TIER 3

ENVIRONMENTAL RISK ASSESSMENT

OF A

FORMER MUNICIPAL HISTORIC LANDFILL

AT

POTTLEBOY

COOTEHILL

CO. CAVAN

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TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

APPENDIX A – DRAWINGS RELATING TO THE SITE

	Details Relating to Drawings	Drawing No.
1	Initial Conceptual Site Model of Cootehill historic landfill site	14.248.100
2	Site Location Map of Cootehill historic landfill site	14.248.101
3	Potential Receptors in the vicinity of Cootehill historic landfill site	14.248.102
4	2000 Aerial Photograph of Cootehill Historic Landfill Site	14.248.103
5	1995 Black and White Aerial Photograph of Cootehill Historic Landfill Site	14.248.104
6	Historic Maps of Cootehill Historic Landfill Site	14.248.105
7	Aquifer Map of Cootehill Historic Landfill Site	14.248.106
8	Vulnerability Map of Cootehill Historic Landfill Site	14.248.107
9	Bedrock Map of Cootehill Historic Landfill Site	14.248.108
10	Subsoil Map of Cootehill Historic Landfill Site	14.248.109
11	Topographic Survey of Cootehill Historic Landfill Site	14.248.110
12	Lateral Extent of Waste at Cootehill Historic Landfill Site	14.248.111
13	Cross Section of Waste at Cootehill Historic Landfill Site	14.248.112
14	Gas Monitoring Points at Cootehill Historic Landfill Site	14.248.113
15	Cross Section of Stand Pipes for Gas Monitoring at Cootehill Historic Landfill Site	14.248.114
16	Trial Hole Locations at Cootehill Historic Landfill Site	14.248.115
17	Concept Model of Cootehill Historic Landfill Site	14.248.116
18	Location of Sampling Points from the Pottleboy Stream.	14.248.117
19	External Gas Monitoring Locations	14.248.118
20	Re-Grading of the Landform Layer for the Historic Landfill.	14.248.119
21	Landscape Plan	14.248.120

APPENDIX B – GAS MONITORING RESULTS

1.0 INTRODUCTION

Traynor Environmental Ltd in conjunction with Cavan County Council has undertaken a Tier 3 Environmental Risk Assessment in relation to Cootehill Historic landfill located at Pottleboy, Cootehill, Co. Cavan. The Tier 3 Environmental Risk Assessment was carried out in accordance with the requirements of the Waste Management (Certification of historic unlicensed waste disposal and recovery activity) Regulations 2008. Taking cognisance of the EPA Code of Practice for Unregulated Waste Disposal Sites. Tier 1 and Tier 2 Environmental Risk Assessments have been carried out previously by Cavan County Council and Traynor Environmental Ltd in 2014, this Tier 3 Risk Assessment must be read in conjunction with the Tier 2 Risk Assessment

1.1 SUMMARY OF TIER 2 ENVIRONMENTAL RISK ASSESSMENT

The Tier 2 Risk Assessment process has resulted in the risk rating for the historic landfill remaining the same as assumed at Tier 1 stage, which is **Moderate Risk (Class B).** SPR Linkage number 10 has been proven and thus risk rating assigned accordingly as **Moderate**. As part of the Tier 2 risk assessment the intrusive site investigation works have confirmed the area were the waste was deposited is as previously predicted, accounting for approximately 1700m^2 plan area.

As part of the Tier 2 Risk Assessment a programme of landfill gas monitoring was undertaken at the site. Very low levels of Landfill Gas were detected in gas well GW 8, with negligible levels of landfill gas detected in gas well GW 3, GW 7, and GW 9, as a result none of the SPR linkages were changed from the Tier 1 Assessment. The full list of SPR values for the Tier 2 assessment are indicated in Table 1.

Table No. 1 Refinement of Conceptual Site Model (CSM After The Tier 2 Risk Assessment

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

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

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

1.2 VERTICAL EXTENT OF WASTE

The main body of waste is located at the centre of the Cavan County Council site which is elevated in the middle of the site and sloping downward towards all the boundaries. With the permission of the land owners Patrick and Siobhan Shields, 7 no. trial holes were excavated in their site which is located directly east of the landfill site. Trial holes excavated in this adjoining site included TH16, TH17, TH18, TH19, TH20, TH21 and TH24 however no waste was encountered in these trial pits.

Waste was encountered in trial holes TH1, TH2, TH3 TH4, TH5, TH6, TH7, TH8, TH9, TH10, TH11, TH12, TH13, TH14, TH15, TH 22, TH 23, TH24 and TH25 see drawing no. 14.248.115 Trial Hole Locations in appendix F. The base of the waste is defined by bed rock encountered across the entire site at depths between 0.6 m and 4.0 m below ground level. Full cross section drawings from two different aspects of the sites are also included in appendix F (Drawing Ref 14.248.112).

Table No. 2 below outlines the depth of all trial holes and the extent in meters of waste encountered in each hole. The trial pits were monitored during excavation for the presence of leachate, odours and landfill gas. Trial holes were logged according to BS 5930:1999(Refer to Appendix A -Trial Hole Logs). A handheld GA 2000 landfill gas analyser was used to assess if landfill gas was

present during excavation. The GA 2000 landfill gas analyser measures methane, carbon dioxide, oxygen, carbon monoxide, and hydrogen sulphide concentrations and has data logging capabilities.

Table 2: Waste Depths in Each Trial Hole.  **= Trial Holes containing Waste**

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

Drawing No 14-248-115 shows locations of all trial holes on site. Please see Appendix A of the Tier 3 assessment.

1.3 LATERAL EXTENT OF THE WASTE

The site is bordered by Drumarket housing estates to the South and the Community Crèche to the north west. The site is bordered to the west by agricultural land and immediately to the east by the parcel of land outside the ownership of Cavan county council. The site is easily accessible to the public at present along the southern and western boundary, as no boundary fencing is in place. A hedgerow & tree line delineates the northern boundary.

Waste was encountered in 19 of the 25 trial holes excavated. There was no waste encountered in the trial holes (TH16, TH17, TH18, TH19, TH20 and TH21) all of which were excavated in the site immediately adjoining the landfill to the east. The most extensive quantities of waste were encountered towards the west and central area of the Cavan County Council landfill site which is elevated. The waste extends from the westerly boundary (TH 1 & TH 2) to the top of the slope (TH 14 & TH 15) in an easterly direction.

The lateral extent of the waste is shown in Drawing No. 14.248.111 - Appendix F and covers an area of approximately 1700 m^2 and has an average depth of 2.2 m of waste. Using a conversation factor of 1.0, it is estimated, that approximately 3740 tonnes of waste intermixed with clay is deposited at the site.

1.4 WASTE CHARACTERISATION

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

2.0 GENERIC QUANTITATIVE RISK ASSESSMENT (GQRA)

2.1 CONTEXT AND OBJECTIVES

GQRA involves the comparison of contaminant concentrations measured in soil, water or gas at a site with generic assessment criteria. Generic assessment criteria are typically conservative to ensure that they are applicable to the majority of sites and normally apply to only a limited number of pollutant linkages.

A Quantitative Risk Assessment has been carried out which includes the development of a conceptual site model. The model describes the types and locations of potential contamination sources, the identification of potential receptors and the identification of potential transport/migration pathways. For a pollutant linkage to be identified a connection between all three elements (source-pathway-receptor) is required.

Known concentrations of various contaminants, obtained as a result of an intrusive investigation, are evaluated for their significance as a contamination source by comparison with Generic Assessment Criteria (GAC).

The significance of the risks presented by the site are assessed in relation to the proposed end-use as a wildlife habitat. The following assessment should not be read independently of other sections of the report and the Tier 2 Assessment Report. The GQRA uses chemical testing and other data used previously in the Tier 2 Assessment Report.

A representation of the conceptual site model is presented in drawing No. 14-248-100 which is located in Appendix A.

Results for Soil samples were compared to "Dutch Target and Intervention Values" while Gas monitoring results were expressed relative to the EPA 1997 threshold values outlined in the document 'Landfill Manuals – Landfill Operational Practices' (EPA, 1997). Dutch Standards are environmental pollutant reference and intervention values. 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 there is a serious case of soil contamination.

2.2 SOIL ANALYSIS RESULTS

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

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

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

From analysis carried out for the parameters listed above, none of the results exceeded the Dutch Reference/Intervention Values, however trace amounts of hazardous waste in the form of asbestos were found in TH 10. The hazardous waste was deemed to be, Chrysotile (white asbestos), a trace amount of 1-2 fibres. Asbestos Soil Sample results are contained in table No. 3 below.

Table 3: Asbestos Soil Sample Results (TH10)

Parameter	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non – Asbestos Fibre
Sample No.4 TH 10	Not detected	Trace	Not detected	Not detected	Not detected	Not detected	Not detected

(Refer to full set of results in Tier 2 Risk Assessment Report)

2.3 GROUNDWATER

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

2.4 SURFACE WATER

2 No. surface water samples were analysed for a range of organic and inorganic parameters that included pH, electrical conductivity, dissolved organic carbon, fluoride, chloride, sulphate, heavy metals to include(arsenic, antimony, barium, cadmium, chromium, copper, mercury, molybdenum, nickel, lead, selenium and zinc), Volatile Organic Compounds (VOC).

All parameters analysed were below their respective EQS.

2.5 LANDFILL GAS MONITORING

2.5.1 Tier 2 Risk Assessment Gas Monitoring

A comprehensive regime of landfill gas monitoring was completed on site. Landfill gas was monitored on 15 No. occasions between 28th October 2014 and the 27th November 2014 as part of the Tier 2 investigations. 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.

During the Tier 2 Risk Assessment 9 no. standpipes were installed at the site. A programme of landfill gas monitoring was subsequently carried out. The nine gas monitoring standpipes were strategically located around the site. Gas Wells GW5 and GW6 were placed in the centre of the site where a high percentage of waste was encountered during the site investigation works. GW7, GW8 and GW9 were located on the northern and western boundary of the site adjacent to the community Crèche. GW2, GW3 and GW4 were located along the eastern edge of the landfill site which also defines the edge of the waste. GW 1 was located outside the waste body in the most easterly aspect of the neighbouring site (marked 11 on figure 1 B of the Tier 2 Risk Assessment) and will be monitored for landfill gas as a control. Refer to a drawing No. 14.248.113 of gas monitoring standpipe locations.

A full breakdown and analysis of all gas monitoring events carried out during the Tier 2 Risk Assessment are detailed in Appendix E of the Tier 2 Risk Assessment.

Table 4: Gas Monitoring Events at Cootehill Historic Landfill for the Tier 2 Risk Assessment

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

2.5.2 Tier 3 Risk Assessment Gas Monitoring Events

Based on the findings of the Tier 2 Risk Assessment, it was decided that further landfill gas monitoring should be undertaken as part of the Tier 3 Risk Assessment.

Seven Additional gas monitoring events were carried out between 8th December 2014 and the 15th December 2014 as part of the Tier 3 Risk Assessment. Landfill gas monitoring was carried out at the existing nine standpipes located within the site. Gas monitoring results together with the relevant assessment criteria are presented in Tables 7 – 16. The full series of gas monitoring results are included in Appendix B. As with the Tier 2 Risk Assessment, Methane and Carbon Dioxide concentrations are expressed as a percentage of volume (% v/v) relative to the EPA 1997 threshold values outlined in the document 'Landfill Manuals – Landfill Operational Practices' (EPA, 1997).

Additional Gas monitoring was carried out at manholes and gullies located in the immediate vicinity of the historic landfill site to insure that no lateral gas migration was occurring.

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;

GW 1 was located outside the waste body in the most easterly aspect of the neighbouring site (marked 11 on figure 1 B of the Tier 2 Risk Assessment). 8 no. of Gas Wells were located in the waste body GW 2, GW3, GW4, GW5, GW6, GW7, GW8 and GW9.

The results of the gas monitoring indicate that outside the waste body (GW 1)the levels of Methane detected were below the Trigger Levels recommended in table 7.1 of the Landfill Monitoring Manual. (Trigger level - Methane 1% v/v).When results for GW 2, GW 4, GW 5, GW 6 and GW 9 are compared and contrasted against the trigger level emissions for methane and carbon dioxide, it is evident that on no monitoring event for the aforementioned wells was this combination trigger level reached. The trigger level emission for GW 8 was exceeded on 11 monitoring events with the remaining 4 monitoring events below the trigger level. It must be noted that trigger levels exceeded were recorded at gas wells located inside the waste body.

Table 5: Gas Monitoring At Cootehill Historic Landfill for the Tier 3 Risk Assessment.

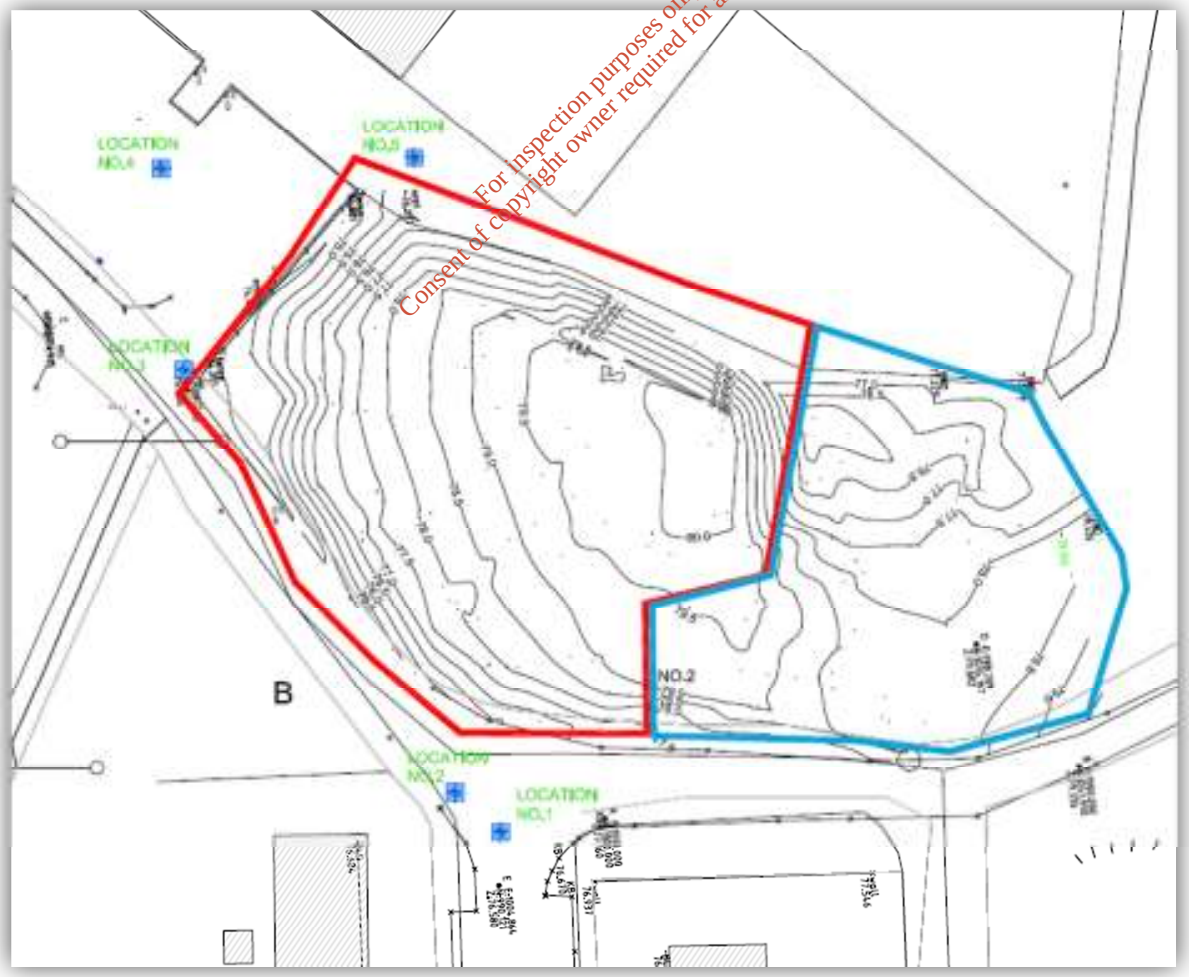
No.	Landfill Gas Monitoring Event	Date
M 16	Event Number 16	08/12/14
M 17	Event Number 17	09/12/14
M 18	Event Number 18	10/12/14
M 19	Event Number 19	11/12/14
M 20	Event Number 20	12/12/14
M 21	Event Number 21	13/12/14
M22	Event Number 22	15/12/14

Table 6: External Gas Monitoring Events outside Cootehill Historic Landfill site for the Tier 3 Risk Assessment

Location No.	Description of Monitoring Point	Grid Reference	Distance for Landfill Boundary
No. 1	Eircom Service Duct(Square)	E 260606 N 313525	5.5 m
No. 2	Eircom Service Duct (Round)	E 260602 N 313526	6.0 m
No. 3	Surface Water Road Gully	E 260579 N 313558	2.5 m
No. 4	Foul Water Inspection Manhole	E 260575 N 313578	15 m
No. 5	Surface Water Inspection Manhole	E 260600 N 813574	3.0 m

On the 16th December 2014 additional Gas monitoring was conducted outside the boundary of Cootehill historic landfill. A number of locations were monitoring namely, Eircom Service Duct, Surface Water Gully, Foul Water Manhole and Surface Water manhole. All 5 additional monitoring locations were within 15 m of the landfill boundary. The results of the gas monitoring indicate that outside the historic landfill site locations (No. 1 - No. 5) the levels of Methane detected were below the Trigger Levels recommended in table 7.1 of the Landfill Monitoring Manual. Monitoring results for the additional external gas monitoring can be seen in Table No. 16

Figure No 1 Location of additional gas monitoring locations.



Photograph 1 : Location No 1 - Eircom Service Duct outside the southern Boundary.

Photograph 2: Location No. 2 Eircom Service Duct outside the southern Boundary.

Photograph 3: Location No. 3 Surface Water Road Gully outside the Westerly Boundary.

Photograph 4: Location No. 4 Inspection Manhole for Foul water.

Photograph5 : Location No. 5 Surface Water Inspection Manhole.

2.5.3 Tier 3 Landfill Gas Monitoring Results

Tables numbered 7 - 16 outline all Tier 2 and Tier 3 landfill gas monitoring results. M1 - M15 represent the result for monitoring carried out during the Tier 2 Risk Assessment. M16 - M22 detail results for monitoring carried out during the Tier 3 Risk Assessments.

Table No. 7 Landfill Gas Monitoring Results - GW 1 **(Tier 2 Results M1 - M15)** = **(Tier 3 Results M16 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 1	M1	28.10.14	0.2	2	0.3	0.3	19.7	79.7	0	0	1001
	M2	30.10.14	0.2	3	0.2	0.9	19.1	79.8	0	0	1001
	M3	06.11.14	0.1	2	0.2	0.8	19.1	79.8	0	0	980
	M4	11.11.14	0.2	3	0.2	0.6	18.9	80.2	0	0	979
	M5	12.11.14	0.1	1	0.1	0.2	19.6	80.1	0	0	979
	M6	14.11.14	0.1	2	0.1	0.1	20.3	79.5	0	0	983
	M7	17.11.14	0.1	2	0.1	0.3	19.6	79.9	0	0	999
	M8	18.11.14	0.1	2	0.1	0.1	19.3	80.5	0	0	1003
	M9	19.11.14	0.1	2	0.1	0.1	19.4	80.4	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.1	20	80	0	0	1016
	M11	21.11.14	0.1	2	0.1	0	19.9	79.8	0	0	1005
	M12	24.11.14	0.1	1	0.1	0.1	16.3	80.1	0	0	1016
	M13	25.11.14	0.1	2	0.1	0.1	19.9	79.8	0	0	1014
	M14	26.11.14	0.1	2	0.1	0.4	19.7	79.5	0	0	1014
	M15	27.11.14	0.2	3	0.2	0.2	19.7	79.9	0	0	993
	M16	08.12.14	0.1	2	0.1	0.5	19.5	79.7	0	0	1014
	M17	09.12.14	0.1	2	0.1	0.6	19.5	79.8	0	0	1001
	M18	10.12.14	0.1	2	0.1	0.4	19.8	79.6	0	0	1001
	M19	11.12.14	0.1	1	0.1	0	20.2	79.6	0	0	994
	M20	12.12.14	0.1	1	0.1	0.4	20.4	79	0	0	993
	M21	13.12.14	0	0	0.1	0.4	19.8	79.7	0	0	991
	M22	15.12.14	0.1	1	0.1	0.4	20.3	79.2	0	0	991

Table No.8 Landfill Gas Monitoring Results - GW 2 **(Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 2	M1	28.10.14	0.2	3	0.2	2.4	16.4	81	0	0	1001
	M2	30.10.14	0.1	2	0.2	4.8	15.2	79.9	0	0	1001
	M3	06.11.14	0.2	3	0.2	0.2	19.7	79.9	0	0	980
	M4	11.11.14	0.2	4	0.2	0.4	19.1	80.2	0	0	979
	M5	12.11.14	0.2	3	0.2	2.8	17.2	79.8	0	0	979
	M6	14.11.14	0.1	2	0.1	1.6	18	80.2	0	0	983
	M7	17.11.14	0.1	2	0.1	8.9	7.3	83.6	0	0	999
	M8	18.11.14	0.1	2	0.1	3.2	16	80.6	0	0	1003
	M9	19.11.14	0.1	2	0.1	7	9.6	83.7	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.2	19.8	79.8	0	0	1016
	M11	21.11.14	0.1	1	0.1	4.3	14.5	81	0	0	1005
	M12	24.11.14	0.1	2	0.1	2.7	15.7	79.6	0	0	1016
	M13	25.11.14	0.1	2	0.1	1.5	18.2	80.2	0	0	1014
	M14	26.11.14	0.2	3	0.2	2.4	16.4	81	0	0	1001
	M15	27.11.14	0.1	2	0.1	1.4	18.4	80.1	0	0	992
	M16	08.12.14	0.1	2	0.1	0.5	19.8	79.5	0	0	1014
	M17	09.12.14	0.1	2	0.1	3.2	18.9	77.6	0	0	1002
	M18	10.12.14	0.1	1	0.1	0	20	79.8	0	0	1001
	M19	11.12.14	0.1	1	0.1	0	20.1	79.7	0	0	993
	M20	12.12.14	0.1	1	0.1	0.9	20.1	78.7	0	0	993
	M21	13.12.14	0	0	0	0	20.1	79.7	0	0	991
	M22	15.12.14	0.1	1	0.1	0.1	20.6	79.1	0	0	991

Table No. 9 Landfill Gas Monitoring Results - GW 3 **(Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 3	M1	28.10.14	1.3	24	1.3	7.6	13.8	77.3	0	0	1001
	M2	30.10.14	0.6	11	0.6	9.2	12	78.3	0	0	1001
	M3	06.11.14	0.4	14	0.7	10.8	9.9	78.5	0	0	979
	M4	11.11.14	0.4	8	0.5	8.9	12.8	77.8	0	0	979
	M5	12.11.14	0.3	6	0.3	8.1	13.5	78	0	0	979
	M6	14.11.14	0.6	11	0.6	9.3	10.5	79.5	0	0	983
	M7	17.11.14	0.7	13	0.7	8.2	12.2	78.9	0	0	999
	M8	18.11.14	0.6	11	0.6	8.1	12.9	78.4	0	0	1003
	M9	19.11.14	0.5	10	0.6	7.5	13.4	78.5	0	0	1007
	M10	20.11.14	0.5	10	0.6	6.2	14.9	78.2	0	0	1015
	M11	21.11.14	0.6	12	0.6	6.1	14.4	78.8	0	0	1005
	M12	24.11.14	0.3	6	0.4	7.3	13	79.2	0	0	1016
	M13	25.11.14	0.4	8	0.4	4.9	15.5	79.1	0	0	1014
	M14	26.11.14	0.4	8	0.4	4.9	15.8	78.8	0	0	1014
	M15	27.11.14	0.2	3	0.2	6.9	13.8	79.1	0	0	992
	M16	08.12.14	0.1	1	0.1	7.6	11.6	80.6	0	0	1014
	M17	09.12.14	0.1	1	0.1	14.4	5	80.3	0	0	1011
	M18	10.12.14	0.1	2	0.1	9.6	1	80.1	0	0	1001
	M19	11.12.14	0.1	1	0.1	8.6	11.7	79.6	0	0	992
	M20	12.12.14	0.1	1	0.1	8.7	11.8	79.3	0	0	993
	M21	13.12.14	0	0	0.1	7.5	13.5	78.9	0	0	991
	M22	15.12.14	0.1	1	0.1	7.4	13.8	78.6	0	0	991

Table No. 10 Landfill Gas Monitoring Results - GW 4 **(Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 4	M1	28.10.14	0.2	3	0.2	4.7	15.8	79.2	0	0	1001
	M2	30.10.14	0.1	2	0.1	5	14.3	80.6	0	0	1001
	M3	06.11.14	0.1	2	0.2	1.4	18.8	79.6	0	0	979
	M4	11.11.14	0.2	3	0.2	1.5	18.2	80.2	0	0	979
	M5	12.11.14	0.1	1	0.1	1.8	17.9	80.3	0	0	979
	M6	14.11.14	0.1	1	0.1	3.5	17.1	79.3	0	0	983
	M7	17.11.14	0.1	1	0.1	4.7	13.3	81.8	0	0	999
	M8	18.11.14	0.1	2	0.1	2.3	16.9	80.6	0	0	1003
	M9	19.11.14	0.1	1	0.1	3.1	17.2	79.5	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.3	19.8	79.7	0	0	1016
	M11	21.11.14	0.3	4	0.3	3.8	15.7	80.4	0	0	1005
	M12	24.11.14	0.1	2	2	4.2	15.2	79.9	0	0	1017
	M13	25.11.14	0.1	2	0.1	4	15.5	80.3	0	0	1014
	M14	26.11.14	0.1	1	0.1	3.6	16.3	79.9	0	0	1014
	M15	27.11.14	0.1	1	0.1	1.3	18.6	79.8	0	0	992
	M16	08.12.14	0.1	2	0.1	3.6	16.8	79.4	0	0	1014
	M17	09.12.14	0.1	1	0.1	3.5	18.3	80	0	0	1000
	M18	10.12.14	0.1	2	0.1	2.5	18.3	79.3	0	0	1001
	M19	11.12.14	0.1	1	0.1	2.8	17.8	79.3	0	0	992
	M20	12.12.14	0	1	0.1	2.8	17.9	79.1	0	0	993
	M21	13.12.14	0	1	0.1	2.8	17.1	79.9	0	0	991
	M22	15.12.14	0.1	1	0.1	2.7	17.5	79.6	0	0	991

Table No. 11 Landfill Gas Monitoring Results - GW 5 **(Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 5	M1	28.10.14	0.2	3	0.2	2.2	15.4	82.2	0	0	1001
	M2	30.10.14	0.1	2	0.2	0	19.8	80	0	0	1001
	M3	06.11.14	0.1	2	0.2	0	19.8	79.9	0	0	979
	M4	11.11.14	0.2	4	0.2	0.4	19.2	80.1	0	0	979
	M5	12.11.14	0.1	1	0.1	0.4	19.9	79.6	0	0	979
	M6	14.11.14	0.1	1	0.1	0	19.9	79.9	0	0	983
	M7	17.11.14	0.1	2	0.1	0.1	10	83.9	0	0	999
	M8	18.11.14	0.2	3	0.2	1	17.6	81.1	0	0	1003
	M9	19.11.14	0.1	2	0.1	2.9	15	81.8	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.6	19.1	80.1	0	0	1016
	M11	21.11.14	0.1	2	0.1	4.4	14.1	81.3	0	0	1005
	M12	24.11.14	0.1	2	0.2	1.6	16.1	80	0	0	1016
	M13	25.11.14	0.1	1	0.1	0.3	19.4	80.1	0	0	1014
	M14	26.11.14	0.1	1	0.1	0.2	19.9	79.9	0	0	1014
	M15	27.11.14	0.1	1	0.1	4.5	11.4	83.9	0	0	992
	M16	08.12.14	0.1	2	0.1	1	19.1	79.7	0	0	1014
	M17	09.12.14	0.1	1	0.1	0	19.8	79.9	0	0	1001
	M18	10.12.14	0.1	1	0.1	0.5	19.8	79.5	0	0	1001
	M19	11.12.14	0.1	1	0.1	0	20.4	79.4	0	0	992
	M20	12.12.14	0.1	1	0.1	0	20.8	79	0	0	993
	M21	13.12.14	0.1	1	0.1	2.1	17.1	80.6	0	0	991
	M22	15.12.14	0.1	1	0.1	2.3	17.1	80.5	0	0	991

Table No. 12 Landfill Gas Monitoring Results - GW 6 **Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 6	M1	28.10.14	0.2	3	0.2	4.2	15.8	79.8	0	0	1001
	M2	30.10.14	0.1	2	0.1	5.5	14.8	79.6	0	0	1001
	M3	06.11.14	0.1	3	0.2	7.9	11.9	80.1	0	0	979
	M4	11.11.14	0.2	3	0.2	0.8	19.2	79.8	0	0	979
	M5	12.11.14	0	0	0.1	2.1	18.2	79.6	0	0	979
	M6	14.11.14	0.1	2	0.1	6.9	9.9	83	0	0	983
	M7	17.11.14	0.1	2	0.1	1.7	18.8	79.4	0	0	999
	M8	18.11.14	0.1	2	0.2	1.9	17.8	80	0	0	1003
	M9	19.11.14	0.1	2	0.1	3.8	16.3	79.8	0	0	1007
	M10	20.11.14	0.1	2	0.1	0.4	19.8	79.6	0	0	1016
	M11	21.11.14	0.1	1	0.1	4.7	13.8	81.3	0	0	1005
	M12	24.11.14	0.2	1	0.2	0.6	16.3	80.3	0	0	1016
	M13	25.11.14	0.1	1	0.1	5	12.6	82.2	0	0	1014
	M14	26.11.14	0.1	1	0.1	3.6	15	81.4	0	0	1014
	M15	27.11.14	0.1	2	0.1	2	17	80.7	0	0	992
	M16	08.12.14	0.1	1	0.1	5.1	13	81.9	0	0	1014
	M17	09.12.14	0.1	2	0.1	10.6	6.4	82.9	0	0	1001
	M18	10.12.14	0.1	1	0.1	9.2	10.8	80	0	0	1001
	M19	11.12.14	0.1	2	0.1	7.9	12.6	79.4	0	0	993
	M20	12.12.14	0	1	0.1	8	12.3	79.6	0	0	993
	M21	13.12.14	0.1	1	0.1	5.2	14.6	80.2	0	0	991
	M22	15.12.14	0	1	0.1	1.5	18.8	79.6	0	0	991

Table No.13 Landfill Gas Monitoring Results - GW 7 **Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 7	M1	28.10.14	0.2	3	0.2	2.6	18.9	79.2	0	0	1002
	M2	30.10.14	1	20	1	1.5	18.7	78.7	0	0	1000
	M3	06.11.14	1.3	18	1.3	4.8	14.7	79.1	0	0	979
	M4	11.11.14	0.2	3	0.6	0.2	19.6	79.8	0	0	979
	M5	12.11.14	0.1	1	0.1	2.6	18.2	79.1	0	0	979
	M6	14.11.14	0.1	2	0.1	4.6	15.4	79.8	0	0	983
	M7	17.11.14	0.1	2	0.1	0.7	18.9	80.1	0	0	999
	M8	18.11.14	0.1	2	0.1	3.7	16.4	79.6	0	0	1003
	M9	19.11.14	0.1	2	0.1	3.9	16.4	79.5	0	0	1007
	M10	20.11.14	0.1	2	0.1	1.1	19.1	79.5	0	0	1016
	M11	21.11.14	0.1	1	0.1	7.2	13.2	79.4	0	0	1004
	M12	24.11.14	0.1	1	0.1	1.8	16.9	80.6	0	0	1017
	M13	25.11.14	0.1	2	0.1	1.6	18.4	79.8	0	0	1014
	M14	26.11.14	0.2	3	0.2	0.9	19.3	79.6	0	0	1014
	M15	27.11.14	0.1	1	0.1	1.8	18.3	79.8	0	0	992
	M16	08.12.14	0.1	2	0.1	1.4	19.1	79.3	0	0	1014
	M17	09.12.14	0.1	2	0.1	3.6	16.5	80	0	0	1001
	M18	10.12.14	0.1	1	0.1	2.6	17.8	79.3	0	0	1001
	M19	11.12.14	0	1	0.1	2.1	18.3	79.4	0	0	993
	M20	12.12.14	0	1	0.1	2.7	11.6	7.9	0	0	992
	M21	13.12.14	0.1	1	0.1	1.9	18.5	79.5	0	0	991
	M22	15.12.14	0.1	1	0.1	1.7	18.9	79.2	0	0	991

Table No.14 Landfill Gas Monitoring Results - GW 8 **Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 8	M1	28.10.14	11.5	>>>	11.5	3.2	15.3	76.2	0	0	1002
	M2	30.10.14	8.8	>>>	8.8	3.9	15.1	72.1	0	0	1001
	M3	06.11.14	4	78	4	5.2	14.1	76.6	0	0	979
	M4	11.11.14	2.7	53	2.7	5.6	14.5	77.2	0	0	979
	M5	12.11.14	2.5	50	2.5	5.7	14.2	77.6	0	0	979
	M6	14.11.14	1.9	37	1.9	6.2	12.7	79.2	0	0	984
	M7	17.11.14	1.6	32	1.7	6.7	12.7	78.9	0	0	999
	M8	18.11.14	1.4	28	1.5	6.8	12.1	79.6	0	0	1003
	M9	19.11.14	1.2	23	1.2	6.3	13	79.5	0	0	1007
	M10	20.11.14	1.2	24	1.2	6.6	12.9	79.2	0	0	1016
	M11	21.11.14	1.2	23	1.2	6.8	12.6	79.4	0	0	1005
	M12	24.11.14	0.2	3	0.2	3.7	16.1	79.8	0	0	1017
	M13	25.11.14	0.8	15	0.8	5.9	14.9	78.4	0	0	1014
	M14	26.11.14	0.8	15	0.8	5.9	15	78.3	0	0	1014
	M15	27.11.14	0.7	13	0.7	6.1	15	78.2	0	0	992
	M16	08.12.14	0.5	10	0.5	5.8	18.8	77.8	0	0	1015
	M17	09.12.14	0.4	8	0.4	5.4	16.6	77.5	0	0	1001
	M18	10.12.14	0.3	6	0.3	5.1	17.3	77.2	0	0	1002
	M19	11.12.14	0.2	4	0.2	3.7	19	76.9	0	0	993
	M20	12.12.14	0.2	4	0.2	3.7	18.9	77	0	0	993
	M21	13.12.14	0.2	3	0.2	3.3	18.9	77.5	0	0	991
	M22	15.12.14	0.1	2	0.1	3.3	19	79.4	0	0	992

Table No.15 Landfill Gas Monitoring Results - GW 9 **Tier 2 Results M1 - M15)** **= (Tier 3 Results M15 - M22)**

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
GW 9	M1	28.10.14	0.3	6	0.3	1.2	18.6	79.8	0	0	1002
	M2	30.10.14	0.8	15	0.8	1.3	18.7	79.3	0	0	1000
	M3	06.11.14	0.3	7	0.4	1.8	19	78.8	0	0	979
	M4	11.11.14	0.5	12	1	2.8	16.9	79.6	0	0	979
	M5	12.11.14	0.4	8	0.4	2.6	17.8	79.1	0	0	979
	M6	14.11.14	0.3	6	0.3	2.1	18.2	79.2	0	0	983
	M7	17.11.14	0.5	9	0.5	3.3	16.4	79.6	0	0	999
	M8	18.11.14	0.4	8	0.4	2.9	16.3	80.3	0	0	1003
	M9	19.11.14	0.3	5	0.3	3.8	15.2	80.4	0	0	1007
	M10	20.11.14	0.5	9	0.5	2.5	17.1	79.9	0	0	1016
	M11	21.11.14	0.4	8	0.4	3.6	15.2	80.7	0	0	1005
	M12	24.11.14	0.5	10	0.5	6	14.7	78.7	0	0	1017
	M13	25.11.14	0.4	7	0.4	2.2	18.1	79.4	0	0	1014
	M14	26.11.14	0.1	1	0.1	2	18.6	79.2	0	0	1014
	M15	27.11.14	0.1	2	0.1	3.9	17.1	78.9	0	0	992
	M16	08.12.14	0.2	3	0.2	0.9	19.1	79.8	0	0	1014
	M17	09.12.14	0.1	2	0.1	0.3	19.8	79.7	0	0	1002
	M18	10.12.14	0.1	1	0.1	0.2	20.2	79.5	0	0	1001
	M19	11.12.14	0.1	2	0.1	0.3	20.4	79.1	0	0	993
	M20	12.12.14	0.1	1	0.1	0.3	20.5	79	0	0	992
	M21	13.12.14	0.1	1	0.1	0.8	19.7	79.3	0	0	992
	M22	15.12.14	0.1	2	0.1	0.9	19.3	79.3	0	0	992

Table No. 16 External Gas Monitoring Results conducted outside the Historic Landfill at 5 Locations.

Monitoring Location No.	Monitoring Location Description	Monitoring Date	Stable Methane (CH_4)	% LEL CH_4	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% v/v	%	% v/v	% v/v	% v/v	% v/v	ppm	ppm	mb
No. 1	Eircom Service Duct(Square)	16.12.14	0.1	2	0.1	0	19.5	80.3	0	0	1001
No. 2	Eircom Service Duct (Round)	16.12.14	0.1	2	0.1	0	19.4	80.3	0	0	1001
No. 3	Surface Water Road Gully	16.12.14	0.1	2	0.1	0	19.4	80.3	0	0	1001
No. 4	Foul Water Inspection MH	16.12.14	0.1	2	0.1	0	19.6	80.2	0	0	1001
No. 5	Surfacw Water Inspection MH	16.12.14	0.1	2	0.1	0	19.5	80.3	0	0	1001

2.5.4 Tier 3 Risk Assessments analysis of Results

GW 1 Monitoring

Stable methane concentrations ranged from 0.0 % v/v to 0.1 % v/v. Carbon Dioxide concentrations ranged from 0.0 % v/v to 0.6% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 2 Monitoring

Stable methane concentrations ranged from 0.0 % v/v to 0.1 % v/v. Carbon Dioxide concentrations ranged from 0.0 % v/v to 3.2 % v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 3 Monitoring

Stable methane concentrations ranged from 0.0 v/v to 0.1 % v/v. Carbon Dioxide concentrations ranged from 7.4% v/v to 14.4% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 4 Monitoring

Stable methane concentrations of 0.0 % v/v to 0.1 % v/v. Carbon Dioxide concentrations ranged from 2.5 % v/v to 3.6% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 5 Monitoring

Stable methane concentrations measured 0.1% v/v during all seven monitoring events of the Tier 3. Carbon Dioxide concentrations ranged from 0.0% v/v to 2.3% v/v . Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 6 Monitoring

Stable methane concentrations of 0.0% v/v to 0.1 % v/v. Carbon Dioxide concentrations ranged from 1.5 % v/v to 10.6% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 7 Monitoring

Stable methane concentrations of 0.0% v/v to 0.1 % v/v. Carbon Dioxide concentrations ranged from 1.4 % v/v to 3.6% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 8 Monitoring

Stable methane concentrations of 0.1% v/v to 0.5 % v/v. Carbon Dioxide concentrations ranged from 3.3 % v/v to 5.8% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 9 Monitoring

Stable methane concentrations of 0.1% v/v to 0.2 % v/v. Carbon Dioxide concentrations ranged from 0.2 % v/v to 0.9% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

2.5.5 Conclusions of Tier 3 Gas Monitoring

Based on the findings of the Tier 3 Risk Assessment landfill gas monitoring events (M16, M17, M18, M19 M20 M21 and M22) the following conclusions can be made;

- The methane monitoring results are broadly consistent with the findings of the previous gas monitoring results and therefore would not warrant any revisions to the findings of the Tier 2 Assessment.
- The results of the landfill gas survey suggest that elevated levels of landfill gases are primarily located at GW 8; however there appears to be no immediate risk to offsite receptors. Methane results have also steadily decreased at GW8 during Tier 3 gas monitoring.
- Although landfill gas flow rate measurements were variable in some of the monitoring locations, the results are consistent with gas flows associated with a landfill of this age. The gas flow rates recorded during the recent monitoring events M16 - M 22 continue to be at low levels.
- Cootehill Historic Landfill is in phase VII of a landfills lifecycle (refer to graph located in Section 3.7.4.2 (Production and Composition of Landfill Gas) of the Tier 2 Risk Assessment.

3.0 PROPOSED REMEDIATION OPTIONS

3.1 GENERAL OBJECTIVES

The Tier 2 Risk Assessment and trial hole investigations confirmed that landfill material consisted mainly of household waste. The waste material unearthed, comprised mainly of plastics, paper, glass, metal and textiles. There was evidence of potentially hazardous waste identified in one of the trial holes (TH10) in the form of Chrysotile (white asbestos). Trace amounts were identified 1 - 2 fibres. The key objective of remediation, being cognisant of time, and health and safety constraints is to prevent and or minimise the impact on the environment and reduce possible migration of landfill gas to offsite receptors.

The remediation options will have the following objectives:-

- The primary objective of remediation is to break linkages identified in the risk assessment being cognisant of gas monitoring results and waste material encountered.
- To break pollution linkage outlined in SPR Linkage No. 10;
- To reduce and /or eliminate any landfill gas risk associated with the site;
- Reduce or eliminate risk to nearby receptors;
- To reduce or eliminate the risk to offsite receptors from Landfill Gas migration;
- To improve overall appearance of the landfill;
- To provide suitable conditions for plant and other vegetation growth.

3.2 PROPOSED REMEDIATION MEASURES

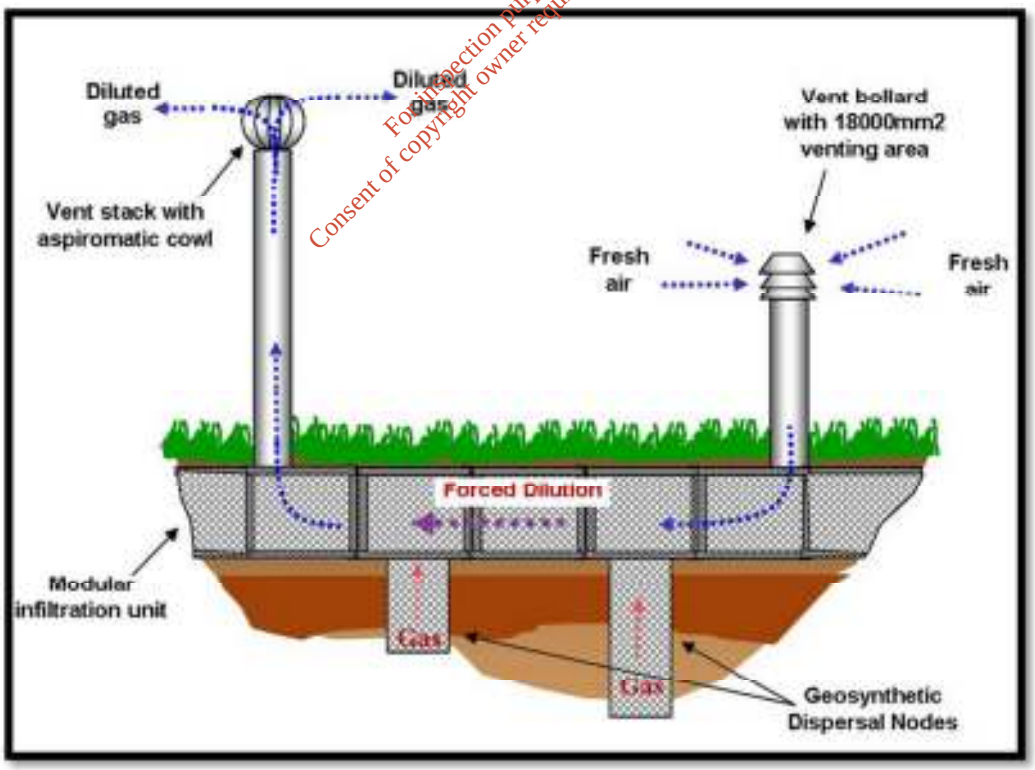
The proposed measures below have been considered in the context of remediation options for Cootehill historic landfill.

- 3.2.1 - Vent Trenches;
- 3.2.2 - Virtual Curtain System;
- 3.2.3 - Programme of Landfill Gas Monitoring;
- 3.2.4 - Passive Venting Wells and Capping of the Landfill;
- 3.2.5 - Removal of Waste Material, Re-Grading of the Landform & Surface water Control/Management

3.2.1 VENT TRENCHES

A proposed vent trench system would consist of the excavation of a minimum 1.2m wide trench to the base of the fill material, i.e. 5 - 6 meters below ground level (mbgl). This trench would then be lined with a geotextile and backfilled with graded aggregate around 160 mm perforated, vertical pipes with filter sock installed at 1m centres. These pipes would be connected to a horizontal gas collection duct with vent stack manifolds and vertical risers as per the venting system. The vertical vent pipes should be proud of the capping material and should not be slotted at the point where they pass through the capping material. Diagram of a reprehensive vent trench construction are shown below.

Figure No. 2 Vent Trench



3.2.1.1 Impact of Remediation Measures

During the installation of the venting trench odour may cause a nuisance to the nearby off site receptors but this would only be temporary and can be mitigated if carried out in suitable weather conditions. The physical act of digging the trench could potentially mobilise contaminants which are dormant within the site and thus create airborne particulates in the vicinity of the work area. Venting of landfill gases would prevent lateral migration to the lower level thus minimise risk. Landfill gas generated, will efficiently be dispersed with the installation of gas venting measures. The future impact of this remediation measure will be the safe and controlled venting of the low levels of landfill gas.

Positive

- Proven approach for the interception of horizontal migration of landfill gases.
- Prevents lateral migration of landfill gas

Negative

- Significant health and safety considerations due to the required depth of the trench
- Would have to be installed a distance away from the site boundary due to health and safety considerations.
- Potential to generate a significant quantity of surplus waste materials, that depending on the disposal option agreed with the EPA would have the potential for significant additional costs. Alternatively this material could be reburied on site
- Mobilisation of Contaminants

3.2.1.2 Alternative Considered

Often combinations of both passive and active gas venting systems are used. However due to the low levels of landfill gas detected during the Tier 2 Risk Assessment, a combination of venting measure was not considered as an alternative. There are numerous gas control systems and the alternatives considered for use at the Cootehill historic landfill are outlined in section 3.2.4 Passive Venting Wells and 3.2.2 Virtual Curtain System.

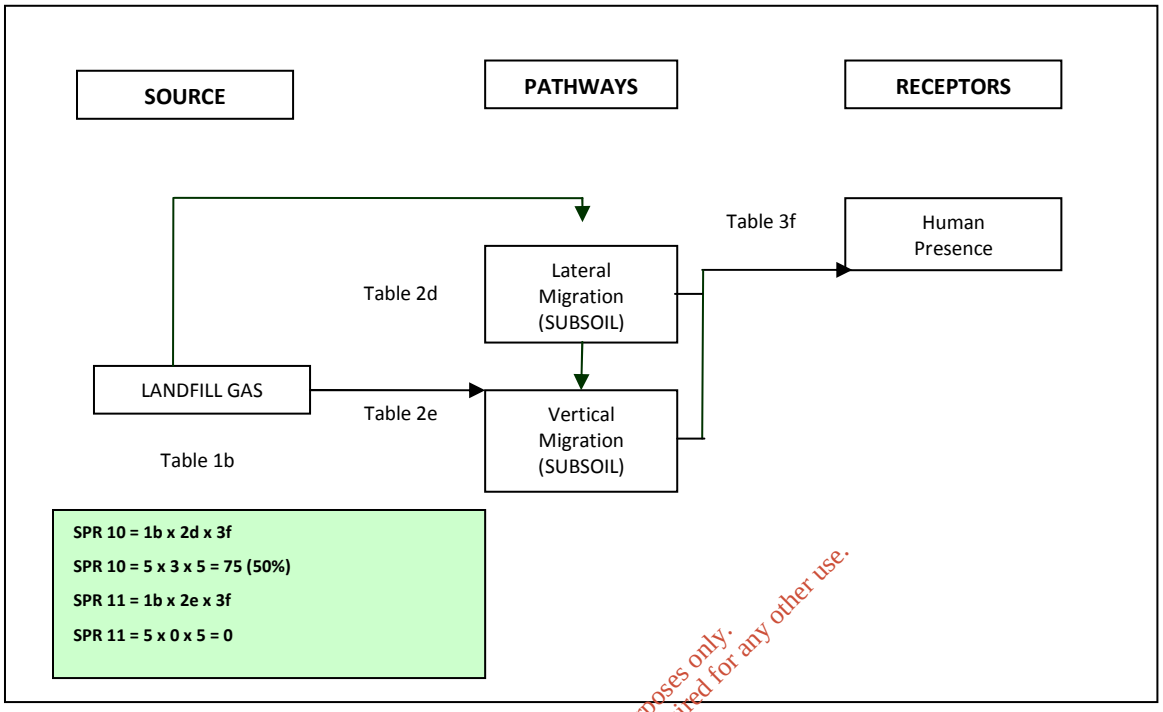
3.2.1.3 Recommended Remediation Measure

A number of different gas venting systems have been considered as part of remediation options proposed for the site. From investigation carried out during the Tier 2 Risk Assessment, Cootehill landfill has shown to be in phase VII of the evolution of gas production over the lifetime of a landfill. This classification is due to the low volume and poor calorific value of the landfill gas detected. The installation of vent trenches is not considered necessary or viable remediation option. The constraints of the site such as bedrock would also affect the installation and effectiveness of the vent trenches.

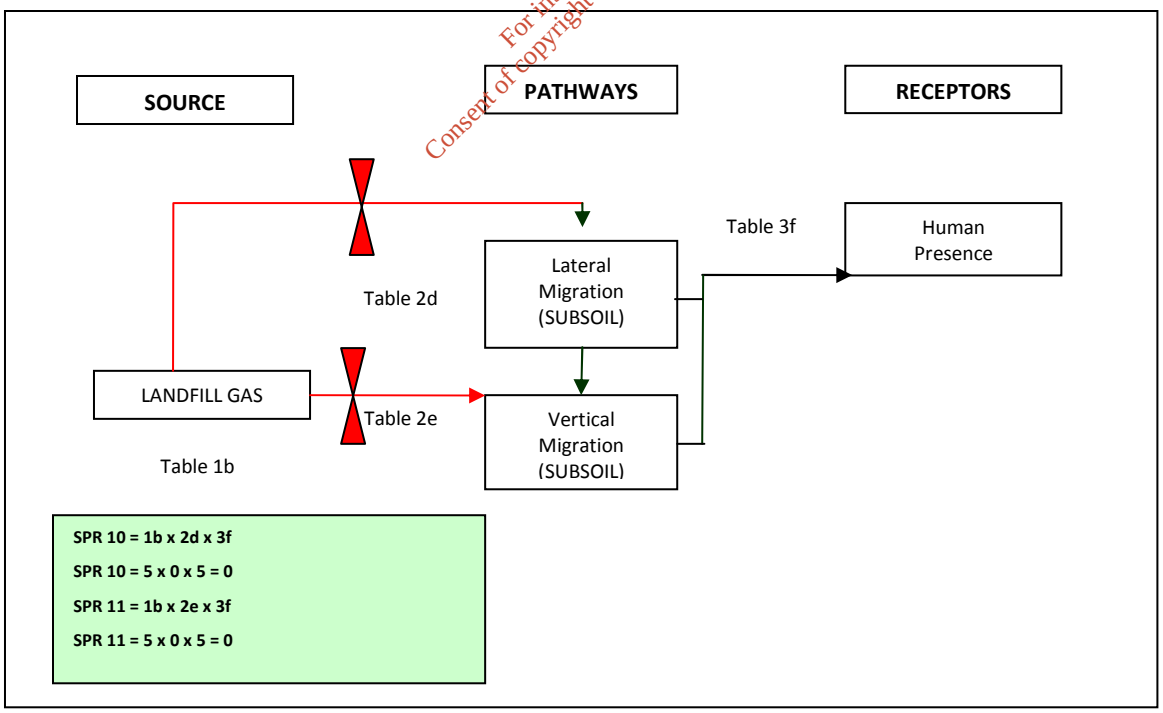
3.2.1.4 SPR Linkage Diagram

Diagram 1 – SPR Linkage Diagram showing the break in the linkage before and after the venting of the landfill gas.

Prior to Remediation - SPR 10 & 11



Post Remediation SPR 10 & 11



3.2.1.5 Timescale for Completion of Works

The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would estimate a timeframe of 1 - 2 months for the installation of the appropriate number of vent trenches on the site. The said timescale for the installation of the system is dependent on a number of conditions such as no unforeseen problems during the excavation and installation works, available resources, appropriate weather conditions to carry out trench works.

3.2.1.6 Evaluation of Works

Vent pipes must be used in all cases of a vent trench. It is not sufficient to rely on the convection of landfill gas through the aggregate alone to achieve venting. Capping must be carried out in a fashion that does not disturb the permeability of the aggregate. Rain fall infiltration could occur in a vent trench which has not been constructed without vertical pipes or capping material.

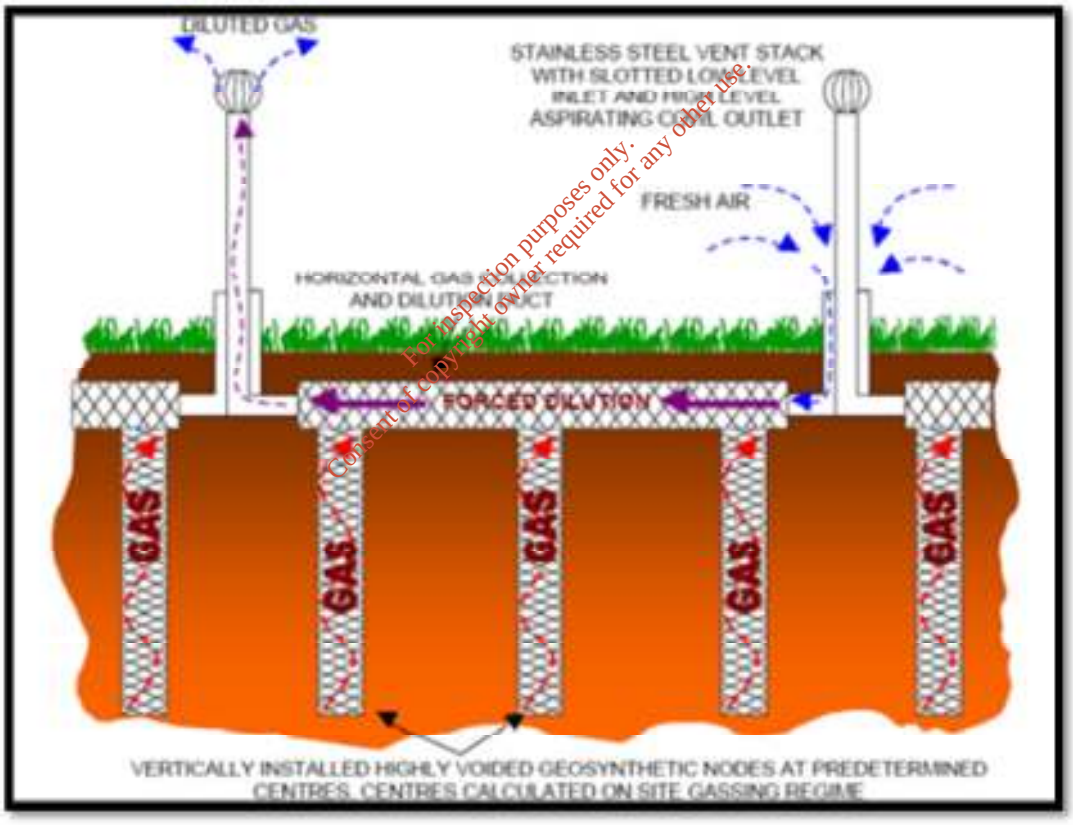
3.2.2 VIRTUAL CURTAIN SYSTEM

This unique method utilises a series of individual vertically driven, highly voided geosynthetic vents that are positioned at calculated centres to create a linear, in-ground "Venting Curtain" gas barrier. The zone of influence and consequent designed spacing of each vent node is dependent on site specific ground conditions.

Virtual Curtain, a proprietary remediation system used widely in the UK, was also considered for installation. This system consists of vent nodes constructed of a gas-permeable geocompostite material installed to the base of the fill material at 1m centres. A horizontal gas collection duct located within a shallow, gravel-filled trench connects the nodes. A prefabricated vent bollard, which vents the diluted landfill gases to the atmosphere, is installed every 10m along the horizontal gas collection duct. Diagram of a reprehensive vent trench construction are shown in figure no. 2

Landfill gas monitoring would take place on both sides of the virtual curtain in order to show whether gas is reaching the barrier and also to test the effectiveness of the barrier.

Figure No. 3 Virtual Curtain



3.2.2.1 Impact of Remediation Measures

Once installed the virtual curtain system the landfill gas will be diluted with fresh air to safe levels before dispersal to atmosphere via a vent bollard or vent stack. In respect of gas, it acts as both a pathway break and conduit for controlled and safe passive venting to atmosphere.

Positive

- Could be installed in close proximity to the road.
- No open excavation and associated health and safety risks
- Virtually all soil generated during activities can be back filled into excavation.
- Documented history of effective usage in the UK
- Short timeframe for installation of the system.
- Dewatering of leachate not required

Negative

- To date this is not a proven technology in Ireland and hence may require some modifications to comply with the EPA.
- Cost
- Site Constraints
- No landfill gas migration thus cost not warranted.

3.2.2.2 Alternative Considered

There are numerous gas control systems and the alternatives considered for use at the Cootehill historic landfill are outlined in section 3.2.4 Passive Venting Wells and 3.2.1 Vent Trenches. Complete removal of all waste material from the site has also been considered. A programme of landfill gas monitoring may form part the remediation measure for the site.

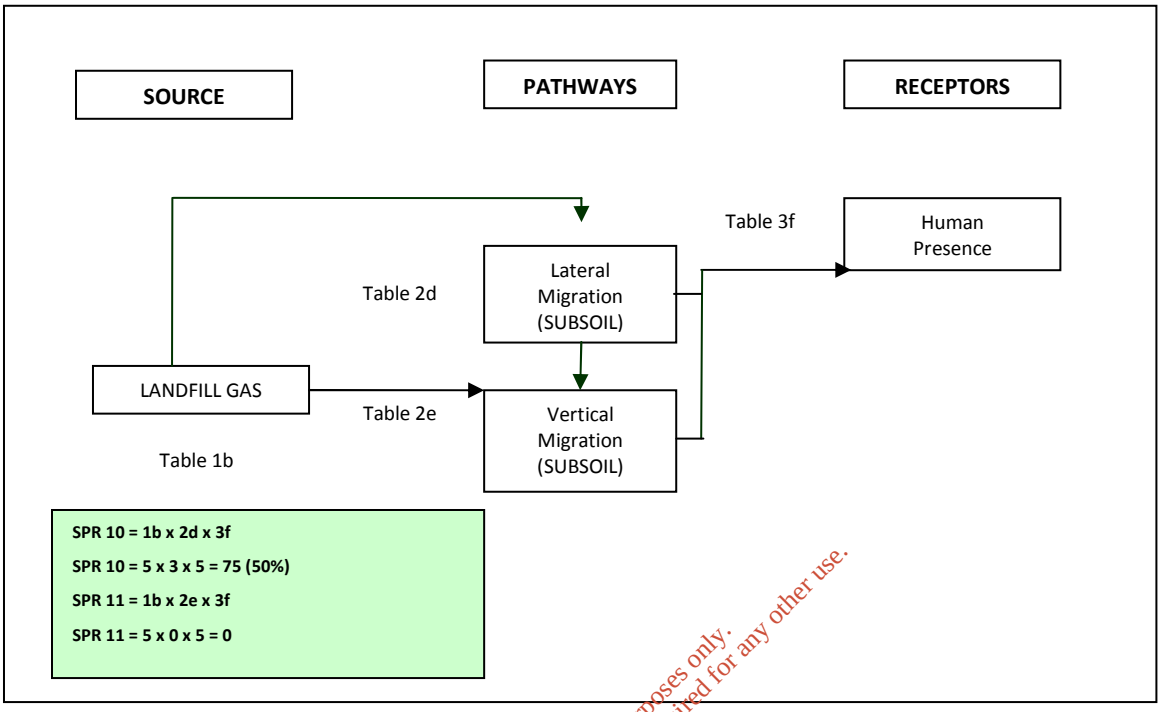
3.2.2.3 Recommended Remediation Measure

Following consideration of the positive and negative effects associated with the installation of a virtual curtain and the site constraints it was not considered a suitable remediation measure for the Cootehill site. From extensive gas monitoring carried out during the Tier 2 and Tier 3 Risk Assessment it has been shown that negligible levels of landfill gas was detected at gas well No. 8 (GW 8) which is located in close proximity to the boundaries near the sensitive receptors. If waste material was present in this area or elevated landfill gas detected it would be an ideal location for a virtual curtain system. Where low levels of landfill gas were detected the site is adjoined by the car park of the community crèche. A virtual curtain was not considered a suitable remediation for the site.

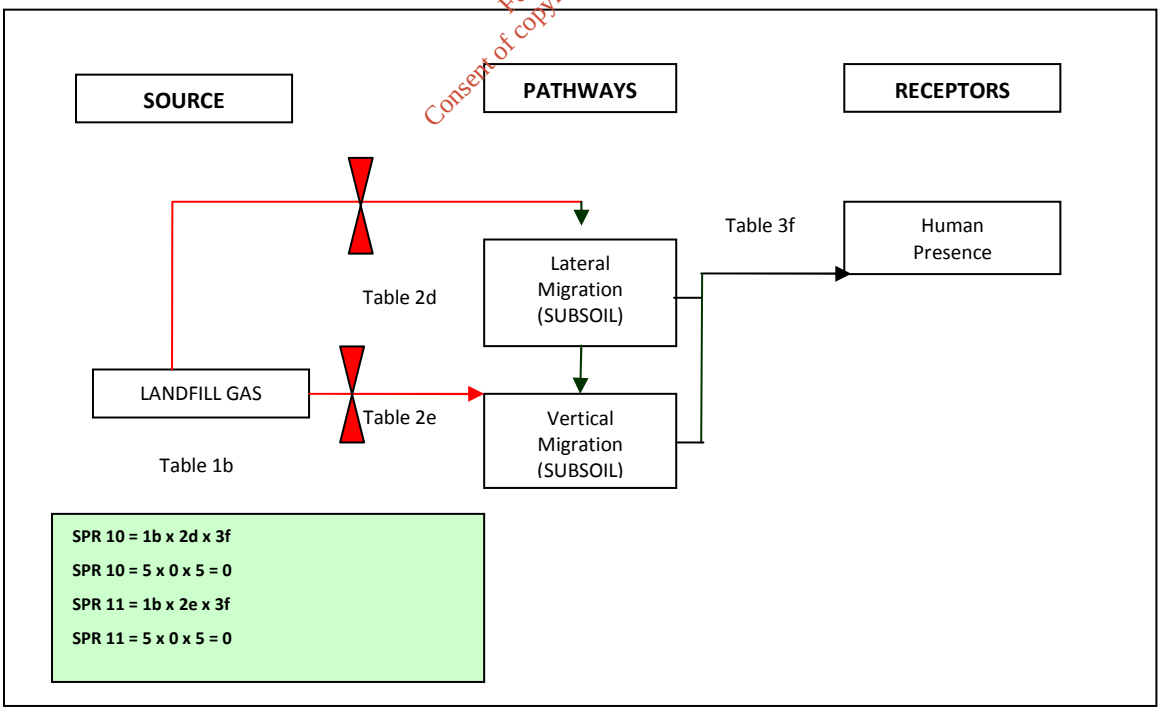
3.2.2.4 SPR Linkage Diagram

Diagram 2 – SPR Linkage Diagram showing the break in the linkage before and after the venting of the landfill gas.

Prior to Remediation - SPR 10 & 11



Post Remediation SPR 10 & 11



3.2.2.5 Timescale for Completion of Works

The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd estimate a timeframe of 1 month for the installation of the Virtual Curtain system on the site. The said timescale for the installation of the system is dependent on a number parameter such as site constraints (bedrock), proximity to offsite receptors, weather and no unforeseen problems during the excavation.

3.2.2.6 Evaluation of Works

Following the installation of the virtual curtain a programme of landfill gas monitoring would be undertaken. With the location of the waste material disposed on the site the option of a virtual curtain does not fulfil the needs of this particular site. The offsite receptors which would be potentially at low risk of landfill gas migration, are not bordering the site where landfill gas was detected during gas monitoring carried out at the site.

3.2.3 CONTINUED PROGRAMME OF LANDFILL GAS MONITORING

There are currently No. 9 Gas monitoring wells installed at the site. As part of a continued programme of monitoring it is proposed to install three additional gas monitoring wells at the site. These additional monitoring locations will be positioned according to the EPA Landfill Manuals - Landfill Operation Practices. (Refer to figure No. 4 Proposed New Monitoring Stand Pipe Locations) In combination with the existing 9 gas monitoring locations the new gas monitoring wells will be positioned on both the Historic Landfill site and the neighbouring site.

In the following situations landfill gas monitoring should be increased in frequency:

- increases in gas quantity or changes in gas quality are observed during monitoring;
- control systems are altered by landfill operations;
- capping of part, or all, of the site takes place;
- pumping of leachate ceases or leachate levels rise within the wastes; or
- buildings or services are constructed within 250 m of the boundary of the waste.

According to the Environmental Protection Agency (EPA) Landfill Manuals - Landfill Monitoring 2nd Edition monitoring should continue at the site until either:

a) the maximum concentration of methane from the landfill remains less than 1% by volume (20% LEL) and the concentration of carbon dioxide from the landfill remains less than 1.5% by volume measured at all monitoring points within the wastes over a 24 month period taken on at least four separate occasions, including two occasions when atmospheric pressure was falling and was below 1,000mb;

b) an examination of the waste using and appropriate sampling method provides a 95% level of confidence that the biodegradation process has ceased.

Table 17: Landfill Gas Trigger Levels - Landfill Monitoring Manual 2nd edition 2003.

Parameter	Trigger Concentration
Methane	Greater than or equal to 1% v/v
Carbon dioxide	Greater than or equal to 1.5% v/v

The following guidelines for monitoring landfill gas from wells will be followed:

- Health and safety precautions shall be adhered to at all times. There shall be no smoking while sampling for landfill gas. Direct inhalation of the landfill gas should be avoided. Chemical resistant gloves shall be worn to avoid contact with landfill gas condensate.

- All equipment shall be operated, calibrated and serviced according to the manufacturer's instructions.

- All boreholes or wells will be fitted with sealable gas sampling valves/bungs to isolate the borehole/well from the atmosphere, to prevent air ingress and to enable equilibrium with the area to be monitored.

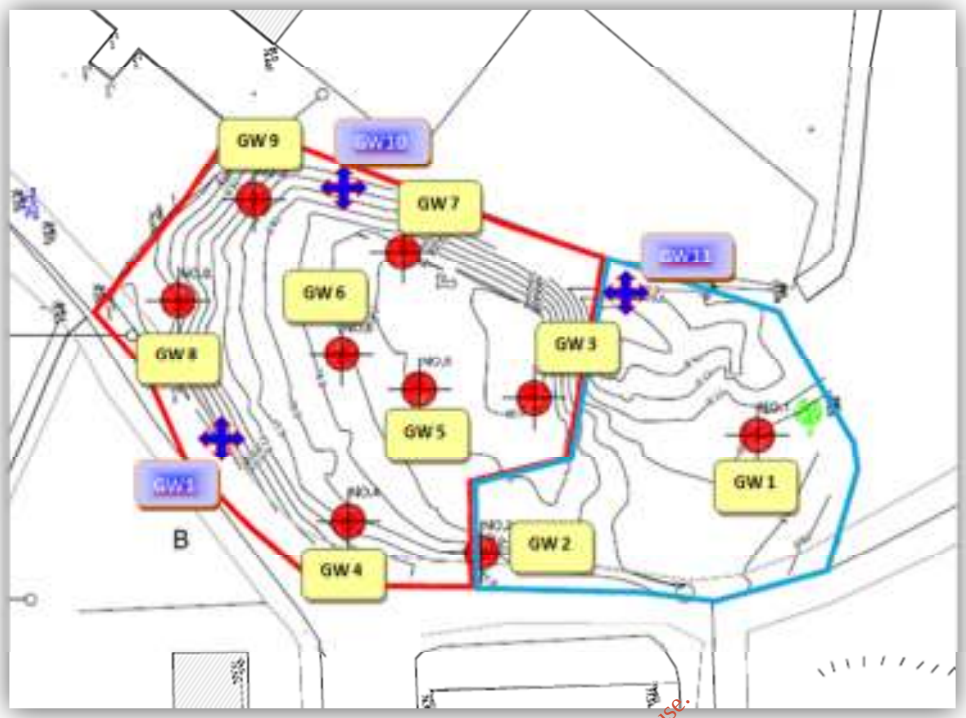
- In order to prevent atmospheric dilution of the sample the gas sampling valve/bung should be closed at all times other than when the gas sampling equipment is attached to the monitoring structure. The well will be resealed after sampling. Monitoring boreholes should also have protective measures to ensure that the valves cannot be tampered with.

- Gas monitoring instruments are susceptible to interference by water vapour or water entering the equipment. Care will be taken to ensure that liquid is not sucked into the gas sampling equipment during monitoring.

- The atmospheric pressure shall be measured during each sampling round and the details noted on the field sheet, e.g. 1001-1003 millibar (rising).

- Any unusual observations shall be noted while monitoring at the facility such as any vegetation die-back, any hissing sounds or bubbling occurring, description of any odours occurring and if the ground is warm.

Figure No. 4 - Proposed Additional Monitoring Stand Pipe Locations.



= Proposed New Standpipe Locations.

3.2.3.1 Evaluation of Works

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. Information from the Tier 2 Risk Assessment Trial Hole investigations was also used to determine, the most appropriate locations of additional Gas monitoring wells GW 10, GW 11 and GW 12.

Landfill gas monitoring results will be analysed for a range of parameters as specified in the EPA Landfill Monitoring Manual. Please refer to table No. 7 - 16 for parameters and sampling frequency. The continued programmed of Landfill Gas monitoring will be undertaken by Traynor Environmental in conjunction with Cavan County Council. Any changes which are detected in the levels of landfill gas being produced will be documented and addressed with the possible implementation of another proposed remediation.

A long term programme of landfill gas monitoring will be established. The Initial phase would include monitoring on a quarter basis and dependant on results would be extended as necessary.

3.2.4 PASSIVE VENTING WELLS & CAPPING OF THE LANDFILL

The findings of the Tier 2 and Tier 3 Environmental Risk Assessment gas monitoring established that the majority of gas being generated at the former landfill is most likely escaping through the surface, due to the shallow depth of the landfill and the composition of the existing landfill cap. However the lateral migration of landfill gases cannot be disregarded given the subsurface rock, fill material and as both methane and Carbon Dioxide are heavier than air. Therefore remedial measures to mitigate against those risks would be required.

During the Tier 2 and Tier 3 Environmental Risk Assessment landfill gas was detected at GW 8. The gas flow rates and levels of landfill gas (Methane and CO_2) recorded during recent monitoring were negligible. The preferential pathway for landfill gas is vertical. Landfill gas can be controlled by installing a passive venting system. A basic system may consist of simple venting trenches that release landfill gas into the atmosphere. A more sophisticated passive venting system may consist of a horizontal network of slotted HDPE pipes connected together and fed to vertical venting columns. Columns may be fitted with rotating aspiromatic cowl to provide a small vacuum and increase the efficiency of the extraction.

A proposed passive venting well system would consist of installation of 300 mm boreholes at 1 m centres to the base of the fill material and constructed with 160 mm diameter perforated vertical pipe with filter sock. All vertical pipes would be connected to a horizontal, 160mm diameter perforated pipe with filter sock located within a gravel-filled trench located in the top 1.0 meters below ground level (mbgl). Vent stack manifolds and vertical risers located at 10m centres along the horizontal gas collection duct would vent the landfill gases to the atmosphere. The efficiency of a passive collection system partly depends on how well the gas is contained within the landfill.

The efficiency of a passive collection system also depends on environmental conditions, which may or may not be controlled by the system design. When the pressure in the landfill is inadequate to push the gas to the venting device or control device, passive systems fail to remove landfill gas effectively. High barometric pressure, sometimes results in outside air entering the landfill through passive vents that are not routing gas to control devices.

The number and spacing of the wells depend on landfill-specific characteristics, such as waste volume, density, depth, and area. In order to maximise the efficiency of the venting system, the preferred approach would be to install the venting measures in the area of the site where the main body of waste has been identified. Venting Wells would be installed to the base of the fill material. The excavation of a vent trench to the base of the fill would entail the removal of large volumes of waste materials which would require costly on-site or offsite disposal. With this proposed option there are also increased health and safety risks associated with working around deep excavations. Passive gas venting systems rely on natural pressure and convection mechanisms to vent landfill gas to the atmosphere. There is no negative air pressure generated like the active systems.

Capping of the Landfill would form an integral part of a passive venting system. Full details of proposed capping of the historic landfill are outlined below in 3.2.4.1 - 3.2.4.2

Figure No. 5 Passive Venting Wells

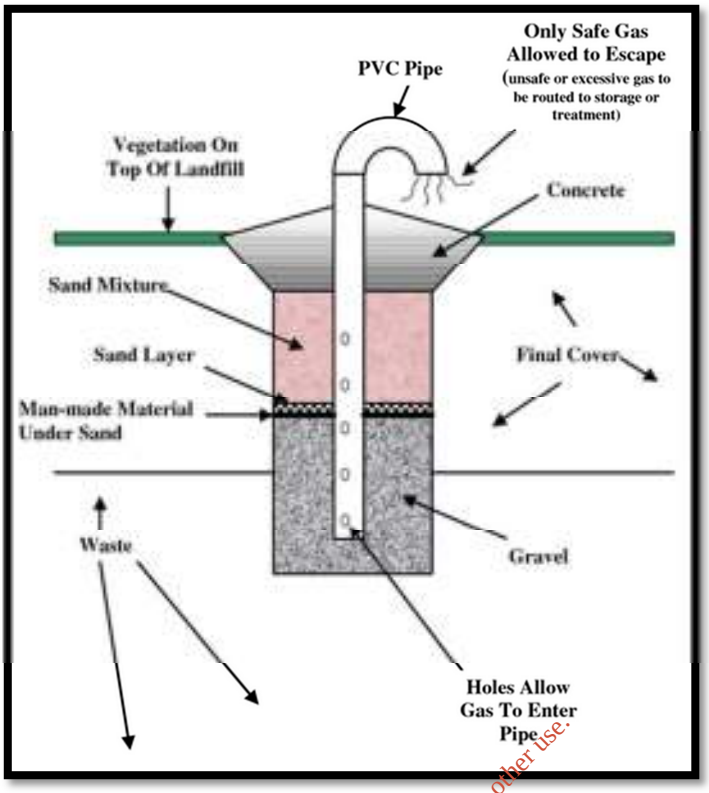


Figure No. 6 Rotating Aspiromatic Cowl

CAPPING OF COOTEHILL LANDFILL

3.2.4.1 Re- Grading of Landform

The re-grading of the landform is vital to the overall remediation of the site and will break the infiltration of rainfall into the waste body. The re-grading of the slopes of Cootehill landfill would have a positive effect on the following:

- Stability of the side slopes;
- Enhanced surface water drainage;
- Reduction in the infiltration of rainwater;
- General landscaping and scenic amenity.

The main aspect of the re-grading is to pull back the side slopes of the landfill to a slope not greater than 1 (v):2.5(h).

Re-grading is also considered necessary in terms of the stability of the side slopes particularly along the Northern and Western faces. The final landform must have watersheds which will direct surface water towards the surrounding surface water. The final contour plan for the waste, prior to capping will be agreed with the Environmental Protection Agency (EPA).

3.2.4.2 Capping

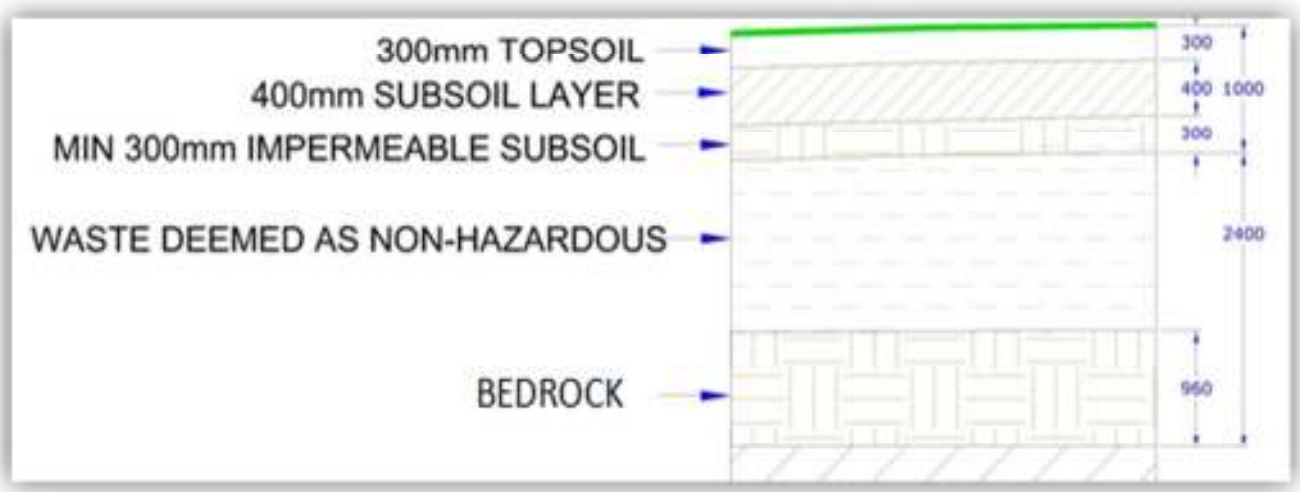
The main factors which influence the rate of infiltration of rainfall and hence the leachate generation is the configuration of the final top cover and associated topography, which will affect the site's run-off pattern and the amount of water percolating into the landfill.

Currently a layer of clayey soil of varying thickness and composition covers the landfill. Regrading of the site slopes, coupled with the capping of the landfill will enhance surface water run-off and reduce the infiltration of rainwater into the waste body. The final cover will consists of clay with a low permeability thus enhancing run-off. The installation of a plastic liner would be an integral part of the passive gas venting system. The liner will prevent the lateral migration of the gas to offsite nearby receptors and force any residual gas through the on-site passive gas venting wells which is ultimately breaking the source pathway receptor linkage.

The lining and capping of the landfill will result in a significant reduction in the amount of surface water infiltrating into the waste body.

1) 300mm topsoil layer for grass and other vegetation.
2) 400mm thick low permeable clayey soil layer;
3) 300mm thick subsoil layer;

Figure No. 7 Diagram Showing a Typical Cross Section of the Capping Layer on Site.



Leachate generation would be reduced once the remediation measures are put in place. It is recommended to extend the capping layer across the surface and down the side slopes of the landfill. The final capping layer could have a dome shape to aid surface water drainage.

3.2.4.3 Low Permeability layer

The main function of this layer is the control of leachate generation by minimising the infiltration of water into the underlying waste. This layer should consist of a material which can be compacted to a suitably low hydraulic conductivity which prevents most, but not all, of the moisture infiltrating into the waste.

The proposed capping should consist of a soil placed and compacted to permeability not greater than 1 x 10^{-9} m/s. To achieve these criteria, a clayey soil with the following characteristics is likely to be required.

- Liquid Limit (LL) < 90
- Plasticity Index (PI) < 65
- % Clay >10
- Casagrande Classification above 'A' line
- Maximum particle size 50mm

Generally low permeability for compacted soils is achieved at moisture contents wet of optimum. Laboratory testing would need to be carried out on any proposed clay source prior to its use in the capping.

3.2.4.4 Subsoil

In addition to the low permeability layer a 400mm subsoil layer would be required across the capping layer in order to protect the low permeability layer and to help support vegetation. A loamy and relatively stone-free soil could be used for this layer.

3.2.4.5 Topsoil or Similar Layer

This layer is necessary to provide a foundation into which grass and any other vegetation might be planted. The topsoil or similar product should be uniform and have a minimum slope of 1 to 30 prevent surface water ponding. The topsoil should be thick enough to:

- Accommodate root systems;
- Provide water holding capacity to attenuate moisture from rainfall and to vegetation through dry periods;
- Allow for long term erosive losses;
- Prevent desiccation and freezing of the barrier layer.

A 200mm to 300mm covering of this material would be provided over the capping layer to give adequate depth for structure to develop.

3.2.4.6 Impact of Remediation Measures

Venting of landfill gases would prevent lateral migration of landfill gas and thus minimise this possible risk. Landfill gas generated, would be efficiently dispersed with the installation of gas venting measures. During the installation of the venting measure odour may cause a nuisance to the nearby off site receptors but this would only be temporary. The future impact of the remediation measure will be the safe and controlled venting of the low levels of landfill gas produced at the site, reducing the risk of lateral migration to offsite receptor in the vicinity.

Positive

- No open excavation and associated health and safety risks.
- Small quantity of surplus material generated during drilling.
- Dewatering and disposal of Leachate not required.
- Cost effective.

Negative

- Installation would be a slow process with possible programme duration of a number of months.
- No biological methane oxidation occurs through the cap nor is methane destructed by flaring.
- Possible odours.

3.2.4.7 Alternative Considered

The exact nature of the infrastructure used to control landfill gas is site specific. The over-riding objective is to prevent landfill gas passing beyond the perimeter of the site, while protecting off site receptors and those using the lower part of the site (Cavan County Council). There are numerous gas control systems and the alternatives considered for use at the Cootehill historic landfill are outlined in section 3.2.1 Vent Trenches and 3.2.2 Virtual Curtain System.

3.2.4.8 Recommended Remediation Measure

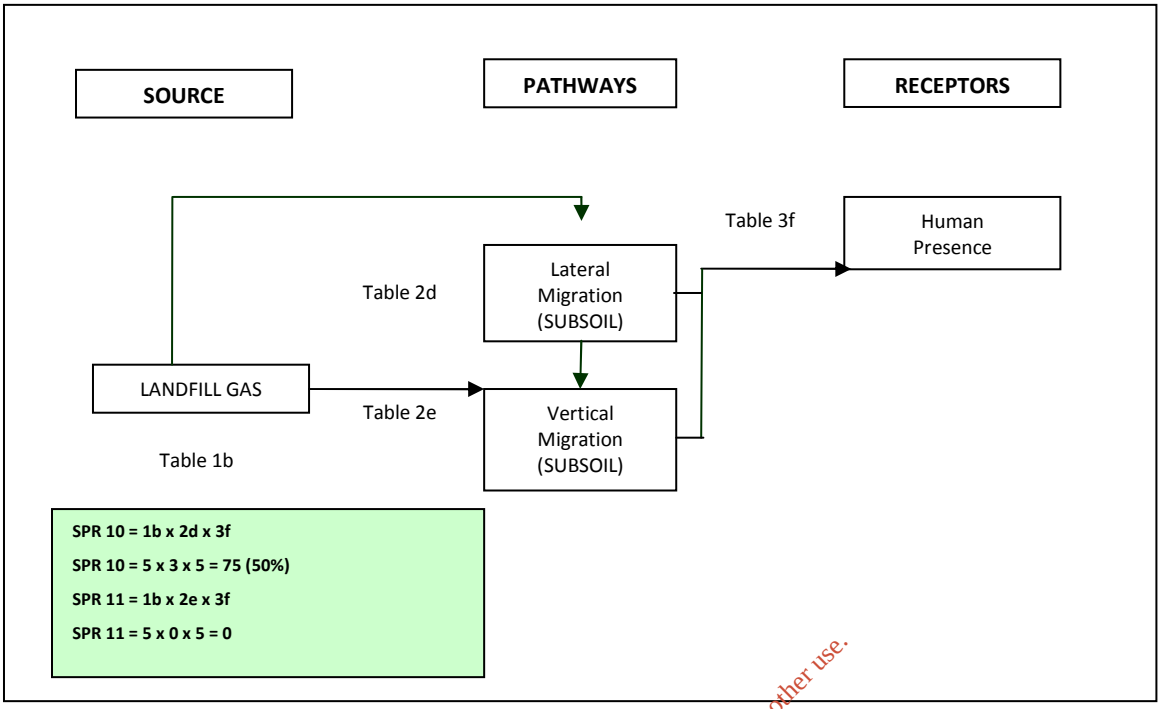
The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would consider a Passive Venting system as a potential remediation option for Cootehill landfill site. Due to the low levels of landfill gas detected and the proximity of sensitive receptors passive gas venting has merit as a remediation option for the site. Landfill Gas levels for Methane CH_4 have steadily decreased over the Tier 2 and Tier 3 Monitoring programme, however low levels were still detected. A Passive Venting System is therefore considered a viable remediation measure for Cootehill Historic landfill.

3.2.4.9 SPR Linkage Diagram

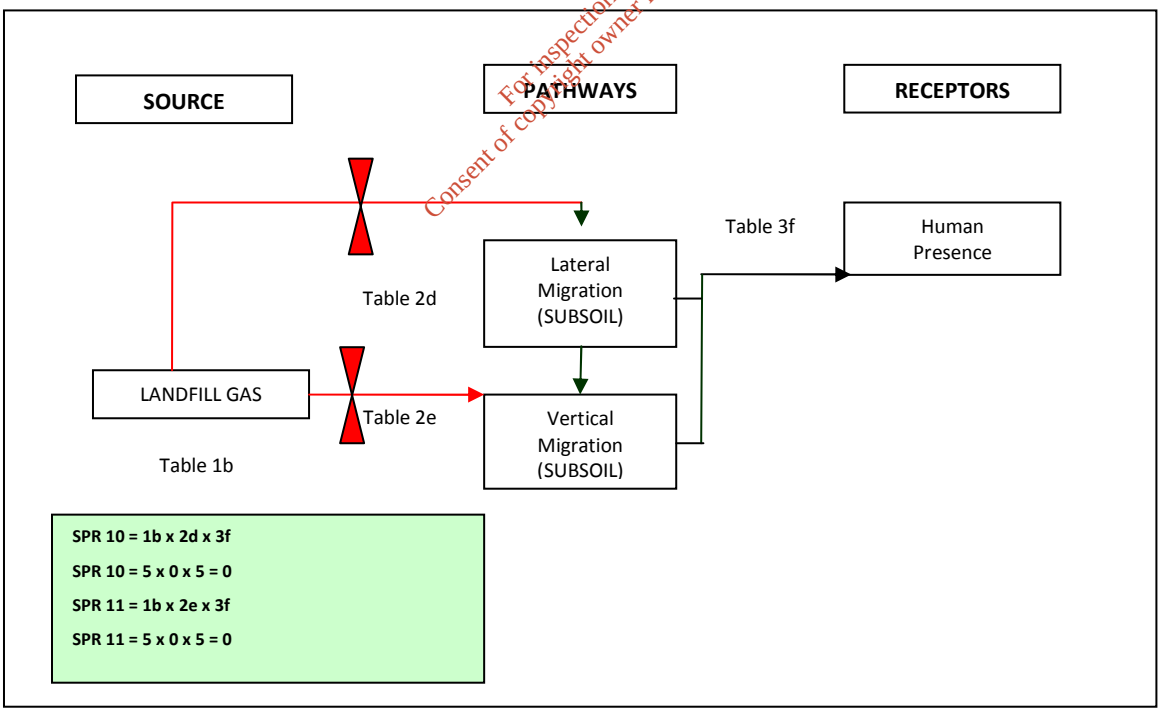
See diagram 3 showing the SPR Linkage prior and post remediation, and highlighting the break in the linkage by the passive venting of the landfill gas.

Diagram 3 – SPR Linkage Diagram showing the break in the linkage before and after the venting of the landfill gas.

Prior to Remediation - SPR 10 & 11



Post Remediation SPR 10 & 11



3.2.4.10 Timescale for Completion of Works

The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd estimate timeframe of 1 - 2 months for the installation of the chosen passive venting system and capping of the landfill. The said timescale for the installation of the system is dependent on resources available, weather conditions and no unforeseen problems during the excavation and installation works.

3.2.4.11 Evaluation of Works

Landfill gas venting options proposed would be designed to vent the landfill gases safely and effectively to the atmosphere. However based on the site specific conditions, the options varied considerably with regard to the ease of installation; potential health and safety considerations; time required for installation and cost. Based on the low volumes of gas being generated at the site, it is not considered that an active landfill gas system is required. A comprehensive programme of gas monitoring would be conducted in conjunction with and post installation of the gas venting system, to check the efficiency of the system and make modifications if required.

3.2.5 REMOVAL OF WASTE MATERIAL

The Tier 2 Environmental Risk Assessment involved the excavation of trial holes within the waste body and across the site. The landfill was divided into equal sections in order to obtain a representative assessment of the location & volume of waste material during the excavation works. A total of 25 trial holes were excavated. With full permission of the landowners, 7 no. of trial holes were excavated in the adjoining site to the east. The other 18 no. of trial holes were excavated within the boundary of the historic landfill site owned by Cavan County Council. No additional trial holes were excavated outside the boundary of either sites due to the close proximity of dwellings, the community crèche and the presence of bedrock in the area. The trial hole logs show photographic evidence of the waste present, a profile of waste depths in each trial hole and European Waste Catalogue (EWC) Codes of all waste encountered (Refer to Appendix A of the Tier 2 Environmental Risk Assessment report - Trial Hole Logs). During the excavation works soil samples were taken and analysed as per the EPA Landfill monitoring requirements. 5 no. Soil samples were taken for analysis to give a representation of the site (TH 2, TH 10, TH 23, TH 25 and TH 20(Control). Each soil sample was compared to the Dutch Reference and Intervention values and on no occasion have values been exceeded. A full listing of parameters sampled and associated results can be found in Appendix C of the Tier 2 Environmental Risk Assessment – Alcontrol Laboratories Certificate of Analysis.

Waste was encountered in 19 of the 25 trial holes excavated TH1, TH2, TH3 TH4, TH5, TH6, TH7, TH8, TH9, TH10, TH11, TH12, TH13, TH14, TH15, TH 22, TH 23, TH24 and TH25 see drawing no. 14.248.115 Trial Hole Locations in Appendix F of the Tier 2 Risk Assessment. There was no waste encountered in the Trial Holes TH 16, TH17, TH18, TH19, TH20, and TH21. The main body of waste is located at the centre of the Cavan County Council site which is elevated and sloping towards all the boundaries. The waste extends from the westerly boundary (TH 1 & TH 2) to the top of the slope (TH 14 & TH 15) in an easterly direction. Negligible quantities of waste were found outside this area. From soil sample results analysis it has been determined that trace amounts of hazardous waste in the form of asbestos were found in TH 10. The hazardous waste was deemed to be, Chrysotile (white asbestos), a trace amount of 1-2 fibres.

The lateral extent of the waste is shown in Figure No.8 below and covers an area of approximately 1700 m^2. From analysis of the vertical and lateral extent of the waste, using an average of 2.2 m of waste and a conversion factor of 1.0, it has been estimated that the approximately 3740 tonnes of waste intermixed with clay, is deposited at the site. This area is hatched in red where the majority of waste was encountered. All areas hatched in green contained no historical waste.

From the trial hole investigation carried out it has been established that the waste material was intermixed with clay. The waste to clay ration in the trial holes which contained waste, ranged from 15:85 in TH 6 to 95:5 in TH 8. Refer to Appendix A of the Tier 2 Risk assessment for waste to clay ratios encountered in all the trials holes.

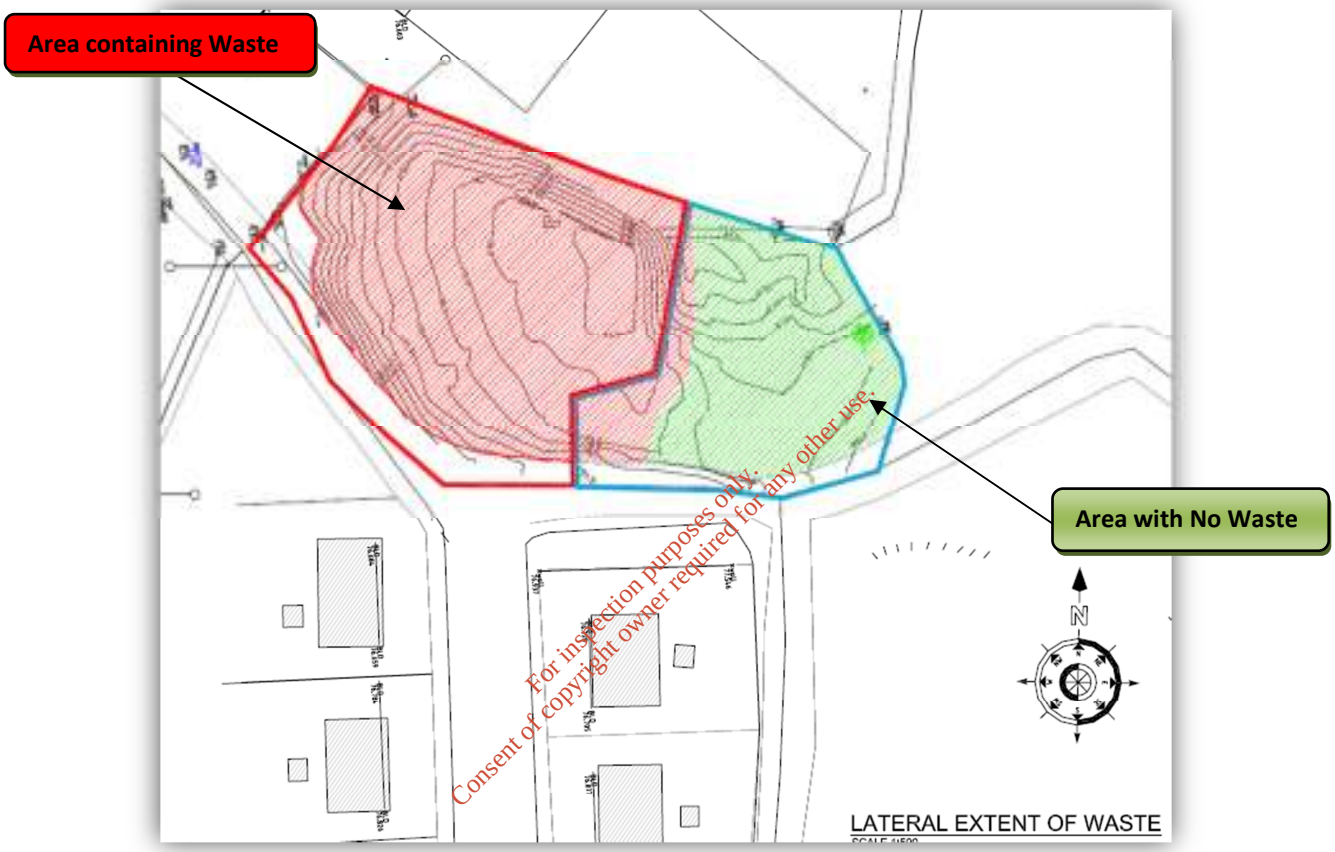
Option 1

Complete dig out of the waste and removal to Scotch Corner landfill. The waste would undergo on site screening to remove the waste from the clay material. The waste would be removed to Scotch Corner landfill while the remaining clay fines would be removed to Corranure Landfill to be used as engineering material. The removal of the waste to Scotch Corner landfill and Corranure landfill would be subject to a Waste Assessment Criteria (WAC) Analysis. The site could be re-developed to benefit the local community (children's playground etc).

Option 2

Complete dig out of the waste and removal to Scotch Corner landfill. The waste would undergo on-site screening to remove the waste from the clay material. The waste would be removed to Scotch Corner landfill (subject to a WAC Analysis) while the remaining clay fines would remain in-stu (subject to a WAC Analysis). Cavan County Council would apply to the Environmental Protection Agency for a Certificate of Registration (infilling of soil and stone) for the site.

Figure No. 8 Lateral Extent of Waste



3.2.5.1 Re- Grading of Landform

The re-grading of the landform is vital to the overall remediation of the site and its future use as a possible amenity area for the community or neighbouring businesses e.g. the community crèche. The re-grading of the site would have a positive effect on the following:

- Enhanced surface water drainage;
- General landscaping and visual impact of the site.
- Potential use for the local community

The main aspect of the re-grading is to re-integrate the site into the existing built environment and maximise its future potential use as an amenity for the local community. The final landform must have watersheds which will direct surface water towards the surrounding surface water drainage system. Re-grading of the Landform with a suitable material will result in the complete remediation of the site.

A 300mm subsoil layer would be required in order to support vegetation and creates a platform for the top soil layer. A loamy and relatively stone-free soil could be used for this layer. Alternatively if option 2 above were chosen, remaining clay fines left after screening could be used as the subsoil layer.

4) 300mm topsoil layer for grass and other vegetation.
5) 300mm thick subsoil layer;

3.2.5.2 Topsoil or Similar Layer

This layer is necessary to provide a foundation into which grass and any other vegetation may be planted. The topsoil or similar product should be uniform and have a minimum slope of 1 to 30 prevent surface water ponding. The topsoil should be thick enough to:

- Accommodate root systems;
- Provide water holding capacity to attenuate moisture from rainfall and to vegetation through dry periods;
- Allow for long term erosive losses;
- Prevent desiccation and freezing of the barrier layer.

A 200mm to 300mm covering of this material would be provided to give adequate depth for root structures to develop if the site is being landscaped.

3.2.5.3 Tree Planting and Final Landscaping

The Cootehill site could be planted with a suitable mix of trees to ensure the establishment of a good sustained vegetative cover and aid the integration of the landform into the surrounding landscape.

Tree planting have the following advantages for the site:

- It reduces soil erosion by establishing ground cover;
- Improves visual appearance;

There are many factors to be considered when planting tree and shrub such as:

- Timing of tree and shrub planting;
- Method of tree and shrub planting;
- Tree and shrub suitability i.e. trees for 2m wide screening belt along road to front of the site;
- Soil suitability;
- Maintenance;
- Cost

The following is a list of trees which could be used as part of the landscaping scheme. Refer to drawing no. 14.248.120

Table 18: Tall/Medium trees to be planted on site as part of the landscaping scheme

No.	Species	Height at year 20(m)	Remarks
1	Silver birch * *Betula pendula*	9	Fast growing, useful nurse crop, tolerates low fertility
2	Common alder * *Alnus glutinosa*	8	Nitrogen fixing, grows well in damp areas, good for wildlife
3	Sycamore *Acer pseudoplatanus*	8	Tolerant to exposure and air pollution, good for wildlife
4	Scots pine * *Pinus sylvestris (conifer)*	7	Visually attractive tree, grows well on poor exposed sites

Table 19: Small trees to be planted on site as part of the landscaping scheme

No.	Species	Height at year 20(m)	Remarks
5	Holly* *Illex aquifolium*	3	Good for wildlife and screening
6	Hawthorn * *Crataegus monogyna*	4	Commonly found in hedgerows, attractive tree with white blooms in the spring and deep red haws in autumn
7	Rowan * (mountain ash) *Sorbus aucuparia*	6	Hardy tree suitable for exposed site, good for wildlife
8	Goat willow *Salix caprea*	4	Associated with damp conditions

Trees suitable for central area of the Landfill site (* indicates native species)

3.2.5.4 Impact of Remediation Measures

The removal of all waste material from the historic landfill would ultimately remove the source of contamination from the site and the environment as a whole. However the potential removal of the waste material from the site poses a number of potential risks. The physical act of removing the waste could potentially mobilise contaminants which are dormant within the site and aid their migration. The risk to workers and nearby residents must also be considered given the close proximity to the site. The removal of the waste could create airborne particulates in the vicinity of the work area. Workers immediate to the work area and residents downwind of the site could be negatively impacted by the dig-out and removal of the waste material. From soil sample analysis it has been determined that trace amounts of hazardous waste in the form of asbestos were found in TH 10. This does not eliminate the possibility of encountering other pockets of hazardous waste during a full excavation of the landfill. The cost for the removal of the waste would be considerable as the waste would have to be removed and transported to a licensed facility. The estimated tonnage for dig-out and removal is 3740 Tonnes of waste intermixed with clay.

Positive

- Source of contamination would be eliminated.
- All SPR linkages will be broken.
- Prevent possible leaching of polluting contaminants.
- Reduce/Eliminate the obligation on Cavan County Council to Monitor and maintain the Landfill in the future.

Negative

- Possible mobilisation of contaminants that could impact on nearby residents.
- Health and Safety of workers
- Possible mobilisation of contaminants could impact on groundwater.

3.2.5.5 Surface Water Control & Management

The landfill is currently capped with a thin layer of soil/aggregate, through which precipitation freely enters the waste body. The removal of the waste will require the soil cover to be stripped. Removal of soil cover will increase the vulnerability of the underlying bedrock. It is envisaged that any soil excavated will be retained on site and reused as fill material and landscaping.

Temporary storage of soil will be carefully managed in such a way as to prevent any potential negative impact on the receiving watercourse and the material will be stored away from the surface water drain. Movement of material will be minimised in order to reduce the potential impact to the local watercourse.

Excavated waste and/or soil material requiring offsite disposal will be classified (where possible) prior to excavation, in order to minimise stockpiling of material at the site. Excavated waste and/or soil material will be transported from the site using appropriately permitted waste contractors, i.e. those holding permits from the National Waste Collection Permit Office. Any stockpiling of excavated waste will be sited away from the watercourse/drain.

If topsoil or subsoil is required to be imported on to the site, the material will be brought from a local site, if possible, to minimise transportation distance. Any vehicles used to transport fill material will be covered to prevent uncontrolled release of material. Any importation of fill material onto the site will be in accordance with Council Decision 2003/33/EC in order to confirm that it is suitable for its proposed use.

The control of surface water runoff, which is likely to contain increased loads of suspended solids, will be by the use of mitigation measures such as bunds, settlement ponds, silt fences, or by covering the stockpiles with plastic sheeting. In addition, water sprays will be used to avoid the generation of dust during dry weather.

In order to minimise the risk of depositing soil onto the surrounding roadways, a wheel wash will be located at the site exit used by all vehicles that leave the site. The wheel wash will contain a suitable sump arrangement for waste waters. In addition, a road sweeper or dust suppressant application may be used.

Refuelling operations will only take place at a designated, bunded area of hard standing that is situated as far away as possible from surface water bodies. A spill tray and an emergency response spill kit shall be available and maintained on-site with the mobile fuel bowser during refuelling operations. Site personnel operating machinery or vehicles on the site will be trained in the use of emergency spill kits. The spill tray will be placed beneath the fill point of the vehicle and the emergency response spill kit will be used in the event of an accidental spill. It is preferable that the maintenance or addition of hydraulic oils or lubricants take place offsite.

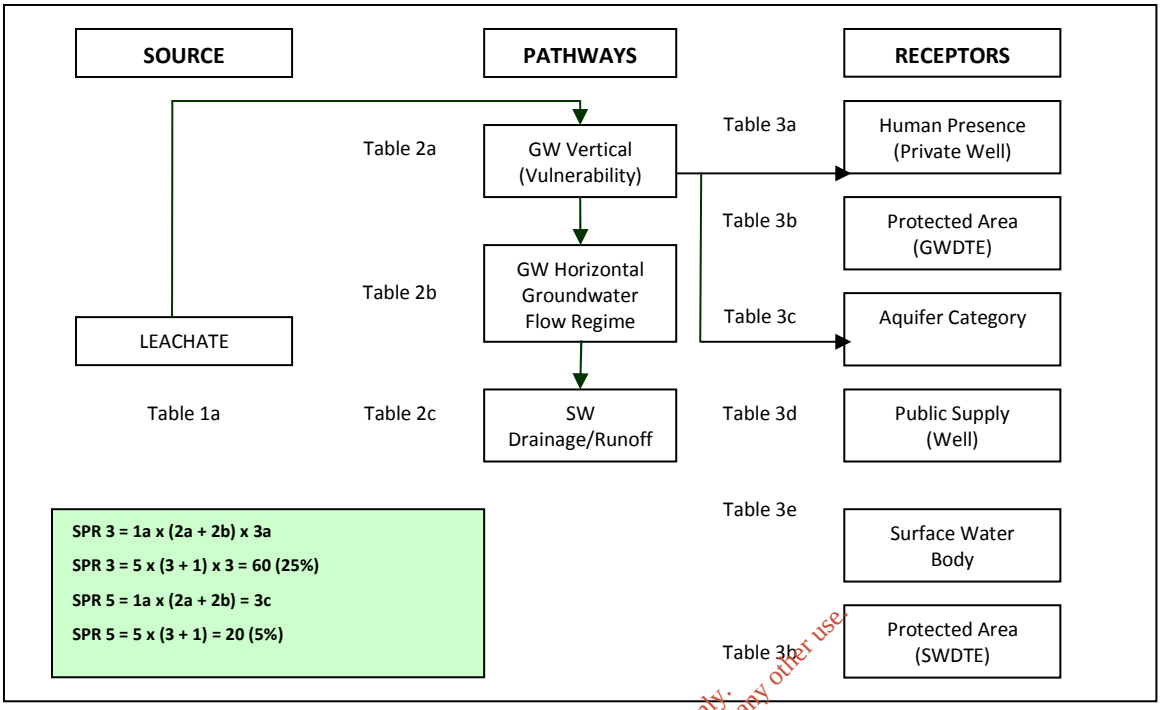
A project-specific Construction and Environmental Management Plan (CEMP) will be established and maintained by the contractors and Cavan County Council during the removal phases. The Plan CEMP will cover all potentially polluting activities and include an emergency response procedure. All personnel working on the site will be trained in the implementation of the procedures.

3.2.5.6 RECOMMENDED CONTROL OF SURFACE WATER DRAINAGE

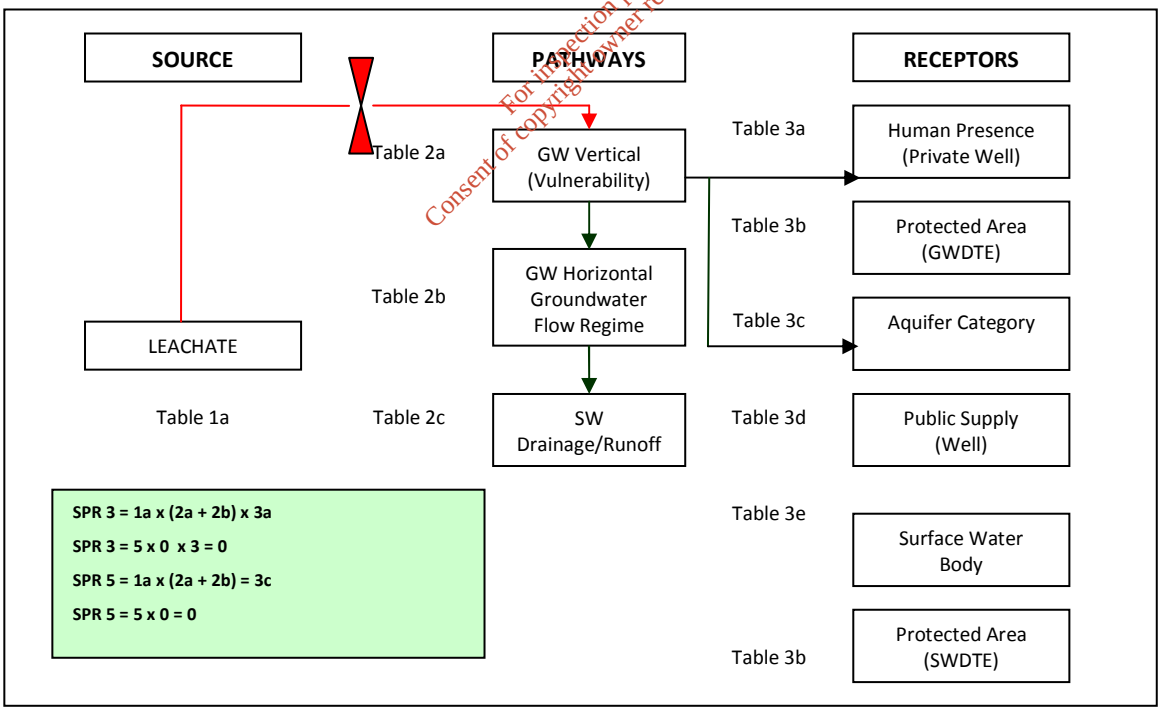
The capping and regrading of the landform will reduce the infiltration of precipitation and promote surface water run-off and drainage to the watercourse/drain on the Northern aspect of the landform.

3.2.5.7 Diagram 4 –SPR Linkage Diagram showing the break in the linkage after the control of Surface water entering the Landfill.

Prior to Remediation - SPR 3 & 5



Post Remediation - SPR 3 & 5



3.2.5.8 Alternative Considered

Leaving the waste in-situ and monitoring the levels of Landfill Gas was also considered as an option for remediation, given the nature of the site and fill material encountered. Gas venting systems such as passive venting wells, vent trench and virtual curtain were also considered as an alternative to removal of waste material. Lining and capping of the landfill would also form part of the remediation works in conjunction with gas venting measures.

3.2.5.9 Recommended Remediation Measure

Following consideration of the positive and negative effects from the complete removal of all waste material, the Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would recommend the complete dig-out and removal of waste from Cootehill historic landfill. The site specific characteristics of Cootehill landfill and monitoring results from the tier 2 and tier 3 risk assessments indicate that, the small site area (0.18 ha), estimated volume of waste encountered, very low levels of Landfill gas recorded, and the site location would justify the complete removal of the waste material from the site. This is considered to be the most appropriate remediation technique for the site by Cavan County Council. The proximity of a fully licensed municipal landfill which could accept the waste material once removed was also considered economical favourable when recommending this remediation option.

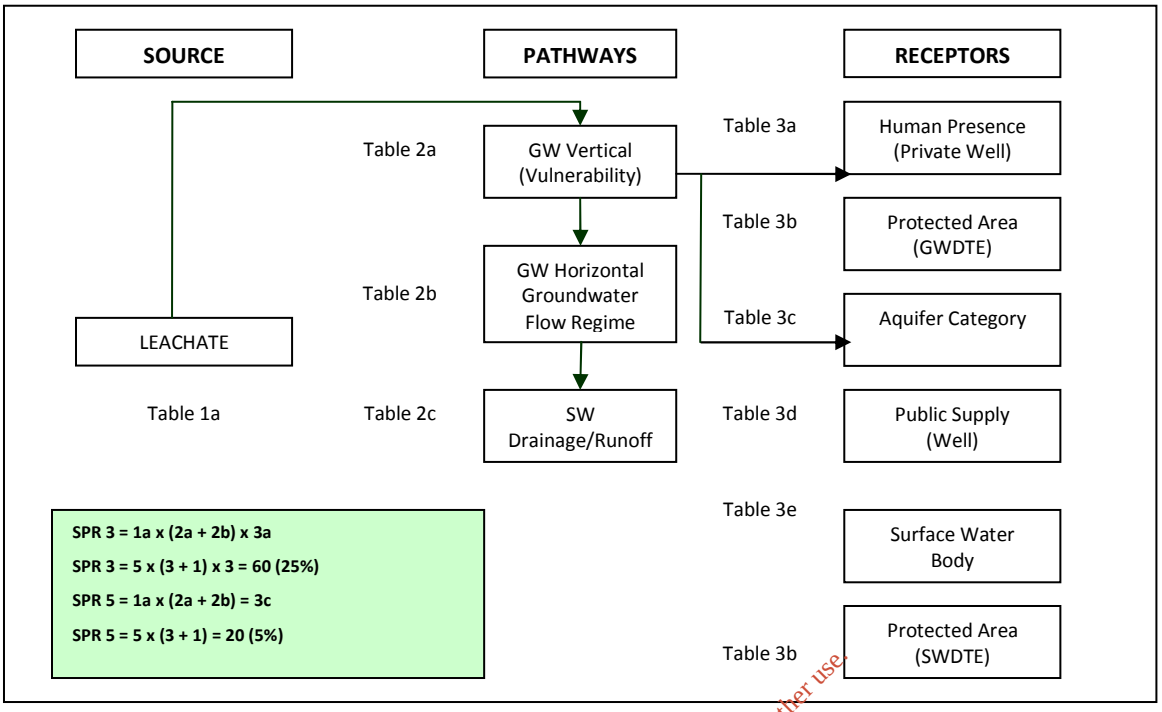
Based on a logistical programme, cost considerations and landfill gas levels/ and concentrations, the removal of all the historic waste, presents the most viable remedial option for the site. Final tonnages of waste will be determined after screening of the material has taken place as detailed in option 1 and 2 above.

3.2.5.10 SPR Linkage Diagram

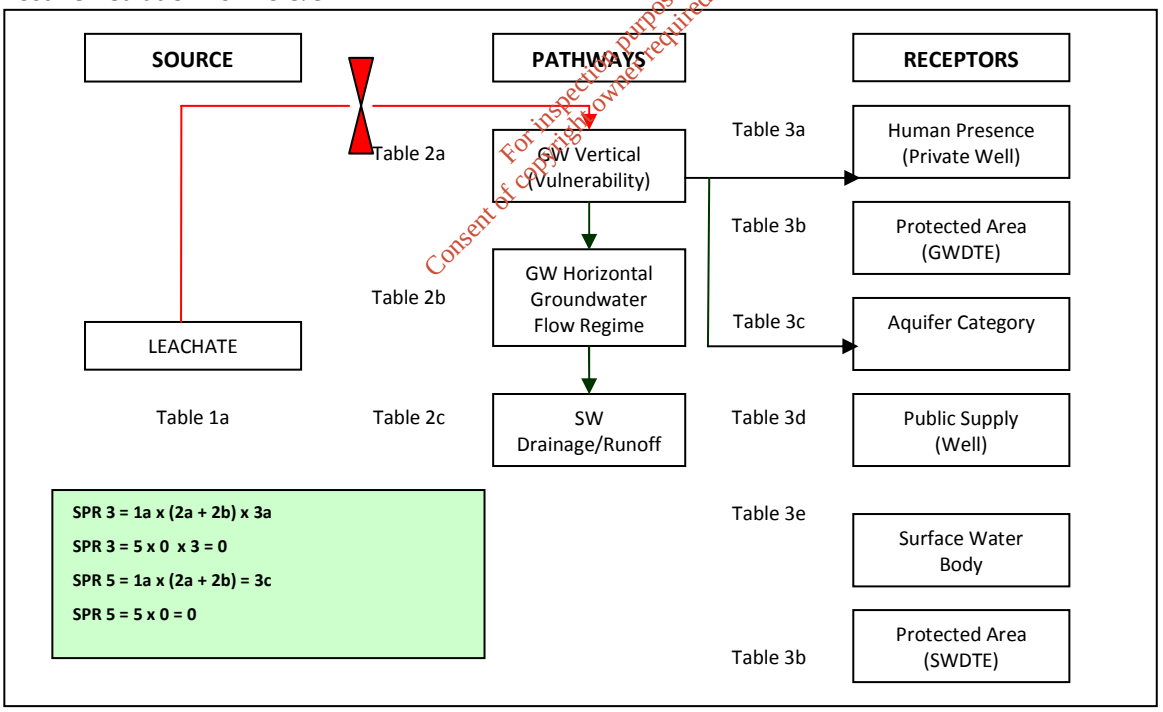
See Diagram 5 showing the SPR Linkage prior and post remediation and highlighting the break in the linkage by the removal of the waste material.

SPR Linkage Diagram 5 showing the break in the linkage before and after the removal of the Waste Material.

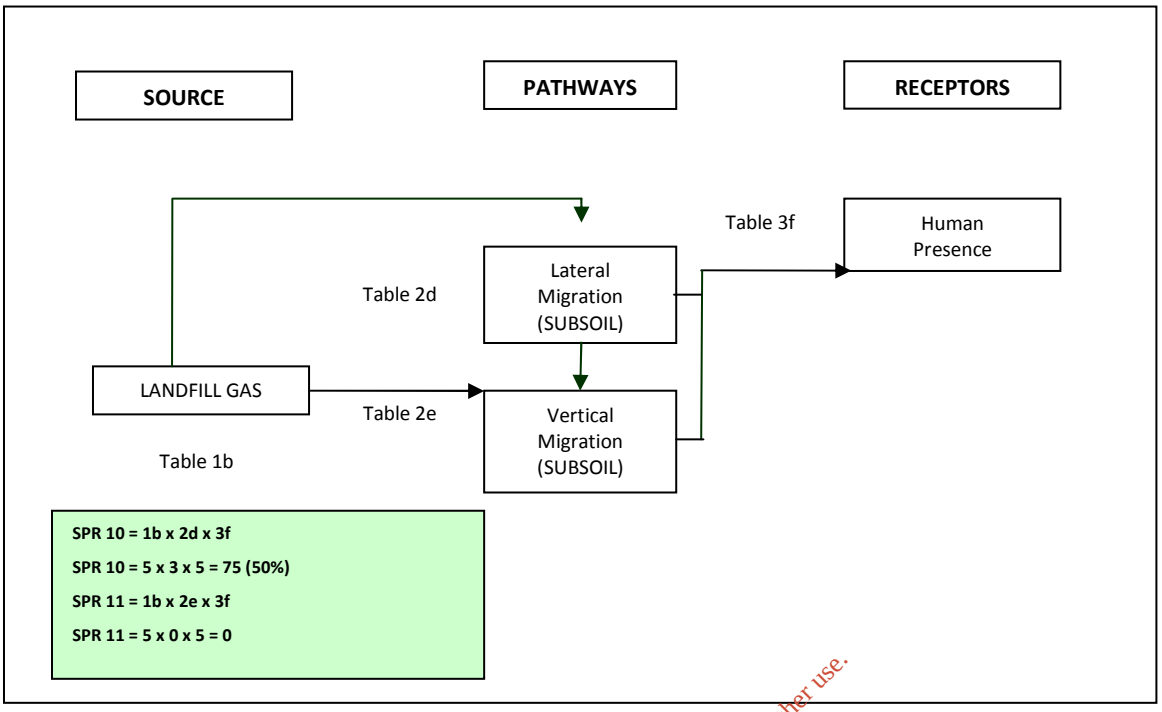
Prior to Remediation - SPR 3 & 5



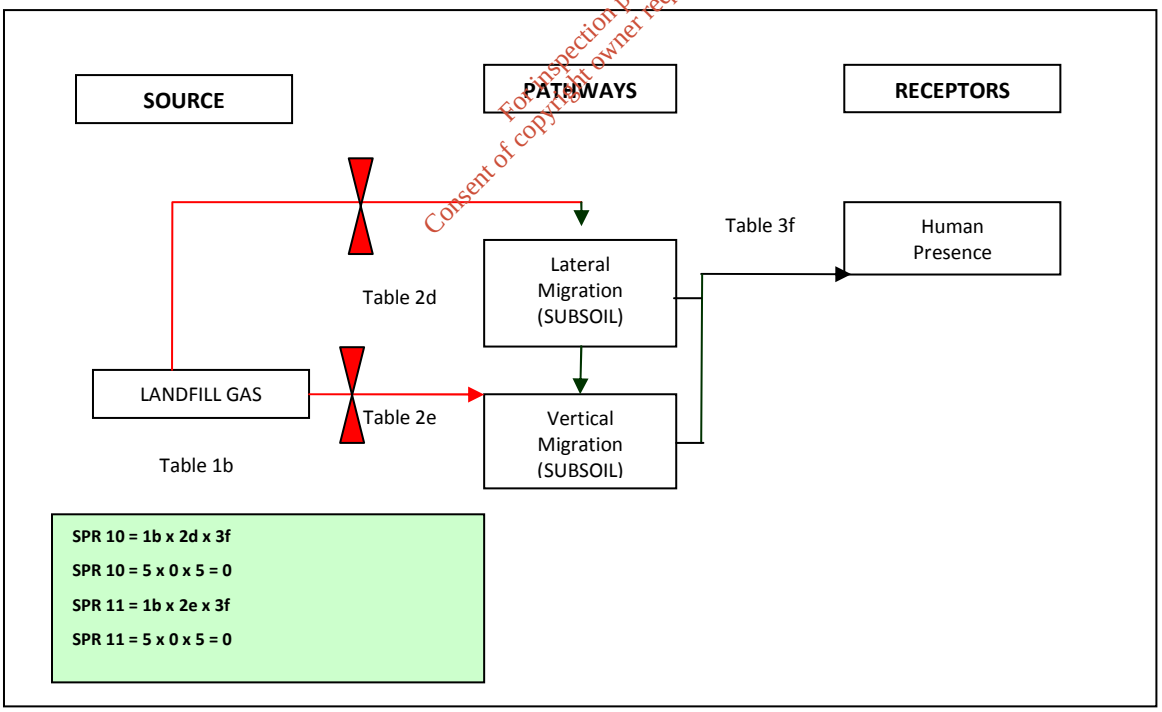
Post Remediation - SPR 3 & 5



Prior to Remediation - SPR 10 & 11



Post Remediation SPR 10 & 11



3.2.5.11 Timescale for Completion of Works

The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would estimate a timeframe of 4 - 5 months for the dig-out and removal of waste material from the site. The said timescale for the removal of the waste is dependent on resources available, weather conditions and no unforeseen problems during the excavation works e.g. encountering additional quantities of hazardous waste, which were not unearthed during the trial hole excavation.

3.2.5.12 Evaluation of Works

The complete removal of waste material from the site would involve large volumes of traffic movement from the site. This could have a temporary negative impact on the local residences. Excavation of the waste could also mobilise contaminants which could pose a risk to offsite receptors and the environment. If the complete removal of waste were to take place, landfill gas monitoring would be undertaken periodically both during and after the excavation of the waste to ensure that there is no gas migration. Complete removal of the waste would have positive long term impacts on the environment and the nearby receptors. This option represents the most economical viable and environmental friendly remediation technique for the historic landfill.

3.3 SETTLEMENT

Suitable geotechnical stabilisation techniques will be employed during the removal of the waste and the grading of the landform in order to ensure slope stability. After the waste has been removed the site will be re-graded in order to re-integrate the site into the surrounding built environment. It is expected that there will be some settlement occurring on the site, however this will be negligible.

3.4 FENCING

The existing fence along a portion of the northern boundary is adequate. As it is expected to use the site for the purpose of a community area a wooden fence approximately 1.2m high would be deemed appropriate.

4.0 SUMMARY OF IMPACT OF REMEDIATION MEASURES AND POTENTIAL RISKS

Table No. 20		RISKS	
No.	**Remediation Measure**	**Positive**	**Negative**
3.2.1	Vent Trenches (Vertical)	- Proven approach for the interception of horizontal migration of landfill gases. - Prevents lateral migration of landfill gas	- Significant health and safety considerations due to the required depth of the trench - Would have to be installed a distance away from the site boundary due to health and safety considerations. - Potential to generate a significant quantity of surplus waste materials that depending on the disposal option agreed with the EPA would have the potential for significant additional costs. - Mobilisation of Contaminants
3.2.2	Virtual Curtain	- Could be installed in close proximity to the road. - No open excavation and associated health and safety risks - Virtually all soil generated during activities can be back filled into excavation. - Documented history of effective usage in the UK - Short timeframe for installation of the system. - Dewatering of leachate not required	- To date this is not a proven technology in Ireland and hence may require some modifications to comply with the EPA. - Cost - Site Constraints - No landfill gas migration thus cost not warranted.
3.2.3	Programme of Landfill Gas Monitoring	- Any changes in the levels of landfill gas will be detected and can be acted upon. - Any future lateral migration of landfill gas will be detected. - Take preventative and corrective actions	- Cost of maintaining a monitoring programme and up keep of the gas monitoring standpipes. - High presence of bedrock on the site.
3.2.4	Passive Venting Wells & Capping of the Landfill	- No open excavation and associated health and safety risks. - Small quantity of surplus material generated during drilling. - Dewatering and disposal of Leachate not required. - Cost effective.	- Installation would be a slow process with possible programme duration of a number of months. - No biological methane oxidation occurs through the cap nor is methane destructed by flaring.

			- Possible odours
3.2.5	Removal of Waste Material and re - grading of the Landform including Surface Water Control and Management	- Source of contamination has been eliminated and SPR linkage will be broken - Prevent further leaching of polluting contaminants. - Reduce/Eliminate the obligation on Cavan County Council to Monitor and maintain the Landfill in the future. - Installation of additional surface water drain preventing the ingress of uncontaminated surface water entering the remaining waste body.	- Possible mobilisation of contaminants that could impact on nearby residents. - Possible mobilisation of contaminants that could impact on groundwater. - Health and Safety of workers - Cost

5.0 VERIFICATION/VALIDATION REPORT

5.1 GENERAL

Following completion of remediation works, Cavan County Council will submit a verification/validation report to the appropriate body for approval. The verification report should provide confirmation that all measures outlined in the approved remediation strategy have been successfully completed, including where appropriate, validation testing. The report should include:

- Validation sampling of any imported soils, including details of the source of material and appropriate analysis carried out by an approved Laboratory with a Quality Management System that has been designed to meet the requirements of BS EN ISO/IEC 17025 and MCERTS (Soil).
- Any monitoring results of tests carried out prior to and during remediation of the site;
- Photographic and other media records;
- Waste management and disposal documentation ('Duty of Care');
- Confirmation that the Environmental Risk Assessment objectives have been met;
- An Environmental/Engineering Company with appropriate Professional Indemnity Insurance shall oversee all works and approve the associated works on site.
- Final topographic survey to confirm slopes of capping layer and all remediation objectives achieved.

6.0 HEALTH & SAFETY

The remediation of the landfill will require consideration of a number of health and safety issues. Apart from the normal precautions required in any earthworks based construction project, the excavation of partially decomposed waste coupled with the removal of waste material, soil and groundwater from the site must be considered and properly assessed. The presence of low levels of landfill gas within the waste body must also be closely monitoring during any remediation works. Furthermore, prior to any remediation works taking place on site the appointed contractor shall carry out a full risk assessment of the site taking cognisance of the contaminants identified in the Tier 2 Risk Assessment. The health and safety plan generated from the aforementioned risk assessment shall be site specific and deal with the removal of the partially degraded waste material while safeguarding the Health and Safety of on site personnel.

Each Contractor to be employed in remediation of the site would have to be competency assessed by Cavan County Council Health and Safety Department and subsequently appointed. No works shall take place on the site until a risk assessment and health and safety plan is submitted and approved by Cavan County Council. All works shall be carried out in strict compliance with the Safety, Health and Welfare at Work Act, 2005 as amended.

7.0 SUMMARY OF REMEDIATION MEASURES

The Tier 2 Risk Assessment process has resulted in the risk rating for the historic landfill remaining the same as the Tier 1 Risk Assessment, which is Moderate Risk (Class B). SPR Linkage number 10 has been proven and thus risk rating assigned accordingly as **Moderate**. As part of the Tier 2 risk assessment the intrusive site investigation works have confirmed the area were the waste was deposited is the same as previously predicted, accounting for approximately 1700m^2.

Six key remediation options have been proposed, in relation to the historic landfill at Cootehill. The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd recommends option 3.2.6 Removal of the Waste Material for the remediation of Cootehill Historic Landfill.

8.0 SPR LINKAGES AFTER REMEDIATION WORKS CARRIED OUT

Subject to Remediation works carried out on site as detailed in section 8.0 Tier 3 Assessment Report the following SPR Linkages would change.

Table 21: SPR Linkages If Remediation Works Carried Out On Site as detailed under section 8.0 in the Tier 3 Environmental Risk Assessment Report

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	0	240	Leachate → human Presence	0.00
SPR 4 = 1a x (2a + 2b) x 3b	0	240	Leachate → GWDTE	0.00
SPR 5 = 1a x (2a + 2b) x 3c	0	400	Leachate → Aquifer	0.00
SPR 6 = 1a x (2a + 2b) x 3d	0	560	Leachate → Surface Water	0.00
SPR 7 = 1a x (2a + 2b) x 3e	0	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	0	150	Landfill Gas → Human Presence	0.00
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	Low Risk (Class C)

After the Tier 3 risk assessment the classification was revised downwards to Class C - Low Risk.

9.0 RECOMMENDED REMEDIATION MEASURE

Following consideration of the positive and negative effects from the complete removal of all waste material, the Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would recommend the complete dig-out and removal of waste from Cootehill historic landfill. The site specific characteristics of Cootehill landfill and monitoring results from the tier 2 and tier 3 risk assessments indicate that, the small site area (0.18 ha), estimated volume of waste encountered, very low levels of Landfill gas recorded, would justify the complete removal of the waste material from the site. This is considered to be the most appropriate remediation technique being mindful of cost considerations and environmental impact.

Based on a logistical programme, cost considerations and landfill gas levels/ and concentrations, the removal of all the historic waste, presents the most viable remedial option for the site.

The re-grading of the site is vital to the overall remediation of the site and the potential re-use of the site by the local community. This re-grading will take place after remediation option 3.2.5 Removal of the Waste Material has been complete. The final contour plan for the site, prior to re-grading of the landform will be agreed with the Environmental Protection Agency (EPA)/Local Authority.

Subject to remediation measures being carried out, the risk rating for Cootehill Historic Landfill would be reduced from a Moderate Risk to a **Low Risk** site as all of the SPR linkages would have been broken. The SPR Linkage diagrams for each option have been detailed under each section.

Taking into consideration the future costs of monitoring, maintenance and venting of landfill gas the removal of the waste from the site represents a complete and comprehensive remediation option for the site.