8th November 2010

CELEBRATING 50 YEARS in 2010

TIER 2 ENVIRONMENTAL RISK ASSESSMENT

Carrigeen Former Landfill Site, Clane, Co. Kildare

Submitted to:
Environment Section
Kildare County Council
Áras Chill Dara
Devoy Park
Naas
Co. Kildare

REPORT

Report Number. 10507190201.500/A.0

Distribution:

Kildare County Council - 3 copies
Golder Associates Ireland Ltd - 1 copy

A world of capabilities delivered locally

Golder Associates

Table of Contents

TABLES

Figures

APPENDICES

1.0 INTRODUCTION

Kildare County Council (KCC) retained Golder Associates Ireland Ltd (Golder) in September 2010 to prepare a Tier 2 Environmental Risk Assessment of a former waste disposal site (ca. 1ha in size) located at Carrigeen, Clane, Co. Kildare (the Site). The purpose of this assessment is to provide information that allows an assessment to be made regarding the existence of possible significant pollutant linkages on-Site, which may lead to remediation measures having to be put in place.

A Tier 1 risk assessment was completed by Kildare County Council in May 2010. The findings of this assessment indicated that the Site was a Moderate Risk (Class B) and so a Tier 2 risk assessment was necessary.

This Tier 2 Risk Assessment is based on the following documents:

- Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007);
- Carrigeen Refuse Depot, Clane: Conceptual Site Model and Risk Assessment; and
- Letter with accompanying Bill of Quantities from Kildare County Council, 17 August 2010.

The Site layout and sampling locations are presented in Figure 01 (Appendix A).

2.0 SITE BACKGROUND

The Site at Carrigeen, Clane Co. Kildare was a former quarry (understood to be limestone) which spanned the four land parcels under investigation i.e. the waste ground, the eastern paddock, the southern paddock and the private residence and gardens (See Figure 01).

From the Tier 1 report, it is understood that the worked out quarry void was leased by KCC between August 1977 and June 1980 for the landfilling of waste, including municipal and construction waste. Once the void was filled, the land was capped with approximately 450 mm soil and the Site was returned to the original owner.

Subsequently the western portion of the Site was developed into paddocks and a private residence.

In recent times, an orange leachate was noted by nearby residents collecting on the roadway immediately to the north of the Site, which instigated the current Tier 2 Environmental Risk Assessment.

3.0 PROJECT OBJECTIVE AND SCOPE OF WORK

The **objective** of this report is the preparation of a Tier 2 Risk Assessment of a former waste disposal site located at Carrigeen, Clane, Co. Kildare in compliance with the requirements identified in the EPA Code of Practice (EPA, 2007).

The **scope of works** of this report includes the assessment of data compiled during a site investigation carried out by Golder in September 2010 and data from the previous site surveys/Tier 1 risk assessment to determine whether *Source-Pathway-Receptor* (S-P-R) linkages exist and the significance of any linkages in conjunction with the EPA Code of Practice (EPA, 2007). (Appendix B, C for laboratory results)

4.0 WORK PROGRAMME

This report has been prepared using data from the intrusive site investigation and subsequent soil, groundwater, sediment and surface water sampling and landfill gas monitoring carried out within the Site

throughout September 2010. The programme of works carried out during the above mentioned works comprised:

- EM31 geophysical survey of the Site;
- 2D resistivity geophysical survey of the Site (Appendix D);
- Drilling and installation of three (3 No) 50 mm diameter groundwater monitoring wells within the Site to a depth of 8 m below ground level (bgl);
- Drilling and installation of two (2 No) 50 mm diameter leachate monitoring wells within the Site to a depth of 6 m below ground level (bgl);
- Excavation of twelve (12 No) trial pits to a maximum depth of 4.5 m bgl using a 13 tonne tracked excavator and collection of soil samples from the waste body and capping materials;
- Carrying out a landfill gas spike survey at a total of 33 No locations by a creating a temporary void using a geoprobe to a depth of 4 metres bgl, inserting a temporary standpipe with gas tap and testing the location for landfill gas using a portable landfill gas detector;
- Analysis of a soil samples for an agreed suite of laboratory analysis (Appendix B);
- Analysis of a soil samples for geotechnical analysis (Appendix C);
- Collection of one (1 No) surface water sample from the stream to the east of the Site;
- Collection of two (2 No) leachate and three (3 No) groundwater samples; and
- Topographical survey of all investigation locations and presentation of these into an existing base drawing for the Site.

Site Investigation Photographs are attached in Appendix E.

5.0 TIER 2 ASSESSMENT

5.1 Details of Site Assessment

The Geophysical surveys were carried out by Golder Geologists on 13 and 14 of September 2010. The topographical survey was carried out on the 13 of September 2010. The trial pit survey was carried out on the 20 of September 2010 (10 No.) and the 24 of September (3 No.) (by Kildare County Council excavator). Soil samples were collected from the trial pit locations for chemical analysis on the 20 of September. The groundwater and leachate/landfill gas monitoring wells were drilled and installed on the 20 and 21 of September 2010. The landfill gas spike survey was carried out on the 23 and 24 of September 2010. The groundwater, leachate and surface water monitoring was carried out on the 23 of September 2010.

5.2 Geophysical Survey

The geophysical surveys were carried out on the 13 and 14 of September 2010. The interpretation of the results was used as an aid to determine trial pitting and well installation locations.

The geophysical report and associated figures is attached in Appendix D of this report.

5.3 Trial Pitting and Soil Sampling

Waste soil samples were collected at each of the trial pitting locations. A total of three (3 No) waste soil samples were analysed for waste acceptance criteria (WAC) in accordance with 2003/33/EC, and a total of

six (6No.) representative samples of the capping layer (typically the top 0.4 to 0.5 metres) were collected and analysed for geotechnical properties during the trial pitting exercise in September 2010. The trial pit depths varied between 1.0 and 4.5 metres below the ground level (depending on bedrock and maximum reach of the excavator). Natural ground was achieved in 6 of a total of 13 trial pit locations.

Of the thirteen (13 No) trial pits, municipal solid waste (MSW) and/or construction and demolition waste (C&D) layers and natural ground were encountered at the following locations:

- The waste ground to the east of the Site, up to 2.9 m, bedrock encountered as shallow as 1.0 m (predominantly MSW);
- The southern half of the main paddock up to 4.5 m in depth (maximum reach of excavator) (predominantly MSW);
- In the eastern section of the back paddock and the eastern section of the residential garden (predominantly MSW);
- The northern section of the main paddock comprised (predominantly C&D waste); and
- The western section of the residential garden (predominantly natural ground).

The thickness of the MSW and C&D waste was limited in the eastern section of the Site by the bedrock which was increasingly shallow to the south and eastern boundary. The bottom of the municipal/C&D waste body was not encountered to a depth of 4.5 m in the southern part of the main paddock. The municipal/C&D waste was encountered within the southern paddock and the garden area, however these trial pits were only opened to 1.5 m in depth in order to minimise disturbance. The bottom of the waste body was not encountered at those locations.

The municipal waste layers comprised in general plastic, rags, bottles, textiles, paper and wood. A strong waste odour was observed while excavating in the waste layers at some locations.

The C&D waste layers comprised crushed stone, brick and reworked soils.

The capping material used at the Site varied from a gravelly silty sand layer in the waste ground to a brown silty sand containing clay over the remainder of the Site. The general waste profile encountered beneath the Site is summarised in the following Table 1. :

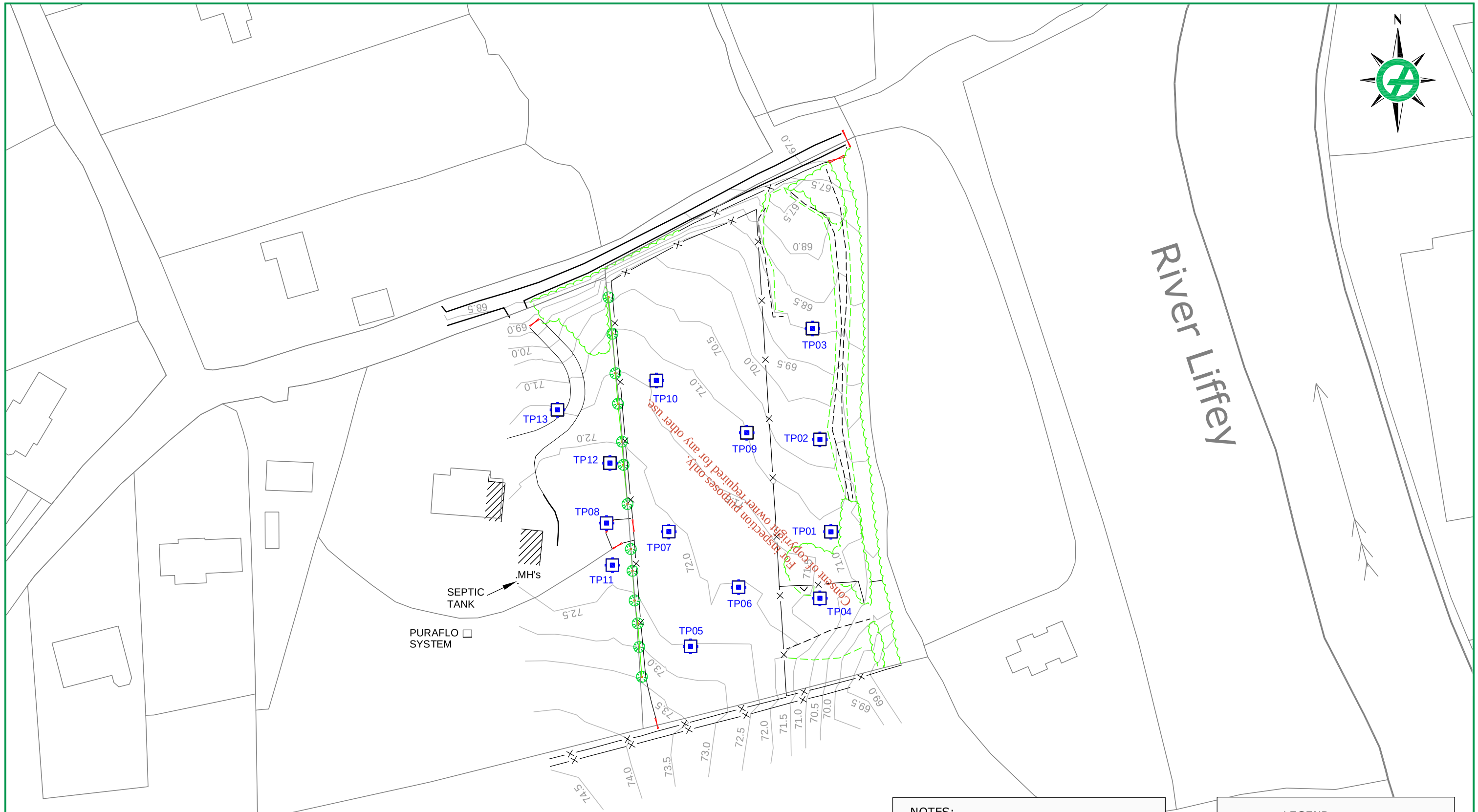
Table 1: Summary of the General Soil Profile Encountered Beneath the Site

Location	Depth (m)	Thickness of Capping (m)	Bedrock depth (mbgl)	Waste Types	Inert/ biodegradable of waste (%)	Additional Comments
TP01	2.70	0.30	2.70	Black plastic 40-60% Wood 5% Bottles 1% Metal 1% Plastic containers 1-3% Rags and Textiles 1-3%	30/70	Strong leachate and sewer smell during excavation
TP02	2.90	1.60	2.90	C&D waste 30% Black plastic 20% Rags and Textiles 1-3% Plastic containers	50/50	Significant water ingress at 2.90m

Location	Depth (m)	Thickness of Capping (m)	Bedrock depth (mbgl)	Waste Types	Inert/ biodegradable of waste (%)	Additional Comments
				1-3% Metal 1%		
TP03	2.70	0.40	2.70	C&D 50% Glass, bricks, rock, wood 5% Plastic <1%	60/40	Water at 2.4m
TP04	2.70	0.50	2.70	Plastic 30-60% Wood 5% Pipes 1-5% Paper 20%		Dry
TP05	4.50	0.80	4.50	C&D 40-60% Plastic 20-30% Wood 2.5-7% Stone 10-15% Metal 2-5% Textiles1-3%	60/40	Dry Layer of dry C&D waste to 2.30mbgl underlain by mixed domestic waste
TP06	4.50	0.70	Not encountered	Black plastic, textiles, paper up to 70% Metal 1-5% Wood 5-10%	50/50	Dry Newspaper dated 1980 still legible Strong waste odour
TP07	4.20	0.70	Not encountered	C&D waste 10% Municipal waste comprising plastic wood and textiles 70-80%	30/70	Dry Moderate waste odour
TP08	1.50	0.50	Not encountered	Boulder clay, possibly fill 90%	100/0	Dry No C&D or municipal waste
TP09	3.00	0.50	Not encountered	Boulder clay possibly C&D fill (all)	100/0	Dry No visible waste or odour
TP10	4.00	0.80	Not encountered	C&D fill and broken rock fragments (all)	100/0	Dry No odour
TP11	1.50	0.50	Not encountered	Mixed domestic and C&D plastic, glass, plastic bottles (30%)	90/10	Dry Moderate odour
TP12	1.20	0.40	Not encountered	Plastic 5% C&D 10%	95/5	Dry Moderate odour

Location	Depth (m)	Thickness of Capping (m)	Bedrock depth (mbgl)	Waste Types	Inert/ biodegradable of waste (%)	Additional Comments
TP13	1.10	0.50	No encountered	Possibly all natural ground, large amount of cobbles and broken rock	100/0	Dry no odour

Figure 2 overleaf presents the locations for the trial pitting.



NOTES:

COORDINATES ARE IN METRES RELATIVE TO THE IRISH NATIONAL GRID.

LEVELS ARE IN METRES RELATIVE TO O.S. DATUM MALIN HEAD

LEGEND:

TRIAL PIT LOCATION

105.5 EXISTING CONTOURS

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL.: 045 874411 - FAX:045 874549 - www.golder.com

Client: **Kildare County Council**	Project number 10.5071.9.0201	Created By POB	Issue to TO KILDARE Co. Co.	Date Nov. '10	Version A	Title: TRIAL PIT LOCATIONS	Figure **02**
Location: Carrigeen Refuse Depot, Clane	File Location Graphics(July2008)/Waste/KildareCoCo/Poll&Carrig/ASBUILT/AUTOCAD/Carrigeen-Fig02	Checked by CC					
Project: Tier 2 Risk Assessment	ORDNANCE SURVEY IRELAND LICENCE NUMBER **AR0056010**	Reviewed by BB				Scale 1:1,000 A3	

5.3.1 Results of Laboratory Chemical Analysis for Soils

Waste soil samples were collected at each trial pitting location. Three most representative locations were chosen to undergo laboratory analysis – TP1, TP4 and TP6. The samples were taken from the waste body within the excavated soil heaps. The following Table 2 represents soils eluate (i.e. CEN leaching test 10:1 liquid to solid) exceedances when compared to the Council Directive 2003/33/EC for waste acceptance criteria expressed as mg/kg for eluates and total pollutant concentration where applicable.

Table 2: Summary of Laboratory Analysis for Soil Waste Acceptance Criteria

Parameter	TP01	TP04	TP05	TP06	Inert WAC limit in mg/kg
Arsenic[†]	0.22	0.06	-	0.22	0.5
Barium[†]	0.21	0.48	-	0.48	20
Cadmium[†]	<0.01	<0.01	-	<0.01	0.04
Chromium[†]	<0.02	<0.02	-	<0.02	0.5
Copper[†]	<0.12	<0.12	-	<0.12	2.0
Mercury[†]	<0.001	<0.001	-	<0.001	0.01
Molybdenum[†]	0.62	0.23	-	1.09	0.5
Nickel[†]	0.10	<0.06	-	0.60	0.4
Lead[†]	<0.1	<0.1	-	<0.1	0.5
Antimony[†]	<0.03	<0.03	-	<0.03	0.06
Selenium[†]	<0.03	<0.03	-	<0.03	0.1
Zinc[†]	0.13	<0.04	-	0.08	4.0
Chloride[†]	188	39	-	1810	800
Fluoride[†]	<1	<1	-	<1	10
Sulphate[†]	1668	938	-	1070	1000
Phenol[†]	<1	<1	-	<1	1.0
DOC[†]	390	190	-	1850	500
TDS[†]	4350	3390	-	10550	4000
BTEX[**]	0.209	0.323	<0.025	0.813	6.0
PCBs[**]	<0.035	<0.035	-	<0.035	1.0
Mineral Oil[**]	<30	<30	<30	<30	500
PAHs[**]	<0.64			1.11	100[note1]

WAC – Council Directive 2003/33/EC Guideline Value for Inert Landfills.
[†]***Eluate analysis***
[**]***Total Pollutant Content***
[note 1]***Only Murphy Environmental Hollywood can accept PAHs at this level, permitted sites generally have a threshold limit of 1-2mg/kg for PAHs***

The above elevated parameters were observed across the Site and typically in the identified waste layers containing municipal wastes.

Moreover elevated Diesel Range Organics aliphatics and aromatics were observed in the three samples tested, varying from 823 mg/kg (TP05) to 3191 mg/kg (TP01). The laboratory confirmed however that these results were as a result of naturally occurring compounds, likely to be humic acid from the biodegradation of organic products.

The complete laboratory analysis results are attached at Appendix B.

5.3.2 Soil PSD Tests

In total six (6 No) Soil Particle Size Distribution (PSD) tests and six (6 No.) Atterberg Limit tests were carried at selected soil samples.

The results of PSD analysis is presented in Table 3 and the results of the Atterberg (liquid) Limits analysis are presented in Table 4. The certificates of analysis are attached in Appendix C.

Table 3: Summary of PSD Analysis

ID	Depth	Description
TP 01	**Capping (surface)**	Loose brown slightly sandy gravelly **SILT** with some organic material
TP 2	**Capping (surface)**	Loose brown slightly sandy gravelly **CLAY** with some organic material
TP 4	**Capping (surface)**	Soft brown slightly gravelly sandy **CLAY** with some organic matter
TP 5	**Capping (surface)**	Loose brown sandy gravelly **CLAY** with some organic material
TP 10	**Capping (surface)**	Loose brown very silty very gravelly **SAND** with some organic material
TP11	**Capping (surface)**	Loose brown very silty very gravelly **SAND**

Table 4: Summary of Liquid Limits Analysis

ID	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
TP 01	Not Applicable	Non Plastic	Not Applicable
TP02	36	24	12
TP04	35	22	13
TP05	45	29	16
TP10	Not Applicable	Non Plastic	Not Applicable
TP11	41	27	14

The geotechnical testing indicated that the Site is capped by material of various properties such as clay, silt and sand. The testing also indicated that the capping material used in the vicinity of TP01 and TP11 would not be classified as generally good capping materials, having little or no plasticity. The remaining samples were indicative of soils classified as generally good capping materials (plasticity index of >10).

5.4 Groundwater and Leachate Sampling

Three No (3 No) groundwater samples and two (2 No.) leachate samples were collected from within the Site at locations BH01 BH02 BH03, LW01 and LW02. The screen depth of the groundwater monitoring wells ranged between 3 and 8.0m bgl. The leachate wells were screened at 1 mbgl. The Certificates of analysis are attached in Appendix B.

5.4.1 Results of Laboratory Analysis for Groundwater

The following Table 5 represents the groundwater test results in comparison against the EPA's Interim Guideline Values (IGV) for the Protection of Groundwater in Ireland (EPA, 2003).

Table 5: Summary of Laboratory Analysis for Waters

Parameter	Unit	BH01	BH02	BH 03	LW01	LW02	SW01	Surface water thresholds a,b,,c	SI No. 9 2010	IGV Values (EPA, 2003)
pH	n/a	8.25	7.54	7.48	7.73	7.82	8.39	6.0-9.0[a]	n/a	6.5-9.5
Electrical Conductivity	µS/cm	725	402	461	2388	1726	507	2500[b]	800-1875	1000
TSS	mg/l	-	-	-	-	-	47	50[c]	n/a	n/a
TDS	mg/l	486	423	370	-	-	-	n/a	n/a	1000
Sulphate	mg/l	7.09	7.18	61.25	86.83	1.59	27.27	250[b]	187.5	200
Chloride	mg/l	31.2	30.2	13.7	150.0	98.5	15.0	250[b]	24-187.5	30
Fluoride	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	500[a]	n/a	1.0
TON as N	mg/l	0.8	8.4	0.7	0.6	0.6	3.7		n/a	n/a
Tot Ammonia as N	mg/l	18.08	1.92	0.10	100.08	91.65	3.05	0.09[a]	n/a	n/a
Ammonium	mg/l	23.28	2.47	0.13	128.89	118.03	3.93	0.30[b]	0.065-0.175	0.15
Arsenic*	µg/l	11.5	<2.5	4	5	20.7	<2.5	25[a]	7.5	10
Boron*	µg/l	175	39	18	759	624	42	1000[b]	750	1000
Cadmium*	µg/l	<0.5	<0.5	1.1	1	0.8	<0.5	5[b]	3.75	5
Chromium*	µg/l	2.2	<1.5	<1.5	32.9	24.7	<1.5	32[a]	37.5	30
Copper*	µg/l	<7	<7	<7	11	8	<7	30[a]	1500	30
Mercury*	µg/l	<1	<1	<1	<1	<1	<1	1[b]	0.75	1
Nickel*	µg/l	10	13	10	43	18	2	20[a]	15	20
Lead*	µg/l	<5	<5	<5	<5	<5	<5	7.2[a]	18.75	10
Zinc*	µg/l	12	28	9	176	25	6		n/a	100
Iron*	µg/l	1124	<20	<20	33320	27010	160	200[b]	n/a	200
Manganese*	µg/l	1228	345	266	5311	1207	146	50[b]	n/a	50
Calcium*	mg/l	92.5	161.5	132.6	244.7	178.2	122.3	n/a	n/a	200
Magnesium*	mg/l	24.0	8.9	15.1	88.0	51.7	5.8	n/a	n/a	50
Potassium*	mg/l	20.7	3.9	1.6	117.6	76.7	3.2	n/a	n/a	5
Sodium*	mg/l	42.1	15.9	9.3	130.9	96.6	9.6		150	150
MRP as P	µg/l	596	545	37	3711	6842	173	25[a]	35	n/a
Orthophosphate as PO_4	mg/l	1.83	1.67	0.11	11.38	20.98	0.53	n/a	n/a	0.03
Dissolved Oxygen	mg/l	-	-	-	-	-	ca.80 %	80%	n/a	n/a
BOD	mg/l	-	-	-	122	2	<1	1.3[a]	n/a	10[+]
COD	mg/l	-	-	-	302	67	20	40	n/a	20[+]
TOC	mg/l	-	-	-	376	74	-	n/a	n/a	10[+]
DOC	mg/l	-	-	-	368	61	-	n/a	n/a	n/a
Total Alkalinity as CaCO3	mg/l	430	348	985	-	-	271	n/a	n/a	No abnormal change
Total Cyanide	µg/l	<40	<40	<40	<40	<40	<40	10	37.5	100
EPH (C8-C40)*	µg/l	-	881	-	<10	-	-	n/a	n/a	10
PAH 16	µg/l	-	<0.1	-	3.180	-	-	n/a	n/a	0.1

*dissolved concentrations

[+]Taken from EPA guidance document 'Landfill Monitoring, 2nd edition, 2003', Minimum Reporting Values for Dirty Water

[a]SI 272 of 2009 where available

[b]SI278 of 2007 where above not available

[c]SI294 of 1989 where above not available

Table 5 highlights parameters that exceed the EPA IGV/Landfill (yellow), S.I. No. 9 2010 (green) and surface water Monitoring values (turquoise).

The complete laboratory analysis results are attached at Appendix B.

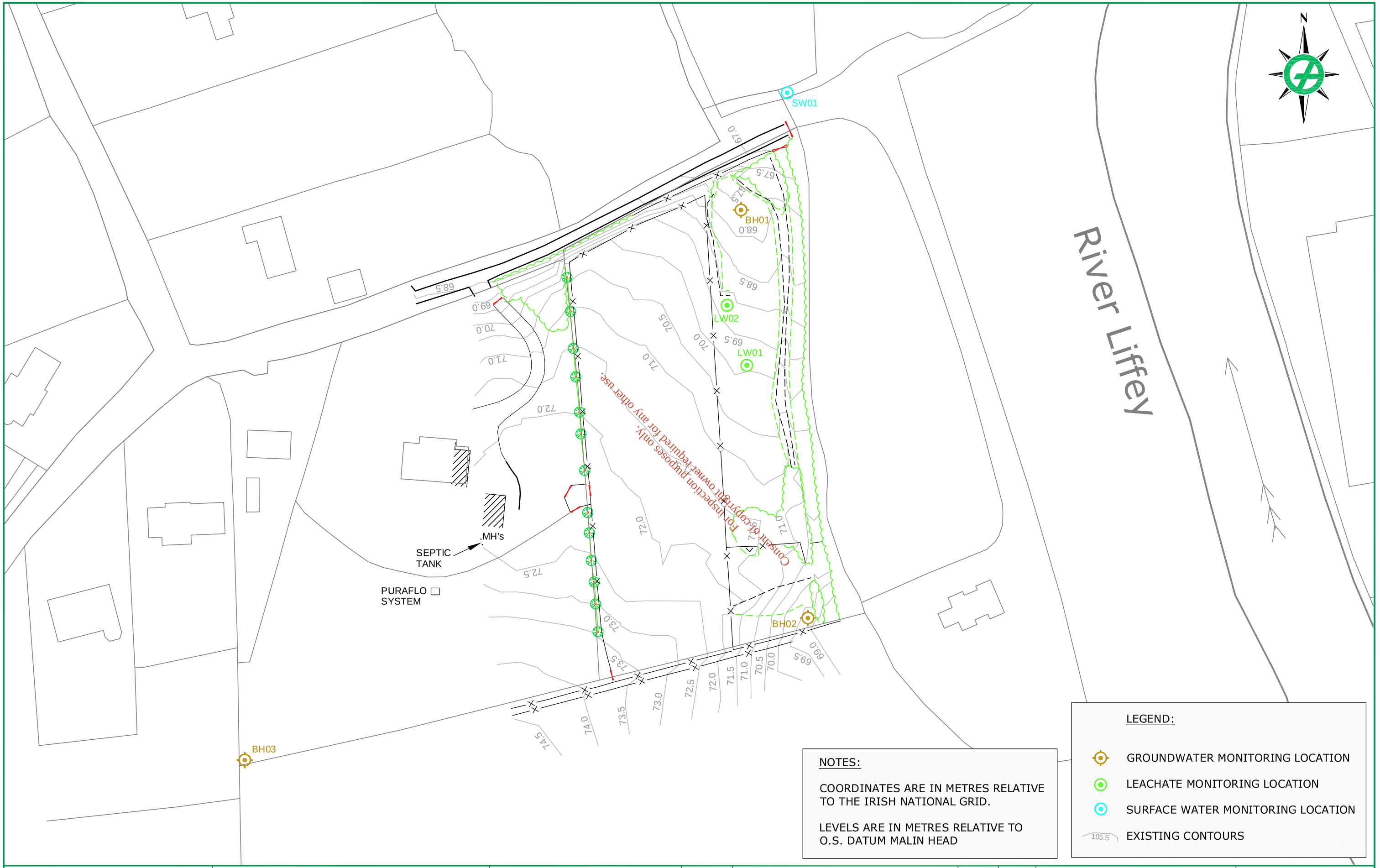
Although it is likely that the elevated parameters in the above table may be entirely associated with the waste body, it is possible that agricultural practices in the vicinity of the Site may contribute to elevated levels of parameters such as ammonium , nitrogen and orthophosphate.

5.5 Surface Water Sampling

Surface water samples were collected at one (1 No) (SW01) location downstream to the north of the Site. It was not possible to collect a sample upstream of the Site as the surface water network was either inaccessible or stagnant, therefore a representative sample could not be taken. The samples were tested for the agreed suite of analysis (see complete list at Appendix B).

Table 4 indicates that total oxidised nitrogen, ammonia, ammonium, manganese and MRP and cyanide (as laboratory detection limit is lower than the guideline value) are elevated at SW01. It is possible that these are indicators of both the waste body and agricultural practices in the vicinity of the sampling location.

Figure 3 overleaf presents the locations for the water monitoring.



NOTES:

COORDINATES ARE IN METRES RELATIVE TO THE IRISH NATIONAL GRID.

LEVELS ARE IN METRES RELATIVE TO O.S. DATUM MALIN HEAD

LEGEND:

- GROUNDWATER MONITORING LOCATION
- LEACHATE MONITORING LOCATION
- SURFACE WATER MONITORING LOCATION
- 105.5 EXISTING CONTOURS

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL.: 045 874411 - FAX:045 874549 - www.golder.com

Client: **Kildare County Council**	Project number 10.5071.9.0201	Created By POB	Issue to	Date	Version	Title: WATER SAMPLING LOCATIONS	Figure **03**
Location: Carrigeen Refuse Depot, Clane	File Location Graphics(July 2008)/Waste/KildareCoCo/Poll&Carrig/ASBUILT/AUTOCAD/Carrigeen-Fig03	Checked by CC	TO KILDARE Co. Co.	Nov. '10	A		
Project: Tier 2 Risk Assessment	ORDNANCE SURVEY IRELAND LICENCE NUMBER **AR0056010**	Reviewed by BB				Scale 1:1,000 A3	

5.6 Gas Monitoring

Landfill gas monitoring was carried out in thirty three (33 No) temporary landfill gas monitoring locations. A spike survey was carried out using a Dando Terrier Rig. The rig progressed a metal probe to a maximum depth of 4.0 mbgl and then pulled out. A HDPE piezometer (one inch) was inserted into the hole created by the terrier rig. The piezometer was perforated below ground level to allow the ingress of any gas and the top of the piezometer was sealed with a rubber gas cap. The contact between the piezometer and the ground surface was compacted (by pressing the soils) to seal the pipe into the ground and to minimise air ingress. After a minimum period of 15-20 minutes the gas cap was opened and landfill gas concentrations within the piezometer was measured using a GA2000 Landfill Gas analyser. The GA2000 instrument is owned by Golder Associates and is currently calibrated to the factory standards.

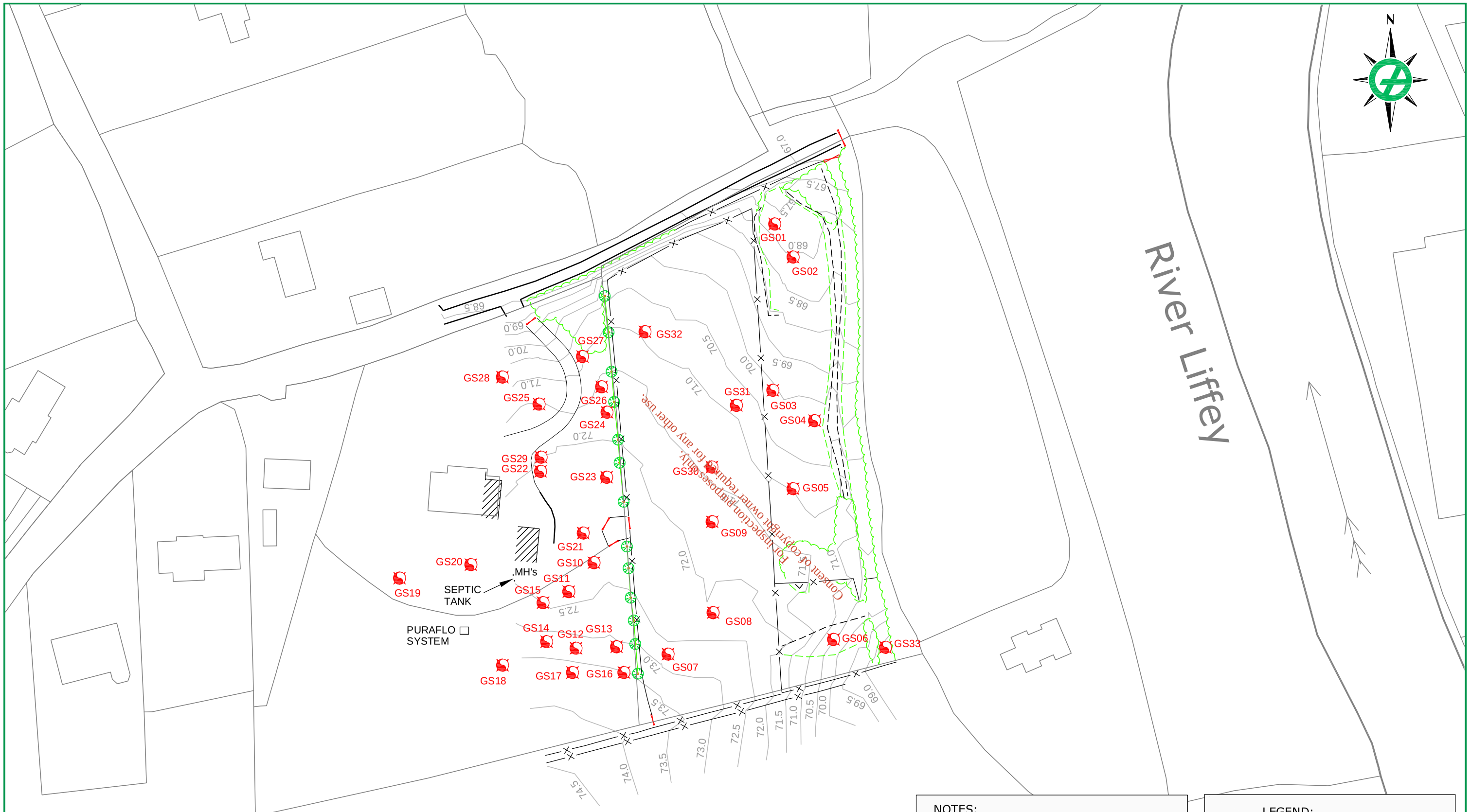
Methane (CH4) was observed to range between 0.0 to 39.2 % (v/v), carbon dioxide between 1.3 and 31.9 % (v/v) and Oxygen between 0.01 to 18.7% - refer to Table 6 overleaf for detailed results.

Table 6: Landfill Gas Monitoring Survey Results Carrigeen

Location	Depth(m)	CH_4(%)	CO_2(%)	O_2(%)	Balance(%)
GS01	1.9	2.9	7.5	12.7	77.9
GS02	2.2	3.6	15.2	3.4	72.6
GS03	2.0	17.4	21	2.2	59.2
GS04	3.5	14.1	13.4	3.4	63.8
GS05	2.5	23.8	24.4	2.6	49.6
GS06	1.0	0.1	3.8	13.6	52.5
GS07	3.0	0.1	12.2	5.0	82.5
GS08	2.5	28.8	28.7	2.2	40.6
GS09	3.0	34.8	31.9	0.01	33.1
GS10	4.0	36.7	26.1	0.4	36.7
GS11	4.0	23.4	27.4	0.3	48.8
GS12	2.3	21.6	20.8	2.9	54.4
GS13	2.0	1.0	3.8	14.3	80.9
GS14	1.7	0.1	6.4	11.0	82.5
GS15	2.0	1.6	9.9	8.4	80.3
GS16	2.0	0.1	3.2	14.9	81.6
GS17	2.0	0.0	3.3	14.9	81.7
GS18	2.5	0.0	3.7	14.8	81.5
GS19	1.4	0.8	2.0	17.9	79.2
GS20	1.2	0.0	1.3	18.4	80.2
GS21	4.0	27.5	19.0	6.1	47.8
GS22	1.2	20.4	18.3	5.3	56.4
GS23	1.8	29.8	25.3	2.4	42.9
GS24	4.0	30.4	25.2	1.2	43.3
GS25	1.5	22.6	18.1	5.0	54.8
GS26	4.0	28.1	25.1	2.8	44.9
GS27	1.3	2.3	10.2	4.7	83.3
GS28	2.0	2.8	10.3	3.5	83.4
GS29	1.2	17.4	12.2	6.9	63.5
GS30	3.0	39.2	27.7	1.9	32.5
GS31	2.0	19.0	19.8	3.5	58.0
GS32	3.0	25.8	23.5	2.5	49.9
GS33	2.5	0.0	1.5	18.7	79.9

The spike survey locations are depicted on Figure 4 overleaf.

As the above Table 6 indicates, a large number of the spike survey monitoring locations indicated elevated methane and carbon dioxide concentrations both inside and outside the estimated area of the waste body, with levels of methane at up to 20.4% recorded at the location closest to the private residence (GS22).



NOTES:

COORDINATES ARE IN METRES RELATIVE TO THE IRISH NATIONAL GRID.

LEVELS ARE IN METRES RELATIVE TO O.S. DATUM MALIN HEAD

LEGEND:

GAS MONITORING LOCATION

105.5 EXISTING CONTOURS

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL.: 045 874411 - FAX:045 874549 - www.golder.com

Client: **Kildare County Council**	Project number 10.5071.9.0201	Created By POB	Issue to	Date	Version	Title: GAS SAMPLING LOCATIONS
Location: Carrigeen Refuse Depot, Clane	File Location Graphics(July2008)/Waste/KildareCoCo/Poll&Carrig/ASBUILT/AUTOCAD/Carrigeen-Fig04	Checked by CC	*TO KILDARE Co. Co.*	*Nov. '10*	*A*	Figure **04**
Project: Tier 2 Risk Assessment	ORDNANCE SURVEY IRELAND LICENCE NUMBER **AR0056010**	Reviewed by BB				Scale 1:1,000 A3

6.0 DISCUSSION OF RESULTS

Soils tested for chemical parameters indicated that certain parameters such as molybdenum, nickel, chloride, sulphate DOC, TDS and PAHs were elevated above inert waste acceptance criteria.

The geotechnical testing of the capping materials indicated that the soil used to cap the waste body is heterogeneous in nature and variable in quality as an engineered cap. The trial pitting indicated that the cover material was of good quality, i.e. waste in trial pit location towards TP10 (residential house) were dry and at some locations newspaper was still readable (e.g.TP05) (slow degradation process due to dry conditions).

The leachate monitoring of the waste body indicated that the following parameters were elevated when compared against guideline values: conductivity, chloride, ammonium, arsenic, chromium, nickel, zinc, iron, manganese, calcium, magnesium, potassium, orthophosphate, COD and PAHs.

The groundwater monitoring indicated that BH03 upstream of the waste body had elevated manganese and orthophosphate. The results for BH01 and BH02 showed elevated values for chloride, ammonium, iron, arsenic EPH and potassium as well as elevated manganese and orthophosphate. This would suggest that baseline manganese and orthophosphate levels in the vicinity of the Site are elevated, however there are a number of other contaminants that are mobilising in the groundwater from the waste body. The laboratory indicated that the elevated EPH values were attributed to humic acids (natural degradation of organic materials).

The surface water monitoring at the Site indicated that total oxidised nitrogen, ammonia, ammonium, manganese and MRP were found to be elevated when compared against guideline values. Cyanide may also be elevated, however this is not possible to measure as the laboratory detection limit is higher than the guideline limit value.

7.0 CONCEPTUAL SITE MODEL

The preliminary Tier 1 assessment identified the following S-P-R linkage – refer to Table 7 for details.

Table 7: In Tier 1 Report Identified S-P-R Linkages (KCC, May 2010)

Source	Pathway	Receptor
Leachate	- Surface water drainage/run-off	- Surface water body

In accordance with the EPA code of practice the overall risk scope was identified as equal to 50% (KCC, May 2010), therefore the risk classification was determined at Moderate Risk (Class B). The EPA Code of Practice required that a Tier 2 assessment be carried out to verify the risk status for a Class B risk site.

The following Sections discusses the – previously identified Tier 1 S-P-R linkages in light of this Tier 2 assessment, i.e. as more site specific is available after the site assessment.

7.1 Body of Waste

The size of the site is approximately 1 ha in size (i.e. 10,000 m^2) and the thickness of the waste varies between 1.0 m and >4.5 m across the waste body footprint. This would indicate that the volume of waste within the site is approximately 40,000 m^3. Further if we assume that of this amount 30% is biodegradable – the amount of gas generating waste is approximately 10,000 m^3. Moreover according to EPA guidance (Landfill Design Manual, EPA 2000) each tonne of waste will generate approximately 10 m^3 of landfill gas during its lifetime – i.e. the Site would generate approximately 150,000 m^3 of landfill gas (i.e. 10,000 m^3 x 1.5t/m^3 = 15,000 tonnes biodegradable waste x 10m^3 gas per tonne).

7.2 Leachate

While the Site does not possess an engineered cap per se, it is apparent that the capping material used over most of the waste body has been quite effective in impeding a large throughput of water from the state of decomposition of waste. However, the geotechnical testing did indicate that the capping materials are quite heterogeneous in nature, and it is likely that leachate which has previously been recorded by residents as coming off the Site along the northern body can be generated through the vertical seepage of rainfall through the capping materials in areas where the capping is low in clay or silt.

7.3 Gas

The gas assessment carried out at the Site's gas monitoring wells indicated elevated methane and carbon dioxide concentrations. An S-P-R linkage does exist as the gas can migrate via subsoil towards the identified receptor locations (in particular the domestic dwelling constructed on the western part of the study area). Elevated readings of methane (at ** % v/v) and carbon dioxide (at ** % v/v) within 10 m of the dwelling house are considered to be within the explosive range and it is proposed that a detailed investigation within the dwelling and around the immediate grounds is carried out in order to quantify this risk to the inhabitants of the dwelling.

By constructing an impermeable cover over an area with elevated gas concentrations this is likely to result in increasing gas concentrations beneath such a cover layer with time. As the gas will look for the easiest pathway to move, it will migrate laterally beneath the cover, possibly towards the identified receptor.

8.0 RECOMMENDATIONS

Golder recommends the following additional works (Tier 3) (outside of our current scope and not included into this Tier 2 assessment) to further assess the identified risks:

- Conduct an in-depth gas survey within the identified receptor locations using a Flame Ionisation Detection Survey in order to assess the potential for environmental and health and safety risks posed by the waste body in its current state;
- Landfill gas resource assessment using GasSim model to assess the current ration of landfill gas production within the Site;
- Design a remediation plan relying on the information gathered within the above survey;
- Depending on the above, remediation of the current capping may be required in order to ensure that leachate generation at the Site is minimised;
- Ongoing monitoring of leachate levels at the Site in order to ensure that mobilisation of leachate from the Site as was previously noted does not occur;
- Installation of gas caps at all the borehole locations and regular monitoring of gas levels to assess the ongoing risks due to landfill gas; and
- The use of a LandSim/ConSim modelling programme (as appropriate) to assess the likelihood of environmental/human risk from the Waste body-groundwater-receptor pollutant linkages at the Site.

Report Signature Page

GOLDER ASSOCIATES IRELAND LIMITED

Caitriona Coyle
Environmental Engineer

Thomas Vainio-Mattila
Senior Consultant

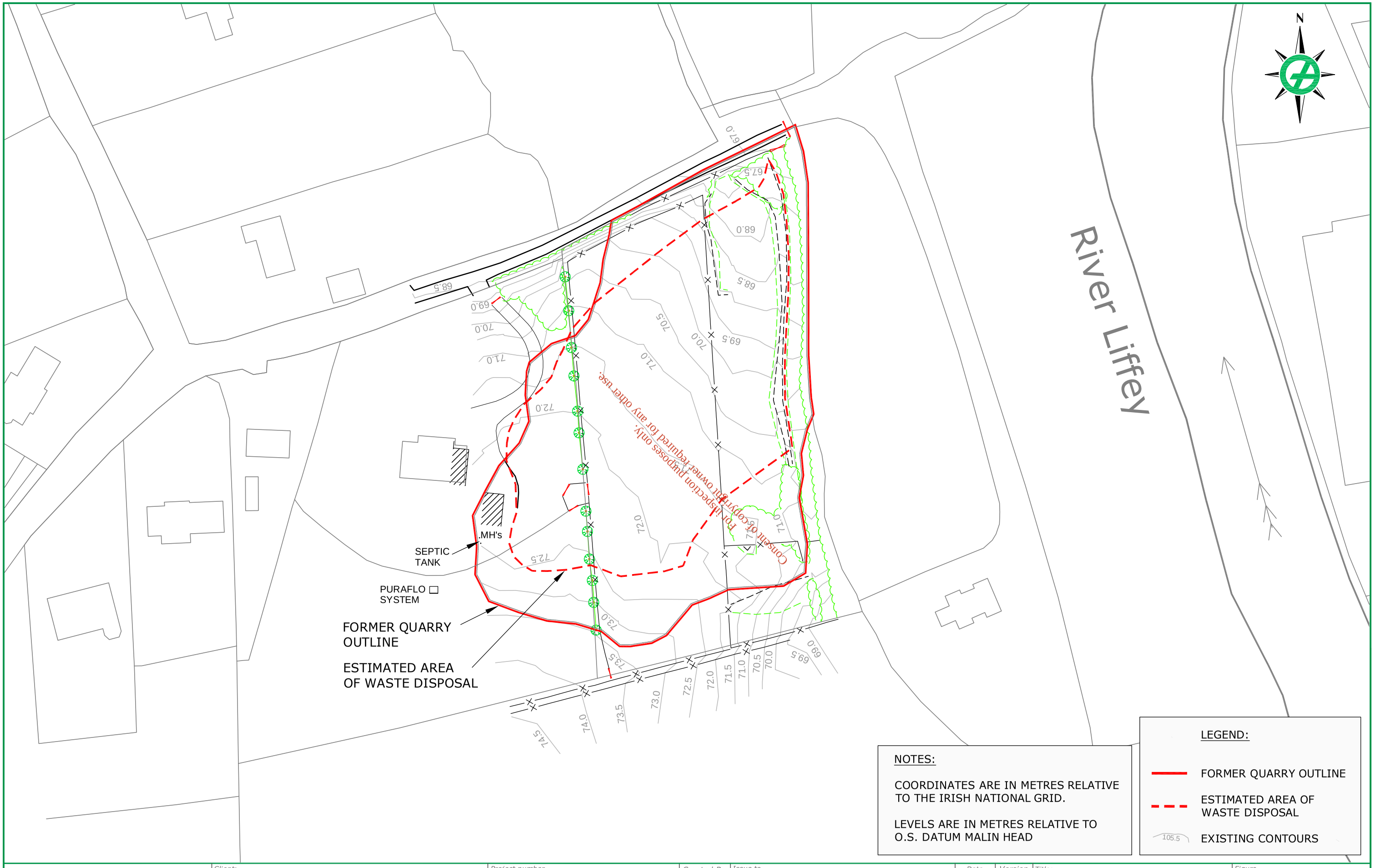
CC/TVM/aw

Date: 26 October 2010

Registered in Ireland Registration No. 297875
Town Centre House, Dublin Road, Naas, Co. Kildare, Ireland
Directors: M. Gilligan, A. Harris (British)
VAT No.: 8297875W

APPENDIX A

Figure 1



NOTES:

COORDINATES ARE IN METRES RELATIVE TO THE IRISH NATIONAL GRID.

LEVELS ARE IN METRES RELATIVE TO O.S. DATUM MALIN HEAD

LEGEND:

- FORMER QUARRY OUTLINE
- ESTIMATED AREA OF WASTE DISPOSAL
- 105.5 EXISTING CONTOURS

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL.: 045 874411 - FAX:045 874549 - www.golder.com

Client: **Kildare County Council**	Project number 10.5071.9.0201	Created By POB	Issue to *TO KILDARE Co. Co.*	Date *Nov. '10*	Version *A*	Title: SITE LAYOUT PLAN
Location: Carrigeen Refuse Depot, Clane	File Location Graphics(July2008)/Waste/KildareCoCo/Poll&Carrig/ASBUILT/AUTOCAD/Carrigeen-Fig01	Checked by CC				Figure **01**
Project: Tier 2 Risk Assessment	ORDNANCE SURVEY IRELAND LICENCE NUMBER **AR0056010**	Reviewed by BB				Scale 1:1,000 A3

APPENDIX B

Chemical Analysis Certificates

Jones Environmental Laboratory

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

Golder Associates Ireland
Town Centre House
Dublin Road
Naas
Co. Kildare

UKAS TESTING
No.4225

Attention :	Caitriona Coyle
Date :	22nd October 2010
Your reference :	Carrigeen
Our reference :	Test Report 10/4483
Location :	Carrigeen (Clane)
Date samples received :	27/09/10
Status :	Final Report
Issue :	2

Eighteen samples were received for analysis on 27th September 2010 which was completed on 12th October 2010. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced.
All interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

J W Farrell- Jones CChem FRSC
Chartered Chemist

Jones Environmental Laboratory

Client Name: Golder Associates Ireland **Report :** **Solids**

Reference: Carrigeen

Location: Carrigeen (Clane) **Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub

Contact: Caitriona Coyle

JE Job No.: 10/4483

J E Sample No.	38-39	40-41	42-43	44-45	46-47	48-49	50-51	52-53	54-55	56-57	LOD	Units	Method No.
Sample ID	TP1	TP1	TP2	TP2	TP3	TP3	TP4	TP4	TP5	TP5			
Depth	0-0.4	1.5-2.0	0-1.6	1.6-3.3	0-0.4	0.4-3.0	0-0.5	0.5-2.7	0.0-0.8	0.8-4.5			
COC No / misc													
Containers	V J	V J	V J	V J	V J	V J	V J	V J	V J	V J			
Sample Date	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	2	2	2	2	2	2	2	2	2	2			
Date of Receipt	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10			
DRO/EPH (C8-40)	~	3191	~	~	~	~	~	2188	~	823	<30	mg/ kg	TM5/PM8
Mineral Oil (interpretation & calculation)	~	<30	~	~	~	~	~	<30	~	<30	<30	mg/ kg	TM5/PM8
BTEX/MTBE# GC-FID													
Benzene #	~	<5	~	~	~	~	~	<5	~	<5	<5	µg/ kg	TM31/PM7
Toluene #	~	<5	~	~	~	~	~	<5	~	<5	<5	µg/ kg	TM31/PM7
Ethyl benzene #	~	35	~	~	~	~	~	160	~	<5	<5	µg/ kg	TM31/PM7
m/p-Xylene #	~	127	~	~	~	~	~	109	~	<5	<5	µg/ kg	TM31/PM7
o-Xylene #	~	47	~	~	~	~	~	54	~	<5	<5	µg/ kg	TM31/PM7
Total BTEX #	~	209	~	~	~	~	~	323	~	**<25**	**<25**	**µg/ kg**	TM31/PM7
MTBE #	~	<5	~	~	~	~	~	<5	~	<5	<5	µg/ kg	TM31/PM7
PCB (7 congeners)#											<5	µg/ kg	TM17/PM8
PCB 28#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
PCB 52#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
PCB 101#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
PCB 118#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
PCB 138#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
PCB 153#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
PCB 180#	~	<5	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM17/PM8
Total 7 PCBs#	~	**<35**	~	~	~	~	~	**<35**	~	~	**<35**	**µg/ kg**	**TM17/PM8**
TOC #	~	15.1	~	~	~	~	~	4.2	~	~	<0.2	%	TM021
% Dry Matter	~	13.8	~	~	~	~	~	57.1	~	~	<0.1	%	PM4

	sample	ID	Depth	EPH/DRO Interpretations
Interpretation	40-41	TP1	1.5-2.0	Naturally occuring compounds
Interpretation	52-53	TP4	0.5-2.7	Naturally occuring compounds
Interpretation	56-57	TP5	0.8-4.5	Naturally occuring compounds

Arsenic #	~	~	~	~	~	~	~	~	~	6.5	<0.5	mg/kg	TM030
Cadmium #	~	~	~	~	~	~	~	~	~	1.5	<0.1	mg/kg	TM030
Chromium #	~	~	~	~	~	~	~	~	~	12.9	<0.5	mg/kg	TM030
Copper #	~	~	~	~	~	~	~	~	~	30	<1	mg/kg	TM030
Mercury #	~	~	~	~	~	~	~	~	~	0.3	<0.1	mg/kg	TM030
Nickel #	~	~	~	~	~	~	~	~	~	23.2	<0.7	mg/kg	TM030
Lead #	~	~	~	~	~	~	~	~	~	51	<5	mg/kg	TM030
Selenium #	~	~	~	~	~	~	~	~	~	<1	<1	mg/kg	TM030
Zinc #	~	~	~	~	~	~	~	~	~	207	<5	mg/kg	TM030
Water Soluble Boron #	~	~	~	~	~	~	~	~	~	3.7	<0.1	mg/kg	TM074
Beryllium	~	~	~	~	~	~	~	~	~	0.6	<0.5	mg/kg	TM030
Vanadium	~	~	~	~	~	~	~	~	~	19	<1	mg/kg	TM030

Please see attached notes for all abbreviations and acronyms

Client Name: Golder Associates Ireland
Reference: Carrigeen
Location: Carrigeen (Clane)
Contact: Caitriona Coyle
JE Job No.: 10/4483

Report : **Solids**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

J E Sample No.	38-39	40-41	42-43	44-45	46-47	48-49	50-51	52-53	54-55	56-57	LOD	Units	Method No.
Sample ID	TP1	TP1	TP2	TP2	TP3	TP3	TP4	TP4	TP5	TP5			
Depth	0-0.4	1.5-2.0	0-1.6	1.6-3.3	0-0.4	0.4-3.0	0-0.5	0.5-2.7	0.0-0.8	0.8-4.5			
COC No / misc													
Containers	V J	V J	V J	V J	V J	V J	V J	V J	V J	V J			
Sample Date	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	2	2	2	2	2	2	2	2	2	2			
Date of Receipt	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10			
PAH 6 Total													
Fluoranthene #	~	<0.03	~	~	~	~	~	0.23	~	8.87	<0.03	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	<0.07	~	~	~	~	~	0.51	~	4.91	<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	<0.04	~	~	~	~	~	0.26	~	3.10	<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	<0.04	~	~	~	~	~	0.21	~	1.92	<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	<0.04	~	~	~	~	~	0.21	~	1.49	<0.04	mg/kg	TM4/PM8
PAH 6 Total	~	<0.22	~	~	~	~	~	1.43	~	20.29	<0.22	mg/kg	TM4/PM8
PAH 16													
Naphthalene #	~	<0.04	~	~	~	~	~	<0.04	~	0.11	<0.04	mg/kg	TM4/PM8
Acenaphthylene	~	<0.03	~	~	~	~	~	0.06	~	0.11	<0.03	mg/kg	TM4/PM8
Acenaphthene #	~	<0.05	~	~	~	~	~	<0.05	~	0.86	<0.05	mg/kg	TM4/PM8
Fluorene #	~	<0.04	~	~	~	~	~	<0.04	~	0.45	<0.04	mg/kg	TM4/PM8
Phenanthrene #	~	<0.03	~	~	~	~	~	0.09	~	5.01	<0.03	mg/kg	TM4/PM8
Anthracene #	~	<0.04	~	~	~	~	~	0.09	~	1.61	<0.04	mg/kg	TM4/PM8
Fluoranthene #	~	<0.03	~	~	~	~	~	0.23	~	8.87	<0.03	mg/kg	TM4/PM8
Pyrene #	~	<0.03	~	~	~	~	~	0.27	~	5.95	<0.03	mg/kg	TM4/PM8
Benz(a)anthracene #	~	<0.06	~	~	~	~	~	0.29	~	2.36	<0.06	mg/kg	TM4/PM8
Chrysene #	~	<0.02	~	~	~	~	~	0.23	~	2.91	<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	<0.07	~	~	~	~	~	0.51	~	4.91	<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	<0.04	~	~	~	~	~	0.26	~	3.10	<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	<0.04	~	~	~	~	~	0.21	~	1.92	<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	~	<0.04	~	~	~	~	~	<0.04	~	0.36	<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	<0.04	~	~	~	~	~	0.21	~	1.49	<0.04	mg/kg	TM4/PM8
PAH 16 Total	~	<0.60	~	~	~	~	~	2.44	~	40.00	<0.60	**mg/kg**	**TM4/PM8**
Coronene	~	<0.04	~	~	~	~	~	<0.04	~	0.36	<0.04	mg/kg	TM4/PM8
PAH 17 Total	~	<0.64	~	~	~	~	~	2.44	~	40.38	**<0.64**	**mg/kg**	**TM4/PM8**

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Client Name:	Golder Associates Ireland	**Report :**	**Solids**
Reference:	Carrigeen		
Location:	Carrigeen (Clane)	**Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub	
Contact:	Caitriona Coyle		
JE Job No.:	10/4483		

J E Sample No.	58-59	60-61	62-63	64-65	66-67	68-69	70-71	72-73			LOD	Units	Method No.
Sample ID	TP6	TP6	TP7	TP7	TP9	TP9	TP10	TP10					
Depth	0.0-0.70	0.7-4.50	0.0-0.70	0.7-4.5	0.0-0.45	0.45-3.0	0.0-0.8	0.8-4.0					
COC No / misc													
Containers	V J	V J	V J	V J	V J	V J	V J	V J					
Sample Date	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	2	2	2	2	2	2	2	2					
Date of Receipt	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10					
DRO/EPH (C8-40)	~	2163	~	~	~	~	~	~			<30	mg/ kg	TM5/PM8
Mineral Oil (interpretation & calculation)	~	<30	~	~	~	~	~	~			<30	mg/ kg	TM5/PM8
BTEX/MTBE# GC-FID													
Benzene #	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM31/PM7
Toluene #	~	74	~	~	~	~	~	~			<5	µg/ kg	TM31/PM7
Ethyl benzene #	~	177	~	~	~	~	~	~			<5	µg/ kg	TM31/PM7
m/p-Xylene #	~	368	~	~	~	~	~	~			<5	µg/ kg	TM31/PM7
o-Xylene #	~	194	~	~	~	~	~	~			<5	µg/ kg	TM31/PM7
Total BTEX #	~	813	~	~	~	~	~	~			**<25**	**µg/ kg**	TM31/PM7
MTBE #	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM31/PM7
PCB (7 congeners)#											<5	µg/ kg	TM17/PM8
PCB 28#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
PCB 52#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
PCB 101#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
PCB 118#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
PCB 138#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
PCB 153#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
PCB 180#	~	<5	~	~	~	~	~	~			<5	µg/ kg	TM17/PM8
Total 7 PCBs#	~	<35	~	~	~	~	~	~			**<35**	**µg/ kg**	**TM17/PM8**
TOC #	~	3.6	~	~	~	~	~	~			<0.2	%	TM021
% Dry Matter	~	69.8	~	~	~	~	~	~			<0.1	%	PM4

Please see attached notes for all abbreviations and acronyms

	sample	ID	Depth	EPH/DRO Interpretations
Interpretation	60-61	TP6	0.7-4.50	Naturally occuring compounds

Jones Environmental Laboratory

Client Name:	Golder Associates Ireland	**Report :**	**Solids**
Reference:	Carrigeen		
Location:	Carrigeen (Clane)	**Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub	
Contact:	Caitriona Coyle		
JE Job No.:	10/4483		

J E Sample No.	58-59	60-61	62-63	64-65	66-67	68-69	70-71	72-73			LOD	Units	Method No.
Sample ID	TP6	TP6	TP7	TP7	TP9	TP9	TP10	TP10					
Depth	0.0-0.70	0.7-4.50	0.0-0.70	0.7-4.5	0.0-0.45	0.45-3.0	0.0-0.8	0.8-4.0					
COC No / misc													
Containers	V J	V J	V J	V J	V J	V J	V J	V J					
Sample Date	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10	20/09/10					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	2	2	2	2	2	2	2	2					
Date of Receipt	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10	27/09/10					
PAH 6 Total													
Fluoranthene #	~	0.17	~	~	~	~	~	~			<0.03	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	0.13	~	~	~	~	~	~			<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	0.07	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	0.08	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	0.08	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
PAH 6 Total	~	0.53	~	~	~	~	~	~			<0.22	mg/kg	TM4/PM8
PAH 16													
Naphthalene #	~	<0.04	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Acenaphthylene	~	<0.03	~	~	~	~	~	~			<0.03	mg/kg	TM4/PM8
Acenaphthene #	~	<0.05	~	~	~	~	~	~			<0.05	mg/kg	TM4/PM8
Fluorene #	~	<0.04	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Phenanthrene #	~	0.16	~	~	~	~	~	~			<0.03	mg/kg	TM4/PM8
Anthracene #	~	<0.04	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Fluoranthene #	~	0.17	~	~	~	~	~	~			<0.03	mg/kg	TM4/PM8
Pyrene #	~	0.20	~	~	~	~	~	~			<0.03	mg/kg	TM4/PM8
Benz(a)anthracene #	~	0.09	~	~	~	~	~	~			<0.06	mg/kg	TM4/PM8
Chrysene #	~	0.13	~	~	~	~	~	~			<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	0.13	~	~	~	~	~	~			<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	0.07	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	0.08	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	~	<0.04	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	0.08	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
PAH 16 Total	~	1.11	~	~	~	~	~	~			<0.60	**mg/kg**	**TM4/PM8**
Coronene	~	<0.04	~	~	~	~	~	~			<0.04	mg/kg	TM4/PM8
PAH 17 Total	~	1.11	~	~	~	~	~	~			**<0.64**	**mg/kg**	**TM4/PM8**

Please see attached notes for all abbreviations and acronyms

Jones Environmental Laboratory

Client Name:	Golder Associates Ireland
Reference:	Carrigeen
Location:	Carrigeen (Clane)
Contact:	Caitriona Coyle
JE Job No.:	10/4483

Report - CEN 10:1 Leachates (expressed as mg/kg)

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

J E Sample No.	40-41	52-53	60-61								LOD	Units	Method No.
Sample ID	TP1	TP4	TP6										
Depth	1.5-2.0	0.5-2.7	0.7-4.50										
COC No / misc													
Containers	V J	V J	V J										
Sample Date	20/09/10	20/09/10	20/09/10										
Sample Type	Soil	Soil	Soil										
Batch Number	2	2	2										
Date of Receipt	27/09/10	27/09/10	27/09/10										
Arsenic #	0.22	0.06	0.22								<0.01	mg/kg	TM30
Barium #	0.21	0.48	0.48								<0.03	mg/kg	TM30
Cadmium #	<0.01	<0.01	<0.01								<0.01	mg/kg	TM30
Chromium #	<0.02	<0.02	0.27								<0.02	mg/kg	TM30
Copper #	<0.12	<0.12	<0.12								<0.12	mg/kg	TM30
Mercury #	<0.001	<0.001	<0.001								<0.001	mg/kg	TM30
Molybdenum #	0.62	0.23	1.09								<0.05	mg/kg	TM30
Nickel #	0.10	<0.06	0.60								<0.06	mg/kg	TM30
Lead #	<0.1	<0.1	<0.1								<0.1	mg/kg	TM30
Antimony #	<0.03	<0.03	<0.03								<0.03	mg/kg	TM30
Selenium #	<0.03	<0.03	<0.03								<0.03	mg/kg	TM30
Zinc #	0.13	<0.04	0.08								<0.04	mg/kg	TM30
Chloride #	188	39	1810								<1	mg/kg	TM38
Fluoride	<1	<1	<1								<1	mg/kg	TM38
Sulphate (Soluble) #	1668	938	1070								<1	mg/kg	TM38
Phenol	<1	<1	<1								<1	mg/kg	TM26
DOC	390	190	1850								<20	mg/kg	TM060
TDS	4350	3390	10550								<400	mg/kg	TM20

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.
Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. Your final report will reflect this, with non-MCERTS results on separate pages.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Asbestos screens where requested will be undertaken by a UKAS accredited laboratory.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples. All samples are treated as groundwaters and analysis performed on settled samples unless we are instructed otherwise.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any analysis that may be compromised highlighted on your schedule/ report by the use of a symbol.

The use of any of the following symbols indicates that the sample was deviating and the test result may be unreliable:

$ sample temperature on receipt considered inappropriate for analysis requested
^ samples exceeding recomended holding times
& samples received in inappropriate containers (e.g. volatile samples not submitted in VOC jars/vials)
~ no sampling date given, unable to confirm if samples are with acceptable holding times

ABBREVIATIONS and ACRONYMS USED

- UKAS accredited
M - MCERTS accredited
NAD - No Asbestos Detected
ND - None Detected (usually refers to VOC and/SVOC TICs)
SS - Calibrated against a single substance
* - analysis subcontracted to a Jones Environmental approved laboratory.
W - Results expressed on as received basis
+ Failed AQC results should be considered as indicative only and are not accredited.
++ Result outside calibration range, may be possible to re-run with higher detection limits

Jones Environmental Laboratory

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

Golder Associates Ireland
Town Centre House
Dublin Road
Naas
Co. Kildare

UKAS TESTING
No.4225

Attention :	Caitriona Coyle
Date :	22nd October 2010
Your reference :	Carrigeen
Our reference :	Test Report 10/4483
Location :	Carrigeen (Clane)
Date samples received :	27/09/10
Status :	Final Report
Issue :	2

Six samples were received for analysis on 27th September 2010 which was completed on 18th October 2010. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced.
All interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

J W Farrell- Jones CChem FRSC
Chartered Chemist

Jones Environmental Laboratory

Client Name: Golder Associates Ireland **Report :** **Liquids**

Reference: Carrigeen

Location: Carrogeen (Clane)

Contact: Caitriona Coyle **Liquids/products:** V=40ml vial, G=glass bottle, P=plastic bottle

JE Job No.: 10/4483 H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

J E Sample No.	1-3,28-30	4-8,31	9,22-27	10-14,37	15-17,32-34	18-21,35-36					LOD	Units	Method No.
Sample ID	BH01	BH02	BH03	LW01	LW02	SW01							
Depth	-	-	-	-	-	-							
COC No / misc													
Containers	V HN P G	V HN P G	V HN P G	V HN P G	V HN P G	V HN P G							
Sample Date	22/09/10	22/09/10	22/09/10	22/09/10	22/09/10	22/09/10							
Sample Type	Water	Water	Water	Water	Water	Water							
Batch Number	1	1	1	1	1	1							
Date of Receipt	24/09/10	24/09/10	24/09/10	24/09/10	24/09/10	24/09/10							
pH#	8.25	7.54	7.48	7.73	7.82	8.39					<0.01	pH units	TM073
Electrical Conductivity# @25°C	725	402	461	2388	1726	507					<100	µS/cm	TM28/PM11
Total Suspended Solids	~	~	~	~	~	47					<10	mg/l	TM037W
Total Dissolved Solids	486	423	370	~	~	~					<35	mg/l	TM020W
Sulphate#	7.09	7.18	61.25	86.83	1.59	27.27					<0.05	mg/l	TM038W
Chloride#	31.2	30.2	13.7	150.0	98.5	15.0					<0.3	mg/l	TM038W
Fluoride	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3					<0.3	mg/l	TM027W
Total Oxidised Nitrogen as N#	0.8	8.4	0.7	0.6	0.6	3.7					<0.05	mg/l	TM038W
Amm N2/Tot Ammonia as N#	18.08	1.92	0.10	100.08	91.65	3.05					<0.03	mg/l	TM038W
Arsenic - dissolved #	11.5	<2.5	4	5	20.7	<2.5					<2.5	µg/l	TM 030W
Boron - dissolved	175	39	18	759	624	42					<12	µg/l	TM 030W
Cadmium - dissolved #	<0.5	<0.5	1.1	1	0.8	<0.5					<0.5	µg/l	TM 030W
Chromium - dissolved #	2.2	<1.5	<1.5	32.9	24.7	<1.5					<1.5	µg/l	TM 030W
Copper - dissolved #	<7	<7	<7	11	8	<7					<7	µg/l	TM 030W
Mercury - dissolved #	<1	<1	<1	<1	<1	<1					<1	µg/l	TM 030W
Nickel - dissolved #	10	13	10	43	18	2					<2	µg/l	TM 030W
Lead - dissolved #	<5	<5	<5	6	<5	<5					<5	µg/l	TM 030W
Zinc - dissolved #	12	28	9	176	25	6					<3	µg/l	TM 030W
Iron - dissolved #	1124	<20	<20	33320	27010	160					<20	µg/l	TM 030W
Manganese - dissolved #	1228	345	266	5311	1207	146					<2	µg/l	TM 030W
Calcium - dissolved#	92.5	161.5	132.6	344.7	178.2	122.3					<0.2	mg/l	TM 030W
Magnesium - dissolved#	24.0	8.9	15.1	88.0	51.7	5.8					<0.1	mg/l	TM 030W
Potassium - dissolved#	20.7	3.9	1.6	117.6	76.7	3.2					<0.1	mg/l	TM 030W
Sodium - dissolved#	42.1	15.9	9.3	130.9	96.6	9.6					<0.1	mg/l	TM 030W
MRP	596	545	37	3711	6842	173					<5	µg/l	TM 030W
Dissolved Oxygen	~	~	~	~	~	6					<1	mg/l	TM059
BOD settled	~	~	~	122	2	<1					<1	mg/l	TM058W
COD	~	~	~	302	67	20					<7	mg/l	TM057W
TOC	~	~	~	376	74	~					<2	mg/l	TM060W
DOC	~	~	~	368	61	~					<2	mg/l	TM060W
Total Alkalinity as CaCO3#	430	348	985	~	~	271					<1	mg/l	TM032W
Total Cyanide*	<40	<40	<40	<40	<40	<40					<40	µg/l	subcontracted
EPH (C8-C40) (dissolved) # SS	~	881	~	<10	~	~					<10	µg/ l	TM5/PM9

Please see attached notes for all abbreviations and acronyms

Jones Environmental Laboratory

Client Name:	Golder Associates Ireland	**Report :**	**Liquids**
Reference:	Carrigeen		
Location:	Carrogeen (Clane)		
Contact:	Caitriona Coyle	**Liquids/products:**	V=40ml vial, G=glass bottle, P=plastic bottle
JE Job No.:	10/4483		$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-3,28-30	4-8,31	9,22-27	10-14,37	15-17,32-34	18-21,35-36					LOD	Units	Method No.
Sample ID	BH01	BH02	BH03	LW01	LW02	SW01							
Depth	-	-	-	-	-	-							
COC No / misc													
Containers	V HN P G	V HN P G	V HN P G	V HN P G	V HN P G	V HN P G							
Sample Date	22/09/10	22/09/10	22/09/10	22/09/10	22/09/10	22/09/10							
Sample Type	Water	Water	Water	Water	Water	Water							
Batch Number	1	1	1	1	1	1							
Date of Receipt	24/09/10	24/09/10	24/09/10	24/09/10	24/09/10	24/09/10							
PAH 16 (Dissolved) MS													
Naphthalene #	~	<0.014	~	2.960	~	~					<0.014	µg/l	TM4/PM30
Acenaphthylene #	~	<0.013	~	<0.013	~	~					<0.013	µg/l	TM4/PM30
Acenaphthene #	~	<0.013	~	0.100	~	~					<0.013	µg/l	TM4/PM30
Fluorene #	~	<0.014	~	0.060	~	~					<0.014	µg/l	TM4/PM30
Phenanthrene #	~	<0.011	~	0.060	~	~					<0.011	µg/l	TM4/PM30
Anthracene #	~	<0.013	~	<0.013	~	~					<0.013	µg/l	TM4/PM30
Fluoranthene #	~	<0.012	~	<0.012	~	~					<0.012	µg/l	TM4/PM30
Pyrene #	~	<0.013	~	<0.013	~	~					<0.013	µg/l	TM4/PM30
Benz(a)anthracene #	~	<0.015	~	<0.015	~	~					<0.015	µg/l	TM4/PM30
Chrysene #	~	<0.011	~	<0.011	~	~					<0.011	µg/l	TM4/PM30
Benzo(bk)fluoranthene #	~	<0.018	~	<0.018	~	~					<0.018	µg/l	TM4/PM30
Benzo(a)pyrene #	~	<0.016	~	<0.016	~	~					<0.016	µg/l	TM4/PM30
Indeno(123cd)pyrene #	~	<0.011	~	<0.011	~	~					<0.011	µg/l	TM4/PM30
Dibenzo(ah)anthracene #	~	<0.01	~	<0.01	~	~					<0.010	µg/l	TM4/PM30
Benzo(ghi)perylene #	~	<0.011	~	<0.011	~	~					<0.011	µg/l	TM4/PM30
PAH 16 Total	~	<0.195	~	3.180	~	~					<0.195	µg/l	TM4/PM30

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.
Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. Your final report will reflect this, with non-MCERTS results on separate pages.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Asbestos screens where requested will be undertaken by a UKAS accredited laboratory.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples. All samples are treated as groundwaters and analysis performed on settled samples unless we are instructed otherwise.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any analysis that may be compromised highlighted on your schedule/ report by the use of a symbol.

The use of any of the following symbols indicates that the sample was deviating and the test result may be unreliable:

$ sample temperature on receipt considered inappropriate for analysis requested
^ samples exceeding recomended holding times
& samples received in inappropriate containers (e.g. volatile samples not submitted in VOC jars/vials)
~ no sampling date given, unable to confirm if samples are with acceptable holding times

ABBREVIATIONS and ACRONYMS USED

- UKAS accredited
M - MCERTS accredited
NAD - No Asbestos Detected
ND - None Detected (usually refers to VOC and/SVOC TICs)
SS - Calibrated against a single substance
* - analysis subcontracted to a Jones Environmental approved laboratory.
W - Results expressed on as received basis
+ Failed AQC results should be considered as indicative only and are not accredited.
++ Result outside calibration range, may be possible to re-run with higher detection limits

APPENDIX C

Geotechnical Analysis Results Certificates

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Liquid and Plastic Limits | **BS 1377 : Part 2 : 1990 : Sec. 4.3 & 5**

Client Name	**Golder Associates Ireland Ltd**	**Address**	**Town Centre House** **Dublin Road** **Naas** **Co. Kildare**
Contact Details	**C. Coyle**		

Job Number	10507290308	**Location**	Material sampled from Clane
Sample Number	KCC TP01		
Sample Date	24/09/2010		
Sampled By	Client		

Moisture Content	**Soil Description**	Loose brown slightly sandy gravelly SILT with some organic material
13.1 %		

Test Method: BS 1377 : Part 2 : 1990 : 4.3/4.4		
Tested using one point method for determination of liquid limit		
Proportion retained on 425mm sieve after washing	**47.8**	**%**
Liquid Limit	**Not Applicable**	**%**
Plastic Limit	**Non Plastic**	**%**
Plasticity Index	**Not Applicable**	

Note 1: Test specimen was washed through a 425micron sieve and then allowed to air-dry.
Note 2: One point liquid limit determined in accordance with "Clayton and Jukes 1978".

Tested By	**Date**	**Checked By**	**Date**	**Signed**	**Report No.**	**Laboratory**	✓
AB	**30-Sep-10**	**SN**	**05-Oct-10**		**KCC TP01**	Naas, Co. Kildare	

Authorised Signatories: ☐ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GeoTesting Ltd.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Particle Size Distribution | **BS 1377 : Part 2: 1990 Clause 9.2**

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 162T

Client Name	Golder Associates Ireland Ltd	**Address**	Town Centre House Dublin Road Naas Co. Kildare
Contact Details	C. Coyle		

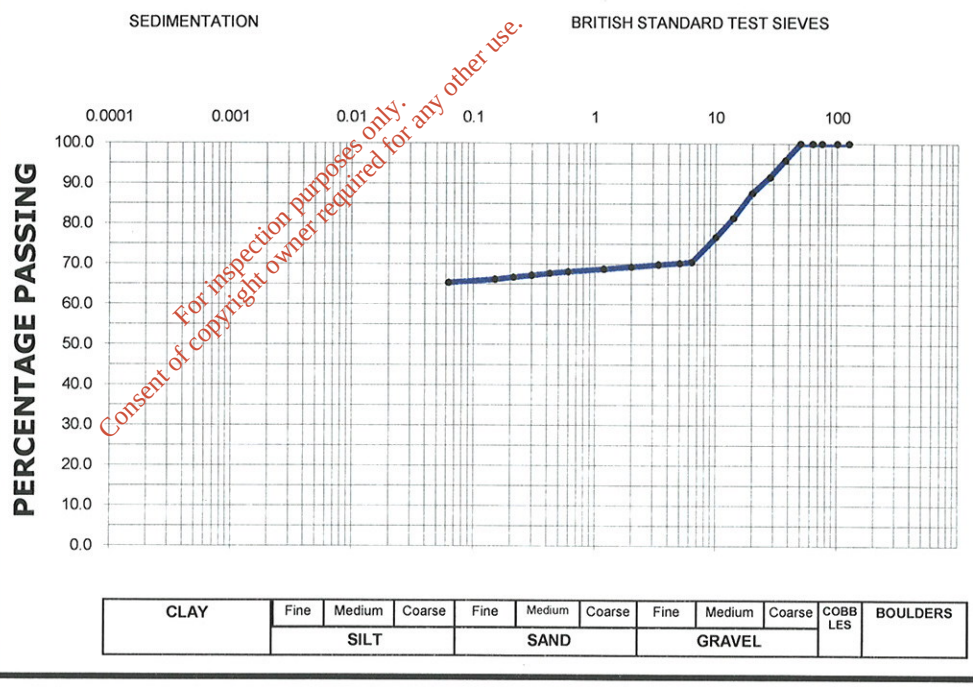
Job Number	10507290308	**Location**	Material sampled from Clane
Sample Number	KCC TP01		
Sample Date	24/09/2010		
Sampled By	Client		

Soil Description	Loose brown slightly sandy gravelly SILT with some organic material

Mass of Bulk Sample(kg) 13.34 **Mass of Test Sample(g)** 6687

Sieve Size	Passing %	Specification
125 mm	100	
100 mm	100	
75 mm	100	
63 mm	100	
50 mm	100	
37.5 mm	96	
28 mm	92	
20mm	88	
14mm	82	
10mm	77	
6.3mm	71	
5 mm	70	
3.35 mm	70	
2 mm	69	
1.18 mm	69	
600 µm	68	
425 µm	68	
300 µm	67	
212 µm	67	
150 µm	66	
63 µm	65	

PARTICLE SIZE mm



Comments

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
KM/KN	29-Sep-10	SN	05-Oct-09		KCC TP01	Naas, Co. Kildare	✓

Authorised Signatories: ☑ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Liquid and Plastic Limits | **BS 1377 : Part 2 : 1990 : Sec. 4.3 & 5**

ISO 17025 IVNAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 1621

Client Name	**Golder Associates Ireland Ltd**	**Address**	**Town Centre House Dublin Road Naas Co. Kildare**
Contact Details	**C. Coyle**		

Job Number	10507290308	**Location**	Material sampled from
Sample Number	KCC TP02		
Sample Date	27/09/2010		
Sampled By	Client		Clane

Moisture Content	**Soil Description**	Loose brown slightly sandy gravelly CLAY with some organic material
15.4 %		

Test Method: BS 1377 : Part 2 : 1990 : 4.3/4.4		
Tested using one point method for determination of liquid limit		
Proportion retained on 425mm sieve after washing	**40.7**	**%**
Liquid Limit	**36**	**%**
Plastic Limit	**24**	**%**
Plasticity Index	**12**	

Note 1: Test specimen was washed through a 425micron sieve and then allowed to air-dry.
Note 2: One point liquid limit determined in accordance with "Clayton and Jukes 1978".

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
AB	01-Oct-10	SN	05-Oct-10		KCC TP02	Naas, Co. Kildare	

Authorised Signatories: Alan Cardiff (Qual Mgr), Dave Tutty (Dep Qual Mgr), Ruth Treacy (Field Services Mgr).

GeoTesting Ltd.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Particle Size Distribution | **BS 1377 : Part 2: 1990 Clause 9.2**

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.1621

Client Name	Golder Associates Ireland Ltd	**Address**	Town Centre House Dublin Road Naas Co. Kildare
Contact Details	C. Coyle		

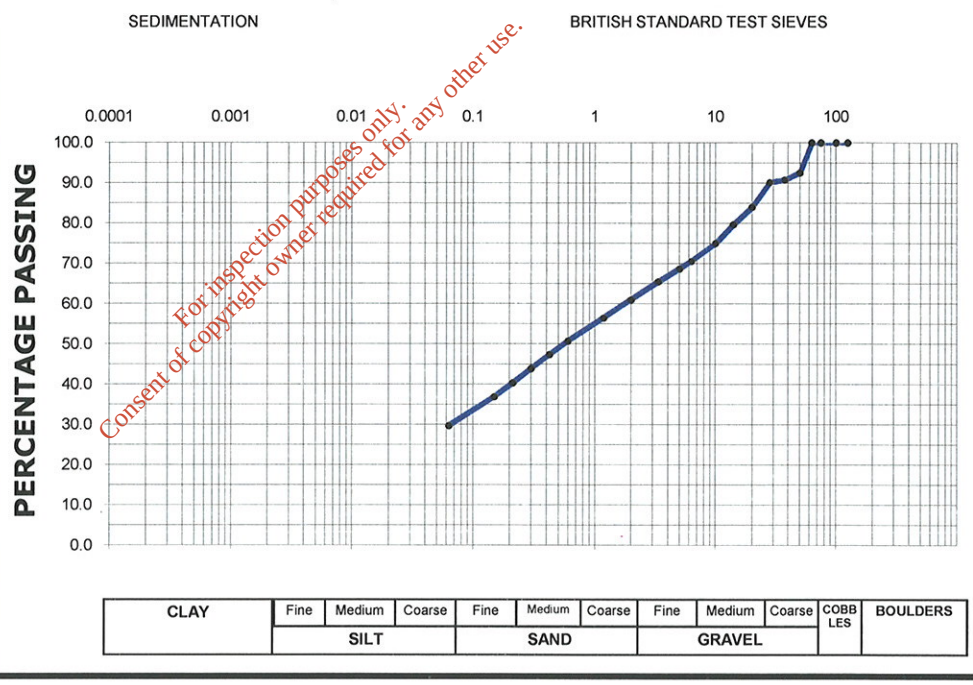
Job Number	10507290308	**Location**	Material sampled from Clane
Sample Number	KCC TP02		
Sample Date	27/09/2010		
Sampled By	Client		

Soil Description	Loose brown slightly sandy gravelly CLAY with some organic material

Mass of Bulk Sample(kg) 12.56 **Mass of Test Sample(g)** 5605.5

Sieve Size	Passing %	Specification
125 mm	100	
100 mm	100	
75 mm	100	
63 mm	100	
50 mm	93	
37.5 mm	91	
28 mm	90	
20mm	84	
14mm	80	
10mm	75	
6.3mm	71	
5 mm	69	
3.35 mm	65	
2 mm	61	
1.18 mm	56	
600 µm	51	
425 µm	47	
300 µm	44	
212 µm	40	
150 µm	37	
63 µm	30	

PARTICLE SIZE mm



Comments

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
KM	29-Sep-10	SN	05-Oct-09		KCC TP02	Naas, Co. Kildare	

Authorised Signatories: ☑ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Liquid and Plastic Limits | **BS 1377 : Part 2 : 1990 : Sec. 4.3 & 5**

ISO 17025 IVNAB ACCREDITED TESTING DETAILED IN SCOPE REG NO 162T

Client Name	**Golder Associates Ireland Ltd**	**Address**	**Town Centre House** **Dublin Road** **Naas** **Co. Kildare**
Contact Details	**C. Coyle**		

Job Number	10507290308	**Location**	Material sampled from
Sample Number	KCC TP04		
Sample Date	27/09/2010		
Sampled By	Client		Clane

Moisture Content	**Soil Description**	
17.7 %		Soft brown slightly gravelly sandy CLAY with some organic material

Test Method: BS 1377 : Part 2 : 1990 : 4.3/4.4		
Tested using one point method for determination of liquid limit		
Proportion retained on 425mm sieve after washing	**17.6**	**%**
Liquid Limit	**35**	**%**
Plastic Limit	**22**	**%**
Plasticity Index	**13**	

Note 1: Test specimen was washed through a 425micron sieve and then allowed to air-dry.
Note 2: One point liquid limit determined in accordance with "Clayton and Jukes 1978".

Tested By	**Date**	**Checked By**	**Date**	**Signed**	**Report No.**	**Laboratory**	✓
AB	**29-Sep-10**	**SN**	**06-Oct-10**		**KCC TP04**	Naas, Co. Kildare	

Authorised Signatories: Alan Cardiff (Qual Mgr), Dave Tutty (Dep Qual Mgr), Ruth Treacy (Field Services Mgr).

GeoTesting Ltd.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Particle Size Distribution | **BS 1377 : Part 2: 1990 Clause 9.2**

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 162T

Client Name	Golder Associates Ireland Ltd	**Address**	Town Centre House Dublin Road Naas Co. Kildare
Contact Details	C. Coyle		

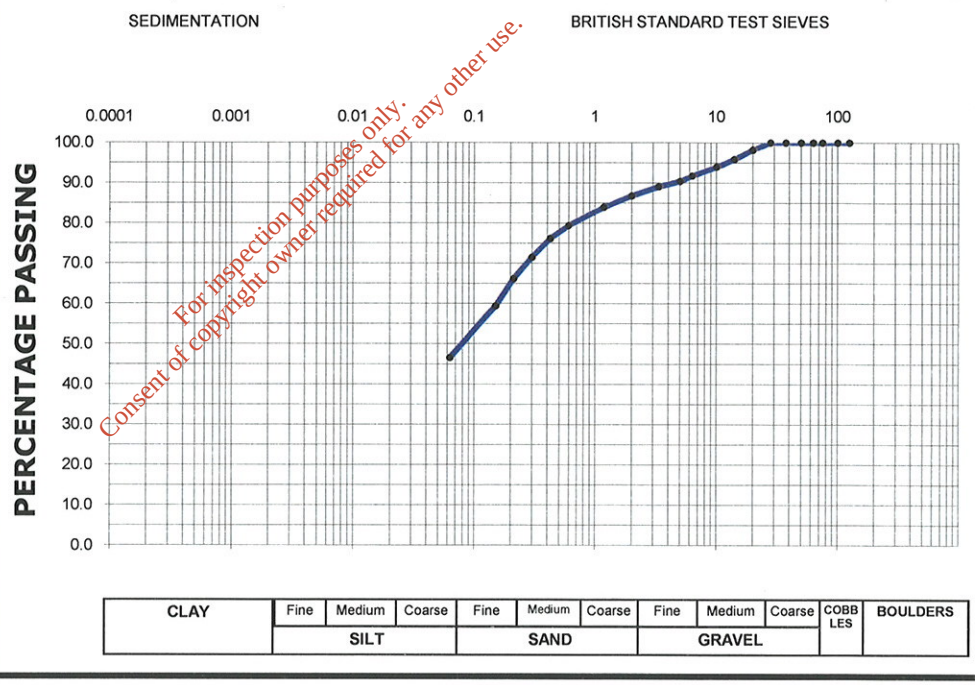
Job Number	10507290308	**Location**	Material sampled from Clane
Sample Number	KCC TP04		
Sample Date	27/09/2010		
Sampled By	Client		

Soil Description	Soft brown slightly gravelly sandy CLAY with some organic material

Mass of Bulk Sample(kg) 10.68 **Mass of Test Sample(g)** 4586.5

Sieve Size	Passing %	Specification
125 mm	100	
100 mm	100	
75 mm	100	
63 mm	100	
50 mm	100	
37.5 mm	100	
28 mm	100	
20mm	98	
14mm	96	
10mm	94	
6.3mm	92	
5 mm	90	
3.35 mm	89	
2 mm	87	
1.18 mm	84	
600 µm	79	
425 µm	76	
300 µm	72	
212 µm	66	
150 µm	59	
63 µm	47	

PARTICLE SIZE mm



Comments

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
KM	29-Sep-10	SN	06-Oct-10		KCC TP04	Naas, Co. Kildare	

Authorised Signatories: ☐ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Liquid and Plastic Limits | **BS 1377 : Part 2 : 1990 : Sec. 4.3 & 5**

ISO 17025 IVNAB ACCREDITED TESTING DETAILED IN SCOPE REG NO 1627

Client Name	**Golder Associates Ireland Ltd**	**Address**	**Town Centre House** **Dublin Road** **Naas** **Co. Kildare**
Contact Details	**C. Coyle**		

Job Number	10507290308	**Location**	Material sampled from
Sample Number	KCC TP05		
Sample Date	27/09/2010		
Sampled By	Client		Clane

Moisture Content	**Soil Description**	
19.5 %		Loose brown sandy gravelly CLAY with some organic material

Test Method: BS 1377 : Part 2 : 1990 : 4.3/4.4		
Tested using one point method for determination of liquid limit		
Proportion retained on 425mm sieve after washing	**37.1**	**%**
Liquid Limit	**45**	**%**
Plastic Limit	**29**	**%**
Plasticity Index	**16**	

Note 1: Test specimen was washed through a 425micron sieve and then allowed to air-dry.
Note 2: One point liquid limit determined in accordance with "Clayton and Jukes 1978".

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
AB	29-Sep-10	SN	06-Oct-10		KCC TP05	Naas, Co. Kildare	✓

Authorised Signatories: ☑ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GeoTesting Ltd.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Particle Size Distribution | **BS 1377 : Part 2: 1990 Clause 9.2**

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 162T

Client Name	Golder Associates Ireland Ltd	**Address**	Town Centre House Dublin Road Naas Co. Kildare
Contact Details	C. Coyle		

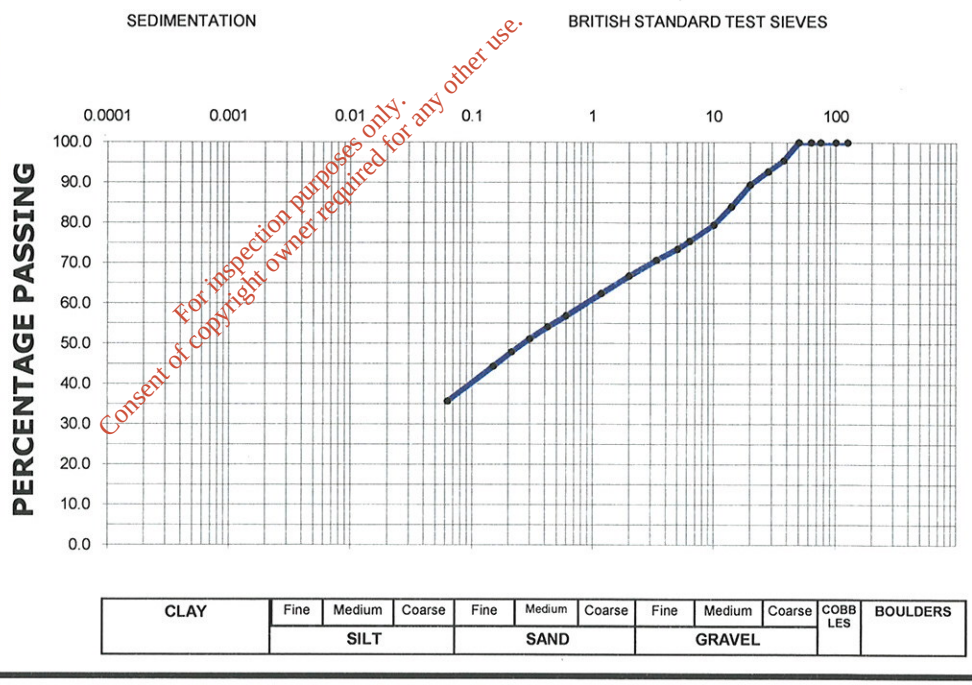
Job Number	10507290308	**Location**	Material sampled from Clane
Sample Number	KCC TP05		
Sample Date	27/09/2010		
Sampled By	Client		

Soil Description	Loose brown sandy gravelly CLAY with some organic material

Mass of Bulk Sample(kg) 10.84 **Mass of Test Sample(g)** 4839

Sieve Size	Passing %	Specification
125 mm	100	
100 mm	100	
75 mm	100	
63 mm	100	
50 mm	100	
37.5 mm	96	
28 mm	93	
20mm	90	
14mm	84	
10mm	80	
6.3mm	75	
5 mm	74	
3.35 mm	71	
2 mm	67	
1.18 mm	62	
600 µm	57	
425 µm	54	
300 µm	51	
212 µm	48	
150 µm	44	
63 µm	36	

PARTICLE SIZE mm



Comments

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
KN	29-Sep-10	SN	06-Oct-09		KCC TP05	Naas, Co. Kildare	

Authorised Signatories: ☑ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Liquid and Plastic Limits | **BS 1377 : Part 2 : 1990 : Sec. 4.3 & 5**

ISO 17025 IVNAB ACCREDITED TESTING DETAILED IN SCOPE REG NO 1621

Client Name	**Golder Associates Ireland Ltd**	**Address**	**Town Centre House Dublin Road Naas Co. Kildare**
Contact Details	**C. Coyle**		

Job Number	10507290308	**Location**	Material sampled from
Sample Number	KCC TP10		
Sample Date	27/09/2010		
Sampled By	Client		Clane

Moisture Content	**Soil Description**	Loose brown very silty very gravelly SAND with some organic material
19.6 %		

Test Method: BS 1377 : Part 2 : 1990 : 4.3/4.4		
Tested using one point method for determination of liquid limit		
Proportion retained on 425mm sieve after washing	**46.1**	**%**
Liquid Limit	**Not Applicable**	**%**
Plastic Limit	**Non Plastic**	**%**
Plasticity Index	**Not Applicable**	

Note 1: Test specimen was washed through a 425micron sieve and then allowed to air-dry.
Note 2: One point liquid limit determined in accordance with "Clayton and Jukes 1978".

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
AB	29-Sep-10	SN	07-Oct-10		KCC TP10	Naas, Co. Kildare	

Authorised Signatories: ☐ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 162T

Determination of Particle Size Distribution | **BS 1377 : Part 2: 1990 Clause 9.2**

Client Name	Golder Associates Ireland Ltd	**Address**	Town Centre House Dublin Road Naas Co. Kildare
Contact Details	C. Coyle		

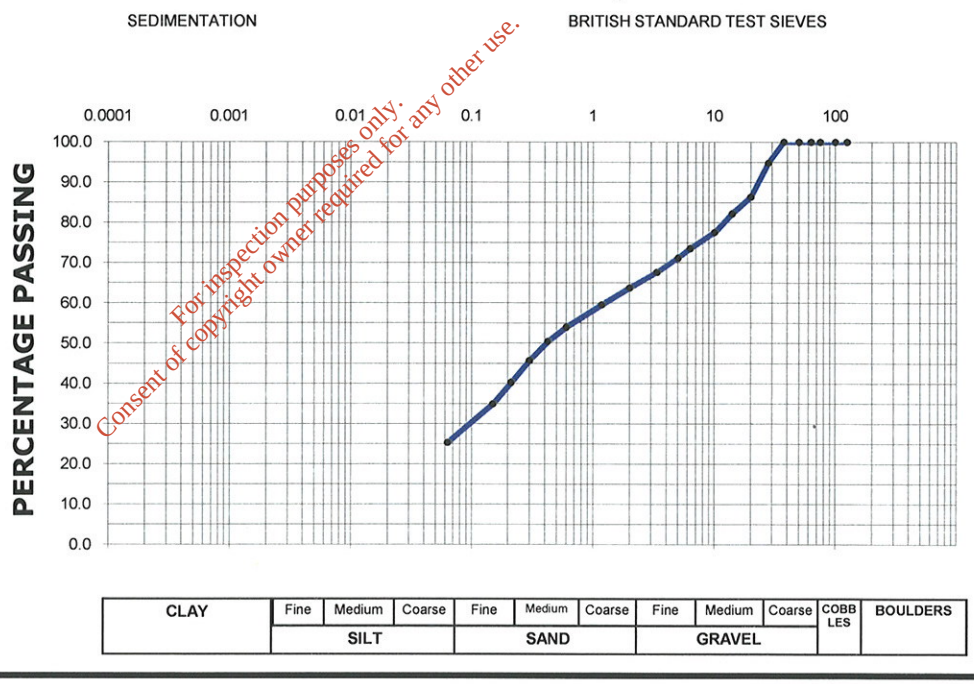
Job Number	10507290308	**Location**	Material sampled from
Sample Number	KCC TP10		
Sample Date	27/09/2010		
Sampled By	Client		Clane

Soil Description	Loose brown very silty very gravelly SAND with some organic material

Mass of Bulk Sample(kg) 13.64 **Mass of Test Sample(g)** 6948

Sieve Size	Passing %	Specification
125 mm	100	
100 mm	100	
75 mm	100	
63 mm	100	
50 mm	100	
37.5 mm	100	
28 mm	95	
20mm	86	
14mm	82	
10mm	78	
6.3mm	74	
5 mm	71	
3.35 mm	68	
2 mm	64	
1.18 mm	60	
600 µm	54	
425 µm	50	
300 µm	46	
212 µm	40	
150 µm	35	
63 µm	25	

PARTICLE SIZE mm



Comments

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
KN	29-Sep-10	SN	07-Oct-10		KCC TP10	Naas, Co. Kildare	

Authorised Signatories: ☐ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GEOTESTING LTD.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Liquid and Plastic Limits | **BS 1377 : Part 2 : 1990 : Sec. 4.3 & 5**

ISO 17025 IVNAB ACCREDITED TESTING DETAILED IN SCOPE REG NO 167T

Client Name	**Golder Associates Ireland Ltd**	**Address**	**Town Centre House Dublin Road Naas Co. Kildare**
Contact Details	**C. Coyle**		

Job Number	10507290308	**Location**	Material sampled from
Sample Number	KCC TP11		
Sample Date	24/09/2010		
Sampled By	Client		Clane

Moisture Content	**Soil Description**	
15.9 %		Loose brown very silty very gravelly SAND

Test Method: BS 1377 : Part 2 : 1990 : 4.3/4.4		
Tested using one point method for determination of liquid limit		
Proportion retained on 425mm sieve after washing	**30.3**	**%**
Liquid Limit	**41**	**%**
Plastic Limit	**27**	**%**
Plasticity Index	**14**	

Note 1: Test specimen was washed through a 425micron sieve and then allowed to air-dry.
Note 2: One point liquid limit determined in accordance with "Clayton and Jukes 1978".

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
AB	29-Sep-10	SN	07-Oct-10		KCC TP11	Naas, Co. Kildare	

Authorised Signatories: ☑ Alan Cardiff (Qual Mgr), ☐ Dave Tutty (Dep Qual Mgr), ☐ Ruth Treacy (Field Services Mgr).

GeoTesting Ltd.

Unit C5, M7 Business Pk, Newhall, Naas, Co. Kildare. Tel: 045 888795; Fax: 045 888796; Email: geotesting@golder.ie

Determination of Particle Size Distribution | **BS 1377 : Part 2: 1990 Clause 9.2**

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 162T

Client Name	Golder Associates Ireland Ltd	**Address**	Town Centre House Dublin Road Naas Co. Kildare
Contact Details	C. Coyle		

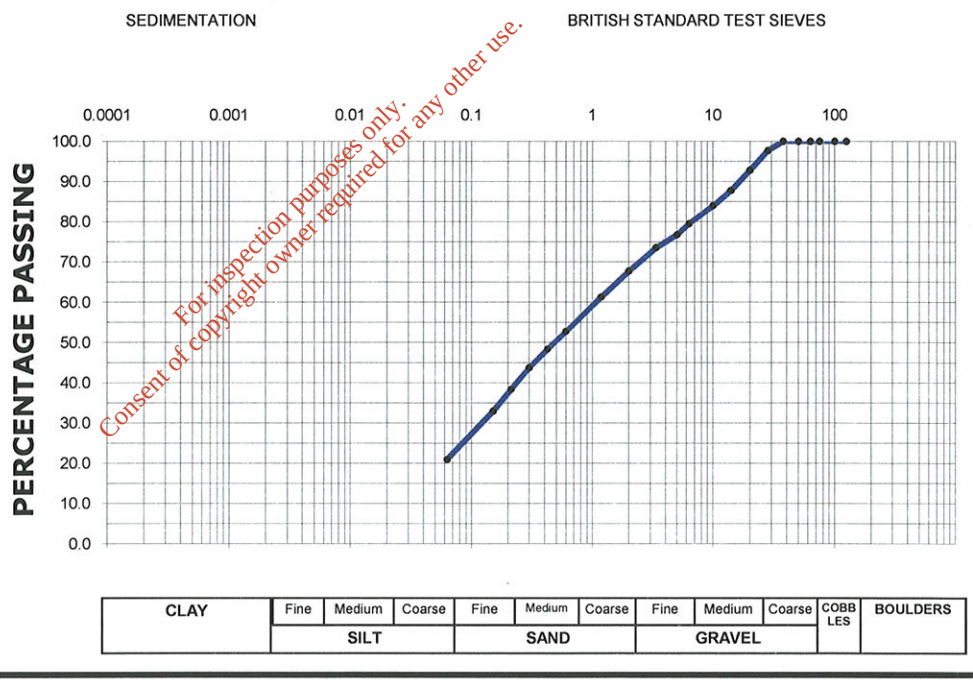
Job Number	10507290308	**Location**	Material sampled from Clane
Sample Number	KCC TP11		
Sample Date	24/09/2010		
Sampled By	Client		

Soil Description	Loose brown very silty very gravelly SAND

Mass of Bulk Sample(kg) 8.1 **Mass of Test Sample(g)** 4165

Sieve Size	Passing %	Specification
125 mm	100	
100 mm	100	
75 mm	100	
63 mm	100	
50 mm	100	
37.5 mm	100	
28 mm	98	
20mm	93	
14mm	88	
10mm	84	
6.3mm	80	
5 mm	77	
3.35 mm	74	
2 mm	68	
1.18 mm	61	
600 µm	53	
425 µm	48	
300 µm	44	
212 µm	38	
150 µm	33	
63 µm	21	

PARTICLE SIZE mm



Comments

Tested By	Date	Checked By	Date	Signed	Report No.	Laboratory	✓
KN	29-Sep-10	SN	07-Oct-10		KCC TP11	Naas, Co. Kildare	

Authorised Signatories: Alan Cardiff (Qual Mgr), Dave Tutty (Dep Qual Mgr), Ruth Treacy (Field Services Mgr).

APPENDIX D

Geophysical Report

September 2010

CELEBRATING 50 YEARS in 2010

GEOPHYSICAL SURVEY

Historical Waste Site, Carrigeen, Clane, Co. Kildare

Submitted to:
Kildare County Council
Naas
Co. Kildare

REPORT

A world of capabilities delivered locally

Report Number. 10507190201/R01/D0

Distribution:

As per main report

Golder Associates

Executive Summary

Golder Associates (Golder) was retained by Kildare County Council to carry out a geophysical survey as part of a ground investigation into the extents of an historical waste site at Carrigeen, Clane, Co. Kildare in September 2010 (the 'Site'). EM31 (electromagnetic induction) and 2D Resistivity Tomography were the geophysical methods employed. The main objective of the survey was to identify both the lateral and vertical extent of possible 'waste' materials beneath the survey area.

The EM31 survey was carried out over the site using a spacing of approximately 3m with a continuous reading taken along survey lines. An interpreted contoured map of the gathered data indicates that the area of 'waste' material is concentrated in the field to the west of the residential property but may extend to the front, side and rear gardens of the property as well as into the paddock to the rear of the property.

Three resistivity lines, cross cutting the known 'waste' area were surveyed using an electrode spacing of 2.0m. This electrode spacing allows for an approximate depth of investigation of approximately 30m below ground level. Lower resistivity values along the lines are interpreted to possibly indicate 'waste' materials, with estimated thicknesses of up to ca. 5m.

Golder recommends that this report is read in close conjunction with the additional intrusive investigations carried out in areas of possible 'waste' material identified from the geophysical surveys to confirm the lateral and vertical extent of the 'waste' materials present at the Site.

Table of Contents

1.0 INTRODUCTION

Golder Associates (Golder) was retained by Kildare County Council to carry out a geophysical survey as part of a Tier 2 Risk Assessment into the extents of an historical waste site at Carrigeen, Clane, Co. Kildare in September 2010 (the 'Site'). The survey consisted of three (3 no.) 2D Resistivity lines across the Site and an electromagnetic induction survey (EM31) over the full extent of the Site. The coordinates of the Resistivity lines were taken along the lines at various points by a surveyor from Golder. The electromagnetic induction survey used a differential GPS system integrated with the system datalogger for continuous location recording during the survey. The surveys were then tied in with existing maps supplied by the client.

1.1 Objectives

The objectives of the geophysical survey were to:

- Identify possible waste areas using 2D Resistivity (both vertically and laterally); and
- Identify the possible extents of the waste area across the Site using EM31.

The identification of possible waste areas and extents was then used to target the intrusive site investigation works detailed in the main report.

1.2 Site Description

The total Site covers an area of approximately 2 hectares (ha). Access is via entrance third class road from Clane and a small cul de sac laneway.

1.3 Report

This report includes the results and interpretation of the geophysical survey. Maps and figures are provided to illustrate the extents of the survey and the results. More detailed descriptions of the geophysical methods employed in this survey can be found in GSEG (2002), Milson (1999) and Reynolds (1997).

Whilst reasonable and practicable efforts have been made to conduct the survey, process the gathered data and interpret the results, non-intrusive ground conditions can only be hypothesised when conducting a non-intrusive survey.

1.4 Methodology

1.4.1 2D Resistivity

The positions of the proposed 2D Resistivity survey lines (Figure 1) were chosen to best investigate the vertical and lateral extents of the 'waste' materials known to underlie the Site.

A SAS 4000 Terrameter (ABEM) instrument was used to collect the data using a gradient array. An 80 electrode (stainless steel) array with an electrode spacing of 2.0m was used to give approximate depths of investigation of about 30m below ground level. This set-up enabled 3 lines to be surveyed over a one day period on 13th September 2010.

Topographical information obtained by the Golder surveyor allowed accurate topographic data for each line to be attained and to be used in the processing of the resistivity data.

The data from the resistivity survey was processed using the software package RES2DINV (V. 3.5). This package allows for the editing of noise from the data, the application of a variety of filters and parameters and the inclusion of topographic information. The results of the inversion indicated that the inverted images produced using a horizontal filter provided the best fit with the observed data, as determined by the Root Mean Square (RMS) errors for the individual inversions. The resulting 2D resistivity pseudosections are presented in Appendix A for each of the resistivity lines surveyed.

The data were interpreted taking into account a number of criteria, including: resistivity pattern, comparison between survey lines and historical maps of the area. Where patterns could be correlated with existing geological information, similar patterns elsewhere along the survey lines were interpreted as having similar

geological conditions. Reference to similar conditions and environments elsewhere enabled a realistic conceptual geological model of the area surveyed to be developed.

1.4.2 Electromagnetic Induction Survey

The GEONICS® EM31 is an electromagnetic induction device well suited to mapping terrain conductivity and response indicative of buried metal and waste material.

With the electromagnetic induction technique, an alternating current is passed through a wire coil (the transmitter) producing a time-varying magnetic field. This field in turn induces current to flow in any nearby conductor, the ground included. These induced currents produce a secondary time-varying magnetic field, which is sensed together with the primary field at a receiver coil. The instrument is one-person operable with the transmitter and receiver coils mounted at either end of a 3.7me long boom. The quadrature and in-phase components of the secondary field are measured relative to the primary field.

Quadrature Response (Apparent Conductivity)

The quadrature component for the EM31 was primarily designed to be sensitive to materials that have a low induction number, such as earth materials, or poorly conducting metallic targets. Typically, the quadrature response is referred to as the apparent conductivity response. The EM31, quadrature response is calibrated to give a measure of the bulk apparent conductivity of the subsurface for a roughly hemispherical volume of radius 5 to 6 m, centred about the measurement point.

Apparent conductivity is a measure of the bulk apparent conductivity of the subsurface, which is primarily a function of interconnected porosity, clay content, moisture content and the dissolved ion concentration in the pore fluid. Temperature, phase state of the pore water, and the amount and composition of any suspended colloids in the pore water also contribute to conductivity but to a lesser degree. An increase in any of these properties would result in an elevated apparent conductivity. Background is estimated as the response from uncontaminated native materials free from the influence of buried or surface metal. Quadrature response is dominated by large positive or negative readings (relative to background) in the near presence of metal conductors, depending on their size, orientation and distribution. Under these conditions, the instrument cannot make a valid measurement of apparent conductivity and the reading can only be considered as an indication of the near presence of highly conductive materials or soils. Instrument output is in milliSiemens per metre (mS/m) which are units of apparent conductivity.

In the absence of buried or surface metal objects, metallic debris or salt impacted groundwater, the EM31 responds to the underlying stratigraphy. A change in clay content in the subsurface significantly alters instrument response because clay particles have a relatively large number of ions adsorbed to their surface. When clays are saturated, these adsorbed ions can become partially dissociated and available for ionic conductivity. Since clay particles have a relatively large surface area, variations in the amounts of clay present can influence the bulk apparent conductivity. Hence, it may be possible to estimate the thickness of fill over a clay substrate where a greater thickness of fill would result in a lower instrument reading.

In-phase Response

The measured in-phase component is most sensitive to targets that have a high induction number and are good conductors (primarily larger surface and buried metal objects). As such, the in-phase response is sensitive to buried and surface metal and relatively insensitive to changes in apparent conductivity of the subsurface. However, highly conductive earth materials can produce an elevated in-phase response. As with the quadrature, in-phase response can be positive or negative (relative to background) depending on the size, orientation and distribution of the metal objects causing the anomalies. Instrument output for in-phase is in parts per thousand (ppt) as a ratio of the secondary to primary field strength.

The electromagnetic induction survey was carried out by walking the Site with the instrument and integrated differential GPS in a series of lines spaced a nominal 3m apart. The apparent conductivity and in phase component was recorded at each recorded GPS point (typically every 1 m to 2 m depending on walking pace). The measured components with their corresponding GPS coordinate were then plotted and contoured. The contoured points were then interpreted (Figure 1).

2.0 WORK CARRIED OUT

2.1 Current Geophysical Investigations

The EM31 and 2D resistivity surveys were carried out on 13th and 14th September 2010. The surveys comprised the following tasks:

- Walkover of Site to validate location of survey area and identify any hazards;
- Installation of electrodes along each line in the case of the resistivity survey; and
- Completion of EM31 and 2D Resistivity Surveys.

The following section (Section 3.0) discusses the findings of the geophysical investigations. Figures 2, 3 and 4 (Appendix A) present the resistivity pseudosections for each of the resistivity lines surveyed generated by the software package RES2DINV (V. 3.5).

3.0 FINDINGS FROM GEOPHYSICAL SITE INVESTIGATIONS

The potential made ground containing waste materials was particularly heterogeneous within the field to the east of the residential property. This was unsurprising as it was known that this section of the Site had previously been a small quarry and had been gradually filled in over a number of years with a variety of waste materials and other materials prior to its most recent use as a paddock for horses.

3.1 2D Resistivity Survey

Figure 1 shows the location of the 3 resistivity lines surveyed. Resistivity pseudosections for the 3 lines are located in Appendix A.

Line 1 (Figure 2)

Line 1 (running from south to north) has a generally flat topography with a gentle rise in elevation towards the north.

Bedrock appears to subcrop between about 3 to 7m below ground level, increasing in depth towards the north of the line away from the road to about 140m. A sharp gradient in resistivity values would seem to indicate a sharp contact between the expected 'waste' materials and the underlying bedrock. However, possible leachate from the waste materials in the underlying bedrock might also provide a sharp contact, thus inferring a depth to bedrock greater than it actually is.

Resistivity values of <100 ohm metres indicate zones of possible 'waste' materials under the central parts of this line, particularly between 46 and 128m. Between 50 and 122m resistivity values suggest predominantly more 'domestic' type wastes (<50 ohm metres) down to depths of ca. 5m below ground level. The higher resistivity values (>50 ohm metres) may indicate more C&D type (and/or drier) waste material.

In summary, the very low resistivity values recorded along Line 1 appear to be well constrained by the underlying bedrock topography. It is recommended that a number of trial pits be excavated to investigate the type of 'waste' materials and depth to bedrock at ca. 50m, 80m, 100m and 125m along this line.

Line 2 (Figure 3)

Line 2 runs sub-parallel to Line 1, trending from south to north across the area, rising gradually towards the north.

As with Line 1, bedrock appears to subcrop between about 3 to 7m below ground level, increasing in depth towards the north of the line away from the road to about 128m. A sharp gradient in resistivity values would seem to indicate a sharp contact between the expected 'waste' materials and the underlying bedrock.

Also, as with Line 1, possible leachate from the waste materials may be encountered towards the centre of this line, around 95m, where resistivity values of <50 ohm metres were recorded. Leachate, if present in the underlying bedrock can produce very low resistivity values comparable to those of the waste materials themselves. A trial pit or monitoring borehole about 95m would help to answer this question. Resistivity values of between 200 and 100 ohm metres along the first 60 metres of this line may indicate the presence of more C&D (dry) type waste materials. A trial pit located about 60m along this line would help to identify the type of materials responsible for these resistivity values. Resistivity values of <50 ohm metres between 62 and 110m might suggest predominantly more 'domestic' type wastes.

It is recommended that intrusive investigations be carried out at selected locations along this line so as to help define the type of 'waste' materials present and to also help identify the base of materials present.

Line 3 (Figure 4)

Line 3 runs sub-parallel to Lines 1 and 2, trending from south to north across the area, rising gradually towards the north.

As with Lines 1 and 2, bedrock appears to subcrop between about 3 to 7m below ground level, increasing in depth towards the north of the line away from the road to about 120m. A sharp gradient in resistivity values would seem to indicate a sharp contact between the expected 'waste' materials and the underlying bedrock.

Resistivity values of <50 ohm metres between 30 and 98m may indicate the presence of possible 'waste' materials under the central part of the line, down to depths of ca. 5 to 7m below ground level. Between 30 and 68m a more resistive layer of materials (ca. 0.5 to 1m thick) can be inferred to exist above the very low resistivity zone.

The sub-vertical low resistivity feature present below 128m is due to a partially buried wire fence. The same feature can also be identified on Line 1 at about 148m.

As with both Lines 1 and 2, the very low resistivity values recorded along Line 3, appear to be well constrained by the underlying bedrock topography. It is recommended that a number of trial pits (in excess of at least 3m deep) be excavated to investigate the type of 'waste' materials and depth to bedrock at ca. 36m, 60m and 82m along this line.

3.2 EM31 Survey

The colour contoured values of apparent conductivity are presented and interpreted in Figure 1. Separate apparent conductivity and in-phase colour contoured values are presented in Appendix B. Figure 1 shows the extents covered by the EM31 survey.

The area to the west of the residential property provides a good indicator of low apparent conductivities (+5 mS/m to -5 mS/m) where bedrock may be close to the surface and the soil above is undisturbed. It is useful when used in comparison with other areas of the Site where ground has been disturbed and waste material may have been deposited. Areas of higher apparent conductivities and high in-phase components correspond particularly well with areas of suspected waste material already identified using historical maps (+15 mS/m to +100 mS/m). These values were then used to estimate the potential extents of waste material across the Site. The potential extents of the 'waste' are estimated to extend from the central and southern parts of the field to the east of the residential property into the front, side and rear gardens of that property. The waste body is also estimated to extend into the grazing paddock to the rear of the property. A rise in conductivity values in this paddock correspond extremely well with a slight fall in ground levels close to the gardens of the house (Figure 1).

Several anomalies were identified from the contoured apparent conductivity and in-phase components (Figure 1). These anomalies are areas with recorded high apparent conductivity and/or in-phase response (>40 mS/m (apparent conductivity) and > 10 ppt (in-phase). These anomalies may represent buried metal.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Two geophysical methods were employed - EM31 (electromagnetic induction) and 2D Resistivity Tomography- at the Carrigeen Site. The main objective of the survey was to both identify the lateral and vertical extent of possible 'waste' materials beneath the survey area.

The EM31 survey was carried out over the Site using a spacing of approximately 3m with a continuous reading along surveyed lines. An interpreted contoured map of the gathered data indicates that the area of 'waste' material is concentrated in the field to the west of the residential property but may extend to the front, side and rear gardens of the property as well as into the paddock to the rear of the property.

In total, 3 No. Resistivity lines, cross cutting the suspected 'waste' area were surveyed using an electrode spacing of 2.0m. This electrode spacing allows for an approximate depth of investigation of 30m below ground level. Lower resistivity values along the lines surveyed are interpreted to possibly indicate 'waste' materials, with estimated waste thicknesses of ca. 5m.

Golder recommends that this report is read in close conjunction with the additional intrusive investigations carried out in areas of possible 'waste' material identified from the geophysical surveys to confirm the lateral and vertical extent of the 'waste' materials present at the Site.

5.0 REFERENCES

GSEG, 2002. *Geophysics in Engineering Investigations. Geological Society Engineering Geology, Special Publication 19, London.*

Milsom, 1989. *Field Geophysics. John Wiley and Sons.*

Reynolds, 1997. *An Introduction to Applied and Environmental Geophysics. John Wiley and Sons.*

Report Signature Page

GOLDER ASSOCIATES IRELAND LIMITED

Jon Hunt
Senior Geologist

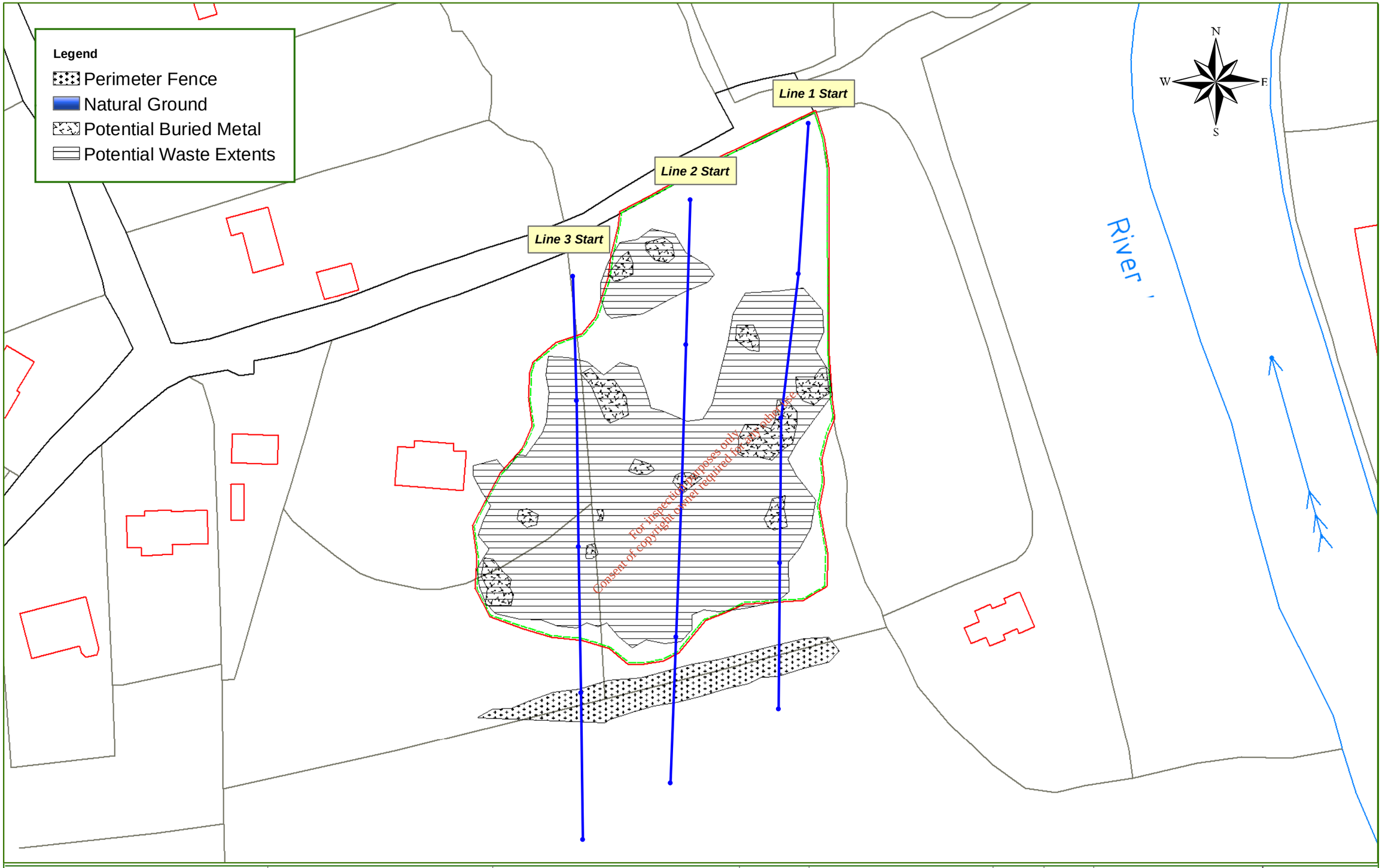
Barry Balding
Associate & Geophysicist

Author:Jon Hunt/BB

Registered in Ireland Registration No. 297875
Town Centre House, Dublin Road, Naas, Co. Kildare
Directors: M. Gilligan, A. Harris
VAT No.: 8297875W

APPENDIX A

Figures



Client: KILDARE COUNTY COUNCIL	Project number: 10507190201	Created by: JH	Issue to: KILDARE CO CO	Date: OCT '10	Revision: A	Title: Electromagnetic Survey Interpretation and Resistivity Line Locations
Location: CARRIGEEN, CO KILDARE	File Location: GRAPHICS\WASTE\KCC\FIG 1	Checked by: BB				Scale: 1:1,010 (A4)
Project: SITE INVESTIGATION	ORDNANCE SURVEY OF IRELAND LICENCE NUMBER AR0056010	Approved by: BB				Figure No. 1

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL: 045 874411 - FAX: 045 874549 - www.golder.com

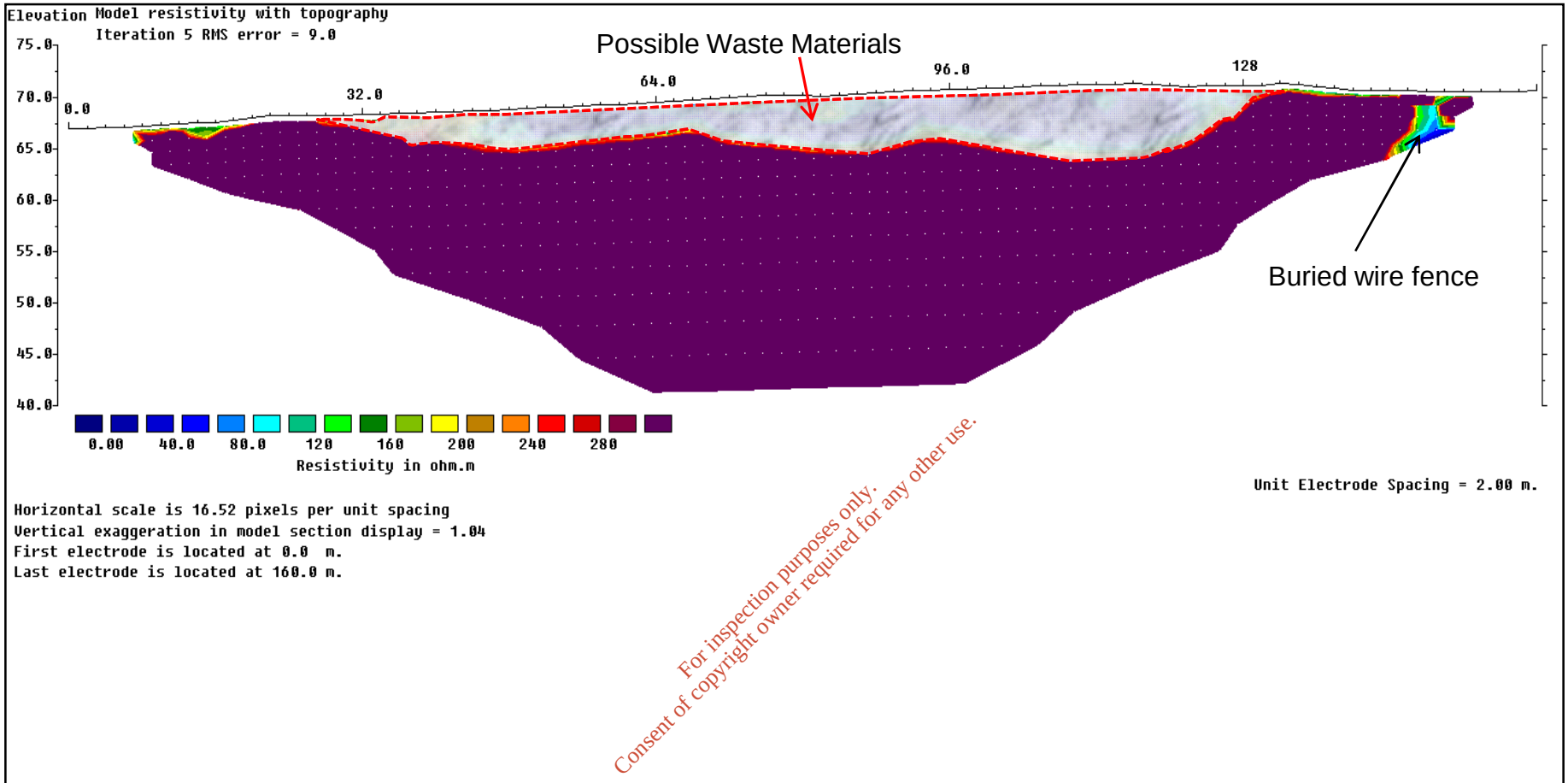


Figure 2

Carrigeen Resistivity Line 1: Looking East

Contour intervals every 20 ohm metres

Elevation in metres OD

Horizontal distance in metres

Golder Associates

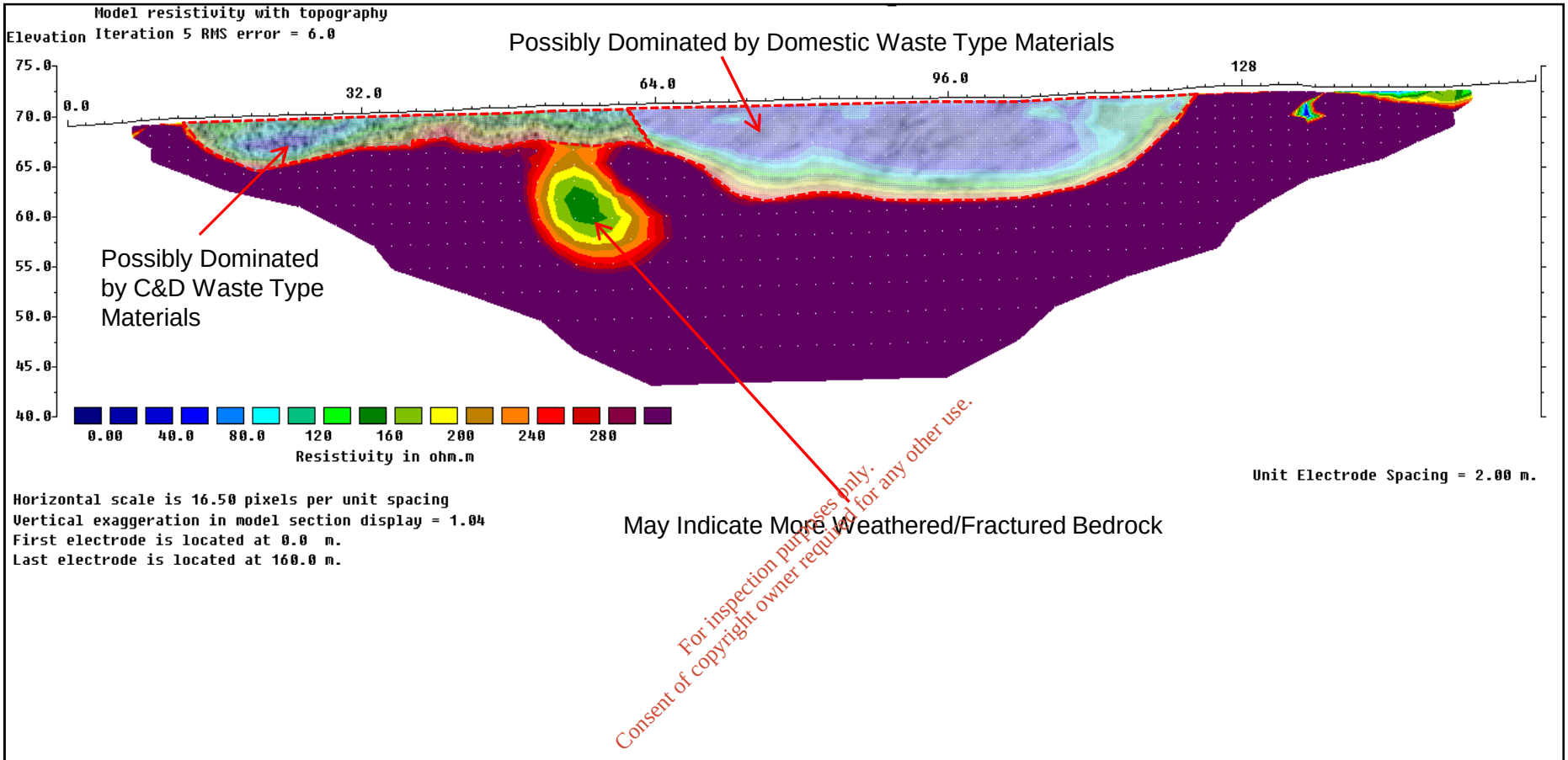


Figure 3

Carrigeen Resistivity Line 2: Looking East

Contour intervals every 20 ohm metres

Elevation in metres OD

Horizontal distance in metres

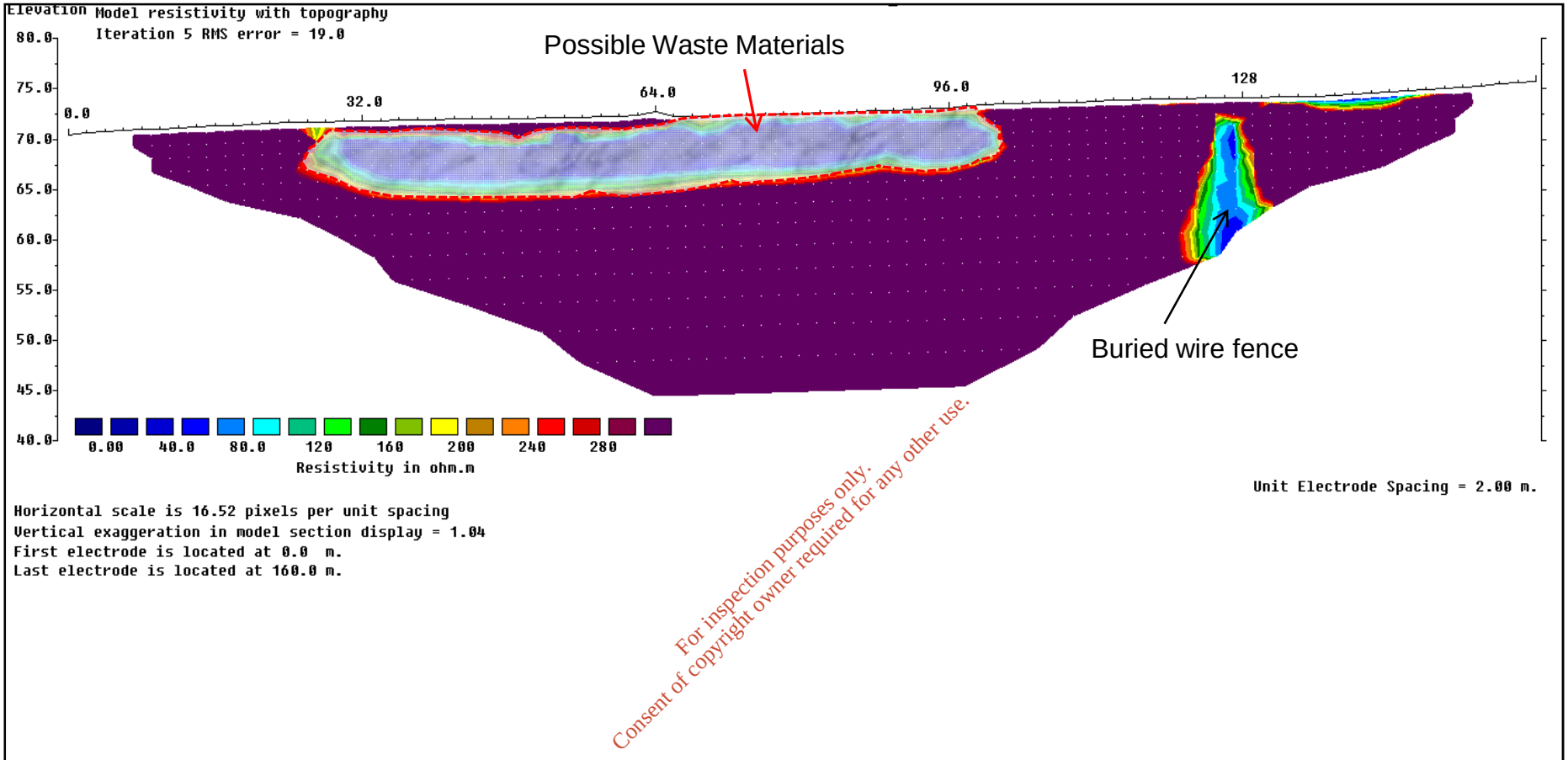


Figure 4

Carrigeen Resistivity Line 3: Looking East

Contour intervals every 20 ohm metres

Elevation in metres OD

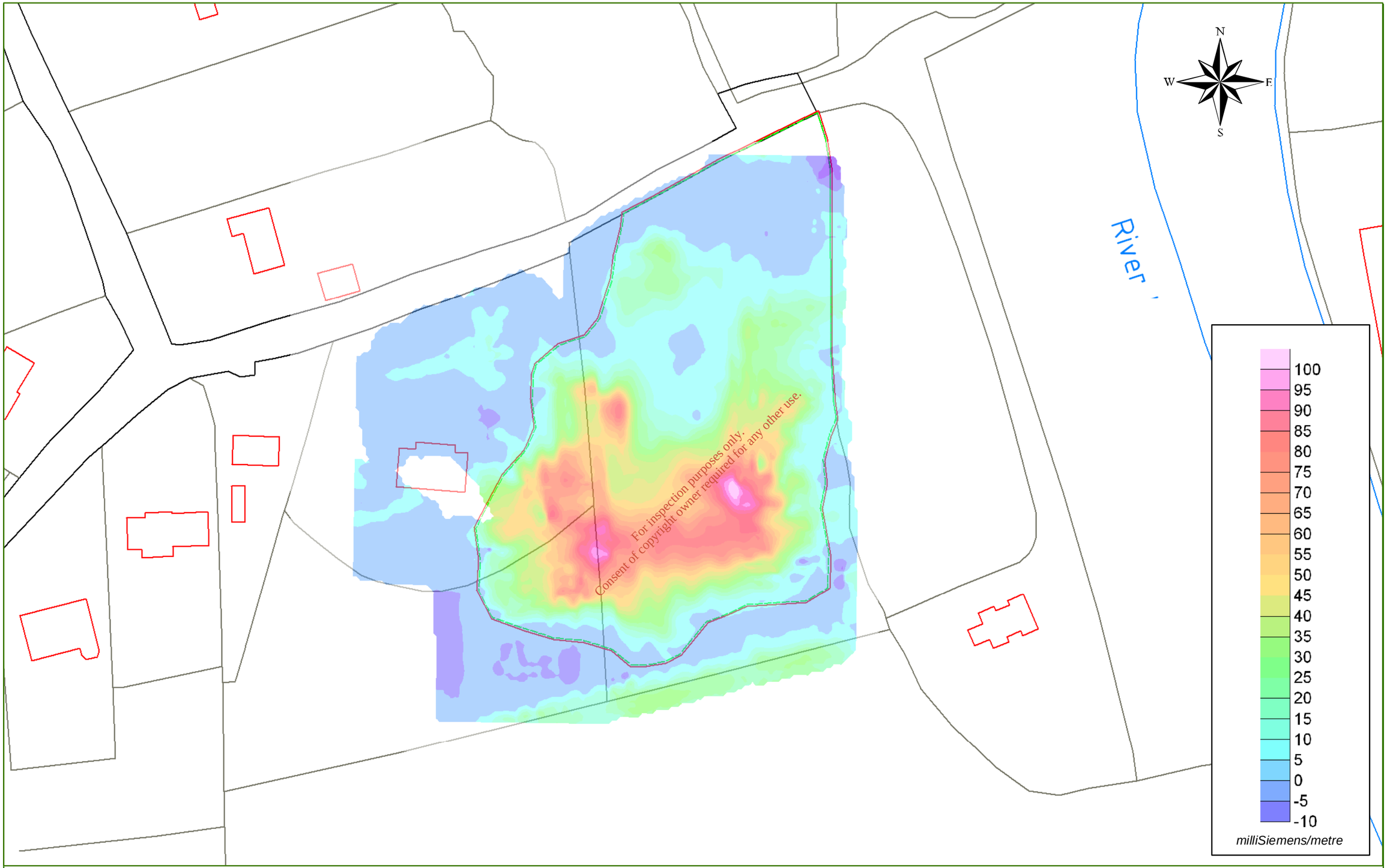
Horizontal distance in metres

Golder Associates

APPENDIX B

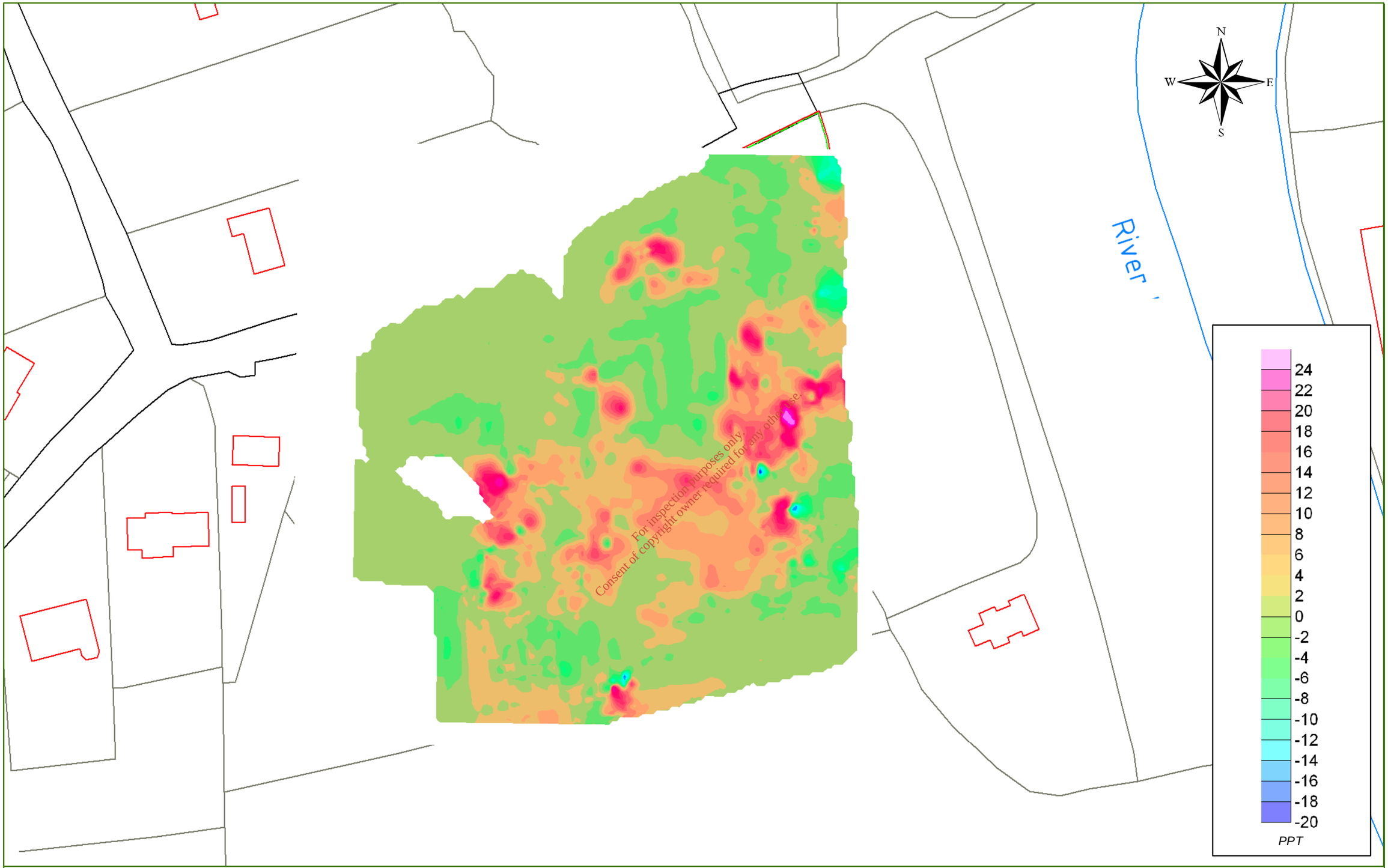
Figure B1: Quadrature Phase EM31

Figure B2: In Phase EM31



Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL: 045 874411 - FAX: 045 874549 - www.golder.com

Client: KILDARE COUNTY COUNCIL	Project number: 10507190201	Created by: JH	Issue to: KILDARE CO CO	Date: OCT '10	Revision: A	Title: Quadrature Phase Contoured Data EM31
Location: CARRIGEEN, CO KILDARE	File Location: GRAPHICS\WASTE\KCC\APPB	Checked by: BB				Figure No. B1
Project: SITE INVESTIGATION	ORDNANCE SURVEY OF IRELAND LICENCE NUMBER AR0056010	Approved by: BB				Scale: 1:1,010 (A4)



Golder Associates

TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL: 045 874411 - FAX: 045 874549 - www.golder.com

Client: KILDARE COUNTY COUNCIL	Project number: 10507190201	Created by: JH	Issue to: KILDARE CO CO	Date: OCT '10	Revision: A	Title: In Phase Contoured Data EM31
Location: CARRIGEEN, CO KILDARE	File Location: GRAPHICS\WASTE\KCC\APPB	Checked by: BB				Figure No. B2
Project: SITE INVESTIGATION	ORDNANCE SURVEY OF IRELAND LICENCE NUMBER AR0056010	Approved by: BB				Scale: 1:1,010 (A4)

At Golder Associates we strive to be the most respected global group of companies specialising in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organisational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ireland Limited
Town Centre House
Dublin Road
Naas
Co. Kildare
Ireland
T: +353 45 87 4411

Golder Associates

APPENDIX E

Photo Sheets

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 1

Trial Heap 1

Trial Pit 2

Trial Heap 2

Date	September 2010	Drawn:	CC
Project No.	10 5071 9 0201	Checked	

Golder Associates

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 3

Trial Heap 3

Trial Pit 4

Trial Heap 4

Date	September 2010	Drawn:	*CC*
Project No.	10 5071 9 0201	Checked	

Golder Associates

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 5

Trial Heap 5

Trial Pit 6

Trial Heap 6

Date	September 2010	**Golder Associates**		Drawn:	*CC*
Project No.	10 5071 9 0201			Checked	

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 7

Trial Heap 7

Trial Pit 8

Trial Heap 8

Date	September 2010	Drawn:	CC
Project No.	10 5071 9 0201	Checked	

Golder Associates

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 9

Trial Heap 9

Trial Pit 10

Trial Heap 10

Date	September 2010	**Golder Associates**	Drawn:	*CC*
Project No.	10 5071 9 0201		Checked	

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 11

Trial Heap 11

Trial Pit 12

Trial Heap 12

Date	September 2010	**Golder Associates**	Drawn:	*CC*
Project No.	10 5071 9 0201		Checked	

SITE PHOTOGRAPHS

Carrigeen, Clane, Co. Kildare, September 2010

Trial Pit 13

Trial Heap 13

Spike Survey

Golder Associates

Date	September 2010
Project No.	10 5071 9 0201

Drawn:	*CC*
Checked	

At Golder Associates we strive to be the most respected global group of companies specialising in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organisational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ireland Limited
Town Centre House
Dublin Road
Naas
Co. Kildare
Ireland
T: +353 45 87 4411

Golder Associates