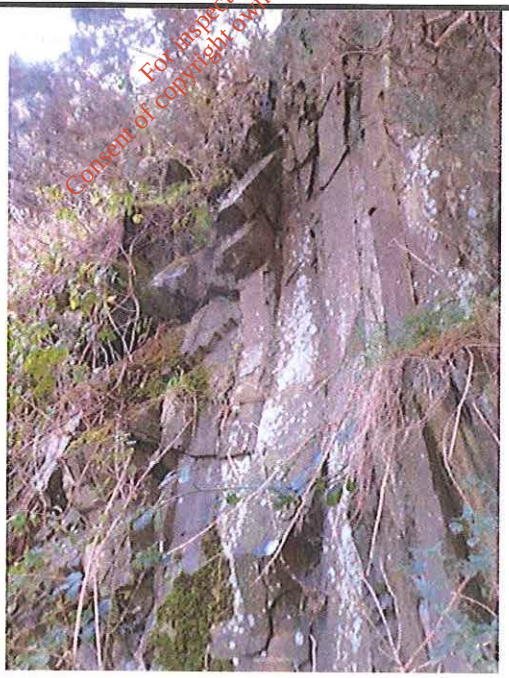


- meteorological conditions at the site
- waste composition (% of biodegradable waste)
- waste density
- overall depth of the landfill
- moisture content
- speed of liquid movement
- waste age
- the existence of any lining system

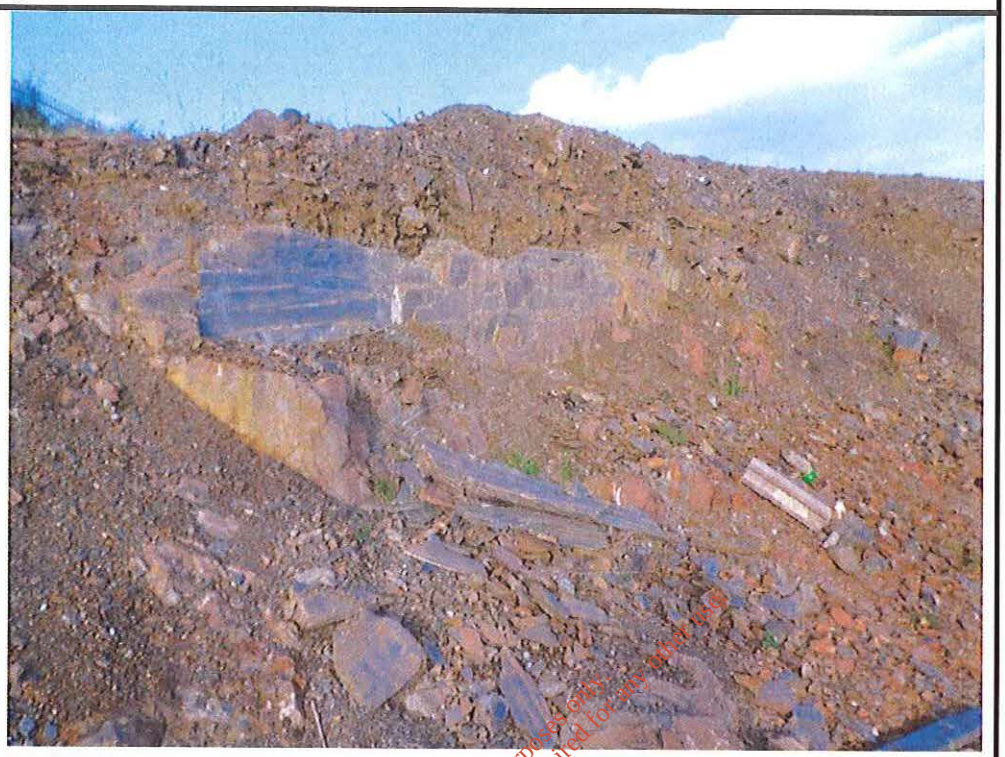
No leachate was encountered at Kingscourt historic landfill site during trial hole investigation. There is a considerable amount of outcropping rock in the area and historical the site has been documented as a quarry. It is likely that any of the rainfall which may reach the base of the waste ultimately discharges through the bed rock. Geological information of the area shows the bedrock lies at 76°, dipping towards the southeast. The bedding in the rock is vertical therefore any migration of leachate and/or rainfall will follow the joints in the rock and move downwards not laterally. There are no surface water drainage systems evident in the area or bordering the site hence no evidence has been obtained to show any migration of leachate which may exist.

Photograph 13: Out cropping rock located in the vicinity of TH 7

Photograph 14: Out cropping rock located in the vicinity of TH 8 and TH 9



Photograph 15: Area located just outside the southeast boundary of the site.





### 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 6 No. trial holes, 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 on the EPA web site. 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. 2 (GW2) showed the highest levels for both methane ($CH_4$ - 3.8 % v/v) and carbon dioxide ($CO_2$ - 9.25% v/v) while containing the lowest quantities of oxygen ($O_2$). Negligible amounts of methane concentrations were evident in all of the other gas well monitoring locations. Gas Well No. 1 contained the highest quantities of $CO_2$ with levels ranged from 1.4% to 8.6%. Low quantities of $CO_2$ were evident in GW 3 and GW 4. In general the $CO_2$ results fluctated greatly in each location. This indicates that the gas being generated from the biodegradation of the waste is not migrating away from the main body of waste.

## 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 this rating as out cropping rock was visible on the site. 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 – Bedrock which is generally unproductive except for local zones. This means that groundwater flow paths are short probably 10s to 100s of metres. Groundwater flow direction appears to be Southwest to Northeast.



### 4.3.3 Landfill Gas Pathways

The main pathway considered for landfill gas migration is through the subsoil and bedrock. There are no underground services, such as pipelines, drainage systems or manholes which can be potential pathways for landfill gas migration.

The stoney matrix clay cover material over the waste is free draining and landfill gas vents freely to atmosphere. As stated previously from the gas wells established on the site for monitoring purposes, only gas well No. 2 showed low levels of landfill gas. Stable methane concentrations ranged from 1.8% v/v to 3.8 % v/v. Carbon Dioxide concentrations ranged from 5.55% v/v to 9.25% v/v. Hydrogen sulphide was detected on one occasion at a concentration of 0.5ppm . Carbon Monoxide was detected ranging from 1ppm - 4ppm. Therefore the likelihood of landfill gas migration to nearby receptor 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 Kingscourt 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 SAC's SPA's or NHA's 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 Kingscourt. The current source of potable water for Kingscourt town is form Ervey Lough located 2km southwest of the site. This supply is supplemented by a well located at Cabragh Castel when needed. The future source of drinking water for the town is a well located in Descart, Co. Monaghan.



### 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. No surface water bodies were identified in the vicinity of the site.

## 4.4.2 Landfill gas Migration Receptors

### Human Presence

Human presence is considered to be the principal sensitive receptor with respect of 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 Kingscourt is situated in a highly developed urban area on the outskirts of the town. Housing estates located on the Northern, Southern and Western aspect of the site are 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 all of the housing developments boarding the site were constructed after the year 2000. Therefore the radon protection measures build into these homes offers a degree of protection in the unlikely event of any landfill gas migration.

The risk posed by landfill gas to off-site receptors is considered to be negligible. No evidence of land fill gas migration was found during the tier 2 investigations. Low levels of landfill gas were detected in GW No. 2 and levels recorded in GW No. 6 were negligible, which is the closest gas monitoring point to a residential property. GW No. 4 is located close to the southwest of the site which is bounded by a housing estate. There were little or no concentrations of landfill gas in monitoring results from GW

No .4. The methane range for GW No. 4 was 0 to 0.3% v/v and 0 to 0.25% v/v in GW No. 6. Results of monitoring carried out at GW No. 5, located close to the northern boundary of the site adjacent to industrial units, were also negligible. (Drawing 13.120.113 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 southern aspect of the site.
- The landfill material has been in place for >20 years
- This section of waste material could be deemed the highest risk area of the site.
- Low Levels of landfill gas were recorded in GW No. 2 where the waste deposited was deepest.
- The Landfill is in phase VII of the decomposition process. This is demonstrated in Figure No. 2 - section 3.7.4.2
- The landfill is unlined, 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.
- No Hazardous waste was encountered.
- The landfill is relatively shallow in relation to its plan area. This is due to the bed rock level in the site.
- The landfill material at present does not have an engineered cap and gas generated is most likely venting through the cover soils in a diffuse manner.
- Towards the northern aspect of the site no waste was encountered during extensive investigation, therefore landfill gas migration is not considered to be a risk from this area.
- 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 of landfill gas.

### 4.5.2 Risk Classification

**Table No. 19 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 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 site score was 70.

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 significantly less than initially though, which has changed the risk rating from high to medium. The waste footprint for Kingscourt Landfill is < 1 hectare and thus the scoring matrix assigns a value of 5 for both municipal and industrial waste. If the site was >1 hectare the scoring matrix will assign a value of 7 thus changing the site from a moderate risk site to a high risk site.

## 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 =** | **0** |

| 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 | 28 | 300 | Leachate → Surface Water | 9.33 |
| SPR 2 = 1a x (2a + 2b + 2c) x 3b | 0 | 300 | Leachate → SWDTE | 0.00 |
| SPR 3 = 1a x (2a + 2b) x 3a | 84 | 240 | Leachate → human Presence | 35.0 |
| SPR 4 = 1a x (2a + 2b) x 3b | 0 | 240 | Leachate → GWDTE | 0.00 |
| SPR 5 = 1a x (2a + 2b) x 3c | 28 | 400 | Leachate → Aquifer | 7.00 |
| SPR 6 = 1a x (2a + 2b) x 3d | 0 | 560 | Leachate → Surface Water | 0.00 |
| SPR 7 = 1a x (2a + 2b) x 3e | 28 | 240 | Leachate → SWDTE | 11.67 |
| 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 | 105 | 150 | Landfill Gas → Human Presence | 70.0 |
| SPR 11 = 1b x 2e x 3f | 105 | 250 | Landfill Gas → Human Presence | 42.0 |

| 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 | Highest Risk (Class A) |
|---|---|

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

**After The Tier 2 Risk Assessment**

| Risk Equation | SPR Values | Max Score | Linkages | Normalised Scores (%) |
|---|---|---|---|---|
| SPR 1 = 1a x (2a + 2b + 2c) x 3e | 0 | 300 | Leachate → Surface Water | 0.00 |
| 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 | 20 | 240 | Leachate → SWDTE | 0.00 |
| 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 was revised downwards to 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 being reduced from a High Risk Site (Class A) to a 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 was lesser than previously expected, accounting for approximately 2300m$^2$ (0.23 Ha). This has changed a number of SPR linkages, namely:

- SPR1 has changed from a linkage score of 9.33 to 0.00;
- SPR3 has changed from a linkage score of 35.00 to 25.00;
- SPR 5 has changed from a linkage score of 7.00 to 5.00;
- SPR 7 has changed from a linkage score of 11.67 to 0.00 ;
- SPR 10 has changed from a linkage score of 70.0 to 50.0.
- SPR 11 has changed from a linkage score of 42.0 to 0.00

The change in the linkage scores has changed the overall risk rating of the site from High Risk to Moderate Risk.



### 5.2 GROUNDWATER

There was no groundwater encountered at the site.

### 5.3 SURFACE WATER

There was no surface water encountered in the vicinity of Kingscourt historic landfill therefore the landfill is not having an impact on any surface water quality.

## 6.0 REFERENCES

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