Path: R:\Map Produc on\2020\P2348\Workspace\P2348_Tier2_ERA.aprx

Site Boundary

BH

ST

TP

N
W E
S

0 50 100 200 Meters

TITLE: Site Inves ga on Loca on Plan			
PROJECT: Claremorris Tier 3 and Remedia on Plan			
FIGURE NO:	3.1		
CLIENT:	Mayo County Council		
SCALE:	1:2,500	**REVISION:**	0
DATE:	15/01/2020	**PAGE SIZE:**	A3

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3.1.1 Trial Pits

A JS Drilling Engineering Geologist supervised the advancement of 7 No. trial pits, shown in Figure 3-1 on the 25th November 2010.

Seven trial pits (TP01–TP07) were excavated using a tracked excavator fitted with a 1m wide and 3m length bucket, to a maximum depth of 6.50m below existing ground level (BGL). The profiles identified during trial pitting provided a picture of the underlying geology of the site and a general profile of the buried waste.

A summary of the ground conditions is presented in Table 3-1 below with photographs and exploratory hole logs provided in the JS Drilling site investigation report, Appendix 2.

Table 3-1: Summary of Ground Conditions

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
TP01	0.0 - 0.40 (Made Ground) 0.40 – 6.40 (Made Ground)	6.40 (base of excavation)	Soft black-brown PEAT with some plastic and waste content. Waste moderately well-rotted, mainly domestic with some C&D (concrete insulation). Strong pungent odour.
TP02	0.0 - 0.40 (Made Ground) 0.40 – 6.50 (Made Ground)	6.50 (base of excavation)	Soft black-brown peat FILL with some plastic and waste content. Waste moderately well-rotted, mainly domestic with some C&D (concrete insulation). Strong pungent odour.
TP03	0.0 – 0.70 (Made Ground) 0.70 – 6.20 (Made Ground) 6.20 – 6.40 (Peat)	6.40 (base of excavation – base of waste body)	Soft black-brown peat FILL with some plastic and waste content. Waste moderately well-rotted, mainly domestic plastic bags of waste. Strong pungent odour. Natural soft-firm dry PEAT.
TP04	0.0 - 0.50 (Made Ground) 0.50 – 5.50 (Made Ground)	5.50 (base of excavation - terminated due to ground conditions)	Soft black-brown peat FILL with some roots and vegetation in top 0.20m. Wet waste poorly well-rotted, mainly domestic plastic bags of waste. Strong pungent odour.
TP05	0.0 - 0.30 (Made Ground) 0.30 – 0.90 (Made Ground)	4.50 (base of excavation – base of waste body)	Soft black-brown peat FILL with some roots and vegetation in top 0.20m. Brown black peat FILL with plastic and waste mixed in.

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
	0.90 – 4.0 (Made Ground) 4.0 – 4.50 (Peat)		Waste moderately well-rotted, mainly domestic plastic bags of waste. Strong pungent odour. Natural dark brown-black PEAT.
TP06	0.0 - 0.40 (Made Ground) 0.40 – 0.70 (Made Ground) 0.70 – 6.50 (Made Ground)	6.50 (base of excavation)	Soft black-brown peat FILL. Brown black peat FILL with plastic and waste mixed in. Waste moderately well-rotted, mainly domestic plastic bags of waste and paper dated 1994. Strong pungent-sweet odour.
TP07	0.0 - 0.30 (Made Ground) 0.30 – 5.40 (Made Ground) 5.40 – 5.50 (Peat)	5.50 (base of excavation – base of waste body)	Soft black-brown peat FILL. Waste moderately well-rotted, mainly domestic plastic bags of waste. Strong pungent-sweet odour. Natural black brown PEAT.

Made ground comprising waste was encountered in all 7 No. trial pits (TP01-TP07). No bedrock was encountered.

Waste material was encountered between 0.0m – 6.50m in all trial pits from TP01 to TP07. No groundwater was encountered. Leachate found in all 7 No. trial pits from 3.70m to 6.0m BGL.

Natural ground comprising of Peat was confirmed in 3 No. trial pits (TP03, TP05 and TP07).

3.1.2 Waste Sampling

A total of 6 No. samples of the made ground / waste at the site was collected from trial pits TP01-TP06.

All samples were submitted for Waste Acceptance Criteria (WAC) testing to Severn Trent Laboratories Ltd., a UKAS/MCERTS approved laboratory. Samples were collected from site under Chain of Custody procedures.

The results are provided in Appendix 1 of the JS Drilling Report, Appendix 2 of this report.

The results are discussed in Section 4.1.

3.1.3 Slit Trenches

The lateral extent of the waste body was determined by 7 No. slit trenches (ST01-ST07) excavated along the edge of the landfill, as shown in Figure 3-1. Slit trench logs are included in Appendix 2 of JS Drilling report, (see Appendix 2 of this report) the findings are summarised on Table 3-2 below.

Table 3-2: Summary of Slit Trench Findings

Slit Trench ID	Length (m)	Description
ST01	4	Edge of waste running into natural PEAT ground.
ST02	6	Edge of waste running into natural PEAT ground.
ST03	5	Waste up to 3.0m BGL, no edge found.
ST05	6	Edge of waste into natural PEAT, very soft saturated ground.
ST06	5	Edge of waste into natural PEAT.
ST07	5	No lateral edge of waste but vertical depth shallow (0.30 – 0.40m) suggesting edge is close.

All slit trenches except ST03 (which waste was up to 3m BGL) were able to identify the edge of waste around the periphery of the site. BH02 was drilled approximately 30m south of this slit trench and waste appears to be tapering to 0.80m at this location indicating the edge of waste.

3.1.4 Evidence of Historic Landfilling

The trial pit excavation works identified waste material tending to the western site boundary with thicknesses ranging from 0.0 (topsoil) – 6.50m BGL (base of excavation). Evidence of waste material was identified in all 7 No. trial pits locations (TP01-TP07). The waste encountered was described mainly as plastic bags, a paper and concrete insulation. The waste material description as described by JS Drilling Engineering Geologist is typical of MSW material.

The base of the waste material was not reached in 4 No. trial pits at the termination depth of 6.50m BGL in 3 No. trial pits (TP01, TP02 and TP06) and at 5.5m BGL in 1 No. trial pit (TP04).

As noted, most of the Made Ground waste material encountered comprised brown black Peat mixed with MSW.

3.1.5 Waste Delineation

The combined findings of the trial pits and slit trenches excavations were used to interpret the aerial extent of the waste mass since a geophysical surveying was not undertaken at the site.

The findings of the intrusive site investigation show the area where landfill material is present however the exact lateral extent of waste is not clear.

Considering the depths found in the trial pitting and the lateral extent found in the slit trenches excavations the interpreted landfill extent covers an area of approx. 32,000 m^2 and initial volume calculation estimates an interred waste volume of approximately 168,000 m^3 at the site.

The maximum anticipated waste footprint is presented in Figure 3.3.

3.1.6 Borehole Installation and Groundwater and Leachate Sampling

Two boreholes, BH01 and BH02, were drilled using window sampling drilling methods to a total depth of 5.90m BGL and 4.0m BGL respectively, at the site. The boreholes were drilled for installing leachate (BH01) and groundwater (BH02) monitoring installations.

BH01 was drilled through the waste body into the underlying natural subsoil and BH02 was drilled on the periphery of the site into natural ground, down gradient of the landfill (see Figure 3-1).

Leachate and groundwater monitoring were undertaken in boreholes BH01 and BH02, respectively, on the 2nd December 2010. The sample containers were labelled with a unique number and placed in a cooler box for transportation to STL laboratories in the UK, time sensitive analysis (BOD, COD and faecal coliforms in the groundwater) was carried out in local lab Complete Laboratory Solutions (CLS) in Galway. Laboratory results can be seen as Appendix 1 in the JS Drilling report, Appendix 2 of this report and are further discussed in Section 4.2 and 4.3.

3.1.7 Knock/Claremorris By-pass Site Investigation

As stated in Section 3.1 above a site investigation was previously prepared on behalf of Mayo County Council (see Appendix 4). This report was prepared in January 1994 and detailed the findings of a programme of site investigation along a proposed route for the Knock/Claremorris N17 by-pass. FT reviewed this report to obtain any relevant information regarding the geological characteristics of the area surrounding the historical landfill site.

The site investigation included the installation of a series of boreholes at locations along the proposed bypass route. It was found that boreholes had been excavated at by-pass chainage section 1250, at a proposed (now existing) railway bridge, approximately 150m north-west of the historical landfill. Two boreholes were bored at this location 1250L and 1250R. 1250L comprised of an initial bore using a cable percussion tool followed by a rotary core while 1250R comprised rotary core only.

A summary of the borehole logs for each borehole are shown in below in Table 3-3.

Table 3-3: Knock/Claremorris By-pass S.I Investigation Borehole 1250 Logs

Borehole Log ID	Depth of material (m BGL)
1250L (cable tool)	0.0 - 0.60 - Made Ground (gravel) 0.6 - 1.4 (soft brown fibrous peat) 1.4 - 2.7 (firm to stiff grey silty sandy gravelly CLAY with cobbles) 2.7 - 3.7 (compact fine to coarse angular sandy GRAVEL with cobbles) Refusal at 3.7m

Borehole Log ID	Depth of material (m BGL)
1250L (rotary core)	0 - 2 - Overburden (fragments of limestone with slight clay smearing present) 2.0 - 3.5m (dark grey fine-grained slightly weathered siliceous LIMESTONE moderately strong or strong 3.5 - 5.05 - Locally moderately weathered and becoming increasingly carbonaceous from 4.1 to 4.4m 5.05/5.25 - 5.7 - highly fractured/non-intact with much of core represented as fine-grained size angular fragments 5.7 - 6.7 generally slightly weathered, strong to very strong (end of borehole)
1250R (rotary core)	0.0 - 3.7 - Stiff dark brown peaty clay/clayey peat 3.7 - 7.0 - Dark grey/grey black fine grained, moderately and slightly weathered limestone, moderately strong to strong. 4.6-4.85 prominent highly weathered shaley limestone, weak to mid-weak

4. ENVIRONMENTAL ASSESSMENT

The results of the environmental assessment previously undertaken as part of the Tier 2 investigation at the Claremorris Historic Landfill site are presented in the following sections.

4.1 Waste / Made Ground Assessment

The waste / made ground sample was compared against Waste Acceptance Criteria (WAC) to determine the appropriate waste classification rating associated with the interred waste. WAC screening is chosen for this assessment to suitably categorise the interred waste as inert, non-hazardous or hazardous material.

4.1.1 Chemical Results for Waste Samples

The waste/ made ground samples analysed from the site investigations were assessed against the Waste Classification Assessment Criteria. A summary of the results for Claremorris Historic Landfill is outlined in Table 4-1 below, while the laboratory reports are presented in Appendix 1 of the JS Drilling report, See Appendix 2 of this report.

Table 4-1: Waste Sampling Results – Solid Waste Analysis

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID					
					TP01 (4.0m)	TP02 (4.0m)	TP03 (3.0m)	TP04 (4.0m)	TP05 (3.50m)	TP06 (4.0m)
Asbestos in soil	--	**Detected**	**Detected**	**Detected**						
Arsenic	l.kg^{-1}	**0.5**	**2**	**25**	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Barium	l.kg^{-1}	**20**	**100**	**300**	0.52	0.4	0.29	0.62	0.33	0.2
Cadmium	l.kg^{-1}	**0.04**	**1**	**5**	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Chromium	l.kg^{-1}	**0.5**	**10**	**70**	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Copper	l.kg^{-1}	**2**	**50**	**100**	<0.10	<0.10	<0.10	<0.10	0.14	0.35
Mercury	l.kg^{-1}	**0.01**	**0.2**	**2**	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum	l.kg^{-1}	**0.5**	**10**	**30**	<0.020	<0.020	0.05	<0.020	0.08	**0.65**
Nickel	l.kg^{-1}	**0.4**	**10**	**40**	<0.20	<0.20	<0.20	<0.20	<0.20	0.22
Lead	l.kg^{-1}	**0.5**	**10**	**50**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Antimony	l.kg^{-1}	**0.06**	**0.7**	**5**	<0.060	<0.060	<0.060	<0.060	<0.060	**0.08**
Selenium	l.kg^{-1}	**0.1**	**0.5**	**7**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	l.kg^{-1}	**4**	**50**	**200**	<0.25	<0.25	<0.25	<0.25	<0.25	0.76
Chloride	l.kg^{-1}	**800**	**15000**	**25000**	510	800	170	470	550	**3600**
Fluoride	l.kg^{-1}	**10**	**150**	**500**	2	<2.0	<2.0	<2.0	<2.0	<2.0
Sulphate	l.kg^{-1}	**1000**	**20000**	**50000**	**1700**	**4200**	**2100**	**4400**	**5100**	**4800**
Total Dissolved Solids (TDS)	l.kg^{-1}	**4000**	**60000**	**100000**	**4200**	**9700**	**4600**	**8400**	**9600**	**16000**
Phenol Index	l.kg^{-1}	**1**	**--**	**--**	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Dissolved Organic Carbon (DOC)	l.kg^{-1}	**500**	**800**	**1000**	170	**580**	240	270	320	**1100**

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID					
					TP01 (4.0m)	TP02 (4.0m)	TP03 (3.0m)	TP04 (4.0m)	TP05 (3.50m)	TP06 (4.0m)
Total Organic Carbon	%	**3**	**5**	**6**	**10**	**9.9**	**7.1**	**12**	**10**	**19**
Loss on Ignition	%	--	--	**10**	**13**	**19**	**16**	**20**	**26**	**37**
Total BTEX	mg.kg^{-1}	**6**	--	--						
Total PCBs (7 Congeners)	mg.kg^{-1}	**1**	--	--	0.045	<0.010	<0.010	<0.010	<0.010	<0.010
Mineral Oil (C10-C40)	mg.kg^{-1}	**500**	--	--	**540**	**1000**	220	170	**780**	310
Total (Of 17) PAH's	mg.kg^{-1}	**100**	--	--	5	3.2	1.5	7.3	7.4	4.3
pH	pH units	--	**>6**	--	7.8	7.9	8	7.8	7.9	8
Acid Neutralisation Capacity (pH4)	mol.kg^{-1}	--	**To evaluate**	**To evaluate**	0.029	0.03	0.03	0.043	0.039	0.069
Acid Neutralisation Capacity (pH7)	mol.kg^{-1}	--	**To evaluate**	**To evaluate**	0.0058	0.0046	0.0081	0.0052	0.0045	0.013
Additional Waste Analysis										
Conductivity @20 C	uS/cm				1100	3200	1100	400	3000	<100
Benzene	mg.kg^{-1}				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	mg.kg^{-1}				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylbenzene	mg.kg^{-1}				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
m&p-Xylene	mg.kg^{-1}				<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	mg.kg^{-1}				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

* Hazardous Waste Landfill Criteria: >6% TOC
* Items in **bold** are in exceedance of the Inert WAC limit value
* Items shaded in **green** are in exceedance of the Non-Hazardous WAC limit value
* Items shaded in **orange** are in exceedance of the Hazardous WAC limit value

4.1.2 Waste Classification

As can be seen in Table 4-1, based on the 6 No. samples submitted for laboratory analysis, waste material encountered within the site are typically inert in terms of leachate production, except for Dissolved Organic Carbon, Total Organic Carbon and Loss on Ignition.

4.2 Groundwater Analysis

One round of groundwater quality monitoring was undertaken at the site on the 2nd December 2010. The findings from the monitoring and an interpretation of the results are presented in the following sections.

4.2.1 Groundwater Depth Analysis

Groundwater depth analysis was undertaken on the 2nd December 2010. The average static groundwater level is presented in Table 4-2.

Table 4-2: Groundwater Depth Analysis

Borehole ID	Location Gradient	Top of Casing (mAOD)	Dip (m) Dec/10	Groundwater Level (mAOD)
BH02	Down gradient	64	0.785	63.215

*Note: Location gradient is in reference to the identified waste deposition area

Based on the above field survey measurements, groundwater levels were present below the surface at 0.785m below ground level (m bgl). Therefore, based on this standalone measurement, it can be assumed that the potentiometric groundwater surface intersects the waste body further upgradient. However, this could not be absolutely confirmed as no groundwater was recorded by JS Drilling within 7 No. trial pits and borehole BH01 within the waste body.

4.2.2 Groundwater Borehole Position

The groundwater sample analysed from BH02 was tested for limited criteria i.e. Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Faecal Coliforms and Total Coliforms. The results for these parameters are shown in Table 4-3 below. The complete laboratory report is presented in Appendix 1 of JS Drilling Report, Appendix 2 to this report.

Table 4-3: Groundwater Sampling Results

Analysis	Units	Sample ID
		BH02
BOD	mg/l	28
COD	mg/l	482
Faecal Coliforms	cfu/100ml	<1
Total Coliforms	cfu/100ml	6,800

4.2.3 Groundwater Quality Discussion

A slight odour was noted from the groundwater sample BH02, which could possibly be attributed to the presence of peat as the underlying strata. The water was brown and murky and cleared slightly after purging 3 well volumes.

4.3 Leachate Analysis

One round of leachate monitoring was undertaken at the site on the 2nd December 2010. The findings from the monitoring and an interpretation of the results are presented below.

4.3.1 Leachate Depth Analysis

Leachate depth analysis was undertaken on the 2nd December 2010 and the result is presented in Table 4-4:

Table 4-4: Leachate Depth Analysis

Borehole ID	Location Gradient	Top of Casing (mAOD)	Dip (m) Dec/10	Leachate Level (mAOD)
BH01	Cross-gradient	68	2.63	65.37

*Note: Location gradient is in reference to the identified waste deposition area

4.3.2 Leachate Borehole Position

The leachate sample analysed from BH01 was tested for limited parameters i.e. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The results for these parameters are shown in Table 4-5 below. The complete laboratory report is presented in Appendix 1 of JS Drilling Report, Appendix 2 to this report.

Table 4-5: Leachate Sampling Results

Analysis	Units	Sample ID
		BH01
BOD	mg/l	2972
COD	mg/l	6160

4.3.3 Leachate Analysis Discussion

A strong pungent odour was noted from the black leachate sample collected from BH01. Leachate did not change in odour or colour after purging. The leachate analysis results are compared to the concentrations provided for COD, BOD_{20} and BOD_5 for typical acetogenic and methanogenic leachates as per the EPA Manual Landfill (2003), as summarised in Table 4-6 below.

Table 4-6: Summary of Acetogenic and Methanogenic Composition for COD, BOD_{20} and BOD_5

	Parameter	COD	BOD_{20}	BOD_5
Acetogenic Leachates (mg/l)	Min	2,740	2,000	2,000
	Max	152,000	125,000	68,000
	Median	23,600	14,900	14,600
	Mean	36,817	25,108	18,632
Methanogenic Leachates (mg/l)	Min	622	110	97
	Max	8,000	1,900	1,770
	Median	1,770	391	253
	Mean	2,307	544	374

Source: EPA Landfill Manual (2003)

When assessed against typical landfill leachate parameters reported in the EPA Landfill Manual (2003), the leachate composition at the Claremorris landfill appears to be more representative of the mean to maximum concentrations of the methanogenic phase. Although the concentrations of BOD do exceed the maximum concentrations for BOD_{20} and BOD_5 of the methanogenic phase it is considered that the leachate would be closer to methanogenic phase waste than acetogenic at the time of sampling.

The results of this assessment are in line with the age of the site and the nature of the waste encountered

4.4 Landfill Gas Monitoring

JS Drilling carried out monitoring of landfill gas (LFG) parameters at each monitoring borehole location (BH01 and BH02), trial pit excavated (TP01-TP07) and slit trench (SL01-SL03 and SL05-SL07). In accordance with the EPA CoP, methane, carbon dioxide, oxygen and atmospheric pressure were analysed at the 15 No. monitoring locations using a portable Landfill Gas Meter GA94.

4.4.1 Monitoring Results

In accordance with the CoP, the trigger level for methane outside the waste body is 1% v/v and for carbon dioxide is 1.5% v/v.

The monitoring results for methane, carbon dioxide and oxygen levels for the monitoring boreholes are summarised in Table 4-7.

Table 4-7: Landfill Gas Monitoring Results November 2010

Date: 25/11/2010					
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member
TP01	0.1	0.2	21.0	0956	AMR
TP02	0.1	0.1	20.9	0955	
TP03	0.1	0.2	20.9	0954	
TP04	0.1	0.2	20.9	0954	
TP05	0.1	0.2	20.9	0956	
TP06	0.1	0.2	20.9	0956	
TP07	0.1	0.1	21.0	0954	
Date: 26/11/10					
BH01	**78.1**	**32.2**	0	0959	AMR
BH02	0.4	**1.6**	20.1	0961	
ST01	0.1	0.1	21.0	0954	
ST02	0.1	0.2	21.0	0954	
ST03	0.1	0.1	21.0	0956	
ST05	0.1	0.1	21.0	0956	
ST06	0.1	0.2	21.0	0958	
ST07	0.1	0.1	21.0	0958	

As can be seen in Table 4-7, concentrations of both CO_2 and CH_4 at all trial pits and slit trenches are below the threshold values set by the CoP during the monitoring round.

However, at monitoring borehole BH01, located within the waste body both gases exceed the limits set, and at BH02 carbon dioxide concentration slightly exceeds the limit.

4.5 Surface Water Monitoring

Surface water sampling was completed in 2009 on adjacent water courses. Two samples were collected from two different locations, one north and the other south of the site, as shown in Figure 4-1.

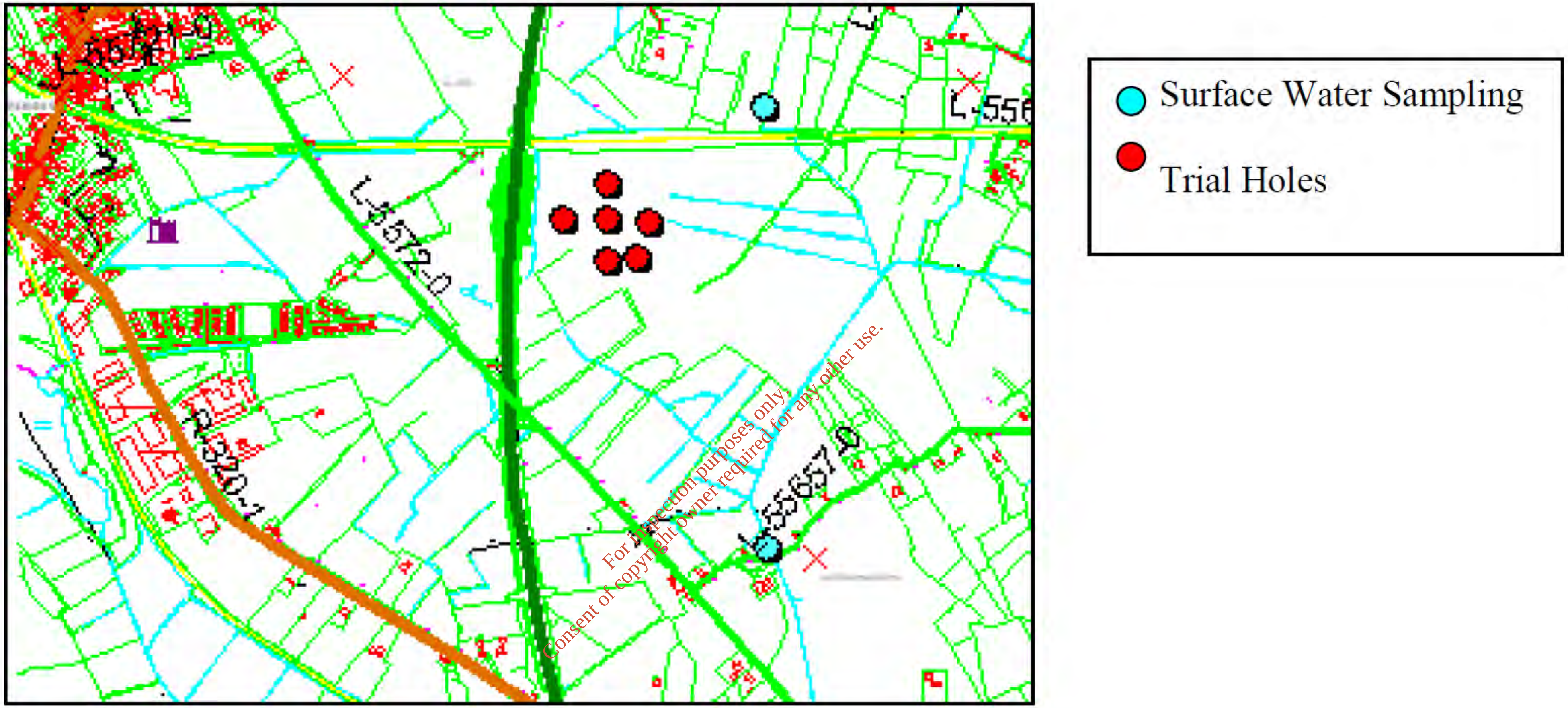


Figure 4-1: Surface Water Sampling Locations

4.6 Conceptual Site Model (CSM)

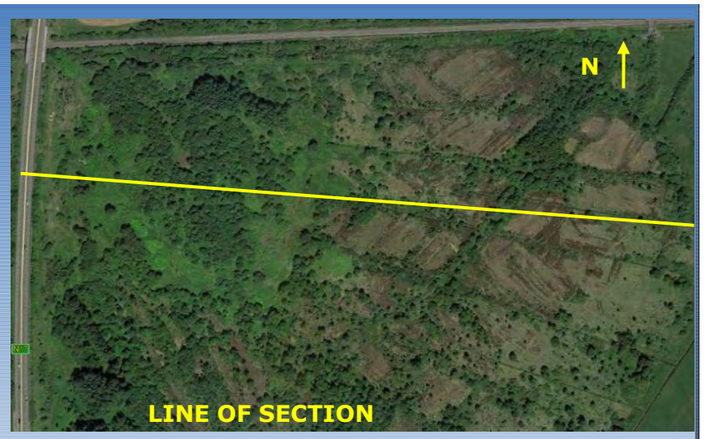
Taking into account the information obtained from the desk study, assessment, intrusive site investigation and site walkover revised conceptual site models were prepared as part of this Tier 3 assessment and is presented overleaf.

INFERRED GROUNDWATER LEVEL

WASTE BODY

LANDFILL GAS

LEACHATE MIGRATION



WEST **EAST**

N17 Road & embankment and

Land drain

TP02 66mOD

TP03 67mOD

Top soil cover 0.4-0.7m

TP04 66mOD

ST06 66mOD

Stream (flowing South /South-east

Waste Body Depth of Waste up to 6.5m

Limestone till/clay

Peat bog

59.5 mAOD Base of waste

60.6 mAOD Base of waste

Weathered Karstified Limestone

60.5 mAOD end of TP (waste continues)

GW FLOW DIRECTION (south/south-east)

REGIONALLY IMPORTANT AQUIFER - KARSTIFIED (DIFFUSE)
GW VULNERABILITY - MODERATE TO HIGH

GW VULNERABILITY - LOW

Ballymore Limestone Formation
Dark fine-grained limestone and shale

FIGURE 4.2 CLAREMORRIS HISTORIC LANDFILL CONCEPTUAL SITE MODEL (West-East)

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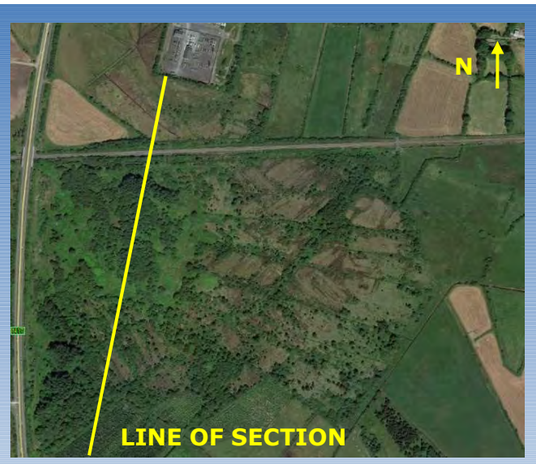
FEHILY TIMONEY 30 YEARS

INFERRED GROUNDWATER LEVEL

WASTE BODY

LANDFILL GAS

LEACHATE MIGRATION



NORTH

SOUTH

Sub-station

Railway c.60m from waste body

Land drain

Top soil cover 0.4-0.7m

TP03 67mOD

TP05 69mOD

BH02 64mOD (40m offset)

63.2 mAOD Base of waste

Limestone till/clay

Made Ground

Waste Body Depth of Waste up to 6.5m

Peat bog

60.6 mAOD Base of waste

64.5 mAOD Base of waste

Weathered Karstified Limestone

GW FLOW DIRECTION (south/south-east)

REGIONALLY IMPORTANT AQUIFER - KARSTIFIED (DIFFUSE)
GW VULNERABILITY - MODERATE TO HIGH

Ballymore Limestone Formation
Dark fine-grained limestone and shale

FIGURE 4.3 CLAREMORRIS HISTORIC LANDFILL CONCEPTUAL SITE MODEL (North-South)

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FEHILY TIMONEY 30 YEARS

5. TIER 3 RISK ASSESSMENT

5.1 Tier 2 Risk Classification and Tier 3 SPRs Considered

Previous assessment carried out by Mayo County Council (MCC) confirmed that the historical landfill typically contains mixed municipal/household waste deposited within a single infill area covering an area approximately 32,000m^2. It is estimated that approximately 168,000 - 191,100 tonnes of waste is present at the site. MCC initially estimated 168,000 tonnes of waste would have been deposited at the site. An estimate of 191,100 tonnes is based on the application of an average waste thickens of 5.25 m over an area of 32,000 m^2 and assumed a waste density of 1.4 tonne/m^3. A factor of 95% is added to account for areas where no waste may be evident.

The initial risk assessment for the site carried out by Mayo County Council utilised the EPA online section 22 register Tier 1 risk assessment tool. In carrying out this Tier 3 assessment a review of the SPR risk scoring was conducted and updated accordingly. This revised risk scoring takes account of the proposed development of the site as a solar farm and therefore considers future receptors of the landfill should the solar farm be constructed.

Table 5-1: Risk Classification Calculation - Claremorris Landfill

EPA Ref	Risk	Points		Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	Municipal >1≤5ha	7.00	Site is <5ha and entirety of the site is likely underlain by waste. Site investigation indicates waste is likely MSW
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	Municipal >1≤5ha	7.00	Site is <5ha and entirety of the site is likely underlain by waste. Site investigation indicates waste is likely MSW
2a	Leachate migration: Pathway (Vertical)	2.00		Groundwater vulnerability varies but is predominantly high beneath the site.
2b	Leachate migration: Pathway (Horizontal)	5.00		Aquifer underlying the site is classified by the GSI as being a regionally important karstified aquifer
2c	Leachate migration: Pathway (Surface water drainage)	2.00		There is a direct connection between the waste body and the adjacent surface water body receptor via drainage ditch immediately west of the site along N17 embankment and ditch immediately north of the site which follows the rail in an easterly direction.
2d	Landfill gas: Pathway (Lateral migration potential)	1.00		GSI characterise surrounding soil in the immediate vicinity as being peat
2e	Landfill gas: Pathway (Upwards migration potential)	1.00		GSI characterise surrounding soil in the immediate vicinity as being peat

EPA Ref	Risk	Points	Rationale
3a	Leachate migration: Receptor (Human presence)	1.00	No houses identified within 250m, but many located within 1km of the site.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	0.00	No SWDTE or GWDTE identified within 1km of the site
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	5.00	Site is underlain by a regionally important aquifer
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	3.00	There were no public water supplies identified likely to be impacted by the site identified.
3e	Leachate migration: Receptor (Surface water bodies)	1.00	An unnamed stream is shown on both the EPA maps and OSI discovery series maps, located approximately 360m east of the waste body. This stream is a tributary of the Robe River which is located c. 2.1km south of the site
3f	Landfill Gas: Receptor (Human presence)	5.0	Proposed development of the site as a solar farm would give rise to a human presence on site and the presence of infrastructure on site i.e. panels framework, pipework, cabling etc. provides potential conduits for landfill gas.

The highest single risk rating for the site was calculated to be 50% for source-pathway-receptor (SPR) Linkage 5 which referred to leachate migration through groundwater pathway to underlying aquifer. The SPR linkages examined in this Tier 3 are highlighted in Table 5-2 and discussed in further detail below.

SPR No.	Linkage	Normalised Score	Justification
Leachate migration through combined groundwater and surface water pathways			
SPR1	Leachate => surface water	21	Site is located within a regionally important karstified aquifer and there are also land drains immediately adjacent to the site, however the nearest mapped waterbody is located approximately 360m from the waste body.
SPR2	Leachate => SWDTE	0	There are no SWDTEs or GWDTEs located within 1km of the site.

SPR No.	Linkage	Normalised Score	Justification
Leachate migration through groundwater pathway			
SPR3	Leachate => human presence	20	There are no houses identified within 250m of the site
SPR4	Leachate => GWDTE or SWDTE	0	There are no SWDTEs or GWDTEs located within 1km of the site.
SPR5	Leachate => Aquifer	61	Site is located within a regionally important aquifer and groundwater vulnerability is high beneath the site.
SPR6	Leachate => Public Supply	26	There were no public water supplies identified within 1km of the site.
SPR7	Leachate => Surface water	20	A stream is located approximately 360m east of the site.
Leachate migration through surface water pathway			
SPR8	Leachate => Surface Water	23	There are land drains located immediately west and north of the waste body.
SPR9	Leachate => SWDTE	0	There are no SWDTEs located
Landfill gas migration pathway (lateral & vertical)			
SPR10	Landfill Gas => Human Presence	23	Closest human receptors identified as being an electrical sub-station <250m north of the site.
SPR11	Landfill Gas => Human Presence	14	Proposed development of the site as a solar farm would give rise to a human presence on site and the presence of infrastructure on site i.e. panels framework, pipework, cabling etc. provides potential conduits for landfill gas.

5.1.1 Leachate Migration Through Groundwater Pathway to Underlying Aquifer (SPR5)

A risk rating of 61% was calculated for the SPR5 linkage. This rating refers to the risk of leachate migrating to the underlying groundwater aquifer. The aquifer underlying the site was identified as being a regionally important and karstified limestone aquifer. The karst characteristic of the aquifer was a significant factor when calculating the risk that the historical landfill site poses to groundwater contamination.

5.1.2 Lateral and Vertical Migration of Landfill Gas (SPR10 And SPR11)

Based on the characteristics of the site, the surrounding environment and receptors the Tier 3 risk evaluation and rating yielded low risk scores of 23% for lateral migration (SPR10) and 14% for vertical (SPR11) landfill gas migration. Landfill gas monitoring at the site showed only trace quantities of methane (0.1% v/v) below the trigger value of 1%v/v at all trial pits and slit trenches. BH02 yielded slightly higher concentration of methane at 0.4% v/v.

BH01 however yielded significantly higher methane concentrations of 78.1% v/v, it is noted however that BH01 is located within the waste body, and therefore higher concentrations of methane are not unexpected. With respect to carbon dioxide both BH01 and BH02 yielded concentrations of 32.2% v/v and 1.6% v/v respectively. BH02 is located on the periphery of the waste body and therefore marginally exceeds the EPA trigger value of 1.5% v/v for carbon dioxide concentrations outside the waste body. Although, no sensitive receptors were identified to be present either directly above the waste or in the immediate vicinity of the waste, these monitoring results dictate that the potential risks from landfill gas migration be examined further, particularly if the site is to be developed.

6. DETAILED QUANTITATIVE RISK ASSESSMENT (DQRA)

The EPA Code of Practice on Environmental Risk Assessment for Unregulated Waste Disposal Sites requires a Tier 3 assessment to include some form of quantitative risk assessment either as a Generic Quantitative Risk Assessment (GQRA) or as a Detailed Quantitative Risk Assessment (DQRA).

This Tier 3 assessment report uses a DQRA to further assess the risks to groundwater and from landfill gas migration and addresses the following primary risks:

- Leachate migration through groundwater pathway to underlying aquifer (SPR5)
- Lateral and vertical migration of landfill gas (SPR10 and SPR11)

The detailed quantitative risk assessments rely on information gathered as part of the Tier 2 investigations (see Sections 2-4). Predictive landfill gas modelling (LandGEM) was used to assess gas migration risks. Based on the outcomes of the DQRA, suitable remediation measures and associated costs are presented in Section 8.7 of this report.

6.1 Landfill Groundwater Recharge/Contribution

The GSI online mapping indicates that the site location is underlain by a 'Regionally Important Aquifer - Karstified (diffuse)'. The aquifer vulnerability is classified as being extreme at the site, indicating that the aquifer at the is location is extremely vulnerable to and can directly influenced by rainwater infiltration at the site, and as subsequently by any pollutants migrating vertically to the bedrock aquifer.

The karstified nature of the underlying aquifer limits the applicability of tradition screening tools or dispersion modelling assessments at the site as karst aquifer can be dominated by conduit flow rather than diffuse flow.

An attempt at quantifying the risk posed by the site at an aquifer scale is therefore made below in assessing the overall size of the site and its potential for leachate generation vs. the overall size of the aquifer.

6.1.1 Potential Leachate Generation

In quantifying the potential impact that the leachate generated at the historical landfill may have on the underlying groundwater aquifer it is important to estimate the quantity of leachate or contaminated groundwater produced at the site.

The vertical infiltration of rainfall above the site to the underlying groundwater aquifer is determined by the groundwater recharge rate at this site. The recharge coefficient as defined by GSI varies across the site, at 4%, 42.5% and 85%, however the majority appears to be lie within areas assigned recharge co-efficient of 42.5% and 85%. In determining the recharge rate at the site, GSI applied an effective rainfall rate of 832 mm/year. At each of the recharge coefficient applied the recharge rates are as follows:

- 33 mm/year (at 4%) [0.033 m/year]
- 354 mm/year (at 42.5%) [0.354 m/year]
- 707 mm/year (at 85%) [0.707 m/year]

Multiplying the recharge rates by the estimated waste footprint area (32,000 m^2) calculates the potential leachate generation.

Recharge Rate (m/year)	Leachate Generation (m^3/year)	Leachate Generation (m^3/day)
0.033	858	**2.35**
0.354	9204	**25.29**
0.707	18,382	**50.5**

GSI have characterised the underlying aquifer, the Clare-Corrib groundwater body as being 1,422 km^2 in area. The Claremorris historical landfill waste footprint was determined to be 32,000 m^2. This is accounts for 0.0002% of the Clare-Corrib GWB area.

6.2 Landfill Gas Assessment - LandGEM

LandGEM is an excel based screening model developed by the US EPA for estimating the quantity of landfill gases generated during both the operational phase of a landfill and post-closure of the landfill. The model applies a first-order decomposition rate equation to estimate the quantity of landfill gases being produced from decomposing waste present in a landfill.

The model relies on a limited number of inputs, some of which are supplied within the model as a variety of default values and site-specific information provided by the user. A summary of the model inputs used for this Tier 3 assessment are presented in Table 6-1 below.

The results of this model would aid in informing what, if any, remedial measures or control measures should be put in place to mitigate or monitor that risk.

Monitoring for landfill gases emitted from offsite well BH02 was conducted in November 2010 as part of the Tier 2 site investigation. This well yielded methane concentrations of 0.4% v/v and carbon dioxide concentrations of 1.6% v/v. In accordance with the EPA CoP the trigger level for methane outside the waste body is 1.0% v/v for and 1.5% v/v for carbon dioxide. Well BH01 which was installed within the waste body yielded methane concentrations of 78.1% v/v and carbon dioxide concentrations of 32.2% v/v (see Table 4-7). In developing the model two waste design capacities were applied. In MCC's initial assessment of the site it was estimated that approximately 168,000 tonnes of waste were deposited at the site. The 2010 site investigation conducted at the site determined that the waste thickness at the sized varied from approximately 4.0 m to 6.5 m. Assuming a waste footprint area of 32,000 m^2 and an average waste thickness of 5.25 m this estimated 136,500m^3 deposited at the site. At an assumed density of 1.4 tonne/m^3 its estimated that 191,100 tonnes of waste have been deposited at the site. A factor of 95% present is used to account for areas where waste may not be present. Both of these tonnages have been applied in the model to show the range of potential of gas generation.

Table 6-1: LandGEM Model Inputs

Landfill Characteristics	Input	Source
Landfill Open Year	1982	Exact timeframe of landfill operation is unknown. Assumed site to be operational through the 1970s. Start of filling operations assumed.
Landfill Closure Year	1996	Anecdotal evidence suggests landfilling activities ceased c.1980
Have Model Closure Calculate Closure Year	Yes	
Waste Design Capacity (megagrams/tonnes)	168,000 (MCC) 191,100 (Site Investigation)	Estimated quantity by Mayo County Council (MCC). Estimate based on 4.0m to 6.5m (average 5.25) waste thickness determined from site investigation and estimated 32,000m^2 waste footprint.
Determining Model Parameters		
Methane Generation Rate, k (year^{-1})	CAA Conventional – 0.05	Default value – maximum values applied as a conservative worst-case scenario approach
Potential Methane Generation Capacity, L_0 (m^3/Mg)	CAA Conventional – 1070	
NMOC Concentration (ppmv as hexane)	CAA – 4,000	
Methane Content (% by volume)	CAA – 50% by volume	
Select Gases/pollutants		
Gas/Pollutant #1	Total Landfill Gas	Standard – No other specific gases of concern
Gas/Pollutant #2	Methane	
Gas/Pollutant #3	Carbon Dioxide	
Gas/Pollutant #4	NMOC	
Enter Waste Acceptance Rates (Mg/year)		
1982 - 1996	11,200 (MCC) 12,740 (S.I)	Exact waste acceptance quantities per year are unknown. Worst case assumed waste design capacity was filled equally over 1970 to 1985 (14 year) period

6.2.1 Results - LandGEM

As an output, LandGEM produces a report on the model inputs and outputs. This report is included in Appendix 5 of this report. LandGEM estimates the mass and volume of landfill gases generated both during the operational/filling phase of the landfill and beyond. The estimated quantity of gas generated for the current year (2019) and after 10 years of further degradation (2029) are presented in Table 6-2. The model predicted that the site is currently generating 38 - 44 m^3/hr of methane across the entire site area. This will reduce to 23 - 26m^3/hr by 2029.

Table 6-2: Estimated landfill Gases Generated (2019 and 2029)

Gas/Pollutant	Tonnes/year		m^3/year		tonnes/hour		m^3/hour	
@ 168,000 tonnes	**2019**	**2029**	**2019**	**2029**	**2019**	**2029**	**2019**	**2029**
Total Landfill Gas	837	508	67,0487	406,671	0.10	0.06	**77**	**46**
Methane	224	136	335,244	20,3336	0.03	0.02	38	23
Carbon dioxide	614	372	335,244	203,336	0.07	0.04	38	23
NMOC	10	6	2,682	1,627	0.00	0.00	0.31	0.19
@ 191,100 tonnes	**2019**	**2029**	**2019**	**2029**	**2019**	**2029**	**2019**	**2029**
Total Landfill Gas	952	578	762,679	462,588	0.11	0.07	**87**	**53**
Methane	254	154	381,340	231,294	0.03	0.02	44	26
Carbon dioxide	698	423	381,340	231,294	0.08	0.05	44	26
NMOC	11	7	3,051	1,850	0.00	0.00	0.35	0.21

The approximate maximum waste deposition footprint was estimated to be approximately 32,000m^2. The estimated volume and mass of landfill gas generated and potentially released per m^2 of the total landfill area are presented in Table 6-3.

Table 6-3: Estimated gases generated/released per m^2 (2019)

Gas/Pollutant At 168,000 tonnes	Tonnes/year/m^2	m^3/year/m^2	tonnes/hour/m^2	m^3/hour/m^2
Total Landfill Gas	0.032	26	0.000	0.003
Methane	0.009	13	0.000	0.001
Carbon dioxide	0.024	13	0.000	0.001
NMOC	0.000	0.103	0.000	0.000
At 191,100 tonnes				
Total Landfill Gas	0.037	29	0.000	0.003
Methane	0.010	15	0.000	0.002
Carbon dioxide	0.027	15	0.000	0.002
NMOC	0.000	0.117	0.000	0.000

6.2.2 Discussion of Results

It is noted that a traditional detailed quantitative risk assessment of the risk posed by the landfill body to the groundwater aquifer is difficult given it karstified nature and the potential of the aquifer to display conduit flow characteristics (which are difficult to model/risk assess) vs. a diffuse flow regime.

Assessment of the landfill area and potential leachate contribution versus the total area of the aquifer at 0.001% indicates that the likely risk is potentially very low to negligible. Review of previous site investigations (Section **Error! Reference source not found.**) do indicated that the waste is likely underlain by peat and possible layers of gravelly clay/stiff gravel directly atop bedrock. It can be assumed that although some protection may be afforded by the underlying subsoils the groundwater vulnerability could be classified as High or even Extreme.

It is therefore difficult to fully discount the risk that the site poses to the underlying aquifer and remediation measures to further limit the potential for leachate generation and isolated the source of the contamination (i.e. capping) are considered necessary.

The outcome of the LandGEM model predicts a rate of landfill gas generation in the current year of approximately 77 – 87 m^3/hr dependant on the estimated tonnages.

The EPA guidance document, 'Management of Low Levels of Landfill Gas' outlines readily available flaring technologies that meet EPA requirements on temperature and retention specifications. These technologies generally require gas flow rates ranging from 40 to 2,500+ m^3/hr. with methane contents ranging from 10 to 50+ percent. The lowest methane content referring to Low-CV (Calorific value) flare technology.

As shown in Table 6-1 LandGEM estimated that in the current year (2019) an estimated quantity of 77 m^3/hour of landfill gas across the whole site is generated and assuming 50% percent of that volume being methane ($38m^3$). Landfill gas monitoring of groundwater well BH02 (in waste) conducted in 2010 yielded high concentrations of methane and carbon dioxide at 78.1% v/v and 32.2% v/v respectively. The LandGEM model suggests that at the estimated quantity of waste deposited at the site that methane production is still occurring and will continue for a number of years.

Figure 6-1 below shows the estimated landfill gas generation rates per year during the assumed operational phase (c.1982 to 1996) and predicted generation rates from 1996 onwards following closure of the site. It is noted that the model assumes equal production rates for both methane and carbon dioxide and are represented by the pink trendline.

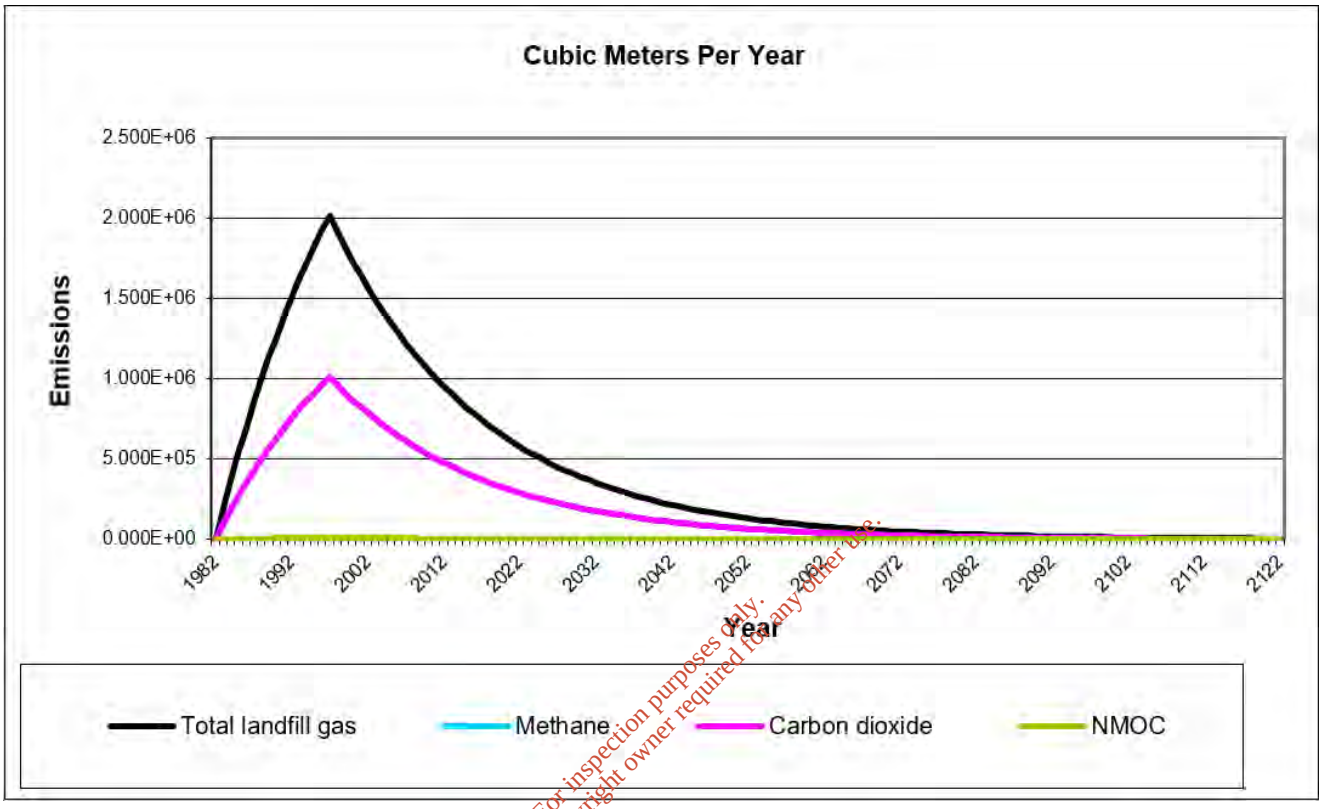

Figure 6-1: LandGEM Landfill Gas Volume Generation Rate (at 168,000 tonnes)

7. CONCLUSIONS AND RECOMMENDATIONS

The aim of this Tier 3 assessment was to examine (quantitatively) the potential impact of the historical landfill site on the receiving environment i.e. leachate generation/migration upon the underlying groundwater and potential vertical and lateral gas migration upon nearby receptors.

The examination of the potential generation from the site determined that on a regional scale the site does not pose a risk to the groundwater quality of the underlying groundwater body with the site only occupying 0.001% of the groundwater body area.

A review of the trial pit and borehole logs showed that the site only comprises a relatively shallow soil cap with an average thickness of 0.56m (min:0.3m, max:0.9m), therefore it is recommended that a more suitable cap be installed. The purpose of the cap will to twofold; to reduce the infiltration of rainfall to the underlying waste subsequently reduce or eliminate any leachate generation and to provide adequate physical separation between the waste mass and future receptors at the site e.g. livestock, construction personnel etc.

Further details regarding the proposed landfill cap are discussed in Section 8.2 below.

The output from LandGEM showed that landfill gas will continue to be generated for several years although in moderate quantities. Gas monitoring indicated the presence of gas in high quantities within the waste body with carbon dioxide concentrations also being detected slightly above the trigger value for wells outside of the waste body. It recognised that, owing to the nature of solar farms the level and frequency of human activity at the site will likely be quite low, however it is recommended that landfill gas control measures should be installed at the site to further minimise the risk of landfill gas migration and exposure to any human receptors at or close to the site.

Appropriate control measures shall be selected in accordance with the EPA Guidance document: *Management of Low Levels of Landfill Gas. Appropriate measures are* are discussed in Section 8.2.7

8. REMEDIAL ACTION PLAN

8.1 Overview

Based on the findings of the modelling exercises and quantitative risk assessment measures are proposed to mitigate the identified risks associated with leachate and landfill gas migration. The previous Tier 2 assessment and DQRA in Section 2 above concluded that the primary risk associated with the site at present is that of leachate migration into the underlying groundwater aquifer.

Regarding the risk of landfill gas migration, although the calculated SPR risk scores were determined to be low, the proximity of the site to residential areas and proposed after use require pro-active measures to mitigate the risk of landfill gas migration.

Following comprehensive desktop review, a site investigation and a Tier 2 assessment identified the primary source-pathway-receptors (S-P-R) linkages for the site to be leachate migration through groundwater pathways to the underlying groundwater aquifer.

8.2 Proposed Remediation Works

The following remediation measures are proposed to mitigate the effect of the landfill on:

- The underlying aquifer and on groundwater quality.
- Landfill gas migration.

8.2.1 Landfill Capping

A fully engineered landfill cap is proposed for the site. The landfill cap shall be design in accordance with the EPA Landfill design manual for non-inert, non-hazardous landfills. The capping shall typically consist of the following or equivalent

- 200mm Topsoil Layer.
- 800mm Sub Soil.
- Sub-Surface Drainage Geocomposite.
- 1mm LLDPE Barrier Layer.
- Sub-Surface Landfill Gas Collection Geocomposite.

The capping design shall be consistent with the proposed development of the site as a solar farm providing a suitable base for the solar panel arrays. The sub soil layer shall be therefore be adequately specified to ensure it is free draining and can support any proposed infrastructure and the solar panel network. Construction details for respective elements of the proposed cap will be subject to detailed design and prior Agency approval.

Key design criteria recommendations for respective elements are listed below under respective section headings.

8.2.2 Topsoil

Topsoil 200 mm shall be placed on top of the subsoil. Topsoil shall be seeded with a robust pasture or similar durable grassland mix.

Topsoil shall be compliant to BS3882:2015 or equal approved and graded to ensure no localized surface depressions are present.

8.2.3 Subsoil

Infill subsoil materials will be required to re-profile the landfill to fill in localised depressions.

Subsoil 800 mm thick shall be provided using a uniformly graded material with stone sizes not greater that 50 mm or equal approved.

8.2.4 Subsurface drainage on cap

A subsurface drainage layer on the cap barrier (hydraulic conductivity should be equal to or greater than $1x10^{-4}$ m/s for a thickness of 500 mm) or equal approved geocomposite shall be placed between the subsoil and barrier layer.

The drainage layer shall discharge to a subsurface pipe work collection system and thence to the surface drainage system.

Sub surface drainage layout shall be subject to detailed design.

8.2.5 Surface drainage

Surface drainage layouts using grassed waterways shall collect and direct surface water runoff including subsurface drainage outfall flows to one or more dedicated surface drainage outfalls into existing surface water perimeter drain(s).

Surface drainage shall be designed to mitigate the risk of rill or gully erosion giving rise to suspended solids loading exceeding of 25 mg/l on the cap and within receiving waters.

Surface drainage layout shall be subject to detailed design.

8.2.6 Barrier System

The barrier system shall use 1.0 mm LLDPE or similar approved.

This barrier will require vertical cut-offs on all boundaries to mitigate the risk of landfill gas migration and leachate egress following secondary consolidation.

8.2.7 Landfill Gas

8.2.7.1 Landfill Gas Pumping Trial

It is proposed that a landfill gas pumping trial be designed and conducted on site to accurately quantify the flow rate and quality of landfill gas being produce at the site to further quantify risks associated with possible landfill gas migration (SPR10 and SPR11).

Landfill gas pumping trials shall be designed and undertaken by an appropriately qualified person, the results of which shall be supported by a suitably calibrated landfill gas generation model.

It is recommended, subject to findings, that an appropriate remediation design shall be adopted. Appropriate control measures shall be selected in accordance with the EPA Guidance document: *Management of Low Levels of Landfill Gas.*

8.2.7.2 Landfill Gas Infrastructure

Subject to landfill gas flow rates the following installations may need to be considered to collect landfill gas:

- Below liner gas collection infrastructure comprising:
  - Under liner gas collection infrastructure
  - Vertical wells
- Above liner gas collection infrastructure comprising:
  - Above liner pipework connecting wells to oxidation technology
  - Condensate management infrastructure

Subject to gas flow rates and calorific value the following oxidation technologies maybe considered:

- High Calorific gas will typically require active extraction and subsequent oxidation using a high temperature high calorific (HTHC) flare.
- Low calorific gas will typically require active extraction and subsequent oxidation using a high temperature low calorific (HTLC) flare.
- Very low calorific gas may require active extraction or passive ventilation to support oxidation in a biological filter.
- Extremely low calorific gas may require passive venting via a carbon filter to mitigate the risk of odour nuisance.

Whichever technology is used the site will require power and telemetry connections to operate and or monitor oxidation technology. Where active extraction is required power will also be required to manage condensate management infrastructure.

8.2.7.3 Landfill Gas Management

A gas management risk assessment shall be carried out prior to detailed design.

Gas management proposals shall:

- Mitigate environmental pollution in accordance with best practice.
- Mitigate risks of asphyxiation and explosion.

Gas management design proposals shall make reference to gas prediction model estimates in this report and shall to facilitate detailed design and or selection of the most appropriate landfill gas oxidation solution or venting as may be required. All gas management proposals shall be subject to detailed designs.

The underliner gas collection layer shall comprise:

- An under-liner gas collection geocomposite or similar approved stone drainage later. e and collection pipework. The Landfill Directive does not define a thickness or permeability. The EPA Landfill Site Design manual advises equivalence should not be less than a 150 mm stone layer with a hydraulic permeability of $1x10^{-4}$m/s. the
- Provision for passive venting of landfill above the liner with methane oxidation if required.
- Management of below liner leachate breakouts.

The above liner gas collection pipework, if required, shall make provision for:

- Vertical wells and above liner collection pipework.
- Condensate management and associated infrastructure

In relation to whichever oxidation or passive venting technologies are required:

- Flare compounds shall be fenced.
- Gas vent stacks shall terminate at least 3.0 m above adjacent ground surfaces and be capped to prevent rainfall ingress and insertion of ignition sources (cigarettes or other).
- Biological filters shall be fenced and isolated from pedestrian, vehicular or animal activities.
- Equipment shall be specified to accommodate appropriate ATEX classifications.

8.3 Environmental Monitoring

8.3.1 Groundwater

It is recommended that groundwater monitoring be conducted quarterly at existing groundwater wells BH01 and BH02 to monitor changes in the leachate composition.

It is recommended that 3 No. additional combined groundwater and landfill gas monitoring wells be installed outside and downstream of the waste body to monitor effects if any of leachate migrating and potentially contaminating downstream groundwater and/or surface water receiving bodies.

8.3.2 Surface Water

It is recommended that surface water monitoring be conducted on a quarterly basis at 5 no. monitoring locations as follows:

- Upstream of waste body on N17 embankment toe drain.
- Upstream of waste body on drain to the railway line.
- Downstream of waste body on drain to the railway line.
- Upstream location on the Robe_020 (Kilbeg-Malone) prior to railway line drain.
- River downstream of railway line drain.

The proposed locations should be selected for accessibility prior to establishing dedicated sampling points with appropriate access and signage.

8.3.3 Monitoring Parameters

The EPA Landfill Monitoring landfill manual outlines recommended, minimum monitoring requirements for surface water, groundwater and leachate. These parameters are shown in Table 8-1 below and are as presented in Table C.2 of the EPA's *Landfill Manuals - Landfill Monitoring, 2nd Edition (2003).*

Table 8-1: Parameters for Monitoring of Groundwater, Surface Water and Leachate

Monitoring Parameter[1] See Footnote	Frequency	Surface Water	Groundwater	Leachate
Level	Quarterly+	-	-	-
Flow Rate		-	-	-
Temperature		✓	✓	✓
Dissolved Oxygen		✓	-	-
pH		✓	✓	✓
Electrical Conductivity[2]		✓	✓	✓
Total suspended solids		✓	-	-
Total dissolved solids		-	✓	
Ammonia (as N)		✓	✓	✓
Total oxidized nitrogen (as N)		✓	✓	✓
Total organic carbon		-	✓	-
Biochemical Oxygen Demand		✓	-	✓
Chemical Oxygen Demand		✓	-	-

[1] Tables D.1 and D.2 of the EPA Landfill Monitoring manual recommend guideline minimum reporting values for parameters

[2] Where saline influences are suspected, a salinity measurement should also be taken

Monitoring Parameter[1] See Footnote	Frequency*	Surface Water	Groundwater	Leachate
Metals[3]		✓	✓	✓
Total Alkalinity (as $CaCO_3$)		✓	✓	-
Sulphate		✓	✓	✓
Chloride		✓	✓	✓
Molybdate Reactive Phosphorous[4]		✓	✓	✓
Cyanide (Total)		✓	✓	✓
Fluoride		✓	✓	✓
Trace organic substances[5]	Annually	✓	✓	✓
Faecal and Total Coliforms[6]		-	✓	-
Biological assessment	-	-	-	-

***Note: Parameters proposed to be monitored on a quarterly basis should initially be monitored monthly for a duration of 12-months following the issuing of a Certificate of Authorisation (CoA) for the purpose of establishing baseline characteristics at each monitoring location**

⁺Annual parameters may be reduced to annual with the agreement on the agency dependant on the results and variation observed with time and versus the baseline assessment

8.3.4 Landfill Gas

Landfill gas migration monitoring shall be conducted in tandem with groundwater monitoring at each proposed and existing borehole location. Monitoring parameters should at a minimum include;

- Methane
- Carbon Dioxide
- Oxygen
- Balance

8.4 Japanese Knotweed Management

The invasive plant species, Japanese Knotweed (Fallopia japonica) is present on site and above the historic landfill. Herbicide was applied in September 2014 and 2015, with no further treatments being carried out since.

[3] Metals for analysis should include: calcium, magnesium, sodium, potassium, iron, manganese, cadmium, chromium (total), copper, nickel, lead, zinc, arsenic, boron and mercury.

[4] Total Phosphorus should be measured in leachate samples where colorimetric interference is likely.

[5] Table D.2 of the EPA Landfill Monitoring manual recommends trace organic substances that should be included in the determination. Surface water should be analysed for the pesticide sand solvents listed in the Water Quality (dangerous Substances) Regulations (S.I No. 12 of 2001)

[6] Required for drinking water supplies within 500m of the landfill

The Japanese Knotweed Company (JKC) on behalf of Mayo County Council - Claremorris & Western District Energy Co-op carried out additional inspections in August 2018 and 2019 and produced an update report on the assessment and management of the Japanese knotweed in September 2019.

A further updated report; *Japanese Knotweed Management and Treatment Plan Including Biosecurity Measures,* was prepared in January 2020 and this is presented in Appendix 6 of this report.

The 2020 *Japanese Knotweed Management and Treatment Plan Including Biosecurity Measures* report specifies a plan for managing and treating the Japanese knotweed during the construction and operational stages of the proposed solar farm. The proposed remediation plan and remediation design must consider the risks associated with Japanese Knotweed and all measures outlined in the management report produced by JKC. The management report also notes the development of a site remediation plan for the site and states that the Japanese Knotweed management plan may also need to be updated to reflect any proposed remediation works.

8.5 Future Potential Use: Solar Farm

All remediation work proposals should be reviewed at detailed design stage with respect to the decision or otherwise to progress with the construction of the proposed solar farm development. All remediation works and solar farm works shall be cognizant of the nature of the site.

Particular attention will be required to the selection and construction of a suitable capping layer upon which the solar farm may be located. It is recommended that the solar farm developer and the remediation designer agree on the mechanism required to fix panels to the engineered cap in order to mitigate the risk of damage to the barrier liner which is normally placed 1.0m below the surface.

The solar development shall also be required to consider the risks associated with landfill gas. Suitable protection and design measures shall be employed particularly with respect to structures and or conduits installed above or within the capping. The detailed solar panel design shall consider all relevant ATEX regulations when preparing detailed designs.

8.6 Remediation Design

The preliminary remediation design is presented in the following drawings:

- P2348-0400-0001
- P2348-0400-0002

Drawings are included in Appendix 3 to this document.

8.7 Remediation Cost Estimates

The following section outlines the potential costs associated with the remediation of the site. The costs estimate is limited to “once-off” civil and mechanical and electrical works.

Long term costs associated with maintenance, license compliance and environmental liabilities are not considered.

8.7.1 Landfill Capping

Table 8-2 outlines the costs associated with capping the site. The proposed capping is as per the EPA Landfill Design manual recommendations as presented previously.

Table 8-2: Landfill Capping: Cost Estimates

Item	Quantity	Unit	Rate, €	Cost	Note
Design					
Allowance for Additional Site Investigation works	1	Rate	€25,000.00	€25,000.00	Allowance
Detailed Design and Supervision	1	Rate	€100,000.00	€100,000.00	Allowance
General Site Clearance and Demolition Works	***3.2***	***ha***			
General Site Clearance	3.2	ha	€7,500.00	€24,000.00	Allowance for Clearance of Existing Site
Allowance for JPK Works	1	Sum	€25,000.00	€25,000.00	Allowance
Excavation Works	32000	m^2			Estimated area of Capping Area 32,000 m2
Excavation of Existing Cover/Capping for Reuse/Filling	6400	m^3	€2.50	€16,000.00	Excavation of area to 500mm
Entrance Works	32000	m^2			Estimated area of Capping Area 32,000 m2
Upgrade of Site Entrance for Works	1	Sum	€25,000.00	€25,000.00	Estimate/PC Sum
Landfill Capping Works	32000				

Item	Quantity	Unit	Rate, €	Cost	Note
Preparation of Excavated Surfaces	32000	m^2	€0.75	€24,000.00	Approximate Area, Local Rates 2018
Supply and Installation of 50mm Protection Layer	32000	m^2	€1.75	€56,000.00	Approximate Area, Local Rates 2018
Supply and Installation of Landfill Gas Collection Layer	32000	m^2	€5.50	€176,002.50	Approximate Area, Local Rates 2018 puse pipes
Installation of 1mm LLDPE Cap	32000	m^2	€6.50	€208,000.00	Approximate Area, Local Rates 2018
Installation of Sub Surface drainage collection Layer	32000	m^2	€5.50	€176,000.00	Approximate Area, Local Rates 2018 plus pipes
Sub Surface Drainage Layer	32000	m^2	€1.00	€32,000.00	
Geogrid	32000	m^2	€4.50	€144,000.00	Allowance for differential settlement
Importation of 800mm Subsoil Capping Layer	32000	m^2	€8.50	€272,000.00	Approximate Area, Local Rates 2018
Importation of 200mm Topsoil Capping Layer	32000	m^2	€3.00	€96,000.00	Approximate Area, Local Rates 2018
Seeding	32000	m^2	€2.00	€64,000.00	
Fencing	716	m	€100.00	€71,554.18	Approximation
Allowance Landfill Gas Migration Network Infrastructure	5000	m^2	€3.00	€15,000.00	Allowance
Allowance Surface Water Drainage Infrastructure	32000	m^2	€4.00	€128,000.00	Allowance
Independent CQA	1	Sum	€15,000.00	€15,000.00	Estimate Local Rates
Landfill Gas Pumping Test					
-					
Mobilisation	1	Sum	€3,500.00	€3,500.00	Local Rates 2018
Landfill Gas Well ex. M&E, inc. piping and backfill	4	No.	€4,000.00	€16,000.00	Assumed design depth 6 8m and spacing, Local Rates 2018
Landfill Gas Well Heads	4	No.	€500.00	€2,000.00	Local Rates 20198
Supporting Infrastructure	1	Sum	€5,000.00	€5,000.00	Allowance
Design, Supervision and Interpretation	1	Sum	€10,000.00	€10,000.00	Allowance

Item	Quantity	Unit	Rate, €	Cost	Note
Sub Total 1				**€1,729,056.68**	
Add 10% Contractor Prelims	10.0%			€172,905.67	
Sub-Total 2				**€1,901,962.34**	
Add 7.5% Contingency	7.5%			€142,647.18	
Grand Total (excl VAT)				**€2,044,609.52**	

- This preliminary cost estimate does not purport to guess potential tender submissions in current and future market conditions.
- FTC has used approximations of rates for similar works items where possible and has used engineering judgement to estimate rates & sums where similar rates are not available
- Management of Hazardous Materials has not been allowed for.
- Pricing is based primarily on concept design provided for the site; no detailed designs have been completed
- This cost estimate assumes that materials to be imported are available from local sources
- This cost estimate excludes VAT
- This cost estimate excludes in/deflation
- This estimate includes for a level of contingency as indicated
- Costs are largely based on previously tendered rates for similar work or cited reference sources, Prices may have changed in the intervening period
- It is assumed that the new site is serviced by public road access, water supply and sewerage services

FEHILY TIMONEY
30 YEARS

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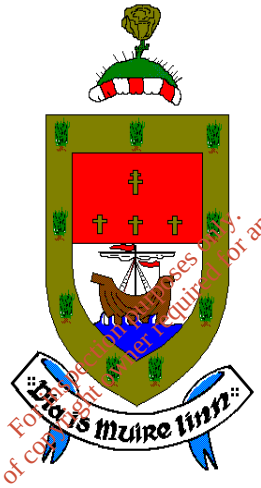
APPENDIX 1

Tier 2 Risk Assessment
Mayo County Council

Claremorris Historic landfill Pilot Project Tier 2 Investigation 2010



Mayo County Council

Comhairle Chontae Mhaigheo

June 2010

Claremorris Historic Landfill

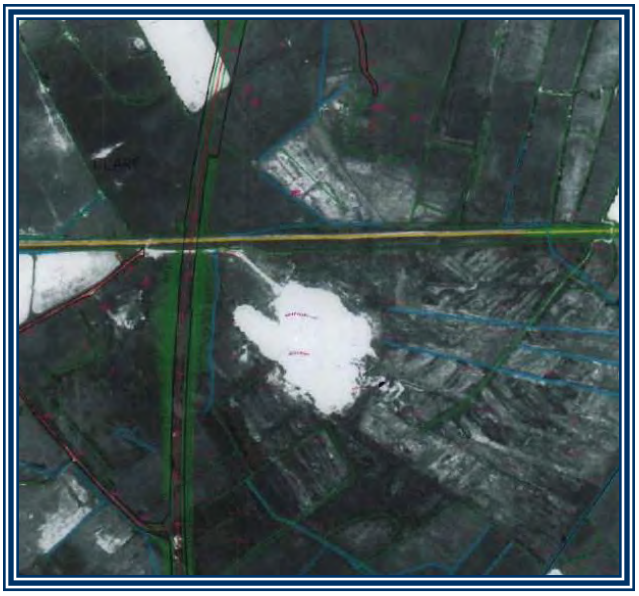
The site is located approximately one kilometre to the east of Claremorris town. It is bounded on the North by a railway line and to the east by the N17. To the South and West the site is surrounded by boggy ground. The original access to the site has been restricted following major road works to the N17. Access to the landfill site is difficult and it is overgrown with an abundance of brambles, gorse, trees and alien species Japanese knot weed.

The site operated as a regional landfill accepting municipal waste from 1982 to March 1996. The area of the site is approximately 26,000m². It is estimated that the 168,000 tonnes of municipal waste was deposited at the site. The site was capped with boulder clay but no remediation works have been completed. It has been reported that on occasion fires broke out on the site.

The tier 1 risk assessment was completed in line with EPA code of practice and indicates the site as moderate risk. Surface water sampling was completed in 2009 on adjacent water courses and it is proposed that further sampling will be undertaken during tier 2.

Tier 2 Objectives

- Confirm results of Tier 1 and modify conceptual model if appropriate;
- Determine depth and nature of capping layer;
- Determine extent and composition of waste body;
- Detrmine potential of waste to cause adverse environmental impacts
- Determine subsoil type, thickness and permeability
- Determine remediation required



Landfill
1995

Landfill
2000

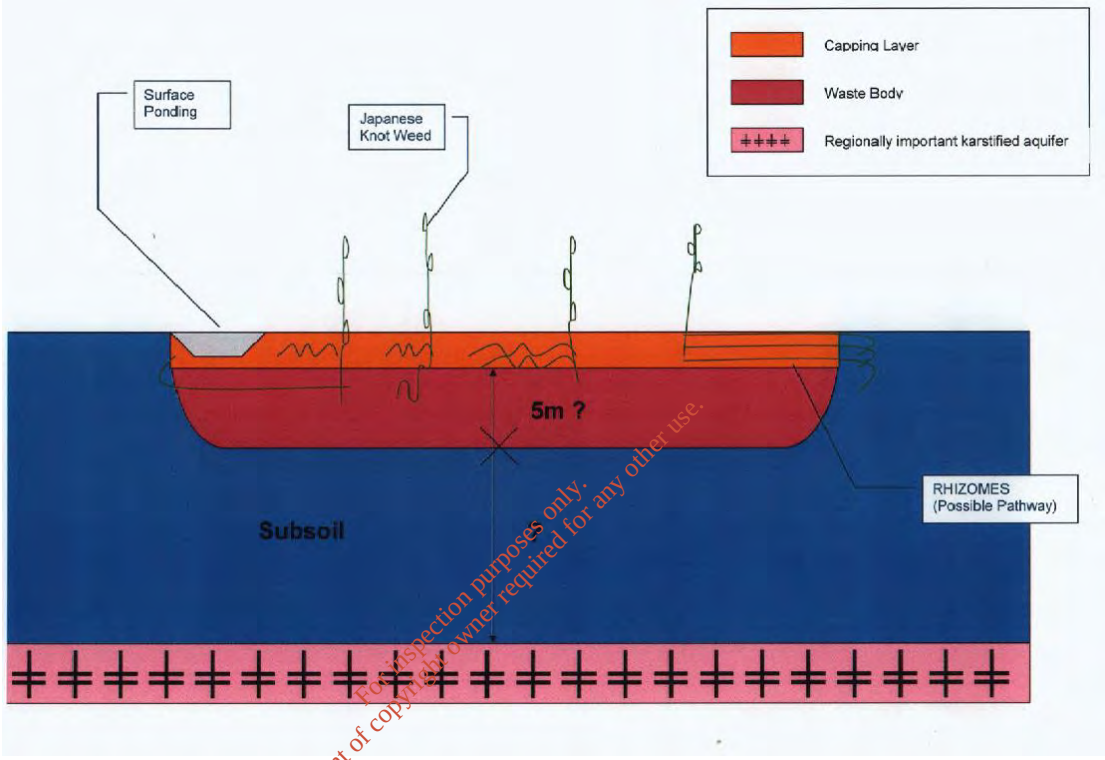
Landfill
2007

EPA
Risk ranking
Report
S22-02588

SPR Linkage	Description	Normalised Score (%)	Risk classification
SPR 1	Leachate migration to surface waters through groundwater and surface water pathways	32.67	Lowest Risk. Class C
SPR 2	Leachate migration to designated areas through groundwater and surface water pathways	0	Lowest Risk. Class C
SPR 3	Leachate migration to human receptors through groundwater pathways	40.83	Moderate Risk Class B
SPR 4	Leachate migration to designated areas through groundwater pathways	0	Lowest Risk. Class C
SPR 5	Leachate migration to aquifer through groundwater pathways	61.25	Moderate Risk Class B
SPR 6	Leachate migration to Public water supply (well) through groundwater pathways	26.25	Lowest Risk. Class C
SPR 7	Leachate migration to surface waters through ground water pathways	40.83	Moderate Risk Class B
SPR 8	Leachate migration to surface waters through surface water pathways	0	Lowest Risk. Class C
SPR 9	Leachate migration to designated areas through surface water pathways	0	Lowest Risk. Class C
SPR 10	Lateral Landfill gas migration to human receptors through subsoil pathways	14	Lowest Risk. Class C
SPR 11	Vertical Landfill gas migration to human receptors through subsoil pathways	14	Lowest Risk. Class C
Overall Risk Classification Class B Moderate Risk			

Tier 1 Conceptual Site Model

Claremorris historic landfill



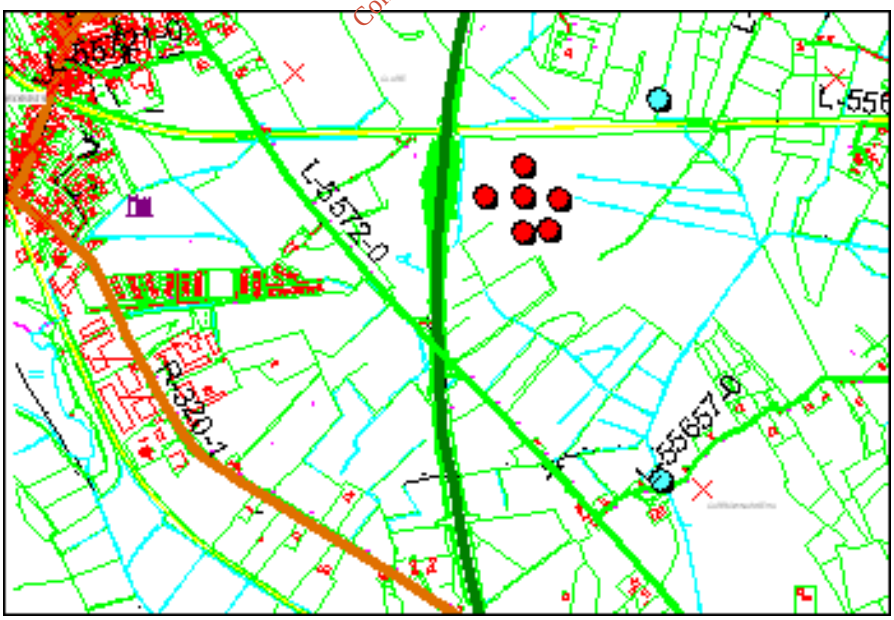
Proposed Tier 2 Investigation

Estimated cost of tier 2 investigation

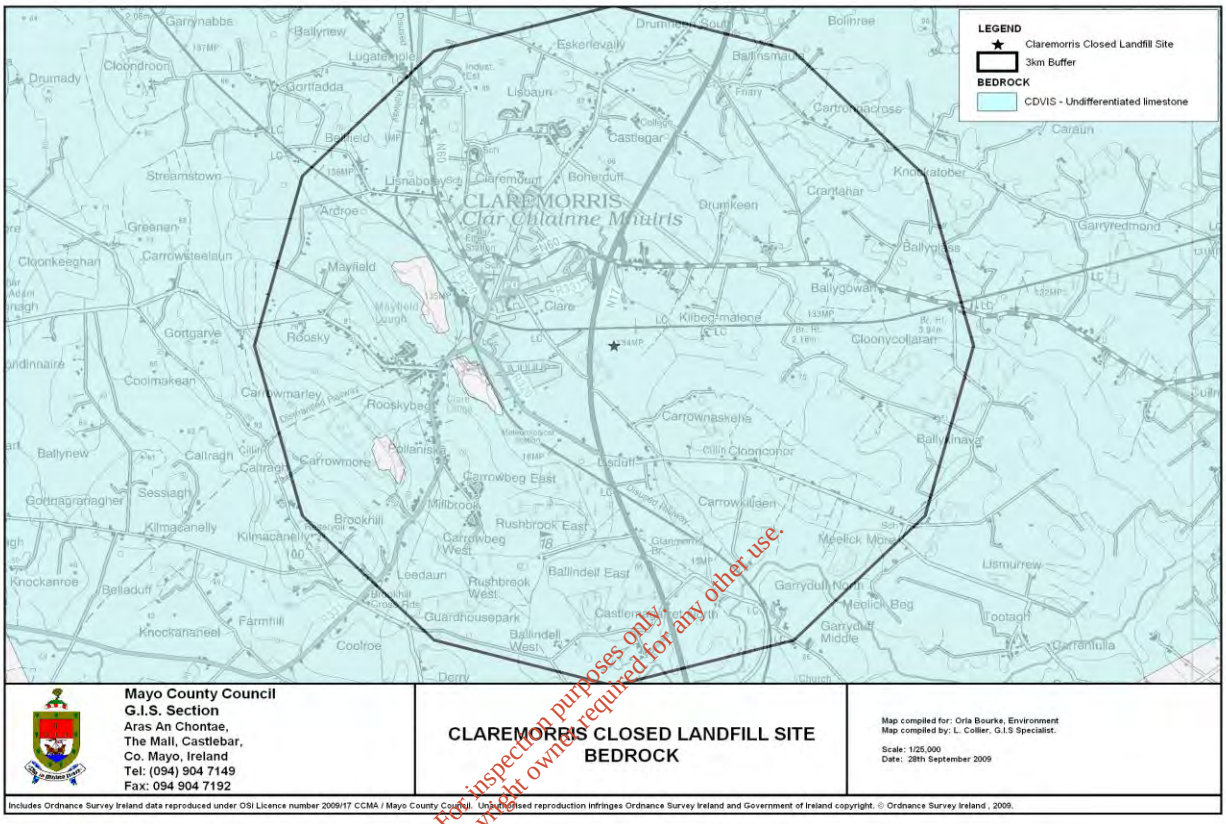
Site Name	Claremorris Historic Landfill		
Item	Number	Estimate	Item Cost
Trial Pits & Trenches	6	**750**	€4,500
Waste Sampling	6	**330**	€1,980
Leachate Sampling	5	**575**	€2,875
Soil Sampling	3	**175**	€525
Groundwater Sampling	3	**350**	€1,050
Topographic Survey	1	**1500**	€1,500
Site Supervision & Field Sampling	1	**900**	€900
Reporting	1	**3000**	€3,000
			€16,330
Air Rotary Open or Cored Hole	3	**3500**	€10,500
Gas Monitoring Or Sampling	1	**1100**	€1,100
Leachate Sampling	3	**575**	€1,725
Surface Water Sampling	2	**375**	€750
			€14,075
		Total	**€30,405**

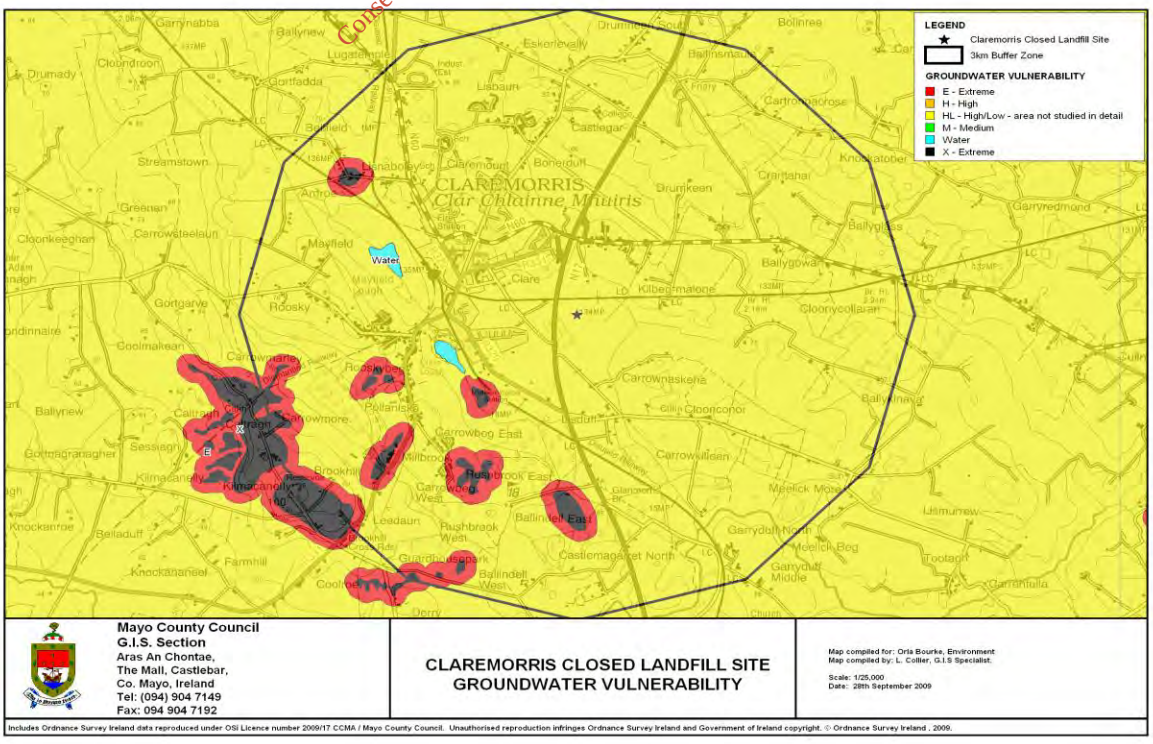
Trial Hole Locations

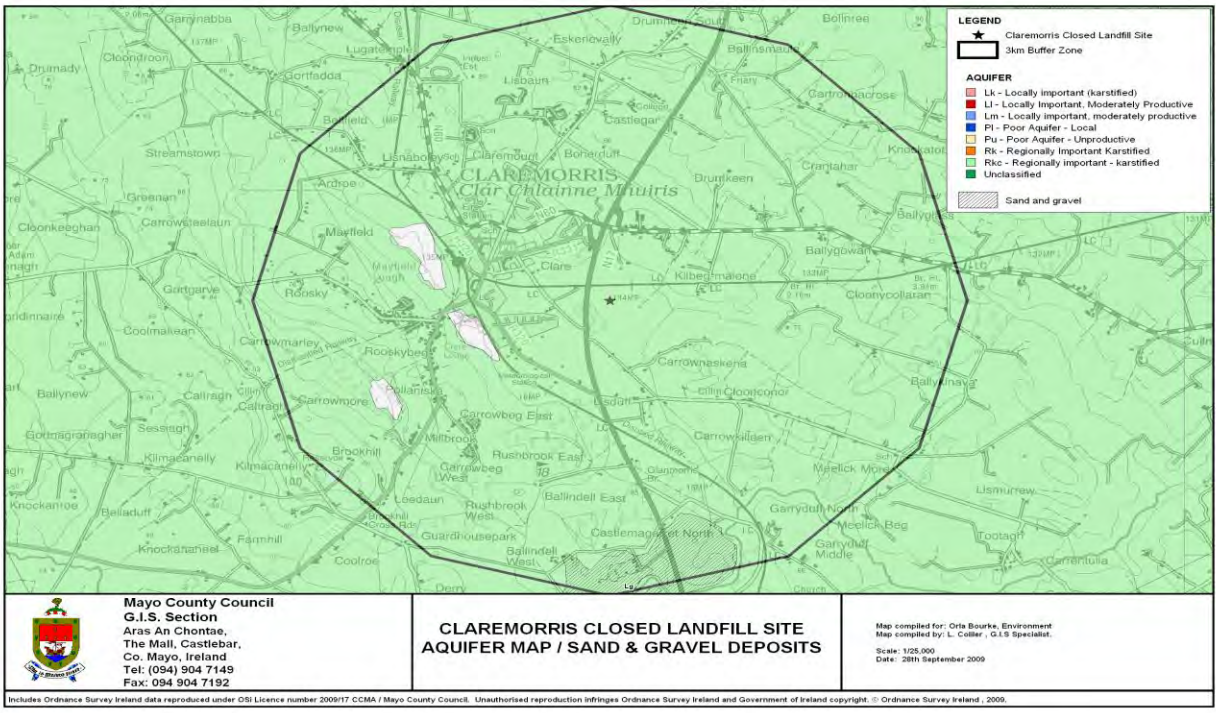
Surface Water Sampling

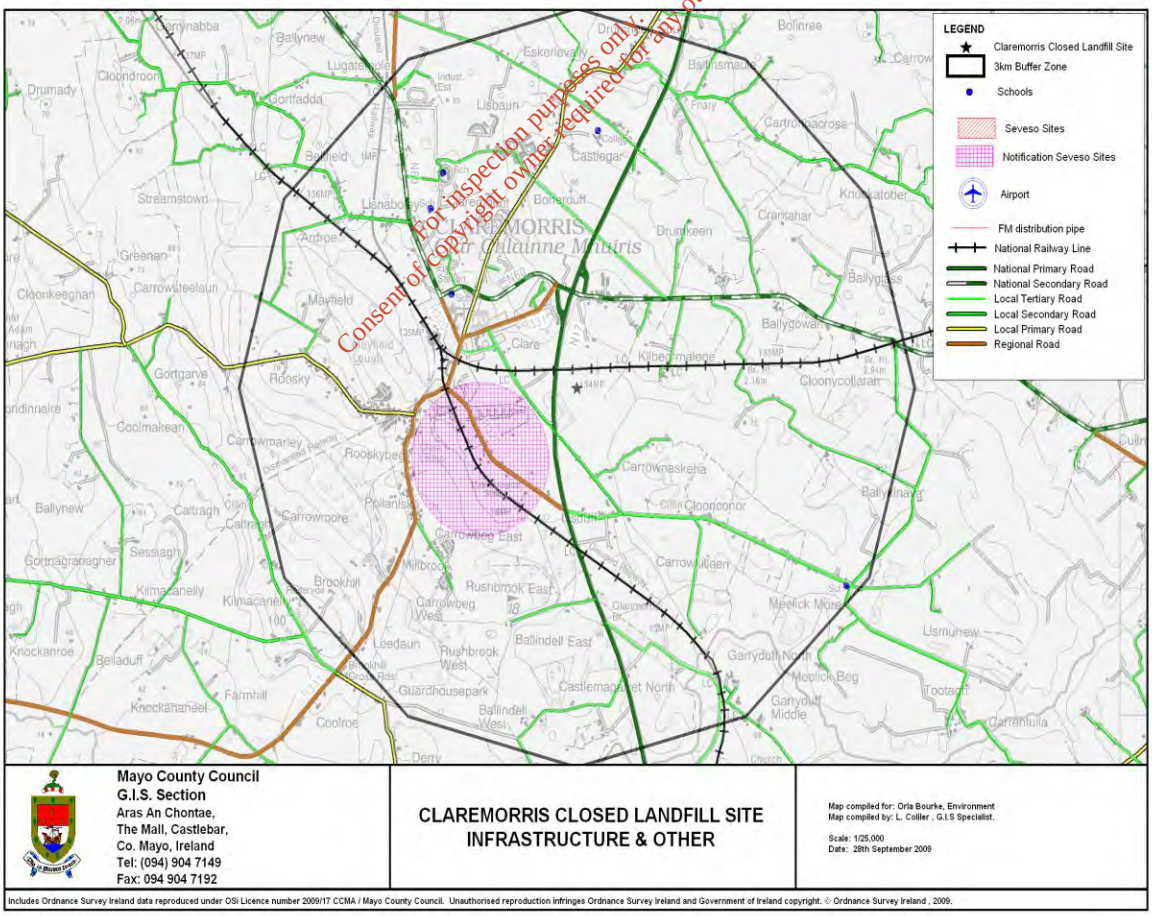


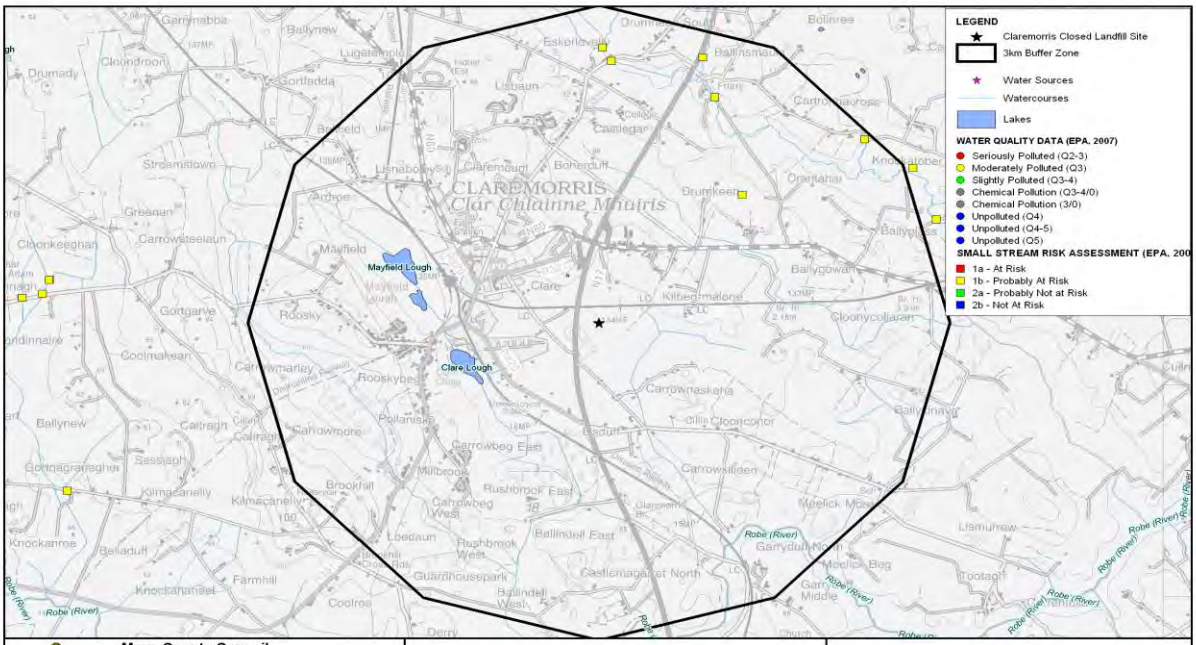
Risk Maps











Mayo County Council
G.I.S. Section
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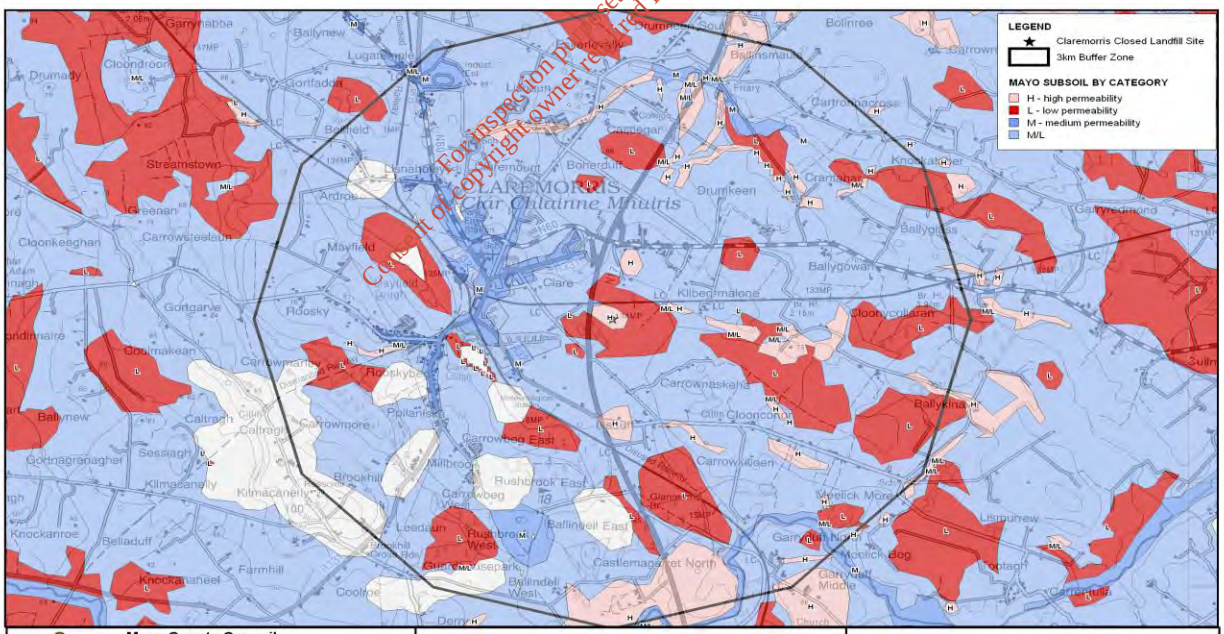
CLOSED LANDFILL SITE - CLAREMORRIS WATER RESOURCES

Map compiled for: Orla Bourke, Environment
Map compiled by: L. Collier, G.I.S Specialist.

Scale: 1/25,000
Date: 28th September 2009



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CLAREMORRIS CLOSED LANDFILL SITE SUBSOIL PERMEABILITY

Map compiled for: Orla Bourke, Environment
Map compiled by: L. Collier, G.I.S Specialist.

Scale: 1/25,000
Date: 28th September 2009

FEHILY TIMONEY
30 YEARS

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ENVIRONMENTAL SCIENCE & PLANNING

APPENDIX 2

JSDrilling Site Investigation Report

Claremorris Unregulated Landfill,

Site Investigation,

Co. Mayo

Mayo County Council

24 January 2011

J S DRILLING
Environmental, Geotechnical & Geothermal Contractors

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Contents

Introduction

JS Drilling is pleased to present this report summarising the site investigation carried out at a former unregulated waste disposal site in Claremorris Co. Mayo. The site investigation was carried out from the 25th-26th November 2010.

The objectives of the site investigation were to determine depth and lateral extent of waste deposited in the site and to collect samples of the waste encountered in order to characterise the waste body.

Scope of works

The following scope of works was derived by Mayo County Council and carried out by JS Drilling between the 25th and 26th of November 2010.

- Drilling of two (2) boreholes BH01 and BH02 to 4m and 6.3m respectively;
- Excavation of seven (7) trial pits to the full depth of the waste body where possible. Where it was not possible to determine the base of waste body trial pits were excavated to the working limit of the tracked excavator 6-6.5m below ground level
- Insitu monitoring of landfill gas using portable Landfill gas meter GA94
- Collection of soil / waste samples during drilling/trial pitting;
- Conversion of the two (2) boreholes to 50mm diameter groundwater/ leachate wells;
- Collection of groundwater / leachate samples from each of the monitoring wells;

Methodology

Onsite investigations

Boreholes and Monitoring Well Installation

Two (2) no. boreholes were drilled on the site using window sampling drilling methods. One borehole was drilled through the waste body (BH01) and into the underlying natural subsoil. One borehole was drilled on the periphery of the site down gradient of the landfill site into natural ground (BH02).

The two (2) boreholes were converted to monitoring wells. BH01 was converted to a 50 mm diameter leachate monitoring well and BH02 drilled on the periphery of the site was converted to a 50 mm diameter groundwater monitoring well.

After installation the monitoring wells were developed so that any materials introduced during drilling were removed. Monitoring wells were finished using upright metal covers. Borehole and monitoring well logs can be seen as Appendix 2.

Trial Pitting

In order to characterise the waste body and assess for the presence of hazardous waste materials seven (7) no. trial pits TP01, TP02, TP03, TP04, TP05, TP06 and TP07 were excavated on an approximate 80m grid according to the map and GPS positions provided by Mayo County Council. It was attempted to excavate the trial pits through the waste body however in 4 of the 7 trial pits, TP06, TP04, TP02 and TP01 the depth of waste exceeded the maximum excavation limit of the tracked excavator.

Each trial pit was one excavator bucket in width (approximately 1m) and approximately 3m in length. Each trial pit was logged and photographed and types of waste types encountered were noted and photographed and evidence of age of waste was recorded. Trial pits were backfilled upon completion. The location of each trial pit was recorded using a GPS. Trial pit logs can be seen as Appendix 2.

Slit trenches

In order to determine the lateral extent of the waste body slit trenches were excavated along the edge of the landfill. Seven (7) slit trenches ST1, ST2, ST3, ST4, ST5, ST6 and

ST7 were excavated and their location recorded using a hand held GPS. Slit trenches were photographed by the field engineer. Slit trench logs can be seen as Appendix 2.

Onsite observations

Trial Pitting

Of the seven (7) no. trial pits excavated on site, three (3) no., TP03 (6.4m), TP07 (5.5m), TP05 (4.5m) were excavated into natural ground. Due to a greater than estimated depth of waste and poor ground conditions the other four (4) trial pits TP01 (6.4m), TP02 (6.5m), TP04 (5.5m) and TP06 (6.5m) were advanced to the maximum reach of the tracked excavator taking into account varying ground conditions on the site.

Depth of waste varied across the site from 4.0m depth in TP05 to in excess of 6.5m in TP02 and TP06.

Slit trenches

The slit trenches excavated around the periphery of the site located the edge of the waste in all but one ST3 which had waste 3m deep. BH02 was drilled approximately 30m south of this slit trench and waste appears to be tapering to 0.8m at this location indicating the edge of the waste.

Sample Collection and analysis

Soil /Waste samples

Soil samples were collected during drilling at nominal depths of 0.25m 2.0m, 4.0m and 6.0m bgl.

Soil / waste samples were collected during trial pitting at nominal depths of 0.25m, 2.0m, 4.0m and 6.0m bgl.

Sample selection was based on inspection of soil/ waste for visual and olfactory evidence of contamination.

Groundwater sampling

Leachate and groundwater samples were collected from MW01 and MW02 respectively on the 02 December 2010.

A slight odour was noted from the groundwater sample MW02 which could possibly be attributed to the presence of peat as the underlying strata. The water was brown and murky and cleared slightly after purging 3 well volumes.

A strong pungent odour was noted from the black leachate sample collected from MW01. Leachate did not change in odour or colour after purging.

The sample containers were labelled with a unique number and placed in a cooler box for transportation to STL laboratories in the UK, time sensitive analysis (BOD, COD and faecal coliforms in the groundwater) was carried out in local lab CLS laboratories in Galway. The field engineer recorded the sample collection location using a GPS, the sample depth and the sample number. Laboratory results can be seen as appendix 1.

Laboratory Results

Results of laboratory analysis of waste samples are summarised in table 1 below. Water and leachate analysis is summarised in table 2 and particle size distribution and moisture content of material underlying the waste body can be seen in Appendix 1.

Table 1 Waste sample analysis

Analysis				*Landfill Waste Acceptance Criteria* BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1		
Liquid:Waste Ratio	10:1	10:01	10:01			
Sample ID	TP01 4m	TP02 4m	TP03 3m			
pH	7.24	7.46	7.17	*Inert Waste*	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
Temperature °C	21	21	21			
Conductivity uS/cm	736	1376	632			
	mg/Kg	mg/Kg	mg/Kg			
Arsenic as As	<0.050	<0.050	<0.050	0.5	2	25
Barium as Ba	0.52	0.4	0.29	20	100	300
Cadmium as Cd	<0.0010	<0.0010	<0.0010	0.04	1	5
Chromium as Cr	<0.025	<0.025	<0.025	0.5	10	70
Copper as Cu	<0.10	<0.10	<0.10	2	50	100
Mercury as Hg	<0.0050	<0.0050	<0.0050	0.01	0.2	2
Molybdenum as Mo	<0.020	<0.020	0.05	0.5	10	30
Nickel as Ni	<0.20	<0.20	<0.20	0.4	10	40
Lead as Pb	<0.10	<0.10	<0.10	0.5	10	50
Antimony as Sb	<0.060	<0.060	<0.060	0.06	0.7	5
Selenium as Se	<0.10	<0.10	<0.10	0.1	0.5	7
Zinc as Zn	<0.25	<0.25	<0.25	4	50	200
Chloride as Cl	510	800	170	800	15000	25000
Fluoride as F	2	<2.0	<2.0	10	150	500
Sulphate as SO4	1700	4200	2100	1000	20000	50000
Total Dissolved Solids (TDS)	4200	9700	4600	4000	60000	100000
Phenol Index	<1.5	<1.5	<1.5	1		
Dissolved Organic Carbon (DOC)	170	580	240	500	800	1000
Total Organic Carbon w/w %	10	9.9	7.1	3%	5%	6%
Loss on Ignition %	13	19	16			10%
BTEX mg/Kg				6		
PCBs (7 congeners) mg/Kg	0.045	<0.010	<0.010	1		
Mineral Oil (C10-C40) mg/Kg	540	1000	220	500		
PAHs mg/Kg	5	3.2	1.5	100		
pH	7.8	7.9	8		>6	
Acid Neutralisation Capacity (pH4) mol/Kg	0.029	0.03	0.03		To be evaluated	To be evaluated
Acid Neutralisation Capacity (pH7) mol/Kg	0.0058	0.0046	0.0081		To be evaluated	To be evaluated
Additional Waste Analysis						
Conductivity @ 20 C uS/cm	1100	3200	1100			
Benzene mg/kg	<0.10	<0.10	<0.10			
Toluene mg/kg	<0.10	<0.10	<0.10			
Ethylbenzene mg/kg	<0.10	<0.10	<0.10			
m&p-Xylene mg/kg	<0.20	<0.20	<0.20			
o-Xylene mg/kg	<0.10	<0.10	<0.10			

Table 1 contd: Waste sample analysis

Analysis				***Landfill Waste Acceptance Criteria*** *BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1*		
Liquid:Waste Ratio	**10:01**	**10:01**	**10:01**			
Sample ID	TP04 4m	TP05 3.5m	TP06 4m			
pH	7.56	7.63	7.83	***Inert Waste***	***Stable Non-Reactive hazardous waste in non-hazardous***	***Hazardous Waste***
Temperature °C	21	21	21			
Conductivity uS/cm	1189	1535	2670			
	mg/Kg	**mg/Kg**	**mg/Kg**			
Arsenic as As	**<0.050**	**<0.050**	**<0.050**	*0.5*	*2*	*25*
Barium as Ba	**0.62**	**0.33**	**0.2**	*20*	*100*	*300*
Cadmium as Cd	**<0.0010**	**<0.0010**	**<0.0010**	*0.04*	*1*	*5*
Chromium as Cr	**<0.025**	**<0.025**	**<0.025**	*0.5*	*10*	*70*
Copper as Cu	**<0.10**	**0.14**	**0.35**	*2*	*50*	*100*
Mercury as Hg	**<0.0050**	**<0.0050**	**<0.0050**	*0.01*	*0.2*	*2*
Molybdenum as Mo	**<0.020**	**0.08**	**0.65**	*0.5*	*10*	*30*
Nickel as Ni	**<0.20**	**<0.20**	**0.22**	*0.4*	*10*	*40*
Lead as Pb	**<0.10**	**<0.10**	**<0.10**	*0.5*	*10*	*50*
Antimony as Sb	**<0.060**	**<0.060**	**0.08**	*0.06*	*0.7*	*5*
Selenium as Se	**<0.10**	**<0.10**	**<0.10**	*0.1*	*0.5*	*7*
Zinc as Zn	**<0.25**	**<0.25**	**0.76**	*4*	*50*	*200*
Chloride as Cl	**470**	**550**	**3600**	*800*	*15000*	*25000*
Fluoride as F	**<2.0**	**<2.0**	**<2.0**	*10*	*150*	*500*
Sulphate as SO4	**4400**	**5100**	**4800**	*1000*	*20000*	*50000*
Total Dissolved Solids (TDS)	**8400**	**9600**	**16000**	*4000*	*60000*	*100000*
Phenol Index	**<1.5**	**<1.5**	**<1.5**	*1*		
Dissolved Organic Carbon (DOC)	**270**	**320**	**1100**	*500*	*800*	*1000*
Total Organic Carbon w/w %	**12**	**10**	**19**	*3%*	*5%*	*6%*
Loss on Ignition %	**20**	**26**	**37**			*10%*
BTEX mg/Kg				*6*		
PCBs (7 congeners) mg/Kg	**<0.010**	**<0.010**	**<0.010**	*1*		
Mineral Oil (C10-C40) mg/Kg	**170**	**780**	**310**	*500*		
PAHs mg/Kg	**7.3**	**7.4**	**4.3**	*100*		
pH	**7.8**	**7.9**	**8**		*>6*	
Acid Neutralisation Capacity (pH4) mol/Kg	**0.043**	**0.039**	**0.069**		*To be evaluated*	*To be evaluated*
Acid Neutralisation Capacity (pH7) mol/Kg	**0.0052**	**0.0045**	**0.013**		*To be evaluated*	*To be evaluated*
Additional Waste Analysis						
Conductivity @ 20 C uS/cm	**400**	**3000**	**<100**			
Benzene mg/kg	**<0.10**	**<0.10**	**<0.10**			
Toluene mg/kg	**<0.10**	**<0.10**	**<0.10**			
Ethylbenzene mg/kg	**<0.10**	**<0.10**	**<0.10**			
m&p-Xylene mg/kg	**<0.20**	**<0.20**	**<0.20**			
o-Xylene mg/kg	**<0.10**	**<0.10**	**<0.10**			

Table 2. Groundwater and leachate results

		Sample ID	
Analysis	Units	Groundwater	Leachate
BOD	mg/l	28	2972
COD	mg/l	482	6160
Faecal coliforms	cfu/100ml	<1	-
Total coliforms	cfu/100ml	6,800	-

Conclusions

The extent and nature of the waste body was determined during the site investigation. Seven no. slit trenches determined the lateral extent of the landfill. Trial pits excavated into the waste body were logged and photographed and determined that the waste body is in excess of 6.5 m in 4 of the 7 locations excavated. Representative samples were collected from the trial pits and sent for leachability analysis in accordance with BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1.

Limitations

JSDrilling prepared this report for the sole use of Mayo County Council. This report is intended to assist Mayo County Council in understanding the ground conditions in relation to the Claremorris Historic Landfill. Field investigations carried out by JSDrilling were restricted to a level of detail appropriate to the presented assessment. It is important that these limitations be clearly recognised when the findings of this report are being interpreted.

To the best of our knowledge information contained in this report is accurate at the time of issue. Subsurface conditions may vary with time. This should be borne in mind if the report is used without further confirmatory testing after significant delay.

APPENDIX 1

STL, CLS and Testconsult Laboratory analysis results

Waste Acceptance Criteria Testing BS EN 12457
Part 2, Single Stage Process
Issue 1

Sample Details		Test Values	
Sample Number	12125259	Mass of Raw Test Portion (MW) kg	0.092
Job Number	743509	Mass of Dried Test Portion (MD) kg	0.09
Sample ID	TP01 @ 4m	Moisture Content Ratio (MC) %	1.76
Site	Claremorris Landfill	Dry Matter Content Ratio (DR) %	98.27
Job Description	Waste Acceptance Criteria	Moisture Content @ 105c	1.7
Date Sampled	26/11/2010	Leachant Volume (L) Litre	0.898
Date Received	08/12/2010	Eluate Volume (VE) Litre	0.821
Particle Size (<4mm)	>95%		
Method of size reduction	Jaw Crusher.		
Non-crushable matter	1.68g		

Eluate Analysis	Concentration in Eluate	Amount Leached	*Landfill Waste Acceptance Criteria*		
Liquid:Waste Ratio	10:1	10:1	*BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1*		
Sample Number	12125260				
pH	7.24		*Inert Waste*	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
Temperature °C	21				
Conductivity uS/cm	736				
	mg/l	mg/Kg			
Arsenic as As	<0.0050	<0.050	0.5	2	25
Barium as Ba	0.052	0.52	20	100	300
Cadmium as Cd	<0.00010	<0.0010	0.04	1	5
Chromium as Cr	<0.0025	<0.025	0.5	10	70
Copper as Cu	<0.010	<0.10	2	50	100
Mercury as Hg	<0.00050	<0.0050	0.01	0.2	2
Molybdenum as Mo	<0.0020	<0.020	0.5	10	30
Nickel as Ni	<0.020	<0.20	0.4	10	40
Lead as Pb	<0.010	<0.10	0.5	10	50
Antimony as Sb	<0.0060	<0.060	0.06	0.7	5
Selenium as Se	<0.010	<0.10	0.1	0.5	7
Zinc as Zn	<0.025	<0.25	4	50	200
Chloride as Cl	50.5	510	800	15000	25000
Fluoride as F	0.2	2	10	150	500
Sulphate as SO4	167	1700	1000	20000	50000
Total Dissolved Solids (TDS)	424	4200	4000	60000	100000
Phenol Index	<0.15	<1.5	1		
Dissolved Organic Carbon (DOC)	17.1	170	500	800	1000
Waste Analysis					
Total Organic Carbon w/w %		10	3%	5%	6%
Loss on Ignition %		13			10%
BTEX mg/Kg			6		
PCBs (7 congeners) mg/Kg		0.045	1		
Mineral Oil (C10-C40) mg/Kg		540	500		
PAHs mg/Kg		5	100		
pH		7.8		>6	
Acid Neutralisation Capacity (pH4) mol/Kg		0.029		To be evaluated	To be evaluated
Acid Neutralisation Capacity (pH7) mol/Kg		0.0058		To be evaluated	To be evaluated

Disclaimer: Eluate concentrations below the detection limit are assumed to be negligible when calculating mg/kg values. The limits quoted for Waste Acceptance are derived from the Landfill (England and Wales) Regulations 2002 (as amended) and are provided as guidance only. STS does not take responsibility for any errors or omissions with regard to these limits.

Additional Eluate Analysis	Concentration in Eluate	Amount Leached
	10:1	10:1
	mg/l	mg/Kg

Additional Waste Analysis	Units	Result
Conductivity @ 20 C	uS/cm	1100
Benzene	mg/kg	<0.10
Toluene	mg/kg	<0.10
Ethylbenzene	mg/kg	<0.10
m&p-Xylene	mg/kg	<0.20
o-Xylene	mg/kg	<0.10

Sample Comments	
12125259	Stainless steel sieve used.
12125259	Method 327 VOC HS Soils, low surrogate standard recovery due to the nature of
12125260	

Waste Acceptance Criteria Testing BS EN 12457
Part 2, Single Stage Process
Issue 1

Sample Details		Test Values	
Sample Number	12125262	Mass of Raw Test Portion (MW) kg	0.094
Job Number	743509	Mass of Dried Test Portion (MD) kg	0.09
Sample ID	TP02 @ 4m	Moisture Content Ratio (MC) %	4.02
Site	Claremorris Landfill	Dry Matter Content Ratio (DR) %	96.14
Job Description	Waste Acceptance Criteria	Moisture Content @ 105c	3.9
Date Sampled	26/11/2010	Leachant Volume (L) Litre	0.896
Date Received	08/12/2010	Eluate Volume (VE) Litre	0.577
Particle Size (<4mm)	>95%		
Method of size reduction	Jaw Crusher.		
Non-crushable matter	2.73g		

Eluate Analysis	Concentration in Eluate	Amount Leached	Landfill Waste Acceptance Criteria		
Liquid:Waste Ratio	10:1	10:1	BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1		
Sample Number	12125263				
pH	7.46				
Temperature °C	21				
Conductivity uS/cm	1376				
			Inert Waste	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
	mg/l	mg/Kg			
Arsenic as As	<0.0050	**<0.050**	*0.5*	*2*	*25*
Barium as Ba	0.04	**0.4**	*20*	*100*	*300*
Cadmium as Cd	<0.00010	**<0.0010**	*0.04*	*1*	*5*
Chromium as Cr	<0.0025	**<0.025**	*0.5*	*10*	*70*
Copper as Cu	<0.010	**<0.10**	*2*	*50*	*100*
Mercury as Hg	<0.00050	**<0.0050**	*0.01*	*0.2*	*2*
Molybdenum as Mo	<0.0020	**<0.020**	*0.5*	*10*	*30*
Nickel as Ni	<0.020	**<0.20**	*0.4*	*10*	*40*
Lead as Pb	<0.010	**<0.10**	*0.5*	*10*	*50*
Antimony as Sb	<0.0060	**<0.060**	*0.06*	*0.7*	*5*
Selenium as Se	<0.010	**<0.10**	*0.1*	*0.5*	*7*
Zinc as Zn	<0.025	**<0.25**	*4*	*50*	*200*
Chloride as Cl	79.6	**800**	*800*	*15000*	*25000*
Fluoride as F	<0.2	**<2.0**	*10*	*150*	*500*
Sulphate as SO4	419	**4200**	*1000*	*20000*	*50000*
Total Dissolved Solids (TDS)	969	**9700**	*4000*	*60000*	*100000*
Phenol Index	<0.15	**<1.5**	*1*		
Dissolved Organic Carbon (DOC)	57.5	**580**	*500*	*800*	*1000*
Waste Analysis					
Total Organic Carbon w/w %		**9.9**	*3%*	*5%*	*6%*
Loss on Ignition %		**19**			*10%*
BTEX mg/Kg			*6*		
PCBs (7 congeners) mg/Kg		**<0.010**	*1*		
Mineral Oil (C10-C40) mg/Kg		**1000**	*500*		
PAHs mg/Kg		**3.2**	*100*		
pH		**7.9**		*>6*	
Acid Neutralisation Capacity (pH4) mol/Kg		**0.03**		*To be evaluated*	*To be evaluated*
Acid Neutralisation Capacity (pH7) mol/Kg		**0.0046**		*To be evaluated*	*To be evaluated*

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Additional Eluate Analysis	Concentration in Eluate	Amount Leached
	10:1	10:1
	mg/l	mg/Kg

Additional Waste Analysis	Units	Result
Conductivity @ 20 C	uS/cm	**3200**
Benzene	mg/kg	**<0.10**
Toluene	mg/kg	**<0.10**
Ethylbenzene	mg/kg	**<0.10**
m&p-Xylene	mg/kg	**<0.20**
o-Xylene	mg/kg	**<0.10**

Sample Comments	
12125262	Stainless steel sieve used.
12125262	Method 327 VOC HS Soils, low surrogate standard recovery due to the nature of
12125263	

Waste Acceptance Criteria Testing BS EN 12457
Part 2, Single Stage Process
Issue 1

Sample Details		Test Values	
Sample Number	12125265	Mass of Raw Test Portion (MW) kg	0.099
Job Number	743509	Mass of Dried Test Portion (MD) kg	0.09
Sample ID	TP03 @ 3m	Moisture Content Ratio (MC) %	10.17
Site	Claremorris Landfill	Dry Matter Content Ratio (DR) %	90.77
Job Description	Waste Acceptance Criteria	Moisture Content @ 105c	9.2
Date Sampled	26/11/2010	Leachant Volume (L) Litre	0.891
Date Received	08/12/2010	Eluate Volume (VE) Litre	0.837
Particle Size (<4mm)	>95%		
Method of size reduction	Jaw Crusher.		
Non-crushable matter	2.32g		

Eluate Analysis	Concentration in Eluate	Amount Leached	*Landfill Waste Acceptance Criteria*		
Liquid:Waste Ratio	10:1	10:1	*BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1*		
Sample Number	12125266				
pH	7.17		*Inert Waste*	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
Temperature °C	21				
Conductivity uS/cm	632				
	mg/l	mg/Kg			
Arsenic as As	<0.0050	<0.050	0.5	2	25
Barium as Ba	0.029	0.29	20	100	300
Cadmium as Cd	<0.00010	<0.0010	0.04	1	5
Chromium as Cr	<0.0025	<0.025	0.5	10	70
Copper as Cu	<0.010	<0.10	2	50	100
Mercury as Hg	<0.00050	<0.0050	0.01	0.2	2
Molybdenum as Mo	0.005	0.05	0.5	10	30
Nickel as Ni	<0.020	<0.20	0.4	10	40
Lead as Pb	<0.010	<0.10	0.5	10	50
Antimony as Sb	<0.0060	<0.060	0.06	0.7	5
Selenium as Se	<0.010	<0.10	0.1	0.5	7
Zinc as Zn	<0.025	<0.26	4	50	200
Chloride as Cl	16.8	170	800	15000	25000
Fluoride as F	<0.2	<2.0	10	150	500
Sulphate as SO4	205	2100	1000	20000	50000
Total Dissolved Solids (TDS)	455	4600	4000	60000	100000
Phenol Index	<0.15	<1.5	1		
Dissolved Organic Carbon (DOC)	24.2	240	500	800	1000
Waste Analysis					
Total Organic Carbon w/w %		7.1	3%	5%	6%
Loss on Ignition %		16			10%
BTEX mg/Kg			6		
PCBs (7 congeners) mg/Kg		<0.010	1		
Mineral Oil (C10-C40) mg/Kg		220	500		
PAHs mg/Kg		1.5	100		
pH		8		>6	
Acid Neutralisation Capacity (pH4) mol/Kg		0.03		To be evaluated	To be evaluated
Acid Neutralisation Capacity (pH7) mol/Kg		0.0081		To be evaluated	To be evaluated

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Additional Eluate Analysis	Concentration in Eluate	Amount Leached
	10:1	10:1
	mg/l	mg/Kg

Additional Waste Analysis	Units	Result
Conductivity @ 20 C	uS/cm	1100
Benzene	mg/kg	<0.10
Toluene	mg/kg	<0.10
Ethylbenzene	mg/kg	<0.10
m&p-Xylene	mg/kg	<0.20
o-Xylene	mg/kg	<0.10

Sample Comments	
12125265	Stainless steel sieve used.
12125265	Method 327 VOC HS Soils, low surrogate standard recovery due to the nature of
12125266	

Waste Acceptance Criteria Testing BS EN 12457
Part 2, Single Stage Process
Issue 1

Sample Details		Test Values	
Sample Number	12125268	Mass of Raw Test Portion (MW) kg	0.094
Job Number	743509	Mass of Dried Test Portion (MD) kg	0.09
Sample ID	TP04 @ 4m	Moisture Content Ratio (MC) %	4.14
Site	Claremorris Landfill	Dry Matter Content Ratio (DR) %	96.02
Job Description	Waste Acceptance Criteria	Moisture Content @ 105c	4
Date Sampled	25/11/2010	Leachant Volume (L) Litre	0.896
Date Received	08/12/2010	Eluate Volume (VE) Litre	0.556
Particle Size (<4mm)	>95%		
Method of size reduction	Jaw Crusher.		
Non-crushable matter	15.36g		

Eluate Analysis	Concentration in Eluate	Amount Leached	*Landfill Waste Acceptance Criteria*		
Liquid:Waste Ratio	10:1	10:1	*BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1*		
Sample Number	12125269				
pH	7.56		*Inert Waste*	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
Temperature °C	21				
Conductivity uS/cm	1189				
	mg/l	mg/Kg			
Arsenic as As	<0.0050	**<0.050**	*0.5*	*2*	*25*
Barium as Ba	0.062	**0.62**	*20*	*100*	*300*
Cadmium as Cd	<0.00010	**<0.0010**	*0.04*	*1*	*5*
Chromium as Cr	<0.0025	**<0.025**	*0.5*	*10*	*70*
Copper as Cu	<0.010	**<0.10**	*2*	*50*	*100*
Mercury as Hg	<0.00050	**<0.0050**	*0.01*	*0.2*	*2*
Molybdenum as Mo	<0.0020	**<0.020**	*0.5*	*10*	*30*
Nickel as Ni	<0.020	**<0.20**	*0.4*	*10*	*40*
Lead as Pb	<0.010	**<0.10**	*0.5*	*10*	*50*
Antimony as Sb	<0.0060	**<0.060**	*0.06*	*0.7*	*5*
Selenium as Se	<0.010	**<0.10**	*0.1*	*0.5*	*7*
Zinc as Zn	<0.025	**<0.25**	*4*	*50*	*200*
Chloride as Cl	47.3	**470**	*800*	*15000*	*25000*
Fluoride as F	<0.2	**<2.0**	*10*	*150*	*500*
Sulphate as SO4	438	**4400**	*1000*	*20000*	*50000*
Total Dissolved Solids (TDS)	838	**8400**	*4000*	*60000*	*100000*
Phenol Index	<0.15	**<1.5**	*1*		
Dissolved Organic Carbon (DOC)	26.8	**270**	*500*	*800*	*1000*
Waste Analysis					
Total Organic Carbon w/w %		**12**	*3%*	*5%*	*6%*
Loss on Ignition %		**20**			*10%*
BTEX mg/Kg			*6*		
PCBs (7 congeners) mg/Kg		**<0.010**	*1*		
Mineral Oil (C10-C40) mg/Kg		**170**	*500*		
PAHs mg/Kg		**7.3**	*100*		
pH		**7.8**		*>6*	
Acid Neutralisation Capacity (pH4) mol/Kg		**0.043**		*To be evaluated*	*To be evaluated*
Acid Neutralisation Capacity (pH7) mol/Kg		**0.0052**		*To be evaluated*	*To be evaluated*

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Additional Eluate Analysis	Concentration in Eluate	Amount Leached
	10:1	10:1
	mg/l	mg/Kg

Additional Waste Analysis	Units	Result
Conductivity @ 20 C	uS/cm	**400**
Benzene	mg/kg	**<0.10**
Toluene	mg/kg	**<0.10**
Ethylbenzene	mg/kg	**<0.10**
m&p-Xylene	mg/kg	**<0.20**
o-Xylene	mg/kg	**<0.10**

Sample Comments	
12125268	Stainless steel sieve used.
12125268	Method 327 VOC HS Soils, low surrogate standard recovery due to the nature of
12125269	

Waste Acceptance Criteria Testing BS EN 12457
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Sample Details		Test Values	
Sample Number	12125271	Mass of Raw Test Portion (MW) kg	0.109
Job Number	743509	Mass of Dried Test Portion (MD) kg	0.09
Sample ID	TP05 @ 3.5m	Moisture Content Ratio (MC) %	21.31
Site	Claremorris Landfill	Dry Matter Content Ratio (DR) %	82.43
Job Description	Waste Acceptance Criteria	Moisture Content @ 105c	18
Date Sampled	26/11/2010	Leachant Volume (L) Litre	0.881
Date Received	08/12/2010	Eluate Volume (VE) Litre	0.626
Particle Size (<4mm)	>95%		
Method of size reduction	Jaw Crusher.		
Non-crushable matter	1.41g		

Eluate Analysis	Concentration in Eluate	Amount Leached	*Landfill Waste Acceptance Criteria*		
Liquid:Waste Ratio	10:1	10:1	*BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1*		
Sample Number	12125272				
pH	7.63		*Inert Waste*	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
Temperature °C	21				
Conductivity uS/cm	1535				
	mg/l	mg/Kg			
Arsenic as As	<0.0050	**<0.050**	*0.5*	*2*	*25*
Barium as Ba	0.033	**0.33**	*20*	*100*	*300*
Cadmium as Cd	<0.00010	**<0.0010**	*0.04*	*1*	*5*
Chromium as Cr	<0.0025	**<0.025**	*0.5*	*10*	*70*
Copper as Cu	0.014	**0.14**	*2*	*50*	*100*
Mercury as Hg	<0.00050	**<0.0050**	*0.01*	*0.2*	*2*
Molybdenum as Mo	0.008	**0.08**	*0.5*	*10*	*30*
Nickel as Ni	<0.020	**<0.20**	*0.4*	*10*	*40*
Lead as Pb	<0.010	**<0.10**	*0.5*	*10*	*50*
Antimony as Sb	<0.0060	**<0.060**	*0.06*	*0.7*	*5*
Selenium as Se	<0.010	**<0.10**	*0.1*	*0.5*	*7*
Zinc as Zn	<0.025	**<0.25**	*4*	*50*	*200*
Chloride as Cl	55.3	**550**	*800*	*15000*	*25000*
Fluoride as F	<0.2	**<2.0**	*10*	*150*	*500*
Sulphate as SO4	513	**5100**	*1000*	*20000*	*50000*
Total Dissolved Solids (TDS)	963	**9600**	*4000*	*60000*	*100000*
Phenol Index	<0.15	**<1.5**	*1*		
Dissolved Organic Carbon (DOC)	32	**320**	*500*	*800*	*1000*
Waste Analysis					
Total Organic Carbon w/w %		**10**	*3%*	*5%*	*6%*
Loss on Ignition %		**26**			*10%*
BTEX mg/Kg			*6*		
PCBs (7 congeners) mg/Kg		**<0.010**	*1*		
Mineral Oil (C10-C40) mg/Kg		**780**	*500*		
PAHs mg/Kg		**7.4**	*100*		
pH		**7.9**		*>6*	
Acid Neutralisation Capacity (pH4) mol/Kg		**0.039**		*To be evaluated*	*To be evaluated*
Acid Neutralisation Capacity (pH7) mol/Kg		**0.0045**		*To be evaluated*	*To be evaluated*

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Additional Eluate Analysis	Concentration in Eluate	Amount Leached
	10:1	10:1
	mg/l	mg/Kg

Additional Waste Analysis	Units	Result
Conductivity @ 20 C	uS/cm	**3000**
Benzene	mg/kg	**<0.10**
Toluene	mg/kg	**<0.10**
Ethylbenzene	mg/kg	**<0.10**
m&p-Xylene	mg/kg	**<0.20**
o-Xylene	mg/kg	**<0.10**

Sample Comments	
12125271	Stainless steel sieve used.
12125271	Method 327 VOC HS Soils, low surrogate standard recovery due to the nature of
12125272	

Waste Acceptance Criteria Testing BS EN 12457
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SEVERN TRENT SERVICES

Sample Details		Test Values	
Sample Number	12125274	Mass of Raw Test Portion (MW) kg	0.101
Job Number	743509	Mass of Dried Test Portion (MD) kg	0.09
Sample ID	TP06 @ 4m	Moisture Content Ratio (MC) %	12.2
Site	Claremorris Landfill	Dry Matter Content Ratio (DR) %	89.13
Job Description	Waste Acceptance Criteria	Moisture Content @ 105c	11
Date Sampled	25/11/2010	Leachant Volume (L) Litre	0.889
Date Received	08/12/2010	Eluate Volume (VE) Litre	0.519
Particle Size (<4mm)	>95%		
Method of size reduction	Jaw Crusher.		
Non-crushable matter	7.58g		

Eluate Analysis	Concentration in Eluate	Amount Leached	Landfill Waste Acceptance Criteria		
Liquid:Waste Ratio	10:1	10:1	BS EN 12457-3 Limit Values (mg/Kg) at L:S 10:1		
Sample Number	12125275				
pH	7.83				
Temperature °C	21				
Conductivity uS/cm	2670				
			Inert Waste	*Stable Non-Reactive hazardous waste in non-hazardous*	*Hazardous Waste*
	mg/l	mg/Kg			
Arsenic as As	<0.0050	<0.050	*0.5*	*2*	*25*
Barium as Ba	0.02	0.2	*20*	*100*	*300*
Cadmium as Cd	<0.00010	<0.0010	*0.04*	*1*	*5*
Chromium as Cr	<0.0025	<0.025	*0.5*	*10*	*70*
Copper as Cu	0.035	0.35	*2*	*50*	*100*
Mercury as Hg	<0.00050	<0.0050	*0.01*	*0.2*	*2*
Molybdenum as Mo	0.065	0.65	*0.5*	*10*	*30*
Nickel as Ni	0.022	0.22	*0.4*	*10*	*40*
Lead as Pb	<0.010	<0.10	*0.5*	*10*	*50*
Antimony as Sb	0.008	0.08	*0.06*	*0.7*	*5*
Selenium as Se	<0.010	<0.10	*0.1*	*0.5*	*7*
Zinc as Zn	0.076	0.76	*4*	*50*	*200*
Chloride as Cl	357	3600	*800*	*15000*	*25000*
Fluoride as F	<0.2	<2.0	*10*	*150*	*500*
Sulphate as SO4	475	4800	*1000*	*20000*	*50000*
Total Dissolved Solids (TDS)	1550	16000	*4000*	*60000*	*100000*
Phenol Index	<0.15	<1.5	*1*		
Dissolved Organic Carbon (DOC)	113	1100	*500*	*800*	*1000*
Waste Analysis					
Total Organic Carbon w/w %		19	*3%*	*5%*	*6%*
Loss on Ignition %		37			*10%*
BTEX mg/Kg			*6*		
PCBs (7 congeners) mg/Kg		<0.010	*1*		
Mineral Oil (C10-C40) mg/Kg		310	*500*		
PAHs mg/Kg		4.3	*100*		
pH		8		*>6*	
Acid Neutralisation Capacity (pH4) mol/Kg		0.069		*To be evaluated*	*To be evaluated*
Acid Neutralisation Capacity (pH7) mol/Kg		0.013		*To be evaluated*	*To be evaluated*

Disclaimer: Eluate concentrations below the detection limit are assumed to be negligible when calculating mg/kg values. The limits quoted for Waste Acceptance are derived from the Landfill (England and Wales) Regulations 2002 (as amended) and are provided as guidance only. STS does not take responsibility for any errors or omissions with regard to these limits.

Additional Eluate Analysis	Concentration in Eluate	Amount Leached
	10:1	10:1
	mg/l	mg/Kg

Additional Waste Analysis	Units	Result
Conductivity @ 20 C	uS/cm	<100
Benzene	mg/kg	<0.10
Toluene	mg/kg	<0.10
Ethylbenzene	mg/kg	<0.10
m&p-Xylene	mg/kg	<0.20
o-Xylene	mg/kg	<0.10

Sample Comments	
12125274	Stainless steel sieve used.
12125274	Method 327 VOC HS Soils, low surrogate standard recovery due to the nature of
12125275	

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[web] www.completelabsolutions.com

Client	:	Ann Marie Ryan JS Drilling Ltd Thomastown Co Kilkenny	Report No. Date of Receipt Start Date of Analysis Date of Report Order Number Sample taken by	: 126112 : 03/12/2010 : 03/12/2010 : 14/12/2010 : : Client

CERTIFICATE OF ANALYSIS

Results				
Lab No	Sample Description	Test	Result	Units
290383	Leachate 2/12/10	BOD (sw)	2972	mg/l
		COD	6160	mg/l

Approved by: Barbara Lee

Barbara Lee
Environmental Scientist

See reverse for Test Specifications
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[web] www.completelabsolutions.com

Client :	Ann Marie Ryan JS Drilling Ltd Thomastown Co Kilkenny	Report No.	: 126111
		Date of Receipt	: 03/12/2010
		Start Date of Analysis	: 03/12/2010
		Date of Report	: 21/12/2010
		Order Number	:
		Sample taken by	: Client

CERTIFICATE OF ANALYSIS

Results				
Lab No	Sample Description	Test	Result	Units
290380	GW 1. 2/12/10	BOD (sw)	28	mg/l
		COD	482	mg/l
		Faecal Coliforms (Filtration)	< 1	cfu/100ml
		Total Coliforms (Filtration)	6,800	cfu/100ml

Approved by: Barbara Lee

Barbara Lee
Environmental Scientist

See reverse for Test Specifications
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Materials Laboratory, Clonminam Ind. Est., Portlaoise
Tel (057) 8664885 Fax (057) 8664380

UKAS TESTING
2528

LABORATORY TEST REPORT

Determination of Particle Size Distribution - BS 1377 : Part 2 : 1990

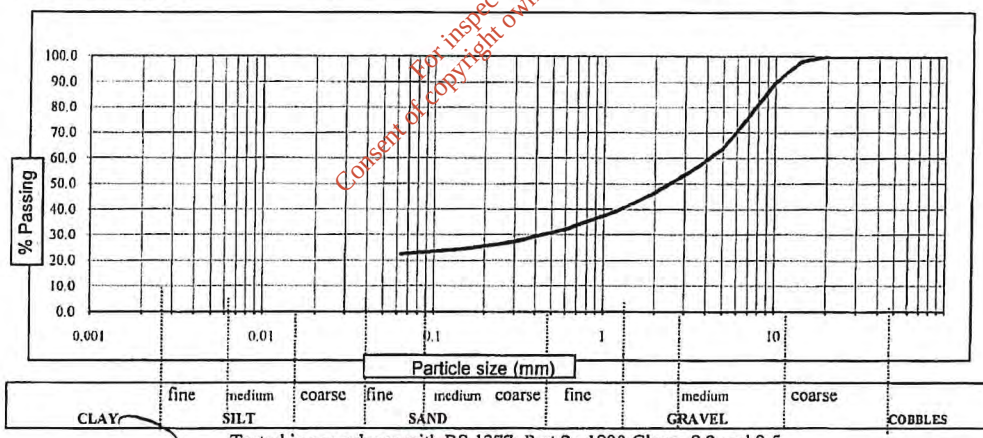
Project:	**JS Drilling**	**Job No:**	**PL 720**
Client:	**JS Drilling**	**Lab Ref No.:**	**ST 50724**
	Thomastown	**Date Received:**	**10/12/2010**
	Co. Kilkenny	**Date Reported:**	**20/12/2010**
		Material:	**Orange/brown SAND,**
Order No:	**N/A**	**Visual Description**	**fine rock deposits**
Originator:	**Jim Stephenson**	**Specification**	**NRA**

Client Ref.	Peat
Location:	Client Info.
Supplier:	Client Info.
Source:	Client Info.
Depth (m):	N/A
Sampling Reason:	Routine
Sampled By:	Client
Specification:	NRA
Preparation Method:	Organics Present

Additional Test Results

Moisture Content (%) 421.8

BS Sieve Size	% Passing	Specification
125 mm	100.0	
100 mm	100.0	
75 mm	100.0	
63 mm	100.0	
50 mm	100.0	
37.5 mm	100.0	
28 mm	100.0	
20 mm	100.0	
14 mm	97.9	
10 mm	89.6	
6.3 mm	72.0	
5 mm	63.9	
3.35 mm	55.4	
2 mm	46.4	
1.18 mm	39.1	
0.6 mm	32.2	
0.425 mm	29.7	
0.3 mm	27.2	
0.15 mm	24.4	
0.063 mm	22.4	



Tested in accordance with BS 1377: Part 2 : 1990 Clause 9.2 and 9.5
Sedimentation by Hydrometer, clause 9.5 - outside scope the of UKAS

Approved Signature
TESTCONSULT IRELAND LIMITED

☐ **Mark Dawkins, Managing Director;** ☐ **Michael Robinson, Director & Lab. Manager**
☑ **James Ward, Senior Technician**