ATTACHMENT D.1

TIER 3 RISK ASSESSMENT

APPLICATION TO THE EPA FOR A CERTIFICATE OF AUTHORISATION

FORMER MUNICIPAL HISTORIC LANDFILL

DUNAREE

KINGSCOURT

CO. CAVAN

Prepared By:

Traynor Environmental Ltd
Belturbet Business Park,
Creeny
Belturbet
Co. Cavan

JUNE 2014

TIER 3

ENVIRONMENTAL RISK ASSESSMENT

OF A

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AT

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1.0 INTRODUCTION

Traynor Environmental Ltd in conjunction with Cavan County Council has undertaken a Tier 3 Environmental Risk Assessment in relation to Kingscourt Historic landfill located at Dunaree, Kingscourt, 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 2012 and 2013 respectively, 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 being reduced from high to **Moderate Risk** due to the extent of the waste body being reduced thus impacting on the risk ranking. SPR Linkage number 10 has been investigated and thus risk rating assigned accordingly as **Moderate**. 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 2, with negligible levels of landfill gas detected in gas well GW 1, GW 3, GW 4, GW 5 and GW 6. After trial hole investigations it was established that the area of the site containing waste was significantly less than initially thought after the Tier 1 Risk Assessment. Due to this a number of SPR linkages were changed from the Tier 1 Assessment as follows:

- SPR1 has changed from a linkage score of 28.00 to 0.00;
- SPR3 has changed from a linkage score of 84.00 to 25.00;
- SPR5 has changed from a linkage score of 28.00 to 5.00;
- SPR7 has changed from a linkage score of 28.00 to 0.00;
- SPR10 has changed from a linkage score of 105.00 to 50.00;
- SPR 11 has changed from a linkage score of 105.00 to 0.00;

The change in the linkage scores changed the overall risk rating of the site from **High Risk** down to **Moderate Risk.** The full list of SPR values for the Tier 2 assessment are indicated in Table 1.

Table 1: Refinement Of Conceptual Site Model (csm) After Tier 2 Environmental Risk Assessment

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

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

Overall Risk	Moderate Risk (Class B)

1.2 VERTICAL EXTENT OF WASTE

The majority of the buried waste was found on the higher ground in the South East of the site. Waste was encountered in trial holes TH1, TH4, TH5, TH6, TH7, TH10, TH12, TH14, TH15, and TH24 see drawing no. 132.120.115 Trial Hole Locations in appendix A of this report. The base of the waste is defined by bed rock encountered between 1.0 m and 4.6 m below ground level. Full cross section drawings from two different aspects of the site are also included in appendix A (Drawing Ref 13.120.112)

Table No. 2 outlines the depth of all trial holes and the extent in meters of waste encountered in each hole. The trial pits were monitored during excavation for the presence of leachate and odours. Trial holes were logged according to BS 5930:1999(Refer to Tier 2 Report 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	149.3	147.3	4.00	2.00	4.00	2.00
TH 2	150.0	-	4.00	n/a	n/a	n/a
TH 3	149.7	-	3.00	n/a	n/a	n/a
TH 4	150.3	147.9	4.40	2.40	4.40	2.00
TH 5	150.0	149.6	3.70	0.40	3.70	3.30
TH 6	150.5	150.4	4.60	0.10	4.60	4.50
TH 7	151.5	150.6	3.60	0.90	3.60	2.70
TH 8	152.5	-	1.00	n/a	n/a	n/a
TH 9	152.0	-	1.40	n/a	n/a	0.30
TH 10	150.0	149.2	4.00	0.80	4.00	3.20
TH 11	150.0	-	4.00	n/a	n/a	n/a
TH 12	149.7	148.2	3.90	1.50	3.90	2.40
TH 13	149.5	-	2.70	n/a	n/a	n/a
TH 14	150.0	149.0	3.30	1.00	3.30	2.30
TH 15	150.0	148.8	3.00	1.20	3.00	1.80
TH 16	148.5	-	1.50	n/a	n/a	n/a
TH 17	149.5	-	2.60	n/a	n/a	n/a
TH 18	144.0	-	1.80	n/a	n/a	n/a
TH 19	146.5	-	2.00	n/a	n/a	n/a
TH 20	147.5	-	4.00	n/a	n/a	n/a
TH 21	143.0	-	2.00	n/a	n/a	n/a
TH 22	143.5	-	3.00	n/a	n/a	n/a
TH 23	150.0	-	1.20	n/a	n/a	n/a
TH 24	150.5	149.5	3.00	1.00	3.00	2.00
TH 25	150.0	-	3.20	n/a	n/a	n/a
TH 26	148.0	-	2.80	n/a	n/a	n/a
TH 27	150.7	-	1.20	n/a	n/a	n/a
TH 28	142.0	-	2.60	n/a	n/a	n/a
TH 29	138.3	-	1.60	n/a	n/a	n/a
TH 30	140.0	-	2.60	n/a	n/a	n/a
TH 31	140.1	-	2.80	n/a	n/a	n/a
TH 32	140.5	-	1.20	n/a	n/a	n/a

Drawing No 13-120-115 shows locations of all trial holes on site. Please see Appendix A of the Tier 3 assessment.

1.3 LATERAL EXTENT OF THE WASTE

Waste was encountered in 10 of the 32 trial holes excavated. There was no waste encountered in the trial holes TH2 , TH3, TH8, TH9, TH11, TH13, TH16, TH17, TH18, TH19, TH20, TH21, TH22, TH23, TH25, TH 26, TH27, TH28, TH29, TH30, TH31, & TH32. It can be confirmed that there was no waste encountered in the trial holes excavated in the Council storage yard which is located in the most northerly aspect of the site. The most extensive quantities of waste were encountered towards the South East of the site on the upper level. The waste extends from the eastern boundary (TH 6) to the top of the slope (TH 12) in a northerly direction towards the Council storage yard.

The lateral extent of the waste is shown in Drawing No. 13.120.111 - Appendix A and covers an area of approximately 2300 m^2. From the trial hole excavations, it is estimated, that approximately 6000 tonnes of waste is deposited at the site.

The site is bordered by housing estates on the Northern, Southern and Western boundary and an undeveloped site on the south-eastern boundary. The site is secure and delineated by palisade fencing on the northern, southern, and south-eastern perimeter. Part of the site is used as a Cavan County Council storage yard, the remainder is overgrown scrub land.

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. Datable material in the form of a newspaper article was unearthed during the trial hole excavations and was from the 23rd of September 1988. There was no evidence of any potentially hazardous waste on site which was based on the absence of oils, staining, odours, asbestos sheeting etc.

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. 13-120-100 which is located in Appendix A.

Results for Soil samples were compared to Dutch 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

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

The soil samples were taken from trial holes TH 10, TH 14 and TH 20(Control) and were analysed for the following:

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

TH14 exceeded the Dutch Reference value for Copper. TH20, TH10, and TH14 all exceeded the Dutch Reference values for Nickel. TH 20 had the same reading for Zinc as the Dutch Reference Values. However none of the results exceeded the intervention values.

Table 3: Soil Sample Results Which Meet/Exceeded The Assessment Criteria (Dutch Intervention Values).

Parameter	Sample Control TH 20	Sample No.2 TH 10	Sample No.3 TH14	Dutch Intervention Values Reference Value (mg/kg)	Dutch Intervention Values Intervention Value (mg/kg)
Copper	27.5	31.9	39	36.0	190
Nickel	58.2	50.4	53.4	35.0	210
Zinc	140	102	138	140	720

(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

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

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 14 No. occasions between 11th July 2013 and the 26th August 2013 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 six standpipes were installed at the site. A programme of landfill gas monitoring was subsequently carried out. The six gas monitoring standpipes were strategically located around the site. GW 1, GW 2 and GW 3 were placed in the main waste body located to the Southeast of the site. GW4 was located on the Western boundary of the site adjacent to a residential housing estate. GW 6 was located on the Northern boundary of the site which is immediate to a housing estate but within the confines of the council storage yard. GW 5 was located on the North Western boundary of the site immediate to a residential dwelling residence. No waste was encountered in GW 4, GW 5 or GW 6. Refer to a drawing No. 13.120.113 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 Kingscourt Historic Landfill for the Tier 2 Risk Assessment

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

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.

Six Additional gas monitoring events were carried out between 12th March 2014 and the 20th March 2014 as part of the Tier 3 Risk Assessment. Landfill gas monitoring was carried out at the existing six standpipes located within the site. Gas monitoring results together with the relevant assessment criteria are presented in Tables 6 – 11. 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).

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;

The site can be sub-divided into two areas i.e. the landfill area (trial pits / boreholes GW 1, GW 2 and GW 3) and area outside the landfill (trial pits / boreholes GW 4 GW 5 and GW 6.

The results of the gas monitoring indicate that outside the waste body (GW 4, GW 5, and GW 6) 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) The levels of Carbon dioxide however exceeded the recommended trigger Levels of 1.5% v/v in one of borehole (GW 5) on a number of occasions. Levels varied between 0.3 and 2.65 for the results from 11/07/13 to the 26/08/13, however the results from the 20/08/14 were all below 0.2%v/v

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

No.	Landfill Gas Monitoring Event	Date
M 15	Event Number 15	12/03/14
M 16	Event Number 16	13/03/14
M 17	Event Number 17	15/03/14
M 18	Event Number 18	16/03/14
M 19	Event Number 19	18/03/14
M 20	Event Number 20	20/03/14

2.5.3 Tier 3 Landfill Gas Monitoring Results

Tables numbered 6 - 11 outline all Tier 2 and Tier 3 landfill gas monitoring results. M1 - M14 represent the result for monitoring carried out during the Tier 2 Risk Assessment. M15 - M20 detail results for monitoring carried out during the Tier 3 Risk Assessments.

Table No.6 Landfill Gas Monitoring Results - GW 1 (Tier 2 Results M1 - M14) = (Tier 3 Results M15 - M20)

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	Peak Methane (CH_4)	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% vol/vol	% vol/vol	% vol/vol	% vol/vol	% vol/vol	ppm	ppm	mb
GW 1	M1	11/07/2013	0.4	0.4	5.45	10.55	83.55	0.5	1	1012
	M2	16/07/2013	0.35	0.35	7.15	10.15	82.15	0	0	1009
	M3	18/07/2013	0.25	0.35	6	12.9	80.75	0.5	1	1012
	M4	22/07/2013	0.05	0.1	1.4	19	79.45	0.5	0	998
	M5	26/07/2013	0.05	0.1	7.2	10.8	81.6	0.5	0	995.5
	M6	29/07/2013	0.25	0.25	7	12.25	80.45	0.5	0	991.5
	M7	02/08/2013	0.1	0.15	5.25	14.75	79.85	0	0	1006
	M8	06/08/2013	0.1	0.1	6.75	12.85	80.15	0	0	999
	M9	09/08/2013	0.15	0.15	3.9	11	84.85	0	0	1004
	M10	12/08/2013	0.2	0.2	2.95	12.6	85.1	0	0	1002
	M11	16/08/2013	0.1	0.1	8.6	10.15	80.45	0	0	997
	M12	21/08/2013	0.2	0.2	2.8	12.1	84.9	0	0	1002
	M13	23/08/2013	0.1	0.2	4.65	16.45	78.65	0	0	996
	M14	26/08/2013	0.1	0.1	4.05	16.3	79.55	0	0	1006
	M15	12/03/2014	0.2	0.2	1.55	19.05	79.25	0	0	1015
	M16	13/03/2014	0.2	0.2	2	18.6	79.15	0	0	1014
	M17	15/03/2014	0.2	0.2	7.3	5.75	86.85	0	0	1011
	M18	16/03/2014	0.2	0.2	7.15	7.65	86.4	0	0	1009
	M19	18/03/2014	0.1	0.1	8.05	6.55	85.25	0	0	999
	M20	20/03/2014	0.2	0.2	8.4	5.8	85.55	0	0	999

Table No.7 Landfill Gas Monitoring Results - GW 2 (Tier 2 Results M1 - M14) = (Tier 3 Results M15 - M20)

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% vol/vol	% vol/vol	% vol/vol	% vol/vol	% vol/vol	ppm	ppm	mb
GW 2	M1	11/07/2013	2.8	2.8	6.3	0.75	90.1	4	0.5	1012
	M2	16/07/2013	3	3	6.7	0.6	89.6	1	0	1009
	M3	18/07/2013	2.55	2.55	6.9	0.6	89.85	3	0	1012
	M4	22/07/2013	2.05	2.05	9.25	0.95	87.75	2	0	998
	M5	26/07/2013	2.4	2.4	7.9	0.4	89.2	1	0	995
	M6	29/07/2013	2.75	2.75	7.15	0.75	89.35	1.5	0	992
	M7	02/08/2013	3.15	3.2	6	1.9	88.85	0	0	1005
	M8	06/08/2013	3	3	6.45	0.2	90.25	0	0	999
	M9	09/08/2013	1.8	1.8	6.65	1	90.4	0	0	1004
	M10	12/08/2013	2.35	2.45	6.55	0.4	90.6	0	0	1002
	M11	16/08/2013	3	3	6.25	0.55	90.1	0	0	997
	M12	21/08/2013	1.8	1.8	5.55	3.05	89.55	0	0	1002.5
	M13	23/08/2013	3.8	3.8	6.3	0.05	89.75	0	0	996
	M14	26/08/2013	3	3	6.05	2.45	88.4	0	0	1006
	M15	12/03/2014	3.2	3.25	7	0.5	89.25	0	0	1015
	M16	13/03/2014	2.95	2.95	7.4	1.15	88.5	0	0	1015
	M17	15/03/2014	3.85	3.95	7.25	0.75	87.95	0	0	1011.5
	M18	16/03/2014	3.5	3.75	7.3	0.45	88.65	0	0	1009.5
	M19	18/03/2014	3.85	3.85	7.6	0.5	87.95	0	0	999
	M20	20/03/2014	3.55	3.6	7.25	0.85	88.35	0	0	999

Table No.8 Landfill Gas Monitoring Results - GW 3 (Tier 2 Results M1 - M14) = (Tier 3 Results M15 - M20)

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% vol/vol	% vol/vol	% vol/vol	% vol/vol	% vol/vol	ppm	ppm	mb
GW 3	M1	11/07/2013	0.35	0.35	2.6	12.8	84.25	2.5	0.5	1012
	M2	16/07/2013	0.15	0.2	1.6	17.9	80.25	0	0	1009
	M3	18/07/2013	0.2	0.2	1.9	17.05	80.85	2	1	1012.5
	M4	22/07/2013	0.1	0.1	1.05	19.05	79.75	1	0	998
	M5	26/07/2013	0.05	0.1	1.9	17.95	80.05	0	0	995
	M6	29/07/2013	0.15	0.2	1.9	17.4	80.55	0	0	992.5
	M7	02/08/2013	0.15	0.2	5.35	11.4	83.05	0	0	1005
	M8	06/08/2013	0.25	0.25	5.3	11.55	82.85	0	0	999
	M9	09/08/2013	0.2	0.2	7.6	5.65	86.4	0.5	0	1004
	M10	12/08/2013	0.9	0.9	11.05	1.95	86	0	0	1003
	M11	16/08/2013	0.5	0.5	7.5	3.4	88.5	0	0	997
	M12	21/08/2013	0.1	0.15	1.9	17	80.95	0	0	1002.5
	M13	23/08/2013	0.15	0.15	2.7	15.95	81.15	0	0	996
	M14	26/08/2013	0.2	0.2	4.7	12.95	82.1	0	0	1006
	M15	12/03/2014	0.3	0.3	3.8	8.45	87.45	0	0	1015
	M16	13/03/2014	0.3	0.3	2.55	8.25	88.85	0	0	1014
	M17	15/03/2014	0.25	0.25	6.1	5.65	87.9	0	0	1011.5
	M18	16/03/2014	0.2	0.2	6.35	5.85	87.5	0	0	1010
	M19	18/03/2014	0.2	0.2	3.55	13.5	82.75	0	0	999
	M20	20/03/2014	0.2	0.2	2.25	15.9	81.55	0	0	999

Table No.9 Landfill Gas Monitoring Results - GW 4 er 2 Results M1 - M14) = (Tier 3 Results M15 - M20)

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% vol/vol	% vol/vol	% vol/vol	% vol/vol	% vol/vol	ppm	ppm	mb
GW 4	M1	11/07/2013	0.3	0.3	1.95	14.6	82.55	2	0	1012
	M2	16/07/2013	0.25	0.25	2.55	17.7	79.45	1	0	1009
	M3	18/07/2013	0.25	0.25	2.35	17.25	80.1	1	0.5	1012
	M4	22/07/2013	0.1	0.1	2.1	18.4	79.35	1	0	998
	M5	26/07/2013	0	0.1	3.45	17.05	79.4	0.5	0	995
	M6	29/07/2013	0.2	0.15	2.35	17.75	79.7	0	0	992
	M7	02/08/2013	0.05	0.15	2.65	17.3	79.7	0	0	1005
	M8	06/08/2013	0.15	0.15	3	17.3	79.55	0	0	999
	M9	09/08/2013	0.1	0.1	2.7	17.4	79.75	0.5	0	1004
	M10	12/08/2013	0.1	0.2	2	18.75	79.05	0	0	1004
	M11	16/08/2013	0.1	0.1	1.55	19	79.25	0	0	997
	M12	21/08/2013	0.1	0.1	1.5	18.95	79.35	0	0	1003
	M13	23/08/2013	0.15	0.15	2.85	17.6	79.35	0	0	996
	M14	26/08/2013	0.1	0.1	2.8	17.35	79.65	0	0	1006
	M15	12/03/2014	0.1	0.1	0.4	19.75	79.7	0	0	1015
	M16	13/03/2014	0.1	0.1	0.6	19.4	79.8	0	0	1015
	M17	15/03/2014	0.1	0.2	0.5	19.45	79.8	0	0	1012
	M18	16/03/2014	0.1	0.1	0.6	19.75	79.5	0	0	1010
	M19	18/03/2014	0.1	0.1	0.35	19.75	79.7	0	0	999
	M20	20/03/2014	0.1	0.1	0.3	19.7	79.8	0	0	999

Table No. 10 Landfill Gas Monitoring Results - GW 5 (Tier 2 Results M1 - M14) = (Tier 3 Results M15 - M20)

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% vol/vol	% vol/vol	% vol/vol	% vol/vol	% vol/vol	ppm	ppm	mb
GW 5	M1	11/07/2013	0.3	0.3	0.3	16.15	83.1	0	0.5	1012
	M2	16/07/2013	0.15	0.15	2.65	15.8	81.35	0	0	1010
	M3	18/07/2013	0.15	0.2	0.6	18.25	80.85	0.5	0	1013
	M4	22/07/2013	0.05	0.1	0.95	19.4	79.5	0.5	0	999.5
	M5	26/07/2013	0.1	0.1	2.2	17.25	80.4	0.5	0	996
	M6	29/07/2013	0.15	0.2	0.6	18.75	80.5	0.5	0	991.5
	M7	02/08/2013	0.1	0.1	2.2	17.3	80.2	0	0	1006
	M8	06/08/2013	0.1	0.1	1.6	18.85	79.35	0	0	1000
	M9	09/08/2013	0.1	0.1	2.35	16.9	80.5	0	0	1006
	M10	12/08/2013	0.2	0.2	1.6	18.75	79.55	0	0	1004
	M11	16/08/2013	0.1	0.1	3.1	15.45	81.25	0	0	998
	M12	21/08/2013	0.1	0.1	2.3	16.9	80.5	0	0	1004
	M13	23/08/2013	0.1	0.1	1.9	18.1	79.8	0	0	997
	M14	26/08/2013	0.1	0.1	2.05	17.85	79.9	0	0	1007
	M15	12/03/2014	0.1	0.15	0	20.25	79.6	0	0	1016
	M16	13/03/2014	0.1	0.1	0.1	20	79.7	0	0	1016
	M17	15/03/2014	0.1	0.1	0	20.05	79.65	0	0	1012.5
	M18	16/03/2014	0.1	0.15	0	20.35	79.4	0	0	1011
	M19	18/03/2014	0.2	0.2	0	20	79.8	0	0	999
	M20	20/03/2014	0.1	0.1	0.2	19.4	80.25	0	0	1000

Table No.11 Landfill Gas Monitoring Results - GW 6 Tier 2 Results M1 - M14) = (Tier 3 Results M15 - M20)

Monitoring Well I.D	Monitoring Event	Monitoring Date	Stable Methane (CH_4)	Peak Methane CH_4	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	Carbon Monoxide (CO)	Hydrogen Sulphide H_2S	Barometric Pressure
		Units	% vol/vol	% vol/vol	% vol/vol	% vol/vol	% vol/vol	ppm	ppm	mb
GW 6	M1	11/07/2013	0.25	0.25	0.3	16.15	83.2	1	0	1012
	M2	16/07/2013	0.15	0.15	0.3	19.85	79.6	0	0	1010
	M3	18/07/2013	0.1	0.2	0.2	16.8	82.6	1	0.5	1012.5
	M4	22/07/2013	0.05	0.05	3.25	13.85	82.85	0.5	0	999.5
	M5	26/07/2013	0	0.1	0.85	19.35	79.7	0	0	996
	M6	29/07/2013	0.1	0.2	2.2	18.05	79.65	0	0	992
	M7	02/08/2013	0.1	0.15	1.3	16.9	81.65	0	0	1007
	M8	06/08/2013	0.1	0.1	0.75	19.3	79.75	0	0	1000
	M9	09/08/2013	0.1	1.5	1.45	17.2	81.15	0	0	1006
	M10	12/08/2013	0.1	0.2	0.75	19.45	79.45	0	0	1004
	M11	16/08/2013	0.1	0.1	0.6	19.55	79.55	0	0	998
	M12	21/08/2013	0.1	0.2	0.25	20.05	79.45	0	0	1004
	M13	23/08/2013	0.1	0.15	0.75	19.6	79.45	0	0	997
	M14	26/08/2013	0.05	0.1	1.05	17.6	81.2	0	0	1007
	M15	12/03/2014	0.1	0.1	0.25	20.2	79.4	0	0	1017
	M16	13/03/2014	0.1	0.1	0.2	19.9	79.8	0	0	1016
	M17	15/03/2014	0.1	0.2	0.15	20	79.7	0	0	1013
	M18	16/03/2014	0.1	0.1	0.1	20.35	79.3	0	0	1010.5
	M19	18/03/2014	0.1	0.1	0.1	19.8	79.8	0	0	1000
	M20	20/03/2014	0.1	0.1	0.1	19.55	80.15	0	0	1000

2.5.4 Tier 3 Risk Assessments analysis of Results

GW 1 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.2 % v/v. Carbon Dioxide concentrations ranged from 1.55 % v/v to 8.4% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 2 Monitoring

Stable methane concentrations ranged from 2.95% v/v to 3.85 % v/v. Carbon Dioxide concentrations ranged from 7.25% v/v to 7.6% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 3 Monitoring

Stable methane concentrations ranged from 0.2 v/v to 0.3 % v/v. Carbon Dioxide concentrations ranged from 2.25% v/v to 6.35% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 4 Monitoring

Stable methane concentrations of 0.1% v/v, were recorded on the Tier 3 landfill gas monitoring events M15 - M20. Carbon Dioxide concentrations ranged from 0.3 % v/v to 0.6% v/v. Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 5 Monitoring

Stable methane concentrations ranged from 0.1% v/v to 0.2% v/v. Carbon Dioxide concentrations ranged from 0.0% v/v to 2.65% v/v . Hydrogen sulphide was not detected. Carbon Monoxide was not detected.

GW 6 Monitoring

Stable methane concentrations of 0.1% v/v, were recorded on Tier 3 landfill gas monitoring events M15 - M20. Carbon Dioxide concentrations ranged from 0.1 % v/v to 0.25% 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 (M15, M16, M17, M18, M19 and M20) 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 2; however there appears to be no immediate risk to offsite receptors along the North east boundary.
- 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 M15 - M 20 continue to be at low levels. Therefore, an active landfill gas system is not required and a passive venting system would be considered to be most appropriate.
- The monitoring results from GW 4, GW 5 and GW 6 would indicate that no lateral migration of landfill gas is occurring.
- Kingscourt 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 no evidence of any potentially hazardous waste on site. The key objective of remediation, being cognisant of time, and health and safety constraints is to prevent the lateral migration of landfill gas to offsite receptors and minimise the impact on the environment.

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 Kingscourt historic landfill.

- 3.2.1 - Removal of Waste Material;
- 3.2.2 - Passive Venting Wells
- 3.2.3 - Vent Trenches
- 3.2.4 - Virtual Curtain System
- 3.2.5 - Landfill Gas Monitoring
- 3.2.6 - Capping of Kingscourt Landfill
- 3.2.7 - Surface water Control and Management

3.2.1 REMOVAL OF WASTE MATERIAL

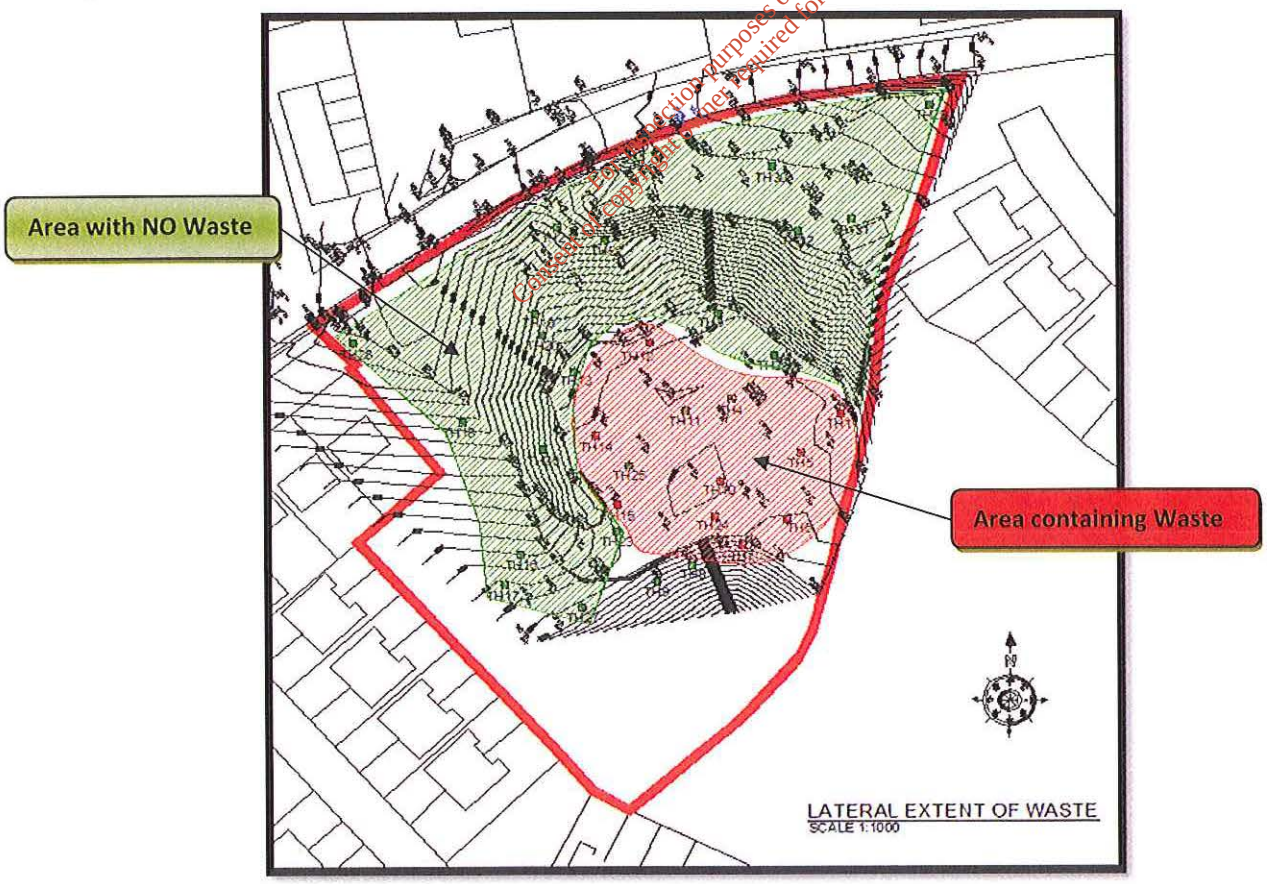
The Tier 2 Environmental Risk Assessment involved the excavation of trial holes within the waste body and across the site. The landfill was divided into equal sections in order to obtain a representative assessment of the location & volume of waste material during the excavation works. All of the trial holes were excavated within the boundary of the historic landfill site. No trial holes were excavated outside the boundary of the landfill site due to the close proximity of domestic dwelling, industrial units and the presence of bedrock in the area. The trial hole logs show photographic evidence of the waste present, a profile of waste depths in each hole and a list of 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. Hazardous waste was not identified in any of the trial holes during investigation works. 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. TH14 exceeded the Dutch Reference value for Copper. TH20, TH10, and TH14 all exceeded the Dutch Reference values for Nickel. TH 20 had the same reading for Zinc as the Dutch Reference Values. However, no Dutch Intervention values were exceeded during analysis of soil samples, therefore no remediation of the soil is considered necessary.

Waste material was encountered in 10 of the 32 trial holes excavated. (TH1, TH4, TH5 TH6, TH7, TH10, TH12, TH14, TH15, and TH24 see drawing no. 132.120.115 Trial Hole Locations in Appendix A). There was no waste encountered in the Trial Holes TH2 , TH3, TH8, TH9, TH11, TH13, TH16, TH17, TH18, TH19, TH20, TH21, TH22, TH23, TH25, TH 26, TH27, TH28, TH29, TH30, TH31, & TH32. The most extensive quantities of waste were encountered towards the South East of the site on the upper level. The waste extends from the eastern boundary (TH 6) to the top of the slope (TH 12) in a northerly direction towards the Council storage yard. Negligible quantities of waste were found outside this area.

The lateral extent of the waste is shown in Figure No.1 below and covers an area of approximately 2300 m^2. From analysis of the vertical and lateral extent of the waste it has been estimated that the approximately 6000 tonnes of waste is deposited at the site. This area is hatched in red where the majority of waste was encountered. All areas hatched in green contained little or no waste. No waste was encountered towards the southern boundary as at this location the bedrock outcrops at the surface.

Figure No. 1 Lateral Extent of Waste



3.2.1.1 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. No hazardous waste has been encountered at the site. However this does not eliminate the possibility of encountering 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 6000 Tonnes.

3.2.1.2 Alternative Considered

Leaving the waste in-situ and monitoring the levels of Landfill Gas was also considered a feasible option 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. Capping of the landfill will also form part of the remediation works

3.2.1.2 Recommended Remediation Measure

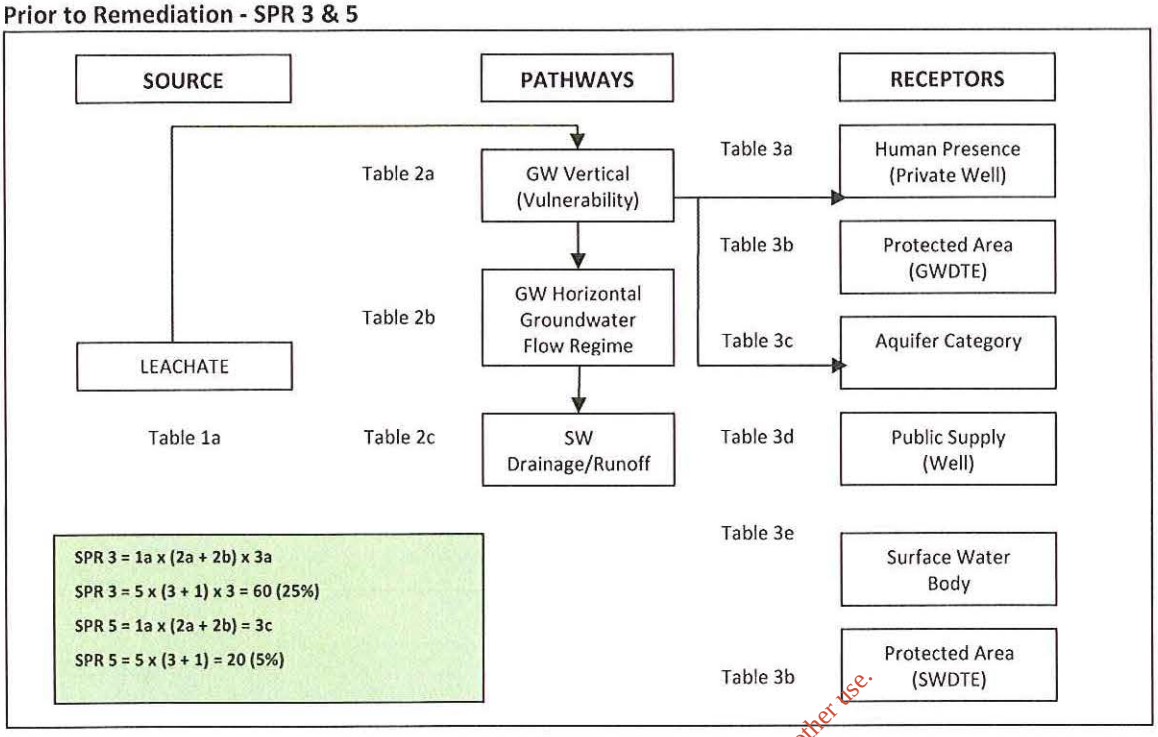
Following consideration of the positive and negative effects from the complete removal of all waste material, the Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would not recommend the complete dig-out and removal of waste from the landfill. As outlined under section 3.2.1.1 **Impact of the Remediation Measures**, the cost involved and the possible risk / proximity to offsite receptors would not justify the complete removal of the waste material from the site.

3.2.1.4 SPR Linkage Diagram

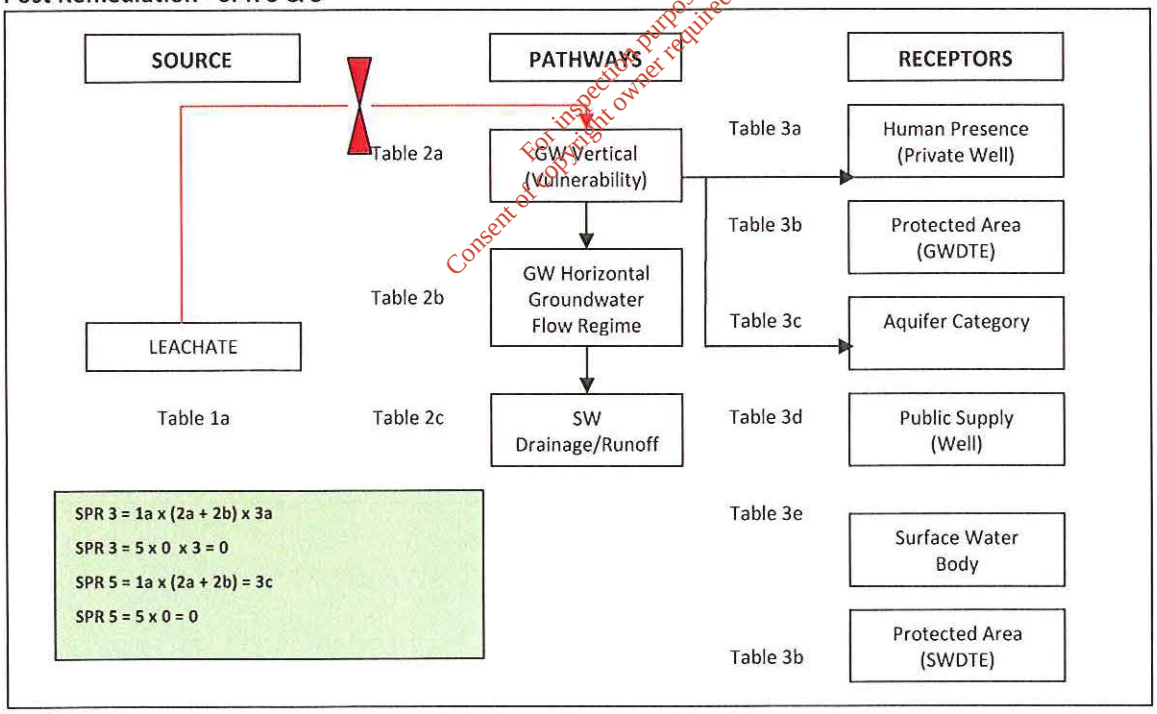
See diagram 1 showing the SPR Linkage prior and post remediation and highlighting the break in the linkage by the removal of the waste material.

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

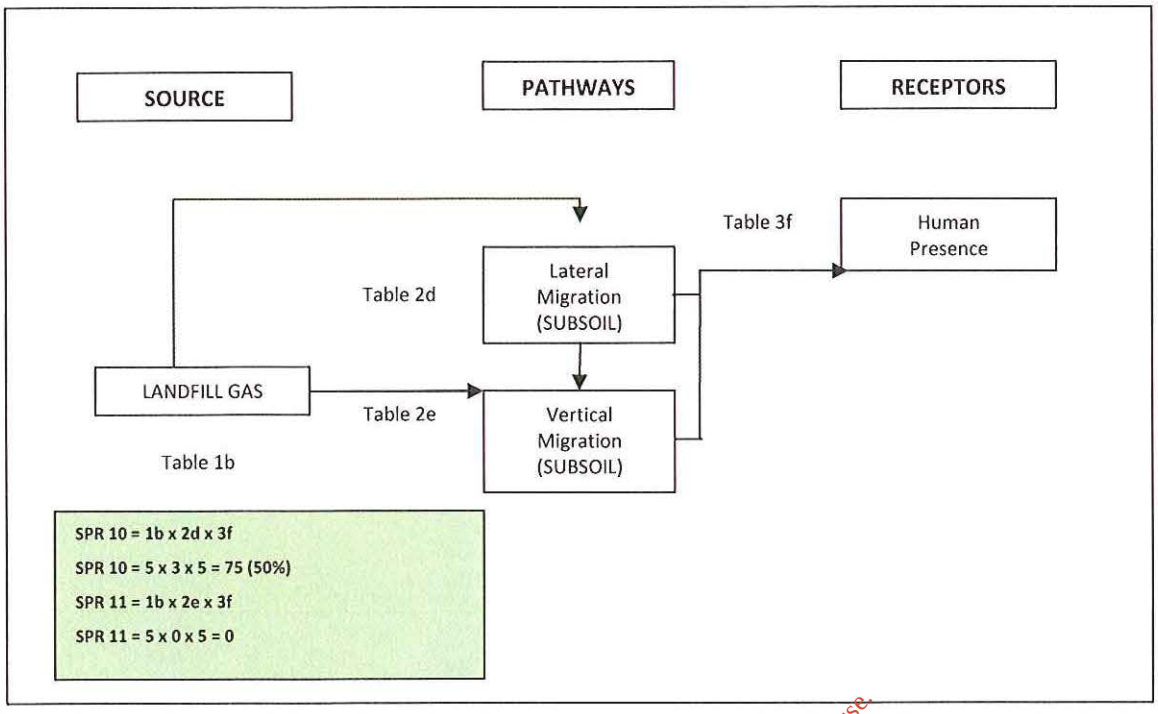
Prior to Remediation - SPR 3 & 5



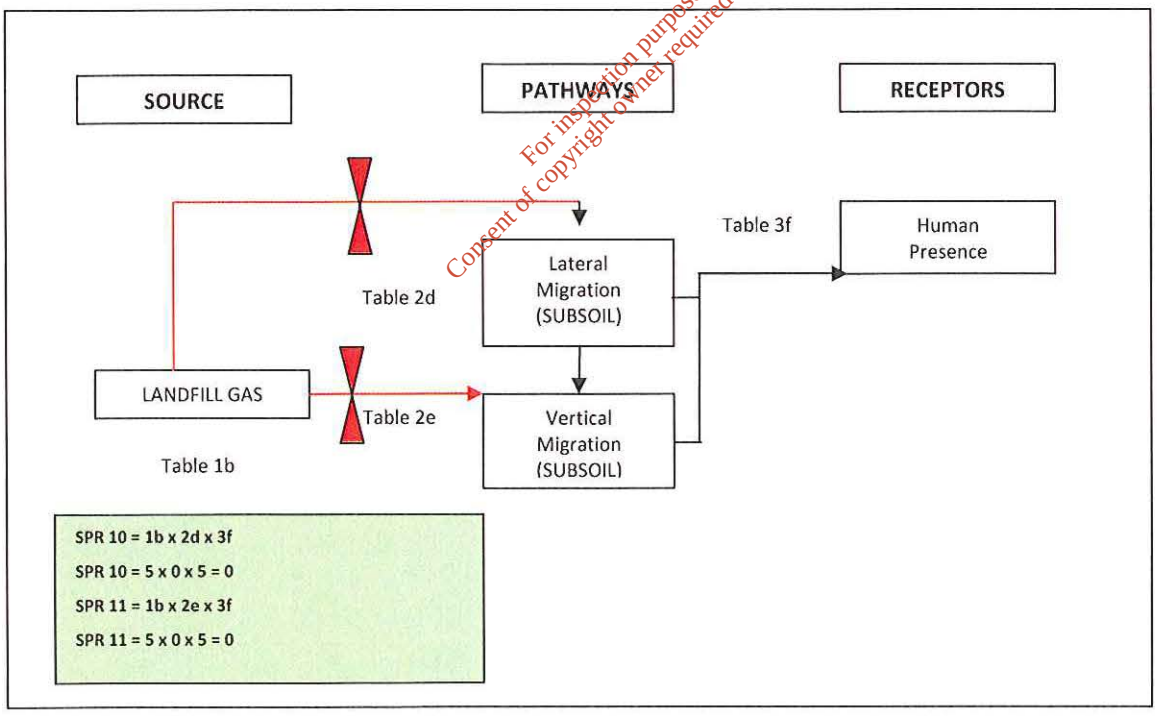
Post Remediation - SPR 3 & 5



Prior to Remediation - SPR 10 & 11



Post Remediation SPR 10 & 11



3.2.1.5 Timescale for Completion of Works

The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd would estimate a timeframe of 5 - 6 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 quantities of hazardous waste that were not unearthed during the trial hole excavation.

3.2.1.6 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 negative impact on the local residences. Excavation of the waste could also mobilise contaminants which could pose a risk to offsite receptor 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.

3.2.2 PASSIVE VENTING WELLS

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 2. The gas flow rates and levels of landfill gas (Methane and CO_2) recorded during recent monitoring were low. As a result, an active landfill gas system is not considered feasible and passive venting is considered to be the more suitable remediation option for the site. 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.

Figure No. 2 Passive Venting Wells

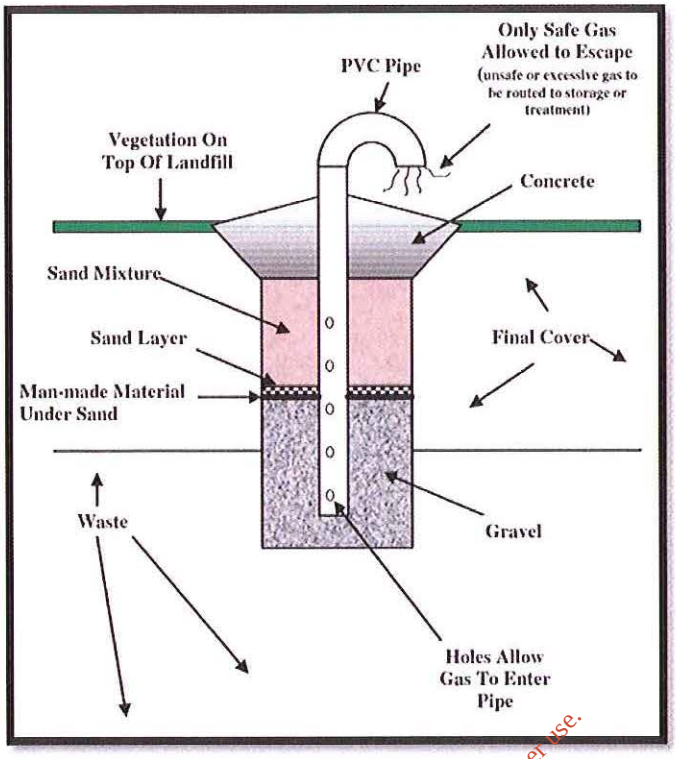


Figure No. 3 Rrotating Aspiromatic Cowl

3.2.2.1 Impact of Remediation Measures

The area of landfill is currently open space with only one small shed located at the lower part of the site. There are no buildings located on the upper section of the site where the waste material is located. Venting of landfill gases would prevent lateral migration of landfill gas and thus minimise risk. Landfill gas generated, will efficiently be 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

3.2.2.2 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 Kingscourt historic landfill are outlined in section 3.2.3 Vent Trenches and 3.2.4 Virtual Curtain System.

3.2.2.3 Recommended Remediation Measure

The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd recommends a Passive Venting system which was considered to be the most appropriate remediation technique for the site. This system presents the most viable remedial option for the site based on a logistical programme, cost considerations and landfill gas levels/ and concentrations. 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. The area of waste on site stretches from the eastern boundary of the site, which is bordered at this point by an undeveloped construction site. Venting Wells would be installed to the base of the fill material which from previous trial holes excavation is underlined by a layer of bedrock. 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 off site disposal. With this proposed option there are also increased health and safety risks associated with working around deep excavations.

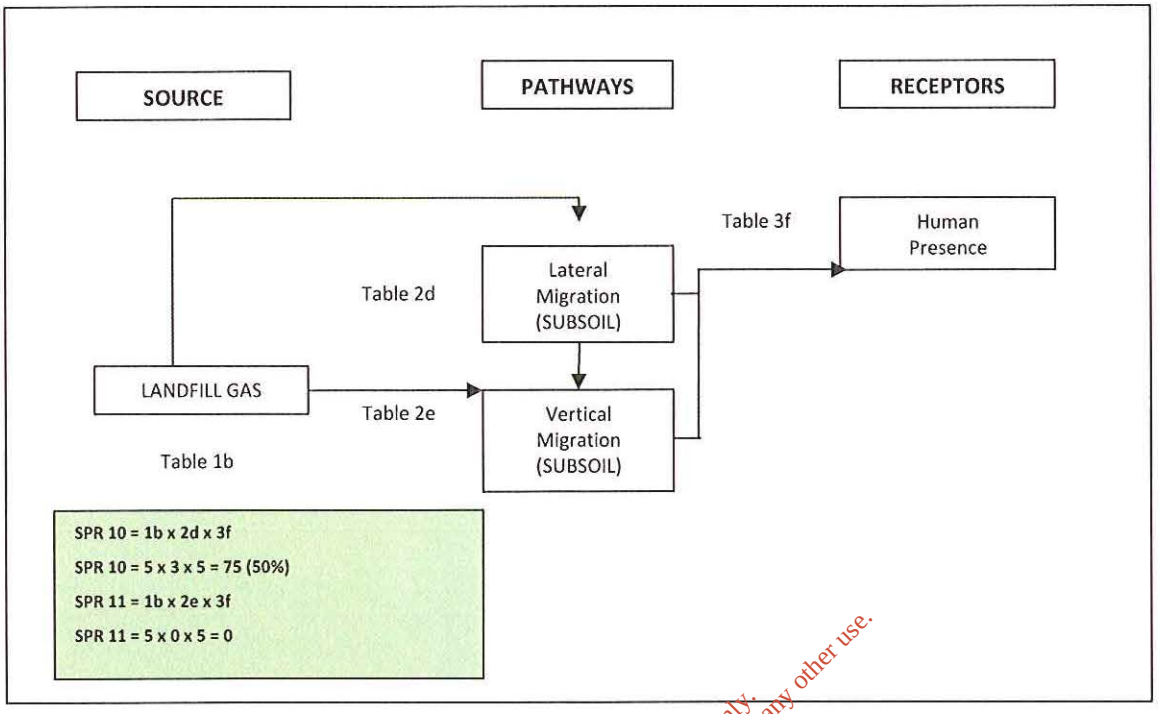
Passive gas venting systems rely on natural pressure and convection mechanisms to vent landfill gas to the atmosphere. There is no negative air pressure generated like the active systems. The site specific characteristics of Kingscourt landfill and monitoring results from the tier 2 and tier 3 risk assessments indicate that a passive gas venting system would be suitable, cost effective and low maintenance for the site.

3.2.2.4 SPR Linkage Diagram

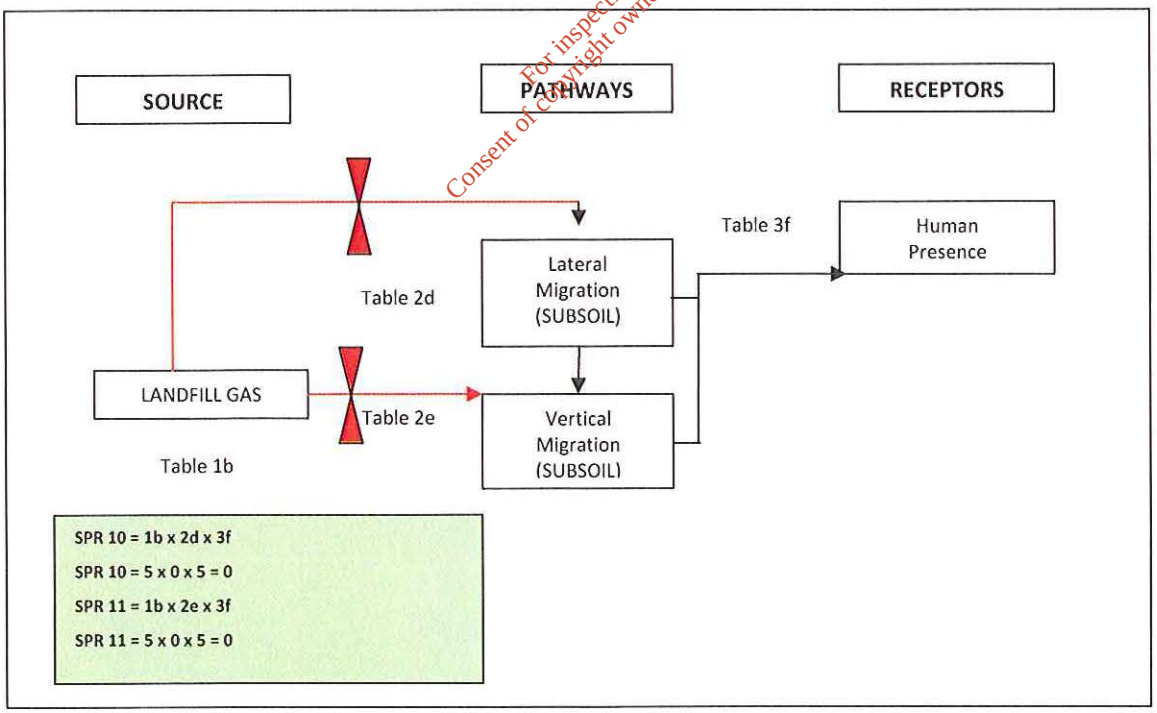
See diagram 2 showing the SPR Linkage prior and post remediation, and highlighting the break in the linkage by the passive venting of the landfill gas.

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 timeframe of 1 - 2 months for the installation of the chosen passive venting system. 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.

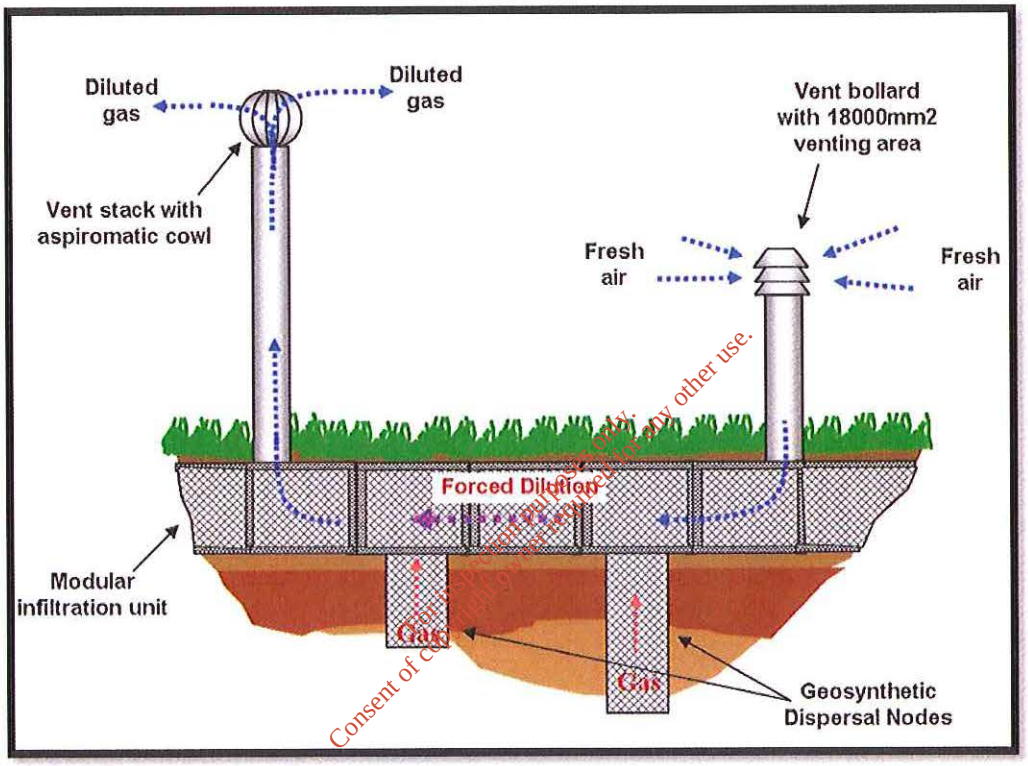
3.2.2.6 Evaluation of Works

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 considerable 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.

3.2.3 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. 4 Vent Trench



3.2.3.1 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

3.2.3.2 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 Kingscourt historic landfill are outlined in section 3.2.2 Passive Venting Wells and 3.2.4 Virtual Curtain System.

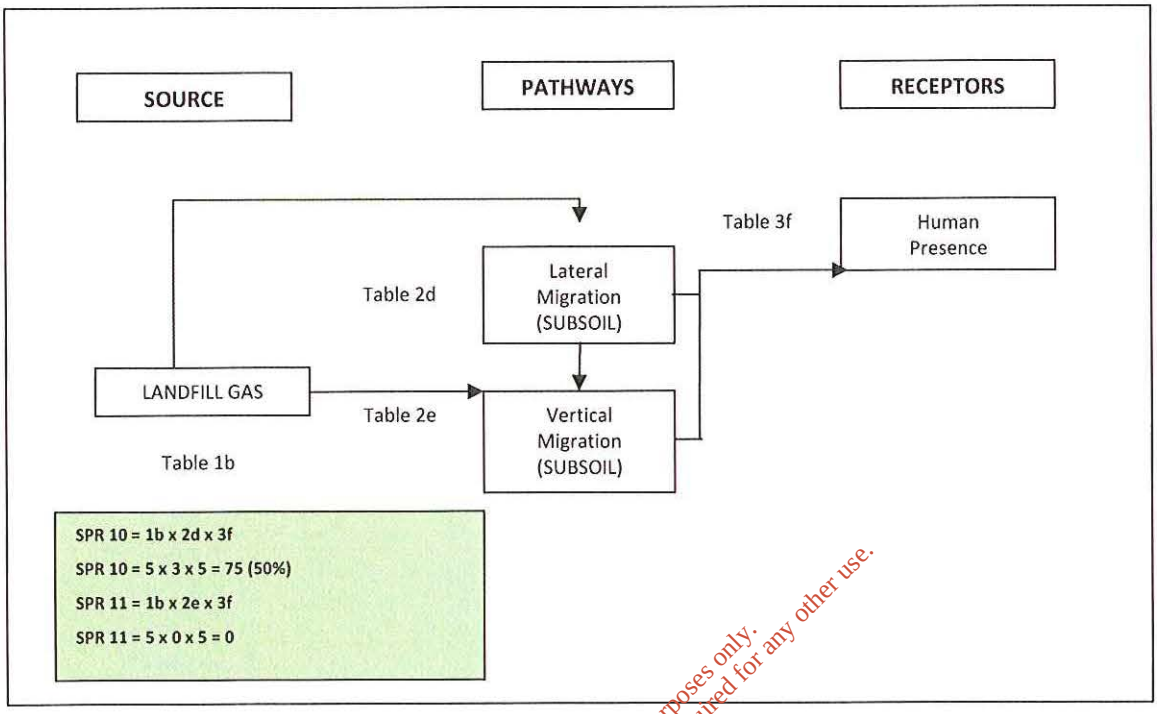
3.2.3.3 Recommended Remediation Measure

A number of different gas venting systems have been considered as part of remediation options propose for the site. From investigation carried out during the Tier 2 Risk Assessment, Kingscourt 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.

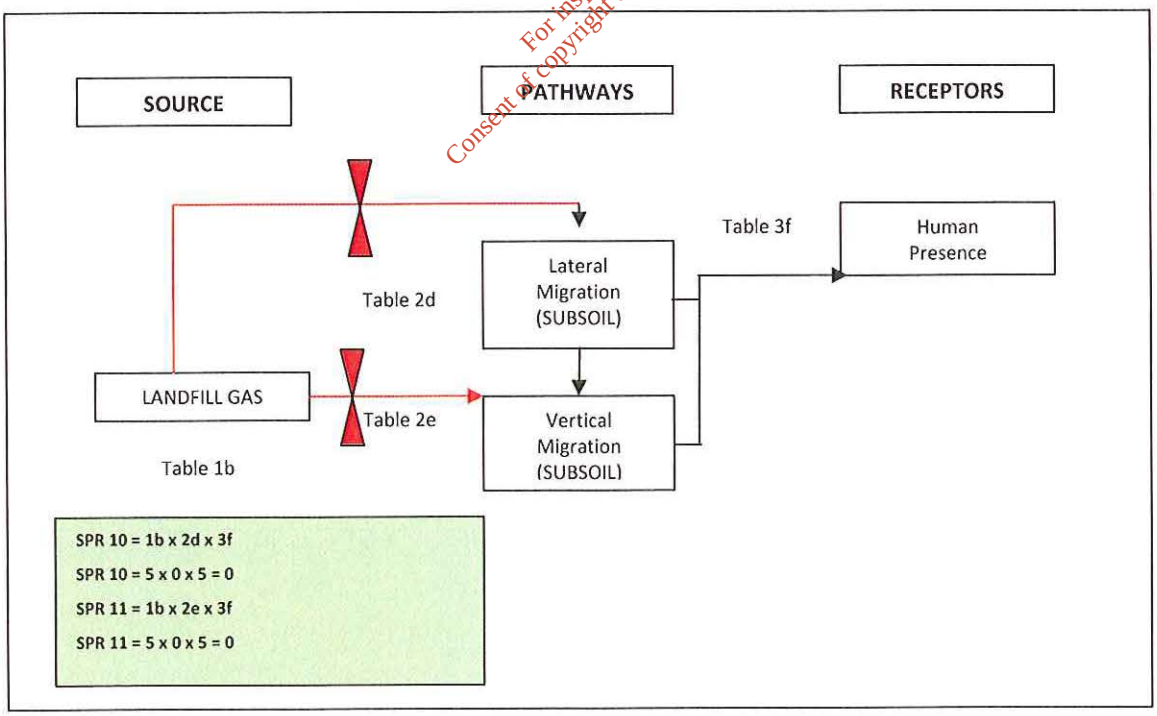
3.2.3.4 SPR Linkage Diagram

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



3.2.3.5 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.

3.2.3.6 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 neither does nor disturbed 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.

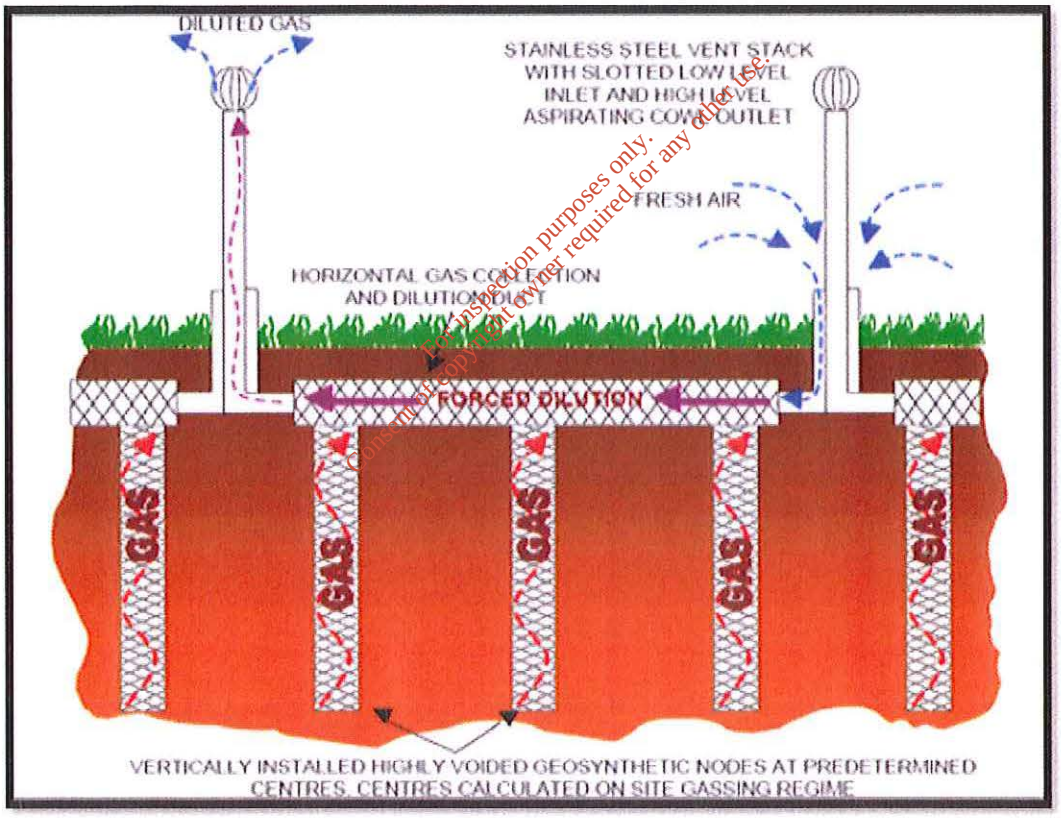
3.2.4 VIRTUAL CURTAIN SYSTEM

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. 5

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. 5 Virtual Curtain



3.2.4.1 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.

3.2.4.2 Alternative Considered

There are numerous gas control systems and the alternatives considered for use at the Kingscourt historic landfill are outlined in section 3.2.2 Passive Venting Wells and 3.2.3 Vent Trenches. Complete removal of all waste material form the site has also been considered. A programme of landfill gas monitoring will from part the remediation measure for the site.

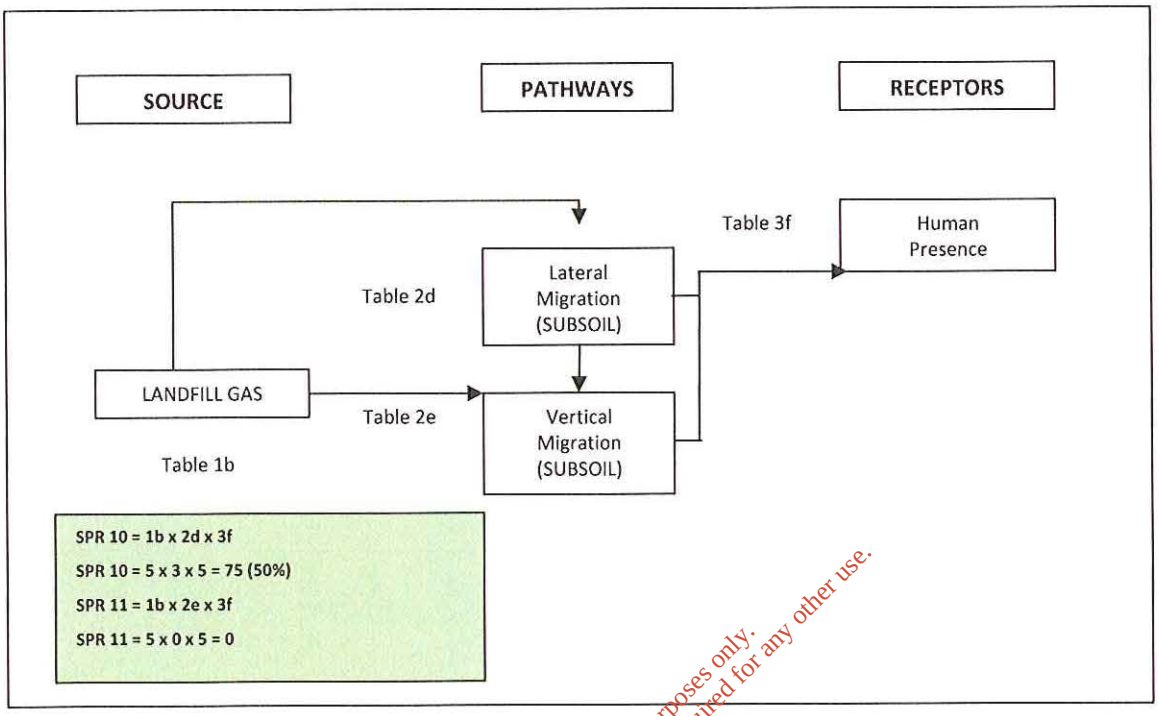
3.2.4.3 Recommended Remediation Measure

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 Kingscourt site. From extensive gas monitoring carried out during the Tier 2 and Tier 3 Risk Assessment it has been shown that no landfill gas was detected at the gas well No. 6 (GW 6) which is located beside the boundary at closest housing estate. If waste material was present in this area or 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 an undeveloped construction site. However the site boundary in closest proximity to the waste material, where low levels of landfill gas were detected (GW 2), does not pose a risk to offsite receptors. A virtual curtain was not considered a suitable remediation for the site.

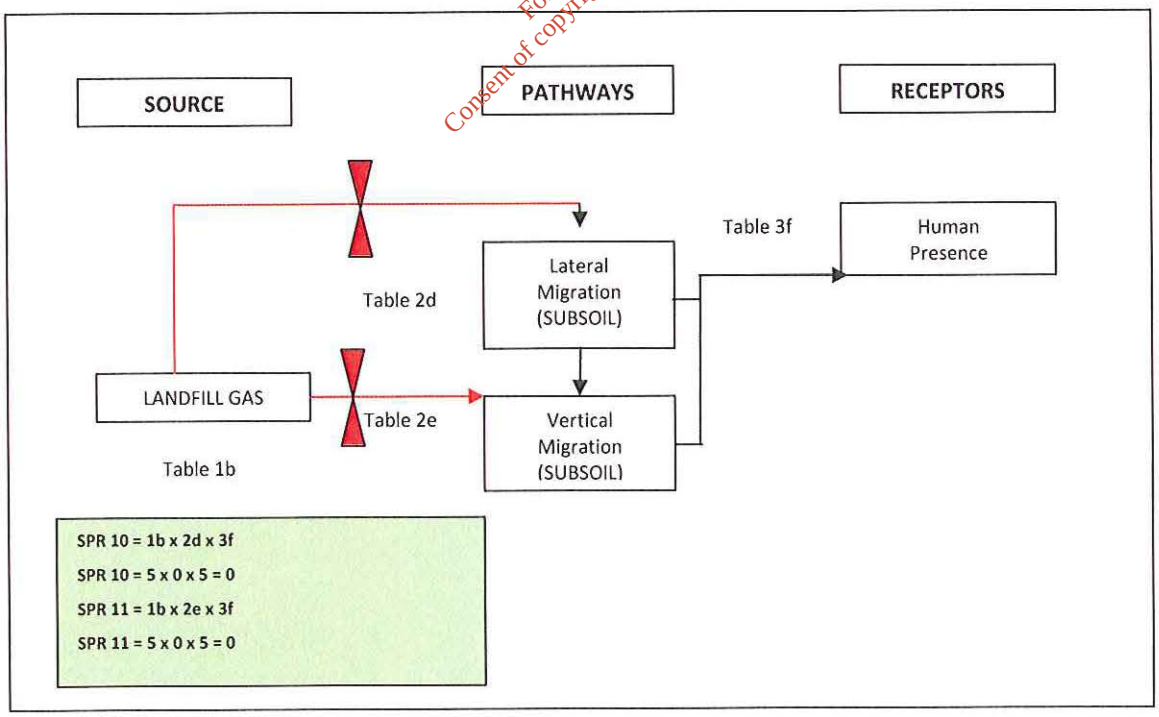
3.2.4.4 SPR Linkage Diagram

Diagram 4 – 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



3.2.4.5 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.

3.2.4.6 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.

3.2.5 CONTINUED PROGRAMME OF LANDFILL GAS MONITORING

There are currently No. 6 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. 6 Proposed New Monitoring Stand Pipe Locations) In combination with the existing six gas monitoring location the new gas monitoring locations will be positioned on both sides of the passive gas venting system in order to show:

a) whether gas is breaching the gas venting barrier

b) to test the effectiveness(or otherwise) of the gas venting system

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 13: 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.

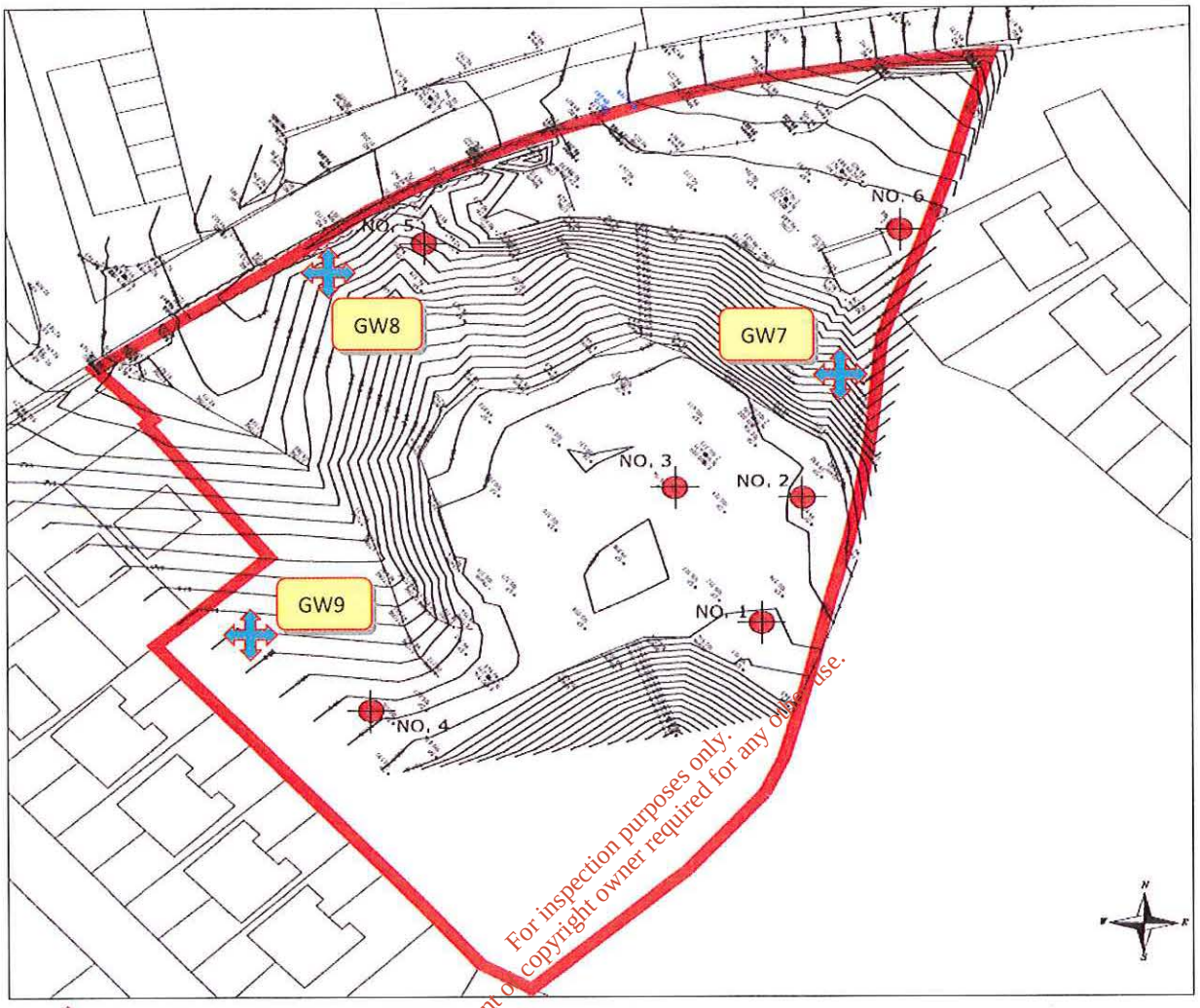
- In order to prevent atmospheric dilution of the sample the gas sampling valve/bung should be closed at all times other than when the gas sampling equipment is attached to the monitoring structure. The well will be resealed after sampling. Monitoring boreholes should also have protective measures to 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. 6 Proposed New Monitoring Stand Pipe Locations



= Proposed New Standpipe Locations.

3.2.5.1 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 Tier2 Risk Assessment Trial Hole investigations was also used to determine, the most appropriate locations of additional Gas monitoring wells GW 7, GW 8 and GW 9.

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. 14 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.

3.2.6 CAPPING OF KINGSCOURT LANDFILL

3.2.6.1 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 Kingscourt 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).

3.2.6.2 Capping

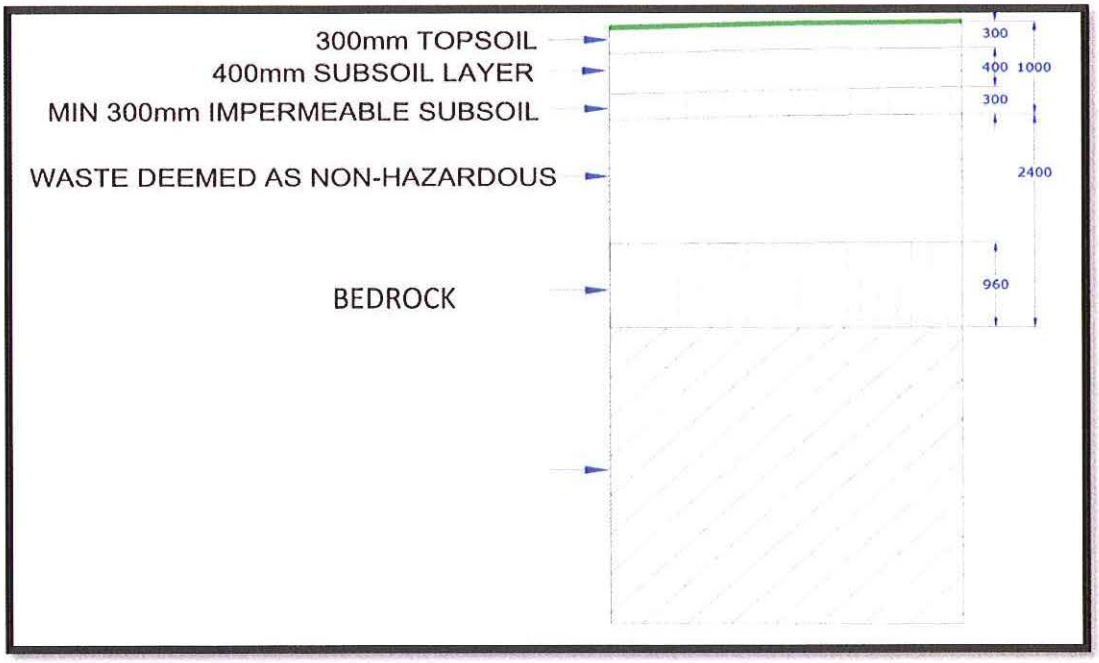
The main factors which influence the rate of infiltration of rainfall and hence the leachate generation is the configuration of the final top cover and associated topography, which will affect the site's run-off pattern and the amount of water percolating into the landfill.

Currently a layer of clayey soil of varying thickness and composition covers the landfill. The lower yard area of the site is covered in a layer of aggregate, which is stored here by Cavan County Council which varies in quantities and sizes. Regarding 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 in the final cover was not considered as the decomposition of residual waste within the landfill body may be reduced or cease altogether if moisture is prevented from entering the landfill. A plastic liner would also cause the lateral migration of landfill gas towards off site receptors which is not acceptable.

Capping of the landfill with a suitable capping layer will result in a significant reduction in the amount of surface water infiltration into the waste body whilst allowing sufficient moisture to penetrate in order to maintain the decomposition process.

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.



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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.

3.2.6.3 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 1×10^{-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.

3.2.6.4 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.

3.2.6.5 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.

3.2.6.6 Tree Planting and Final Landscaping

The landfill at Kingscourt 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 landfill into the landscape.

Tree planting have the following advantages for the site:

- It reduces soil erosion by establishing ground cover ;
- It reduces water infiltration on capped site and reduces discharge to watercourse/drain ;
- Improves visual appearance;

All tree and shrub planting should be carried out, in accordance with EPA guidelines for Landfill Restoration and Aftercare.
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 should be used as part of the landscaping scheme.

Table 14: 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 15: 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)

3.2.6.7 Gas Monitoring

A passive gas venting system incorporated into the remediation including monitoring wells places in strategic locations and monitored frequencies in accordance with EPA Landfill Manuals Landfill Monitoring 2nd edition will ensure any gas occurring will be safely venting to the atmosphere. Monitoring of other surface emissions such as hydrogen sulphide or non-methane volatile organic compounds (NMVOCs) will also be undertaken.

3.2.7 SURFACE WATER CONTROL & MANAGEMENT

3.2.7.1 EXISTING SITUATION

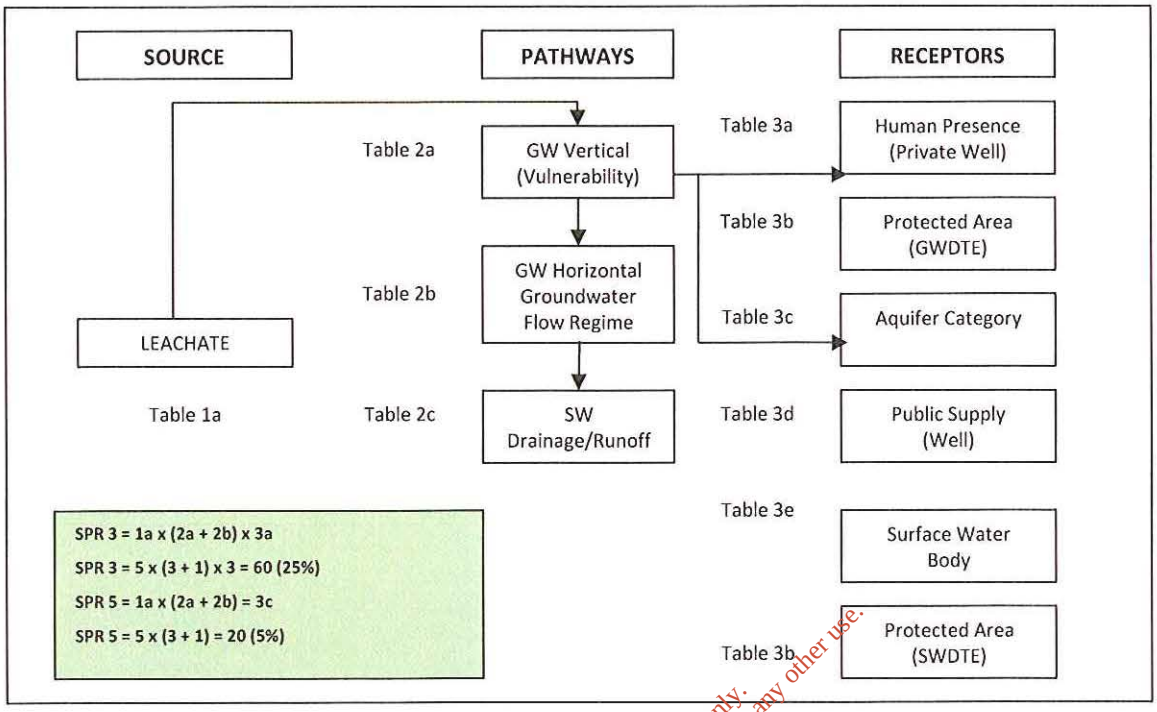
The landfill is currently capped with a thin layer of soil/aggregate, through which precipitation freely entering the waste body. There is poor water run-off from the surface of the waste body with precipitation entering the landfill. The discharge from the waste body as stated in the Tier 2 is that most of the rainfall reaching the base of the waste ultimately discharges through the bed rock. The base of the waste is defined by bed rock encountered between 1.0 m and 4.6 m throughout the site. The bedding in the rock is vertical therefore any migration of leachate and/or rainfall will follow the joints in the rock and move downwards not laterally. There are no surface water drainage systems evident in the area or bordering the site hence no evidence has been obtained to show any migration of leachate/surface water which may exist. Due to the fact that the majority of the waste is underpinned by the bedrock the downward movement of any rainfall/leachate resulting in preferential flow to groundwater.

3.2.7.2 RECOMMENDED CONTROL OF SURFACE WATER DRAINAGE

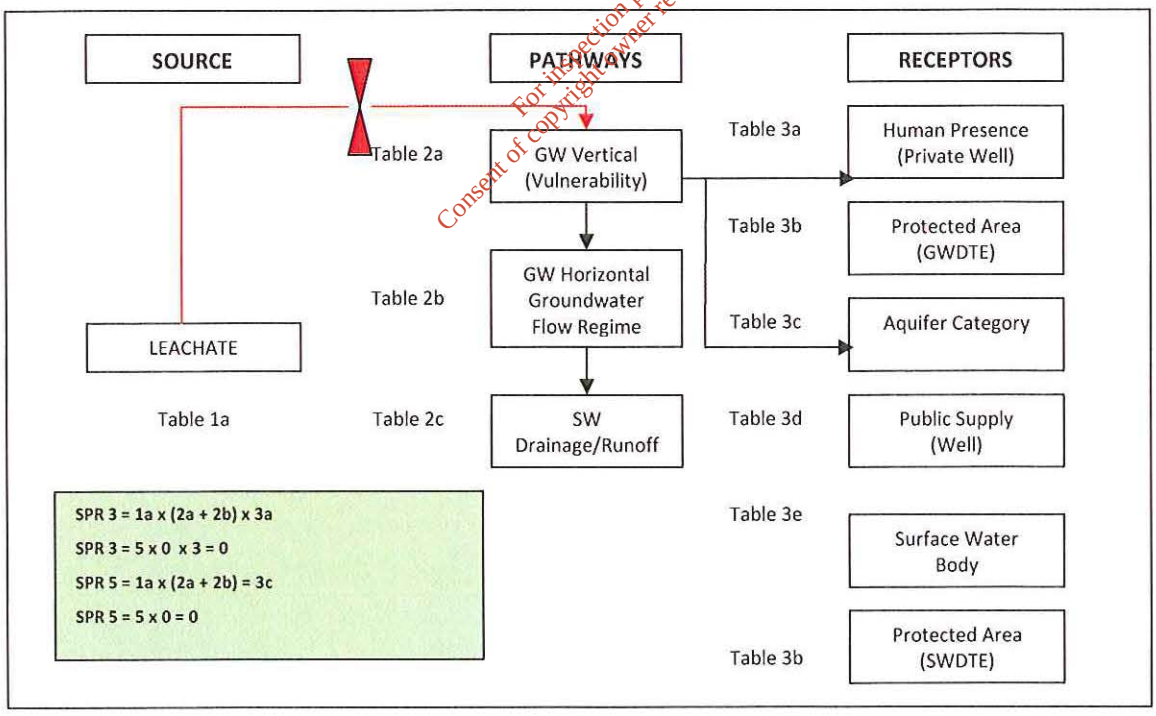
The capping and regarding of the landfill will reduce the infiltration of precipitation into the waste body and promote surface water run-off and drainage to the watercourse/drain on the North-eastern aspect of the landfill. This will prevent the interaction of clean precipitation with the waste body, minimise the generation of leachate and limit the recharge of shallow groundwater flow. These measures combined will control the ingress of surface water and limit any possible interaction with the waste body.

3.2.7.3 Diagram 5 –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



3.3 SETTLEMENT

The final post settlement levels and contours of a landfill must be taken into account. This is to predict the amount of settlement that will occur and to ensure that this takes place as evenly as possible across the site. The rate and degree of settlement occurring at a landfill will always be site specific and will be influenced by the site conditions, landfill practices, types of waste deposited and the effects of the mechanical and biochemical processes. Settlement values of between 10 and 25 % of the depth of the landfill can be expected.

3.4 FENCING

The existing fence and gates at both entrances to the site are adequate. It is recommended to install new green palisade fencing along the section of the northern boundary which currently has no fence in place. This section adjoins the local road and would present a health and safety risk to unauthorised entry to the site by the public. The fence along the eastern boundary should be monitored where it meets the rock face, as it may be possible for a person to enter the landfill at this point. It is recommended to check all fences and gates upon completion of the remediation works.

As previously stated in the Tier 1 risk assessment, the landfill is located in a densely populated area and therefore public access to the site should be restricted by adequate fencing and warning signage.

4.0 SUMMARY OF IMPACT OF REMEDIATION MEASURES AND POTENTIAL RISKS

Table No. 16		RISKS	
No.	**Remediation Measure**	**Positive**	**Negative**
3.2.1	Removal of Waste Material	- Source of contamination has been eliminated and SPR linkage will be broken - Prevent further leaching of polluting contaminants.	- 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
3.2.2	Passive Venting Wells	- 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
3.2.3	Vent Trenches (Vertical)	- Proven approach for the interception of horizontal migration of landfill gases.	- Significant health and safety considerations due to the required depth of the trench

		- Prevents lateral migration of landfill gas	- 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
3.2.4	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.
3.2.5	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.
3.2.6	Capping of Kingscourt Landfill	- Prevent/significantly reduce infiltration of rainwater to the remaining waste body - Improve the visual appearance of the remediated landfill area.	- Disturbance of the waste may create airborne particulates and impact negatively on workers and nearby residents. - Noise - Traffic Movements - Odour
3.2.7	Surface Water Control and Management	- Installation of additional surface water drain preventing the ingress of uncontaminated surface water entering the remaining waste body.	No Negative effect

5.0 VERIFICATION/VALIDATION REPORT

5.1 GENERAL

Following completion of remediation works, Cavan County Council will to 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 resulted in the risk rating for the historic landfill being reduced from **High Risk** down to **Moderate Risk.** The risk rating was initially high due to the estimated area of the site containing waste and the possible levels of landfill gas present. The area of the site containing waste material has been shown to be less than initial estimates and landfill gas levels recorded are of very low levels with no evidence of lateral migration. The SPR Linkage number 10 has therefore been shown to be less of a risk after the Tier 1 risk assessment, therefore the risk rating assigned accordingly as **Moderate**.

Seven key remediation options have been proposed, in relation to the historic landfill at Kingscourt. The specific circumstance of the site will require a combination of these proposed measures. The Waste Management Section of Cavan County Council in conjunction with Traynor Environmental Ltd recommends a combining four of the measures which have been proposed for the remediation of Kingscourt Historic Landfill.

A combination of the following measures is proposed

- 3.2.2 - Passive Gas Venting System
- 3.2.3 - Vent Trenches
- 3.2.4 - Virtual Curtain System
- 3.2.5 - Landfill Gas Monitoring
- 3.2.6 - Capping of Kingscourt Landfill
- 3.2.7 - Surface water Control and Management

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 18: 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

Based on the low volumes and poor calorific value of landfill gas being generated at the site, it is not considered that an active landfill gas system is required. Following analysis of a number of venting systems (passive and active), a passive venting system was considered to be the most appropriate remediation technique for the site. This type of system presents the most viable remedial option for the site based on logistical programme and cost considerations. In conjunction with the system three additional gas monitoring wells will be installed at the site. A programme of monitoring will be undertaken to insure the venting system is functioning as intended and the lateral migration of landfill gas is not occurring. Monitoring will take place at the existing No.6 monitoring wells and at the newly installed GW 7, GW 8 and GW 9.

The re-grading of the landfill is vital to the overall remediation of the site and will break the infiltration of rainfall into the waste body. This re-grading will take place in conjunction with remediation options 3.2.2 Passive Gas Venting System and 3.2.5. Landfill Gas Monitoring. 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. These watersheds should contain silt traps and removable dams to stop water leaving the site in an emergency situation. The final contour plan for the waste, prior to capping will be agreed with the Environmental Protection Agency (EPA)/Local Authority.

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

- Passive Gas Venting System;
- Capping of the landfill which reduces and /or eliminates infiltration of rainwater and the mobilisation of residual contaminants (if any);
- Additional Landfill Gas monitoring;
- Tree plantation and landscaping of the site to minimise reduce rainfall infiltration and leachate generation.

The effectiveness of works carried out will be closely recorded in the time frame after completion of remediation and removal works. This will be achieved through a comprehensive schedule of monitoring. Results will be documented and comparisons drawn from prior sampling at the site to evaluate effectiveness of remediation measures.