> Appendix 5: Site Notice

APPLICATION TO
THE ENVIRONMENTAL PROTECTION AGENCY
FOR THE REVIEW OF A WASTE LICENCE

Murphy Environmental, a registered trading division of Murphy Concrete (Manufacturing) Ltd. (MCM), is applying to the Environmental Protection Agency for a **Review of Waste Licence W0129-01** in respect of its inert landfill facility at Hollywood Great, Nags Head, Naul, Co. Dublin (National Grid Reference E315723 N258073). The MCM registered office is located at 6 Hampton Place, Balbriggan, Co. Dublin.

The Licence Review Application proposes to infill an extended quarry area, and at an increased rate per year. The proposed rate of fill is 500,000 tonnes per annum. This review is in accordance with an appropriate planning consent Ref: F07A/0262. An Environmental Impact Statement will be submitted to the Agency to accompany this application.

The relevant waste disposal and waste recovery activities, as per the Third and Fourth Schedules of the Waste Management Acts 1996 to 2007 and the Waste Management Licensing Regulations, 2004 (S.I. No. 395 of 2004), to which this application relate are:

Licensed Waste Disposal Activities, in accordance with the Third Schedule of the Waste Management Acts 1996-2007

Class 1: Deposit on, in or under land (including landfill)

Class 5: Specially engineered landfill, including placement into lined discrete cells, which are capped and isolated from one another and the environment [*Principal activity*]

Class 13: Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced

Licensed Waste Recovery Activities, in accordance with the Fourth Schedule of the Waste Management Acts 1996-2007

Class 3: Recycling or reclamation of metals and metal compounds

Class 4: Recycling or reclamation of other inorganic materials

Class 13: Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced

A copy of the Application for the Review of Waste Licence W0129-01, accompanying Environmental Impact Statement, and any further information relating to the application as may be furnished to the Agency in the course of the Agency's consideration of the application, will, as soon as practicable after receipt by the Agency, be available for inspection or purchase at the Headquarters of the Environmental Protection Agency, PO Box 3000, Johnstown Castle Estate, Co. Wexford.

> Appendix 6: Newspaper Advertisement

- Please note the original document contains a copy of the entire newspaper in which the advertisement was placed

National Roads Authority

Transport

NDP National Development Plan 2007 - 2013

Transforming Ireland

Funded by the Irish Government under the National Development Plan 2007 - 2013

Leitrim County Council

Comhairle Chontae Liatroma

INVITATION TO TENDER

NORTH LEITRIM REGIONAL WATER SUPPLY SCHEME – PHASE II

CIVIL WORKS CONTRACT

PROVISION FOR SUPPLY TO LECKAUN GWS AND FIVEMILEBOURNE PWS

Tenders are invited from competent experienced Contractors to construct approximately **19,482m** of new Watermains and 1 No. **158m³** Precast Concrete Reservoir & 2 No. Pumping Stations and associated works in the vicinity of Fivemilebourne, Co. Leitrim

For full tender information please visit the Public Sector Procurement Opportunities website at www.etenders.gov.ie

Tenders should be clearly marked "**Tender for North Leitrim Regional Water Supply Scheme – Phase 11 – Civil Works Contract**" – and addressed to the **Senior Executive Officer, Corporate Services, Leitrim County Council, Áras an Chontae, Carrick-on-Shannon, Co. Leitrim** to be received not later than **4.00 p.m. on Friday, 17th August 2007.**

NDP National Development Plan 2007 - 2013

Transforming Ireland

Funded by the Irish Government under the National Development Plan 2007 - 2013

www.leitrimcoco.ie

Serving the people with care and quality

Senior Executive Officer, Corporate Services Department, Dun Laoghaire-Rathdown County Council, County Hall, Dun Laoghaire, Co. Dublin.

Dun Laoghaire-Rathdown County Council is subject to the provisions of the Freedom of Information Act 1997.

NDP National Development Plan 2007 - 2013

Transforming Ireland

County Hall, Dún Laoghaire, Co. Dublin, Ireland
Tel: 01 205 4700 Fax: 01 280 6969
Web: www.dlrcoco.ie

TENDERS

RTÉ

Television Studio Carpentry & Painting Support Services

RTÉ invites expressions of interest from suitably qualified companies to provide the above services.

To be considered please provide the following information:

- Details of company Resources and Structure
- Details of relevant experience in the TV / Film industry
- Current TAX Clearance Certificate

Closing date for receipt of expressions is 27th July. All correspondence should be addressed to:

The Purchasing Manager, Robby Hill, RTÉ, Donnybrook, Dublin 4.

of the N2/N3 link road) for the extent of the eastern boundary of the site, including public lighting, [5] new estate roads with public lighting, to include cycle path links from the main open space area to the cycle way in Ratoath Road, and the Church Road, [6] The application will include, for the provision of a new 2 storey 1115 sq m Neighborhood Centre, to house, a Local Convenience Store, Crèche, Café, Pharmacy, Medical Centre, Restaurant and Hair and Beauty salon, [7] storm water attenuation works, storm and foul water drainage, including a link to existing public sewers, [8] set aside of a 5 acre site for proposed new council owned and run school, complete with entrances to the west and pedestrian links to the proposed development, [9] Landscaping to include the provision of amenity open space areas, [10] the application includes for the provision class 1 and class 2 public open space of which 0.94 hectares (2.32 acres) of Class 1 Public Open Space has been relocated from the Chapelwood site, [10] under grounding of the overhead 110kV Corduff/Drybridgeline from the existing substation to the North West Boundary of the site, rising at this point via a pylon, (the ESB will be applying separately for the pylon under an alternative application) [11] and other associated site development works on Lands at Hollywoodrath on the southern side of the junction of Church Road and Ratoath Road, Hollystown, Dublin 15 all on 27.1 hectares (67.04 acres). The planning application may be inspected or purchased between 9.15.30 Monday-Friday at: Fingal County Council, Grove Road, Blanchardstown, Fingal, Dublin 15. A submission or observation in relation to the application may be made in writing to the Planning Authority on payment of a fee of €20, within the period of 5 weeks, beginning on the date of receipt by Fingal County Council of the application.

LEGAL

Schedule 1 Article 4
Employment Agency Act, 1971

Notice of intention to apply to the Minister of Enterprise, Trade and Employment for a license under the above act.

We, Bluestone Resource Management Ltd carrying on business at 9 Marlinstown Park, Dublin Road, Mullingar, Co. Westmeath herby give notice of intention to apply for a licence under the above act to carry on the business of an employment agency at the premises specified below.9 Marlinstown Park, Dublin Road, Mullingar, Co. Westmeath.

CHARTERED ACCOUNTANTS REGULATORY BOARD

Gives notice that public hearings before Disciplinary Tribunals will take place at 10.30 a.m. on Wednesday, 25th July and Thursday, 26th July 2007 at CA House, 83 Pembroke Road, Ballsbridge, Dublin 4.

The alternative route available is via: - Laraghcon Distributor Road, Lucan/Clonee Road, Westcanstown Road, Anna Liffey/Woodwall Road, Luttrellstown Road and Tower Road.

Local access will be maintained at all times.

Any interested persons may lodge an objection in writing with Tommie McManus, Administrative Officer, Transportation Department, Fingal County Council, Grove Road, Blanchardstown, Dublin 15 to arrive no later than 4.30pm on Monday 23rd July 2007.

Tommie McManus
Administrative Officer

APPLICATION TO MEATH COUNTY COUNCIL FOR A WASTECOLLECTION PERMIT RELATING TO ACTIVITIES IN THE LOCAL AUTHORITY AREAS OF COUNTIES MEATH, LOUTH, CAVAN AND MONAGHAN.

MCR Personnel Ltd., 1-3 The Capel Building, Mary's Abbey, Dublin 7, will be making an application to Meath County Council within 2 weeks from the date of this notice, for a Waste Collection Permit to collect non-hazardous household, commercial, industrial, construction and demolition wastes in all areas of Counties Meath, Louth, Cavan and Monaghan.

A copy of the application will, as soon as practicable after receipt by Meath County Council, be available for inspection or purchase at the offices of Meath County Council, County Hall, Navan, Co. Meath. Any member of the public may, within a period of 6 weeks after publication of the application, make a written submission to Meath County Council in relation to this application.

APPLICATION TO THE ENVIRONMENTAL PROTECTION AGENCY FOR THE REVIEW OF A WASTE LICENCE

Murphy Environmental, a registered trading division of Murphy Concrete (Manufacturing) Ltd. (MCM), is applying to the Environmental Protection Agency for a Review of Waste Licence W0129-01 in respect of its inert landfill facility at Hollywood Great, Nags Head, Naul, Co. Dublin (National Grid Reference E315723 N258073). The MCM registered office is located at 6 Hampton Place, Balbriggan, Co. Dublin.

The Licence Review Application proposes to infill an extended quarry area, and at an increased rate per year. The proposed rate of fill is 500,000 tonnes per annum. Thus review is in accordance with an appropriate planning consent Ref: F07A/0262. An Environmental Impact Statement will be submitted to the Agency to accompany this application.

The relevant waste disposal and waste recovery activities, as per the Third and Fourth Schedules of the Waste Management Acts 1996 to 2007 and the Waste Management Licensing Regulations, 2004 (S.I. No. 395 of 2004), to which this application relate are:

Licensed Waste Disposal Activities, in accordance with the Third Schedule of the Waste Management Acts 1996-2007

Class 1: Deposit on, in or under land (including landfill)
Class 5: Specially engineered landfill, including placement into lined discrete cells, which are capped and isolated from one another and the environment [Principal activity]
Class 13: Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced

Licensed Waste Recovery Activities, in accordance with the Fourth Schedule of the Waste Management Acts 1996-2007
Class 3: Recycling or reclamation of metals and metal compounds
Class 4: Recycling or reclamation of other inorganic materials
Class 13: Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced

A copy of the Application for the Review of Waste Licence W0129-01, accompanying Environmental Impact Statement, and any further information relating to the application as may be furnished to the Agency in the course of the Agency's consideration of the application, will, as soon as practicable after receipt by the Agency, be available for inspection or purchase at the Headquarters of the Environmental Protection Agency, PO Box 3000, Johnstown Castle Estate, Co. Wexford.

> Appendix 7: Borehole Logs

- For new groundwater monitoring boreholes drilled for the Waste Licence Review Application

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH10A

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 5/3/2007

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 137.140
0	Monitoring Borehole Air Rotary	Overburden-brown soil		0.00								Bentonite seal
5												
10		Weathered shale		10.00								
15												Riser pipe
20		Limestone		21.00								
25												
30												
35												Bentonite Plug
40												Riser pipe and gravel pack
45												
50												
55												Entry 5/3/07 Screen and gravel pack
60												
65												
70				68.00								EOH

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: CG
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH11A

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 2/5/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 100.01
0	Monitoring Borehole Air Rotary	Overburden/madeground		0.00								Cement Backfill
5		Weathered grey shale		2.00								
10		Fractured shale		8.00								Bentonite
15		Shale		12.00								
20		Heavily weathered shale		18.00								Gravel pack
25		Grey sandy shale		21.00								Screen and gravel pack
30				30.00								
35												
40												
45												
50												
55												
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH12

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 1/5/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	Limestone Groundwater Monitoring Borehole Symetrex	PAVEMENT SURFACE										Top of Pipe Elev. 146.994
		Concrete										Concrete seal
		Overburden		0.30								
5		Shale		5.50								
10												
15												
20												Backfill
25												
30												
35												
40												
45		Limestone		46.00								Bentonite plug
50												Gravel Pack
55												Screen and gravel pack
60												
65				65.00								
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH13

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 15/04/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	Shale Groundwater Monitoring Point / Air Rotary	PAVEMENT SURFACE										Top of Pipe Elev. 146.922
		Pavement										Concrete seal
		Overburden		0.30								
5		Shale		5.50								
10												
15												Riser
20												
25												
30												Bentonite Plug Gravel Pack
35												Gravel Pack, 50mm Screen Water Level 16/04/07
40												
45												Bentonite Backfill
		Limestone		46.00								
				48.00								
50												
55												
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH14

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 2/3/2007

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 125.064
0	Monitoring Well / Air Rotary	Topsoil		0.00								Bentonite
5		Broken weathered shale		6.00								
10												Backfill
15												
20												Bentonite
25												Gravel Pack
30		Limestone		30.00								
35												Screen and gravel pack
				38.00								EOH 2000 gph est.
40												
45												
50												
55												
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: TVM
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

> Appendix 8: Summary List of Monitoring Locations

- Including monitoring locations as per W0129-01
- Additional monitoring locations for the Waste Licence Review Application
- Proposed ongoing monitoring locations under the revised Waste Licence

Summary List of Monitoring Locations
Murphy Environmental, Hollywood (W0129-01)

Monitoring as per Waste Licence W0129-01	Monitoring for the purpose of the Waste Licence Review Application	Proposed Ongoing Monitoring Locations, following Review of W0129-01	Comments
Dust			
D1	D1	D1	No change
D2	D2	D2	No change
D3	D3	D3A	EPA has verbally agreed we can move this point to beside BH10A for ease of access
D4	D4	-	D4 has been tampered with in the past; D5 will replace it
-	D5	D5	To address a new sensitive receptor. It is proposed this will replace D4
-	D6	-	To address a new sensitive receptor, however ongoing monitoring not proposed – potential impact can be assessed by D5
Noise			
N4	N4	N4	No change
N5	N5	N5	No change
N6	N6	N6	No change
-	N7	N7	To address a new sensitive receptor
-	N8	N8	To address a new sensitive receptor
-	N9	-	To address a new sensitive receptor, however ongoing monitoring not proposed – potential impact can be assessed by N8
Surface Water Discharge			
SWD1 (*discharge after flowing through silt trap/oil interceptor)*	SWD1	SWD1	No change
SWD2 (*Water pumped from base of quarry)*	SWD2	SWD2	No change Discharge currently inactive, but may be required again in future
SWD3 (*Water discharge from new settlement pond)*	SWD3	SWD3	No change
SWD4 (*Quarry water discharge from rock cell at south of site)*	SWD4	SWD4	No change
-	Flow into Settlement Pond 1	-	To monitor effectiveness of settlement ponds – ongoing effectiveness will be monitoring at SWD3
-	Flow into Settlement Pond 2	-	To monitor effectiveness of settlement ponds – ongoing effectiveness will be monitoring at SWD3

Summary List of Monitoring Locations
Murphy Environmental, Hollywood (W0129-01)

Monitoring as per Waste Licence W0129-01	Monitoring for the purpose of the Waste Licence Review Application	Proposed Ongoing Monitoring Locations, following Review of W0129-01	Comments
Leachate			
LC1	LC1	LC1	No change
-	LC2	LC2	New leachate monitoring BH
-	LC3	LC3	New leachate monitoring BH
Surface Water			
SW1	SW1	SW1	No change
SW2	SW2	SW2A	Propose to move SW2 closer to the site to provide a suitable downstream sample
Groundwater			
BH4	BH4	BH4	No change
BH5	BH5	BH5	No change
BH6	BH6	BH6	No change
BH8	BH8	-	Propose to decommission as appears to be damaged/blocked/unsuitable – BH12 and BH13 will replace
BH9	BH9	BH9	No change
BH10	BH10 BH10A	BH10A	Propose to decommission BH10 as appears to be damaged/ blocked/ unsuitable and replace with new borehole, BH10A
BH11	BH11	BH11A	Propose to decommission as excavation on all sides and replace with new borehole, BH11A
-	-	BH12	Installed as part of new drilling programme
-	-	BH13	Installed as part of new drilling programme
-	BH14	BH14	Installed as part of new drilling programme

> Appendix 9: Risk Assessment

- For proposed changes to Waste Acceptance Criteria

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

Tel: [353] (0)45 874411
Fax: [353] (0)45 874549
E-mail: info@golder.ie
http://www.golder.com

REPORT ON

HYDROGEOLOGICAL RISK ASSESSMENT AT MURPHY ENVIRONMENTAL SITE AT HOLLYWOOD GREAT, NAGS HEAD, NAUL, CO DUBLIN

Submitted to:

Murphy Environmental
Nags Head
The Naul
County Dublin

DISTRIBUTION:

3 Copies - Environmental Protection Agency
2 Copies - Murphy Environmental
1 Copy - Golder Associates Ireland

July 2007 07507190091

REPORT ISSUE FORM

Version Code	A.1	***Issue Date***	4 July 2007

Document Title	**Hydrogeological Risk Assessment at Murphy Environmental site at Hollywood Great, Nags Head, Naul, Co Dublin** 07507190091
Comments	
List of Authors	Andrew Skelton Anna Goodwin David Hybert
Client	Murphy Environmental
Client Reference	
Project Manager Approval	Thomas Vainio-Mattila (name)
Reviewer	Dr. Stephen Barnes (name)

Report Distribution	***Name***	No. Copies
	Environmental Protection Agency	3
	Murphy Environmental	2
	Golder Associates Ireland	1

Definition of Version Code:

D. Applied during initial drafting of the report before it has been reviewed.

C. Applied after the report has been reviewed but before it has been approved by the Project Manager.

B. Applied after the Project Manager has approved the report ready for issue to the client.

A. Applied to reports after external/client review.

The version number starts at '0' and is raised by '1' at each re-type.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF DRAWINGS

Drawing Ref	Description
RA01 Rev. A	Site location with watercourses
RA02 Rev. A	Site Layout with Phases 1, 2 and 3
RA03 Rev. A	Groundwater Borehole Locations (on-Site)
RA04 Rev. A	Groundwater Borehole Locations (Regional)
RA05 Rev. A	Local Geology
RA06 Rev. A	Cross Section A-A'

LIST OF APPENDICES

Appendix 1	Drawings
Appendix 2	CQA Results
Appendix 3	Monitoring results
Appendix 4	PDFs
Appendix 5	Landsim Model and Results
Appendix 6	Borehole Logs

1.0 INTRODUCTION

Murphy Environmental has requested that Golder Associates Ireland (Golder) assess the risks posed to the groundwater and surface water environment by the existing and proposed inert landfill development at the Murphy Environmental Site, Hollywood Great, Nag's Head, Naul, Co. Dublin. This will be referred to as 'the Site' for the purposes of this report.

Planning permission for landfilling activities at the Site already exists. However, Murphy Environmental proposes to increase the area of the Site and the volume of waste accepted (input rate). Furthermore, Murphy Environmental will submit a Waste Licence Review application to the EPA.

The Council Decision contains an option for Member States to allow the limit values for some parameters to be higher for individual wastes at individual sites, provided that landfill operators demonstrate, through risk assessment, that the environmental risks are acceptable. Under this option, the limits can increase by up to three times the Waste Acceptance Criteria (WAC) limit value. This report details an assessment of the hydrogeological risks associated with such a variation (including LandSim modelling), and will accompany the application.

The assistance of Murphy Environmental and third parties in the provision of data for this work are gratefully acknowledged.

2.0 BACKGROUND AND REPORT STRUCTURE

This report provides a Hydrogeological Risk Assessment (HRA) for the Site. Within this HRA, Golder have assessed the proposed increase in waste volume and Site footprint with respect to the hydrogeological regime at, and adjacent to, the Site.

The Environmental Protection Agency (EPA) recently agreed a change in the waste acceptance criteria for poly aromatic hydrocarbons (PAH) for the Murphy Environmental Hollywood site. The allowable upper concentration limit for PAH was increased from 2mg/kg (for 6 PAHs) (as specified in the Waste Management License) to 100mg/kg (for 17 PAHs) (WO129-01/WAR14EM, EPA January 2007). As such, it is possible that any leachate produced by the waste at the Site will have a higher concentration of PAH than for most other inert sites.

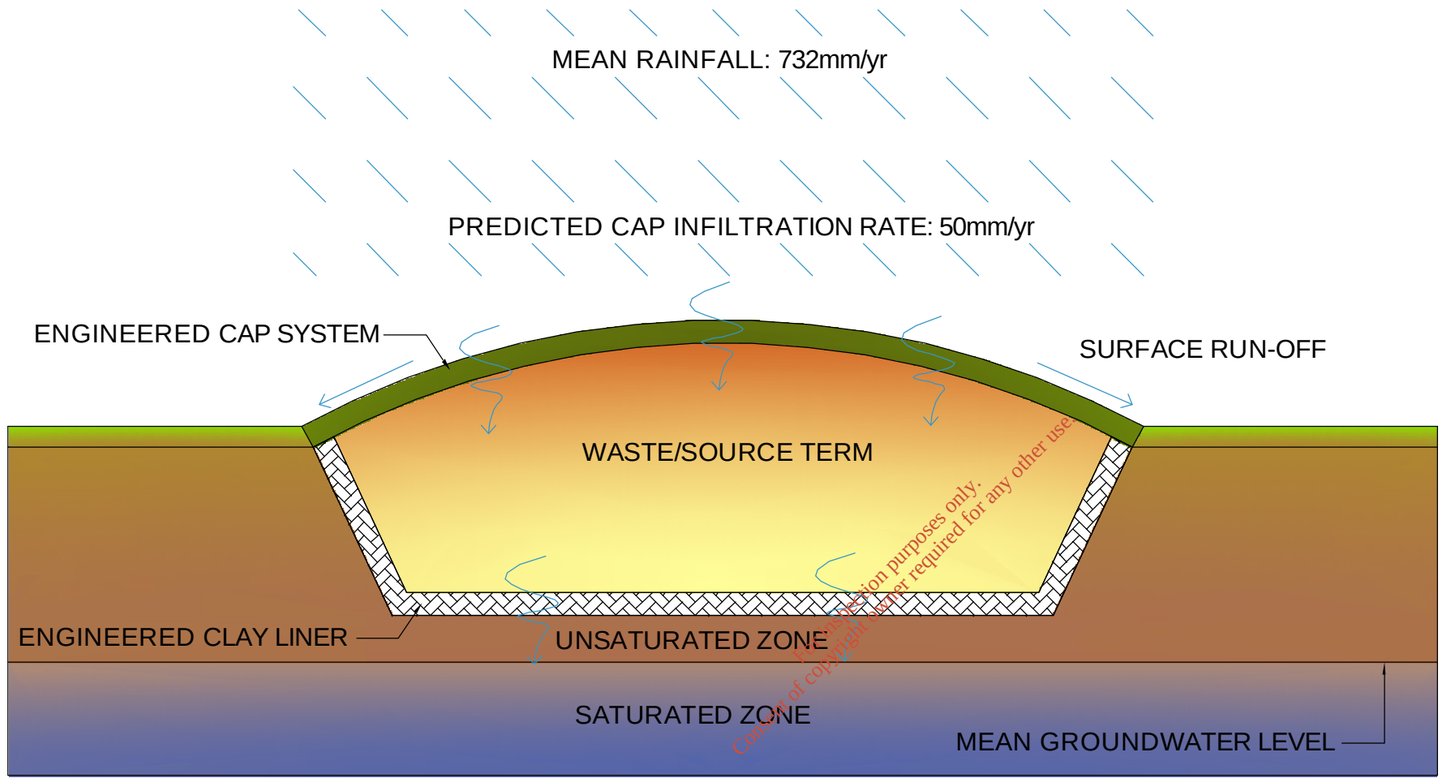
The HRA has been undertaken based on the methodology outlined in the Environment Agency (England and Wales) guidance documents entitled 'Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Levels' (Environment Agency, 2003) and 'Guidance on the Monitoring of Landfill Leachate, Groundwater, and Surface Water' (Environment Agency, 2002). Consultation of EPA documents entitled 'Guidance Documents and Assessment Tools on Environmental Liabilities Risk Assessment and Residuals Management Plans incorporating Financial Provision Assessment (EPA Contract OEE-04-03)' (EPA, 2005) and 'Environmental Risk Assessment for unregulated Waste Disposal Sites' has also been undertaken.

This report presents the conceptual model (see Chapter 7.0) developed by Golder, based on information and data (presented in Chapters 3.0 to 6.0) from the following sources:

- GSI;
- Murphy Environmental;
- Patel Tonra Ltd.;
- Recent installations of five (5 No) new groundwater monitoring locations with associated permeability testing carried out at the new locations;
- GeoTesting Ltd. (Golder).

Chapter 8.0 details the Hydrogeological Risk Assessment modelling using the LandSim Version 2.5.17 Monte Carlo Risk Assessment software. LandSim uses probabilistic performance assessment models to track leachate production, migration and leakage through engineered and non-engineered structures, followed by leachate migration through the unsaturated zone to assess the ultimate impact on the aquifer.

A discussion of the modelling results, along with any conclusions and recommendations can be found in Chapters 9.0, 10.0 and 11.0.



Client: **Murphy Environmental**

Project: **WASTE LICENCE 129-1**

Location: **Hollywood Great, Nags Head, The Naul, Co. Dublin.**

Title: **CONCEPTUAL MODEL**

Project No. 07507190035	Engineer AS	Figure No. FIG 1	
File No. FIGURES	Reviewed by TVM		
Created by AS			
FOR CLIENT REVIEW		JUNE '07	A
Description		Date	Revision

Scale 1:1500A1 Date JUNE 2007

Golder Associates

3.0 SITE DETAILS

3.1 Location and Setting

The Site is located at Irish National Grid co-ordinate 315825, 258140, approximately 19 km north of Dublin (see Figure RA01 Revision A). The town of Naul in located to the northwest of the Site, and Portrane and the Rogerstown Estuary are located to the southeast.

The local area incorporates the quarry and the immediate surrounding area, which is predominantly agricultural land. The land under the control of Murphy Environmental covers an area of approximately 40 hectares. The Site is located close to a local topographic high, which reaches an elevation of 147 m AOD in the west and falls to 99 m AOD along its eastern boundary.

3.2 Site Development and design summary

This Site has been quarried since the 1940s. Limestone, shale and clay have all been quarried at various stages during the development of the quarry. Currently, shale bedrock is being extracted and exported off site. The topsoil, which has been removed to enable excavation of the underlying deposits, is stock-piled on-site for use in the future reinstatement of the landfill.

The Site has a 15 year planning permission to allow extraction of material and reinstatement of the land. Landfilling activities commenced in 2003, therefore, it is anticipated that the Site will be operational until 2018. The quarrying of deep Limestone deposits has ceased. However, the overlying Shale and the clayey deposits continue to be excavated in parallel with the landfilling of previous phases of quarrying. Details of the geology at the Site can be found in Chapter 4.0.

Phase 1 of the development is currently being infilled (see Current Landfill Operations, below). Phase 2 will be constructed to the east of Phase 1, and Phase 3 will be constructed to the south of both Phases 1 and 2 (see Drawing RA02 Revision A).

The restoration plan for Phase 1 of the quarry involves the construction of three lined landfill cells, all to contain inert fill. Cells 1, 2 and 3 have fully CQA engineered liners constructed from local clay. The requirements for the base liner design specification (as per Waste Licence W0129-01) incorporates a thickness of 1 m clay with a permeability of $\leq 1 \times 10^{-7}$ m/s. It is noted that the liner in Cells 1 to 3 has been constructed using a local borrow source – clays with permeability's in region of 1×10^{-10} m/s. The side-walls of each cell are also composed of this low-permeability clay which has been emplaced against the steep rock walls of the pre-existing quarry.

All landfilling to date at the site has taken place in cells engineered to Construction Quality Assurance (CQA) standards. The following reports detail the CQA data for Cell 1, Cell 2, Cell 3, and the Cell 3 extension:

- Construction Quality Assurance Validation Report, Final Report, June 2003. White Young Green, Project No.: C002153.

- Report No. G.031.02 'Report to Environment and Resource Management Ltd. On "Geotechnical Laboratory and Field Testing of Clay Liner System for Cell 2 at Hollywood Great Inert Landfill Facility, Naul, Co. Dublin", GeoTesting Ltd, June 2004

- 'Construction validation report: preparatory works and lining system landfill for inert waste Cell 3 Waste Licence Register WO129-01' Golder Associates, May 2006

- 'CQA report on the construction of the clay liner system for the Cell 3 extension, Hollywood landfill facility, Naul, Co. Dublin' Golder Associates, February 2007

The formation horizon has an agreed final level of 104.5 m AOD prior to a lining or engineering works. This essentially means that some components of the quarry will require significant amounts of backfilling prior to the commencement of landfilling engineering (perhaps approaching 20m in places).

Cell 2 CQA was undertaken by GeoTesting Ltd. in 2004. The results of the clay liner testing for Cells 2 and 3 are presented in Appendix 2.

Filling of Cell 1 and Cell 2 is underway, and both cells are nearing capacity. The construction of Cell 3 was completed during 2006 and has been filled since. It can be estimated that Cells 1 to 3 will be nearing completion in mid 2008. Details of the Site layout can be observed in Figure RA02 Revision A. Following the completion of landfilling activities, it is likely that the restoration of the land will be for agricultural purposes, which is consistent with the predominant surrounding land use. The final cap for the site comprises (in compliance with Waste Licence Register No W0129-01) 150 to 300mm topsoil overlying subsoils, such that the total thickness of topsoil and subsoils is at least 1 metre.

In compliance with the waste licence each waste phase has a leachate monitoring location. These monitoring locations comprise concrete rings with HDPE risers, consisting of 50mm screens which are perforated towards the bottom. The cell bases have a made fall towards the monitoring location.

3.3 Future Development

Murphy Environmental is currently seeking to amend the planning permission to allow an increase in tonnage accepted at the Site per year. The proposed increase will raise the annual

tonnage from 340,000 to 500,000 tonnes per annum. At the same time, Murphy Environmental is seeking to extend the area of activities. For the purposes of this risk assessment, the proposed increased annual tonnage of waste (500,000 tonnes per annum) has been used in all calculations and modelling.

In line with the current Phase 1, works on the future Phases 2 and 3 will involve backfilling the excavations with quarry waste material to level the floor of the Site to 104.5 m AOD. It is proposed that the floors of both Phases are progressively lined with clay (sourced on-site) to a thickness of 1m, with a series of cells created in each Phase. The waste accepted in all future phases of the landfill will be restricted to inert wastes as outlined below and in Section 2.0.

3.4 Waste inputs

Presently, the Waste Licence held by Murphy Environmental allows for the acceptance of inert wastes in compliance with the Council Decision 2003/33/EC ***(2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC)***. Murphy Environmental have procedures in place to accept wastes in compliance with the Council Decision 2003/33/EC, which sets out measures for waste acceptance criteria at landfill sites.

Schedule A.1 of Waste Licence W0129-01 states that a maximum of 340,000 tonnes per annum of 'inert construction & demolition and inert dredging spoils' can be accepted at the site. Schedule A.1 also states that an unlimited quantity of 'inert mineral extraction wastes arising from quarrying activities' may be accepted.

This risk assessment supports the acceptance of wastes at up to three times the inert WAC limit value, as outlined in the Council Decision as being subject to risk assessment.

4.0 GEOLOGY

4.1 Regional Geology

The region is covered by the Geological Survey of Ireland (GSI), Geology of Meath, Map Sheet 13 (1999), and supporting pamphlet. These documents report several lithologies in the area, which are summarised in Table 1, below.

Table 1: Summary of Regional Geology

Lithology		Description	Maximum Thickness (m)
Quaternary	Glacial Till and Boulder Clay Deposits	Variable texture, mainly a clayey to silty matrix with dispersed pebble clasts of Namurian (mid-Carboniferous) **shale and sandstone**, with some limestone. Where deposits are thinner, the matrix tends to be coarser (silty to sandy).	Variable, over 6m thick in certain areas of the Site
Carboniferous	WALSHESTOWN FORMATION	Black **shales** with ironstone, and subordinate siltstone and rippled fine sandstone bands, calcareous mudstone and biosparite	<200m reported
	BALRICKARD FORMATION	Feldspathic micaceous **sandstone with shale** and argillaceous fossiliferous micrite	75-100m reported
	LOUGHSHINNY FORMATION	Dark grey micrites, turbiditic calcarenites and interbedded **shales**	100-150m reported. Thickness on-site unclear
	NAUL FORMATION	Calcarenite and calcisiltite with minor chert and occasional thin **shales**	0-100m reported
	LUCAN FORMATION	Dark grey, well bedded, cherty, graded **limestones** and calcareous shales	300-800m reported

The geology is typical of the geology of most of Ireland, namely comprising a veneer of Quaternary glacial deposits overlying Carboniferous limestones and shales. Overlying the glacial deposits and bedrock is a soil horizon classified as part of the Gley group of soils.

The Quaternary deposits were deposited by an ice sheet that most likely extended from the Irish midlands, southwards and eastwards across the area. As such, the clasts (which are largely limestone dominated) included in these deposits may have been transported for some distance.

The Calp Limestone is a basinal limestone. No karstification has been reported for this formation.

Structurally, the deposits in this area generally dip at 10 degrees in a broad northerly direction. There is a general trend of east-west faulting and folding in the region which corresponds with the Variscan Orogeny period of tectonic activity.

4.2 Local Geology

The local geology is illustrated on Drawing RA05 Revision A. It corresponds well with the regional picture outlined above. Within the quarry, excavations have stripped the topsoil, much of which is stock-piled on-site for future reinstatement. Quaternary deposits encountered have included Boulder Clay and 'Blue Clay'. Up to 6m in thickness of 'Blue Clay' has been found in the subsoil to the north of the site. Samples of these deposits have been tested by Geotesting Ltd. and were found to have permeabilities as low as 8.6×10^{-11} m/s. This material has been used as the primary source for the liner material that forms the base of the engineered landfill cells of Phase 1 (Cells 1, 2 and 3).

The bedrock beneath the Quaternary deposits at the Site comprises thinly bedded black shales, conformably overlying dark grey bedded limestones. These are likely to belong to the rocks of the Balrickard Formation. The limestone is exposed towards the south of the Site where excavations have been deepest. The GSI consider this bedded limestone to belong to the Loughshinny Formation.

On-site observations suggest that there is evidence of small scale thrust faulting and associated chevron folding of the shale deposits running east-west through the centre of the site.

Recent drilling of groundwater monitoring locations around the site has indicated the following thicknesses for the overburden and bedrock formations:

- The strata encountered in borehole BH10a consisted of approximately 10m of overburden overlying 11m of shale. 47m of limestone was found to underlie the shale but the base of the limestone was not reached.

- Borehole BH11a encountered some 2m of overburden and drilling terminated in 30m of shale. Limestone was not reached under the shale.

- In borehole BH12, some 5.5m of overburden was encountered. The bedrock consisted of 40.5m of shale overlying 19m of limestone. Again the final thickness of the limestone was not proven.

- Borehole BH13 encountered 6m of overburden overlying 24m of shale. 8m of limestone was drilled under the shale but the limestone was not fully penetrated.

- Borehole BH14 encountered 6m of overburden overlying 24m of shale. Beneath the shale, 8m of limestone was penetrated.

The GSI report an estimated thickness for the Loughshinny formation of 100-150m in the North Dublin Basin.

4.3 On-Site Conditions

Overburden (clays, till etc) material has been removed from the active quarrying sections of the site in order to gain access to the bedrock, i.e. shale and limestone formations. The overburden comprises of dark brown glacial till and very dark grey stiff clay (known to the site staff as the Blue Clay). The majority of these clay deposits are distributed towards the north-east of the site and are thought to exceed 6m in thickness. Much of the overburden and topsoil is stockpiled in the north-east of the site for future reinstatement works.

Shale has been exposed and excavated in the centre of the site. The exposed material is heavily weathered to orange and black. The thickness of the shale is unknown but is likely to exceed 50m. The bedding of these rocks dips gently towards the north at approximately 10°.

Where excavations have been deeper in the southern end of the site, the underlying limestone of the Loughshinny Formation has been exposed. This area is known as the 'rock cell' to the site staff. These rocks outcrop as evenly bedded dark bluish-grey limestone.

Refer to Drawing RA05 Revision A for details of the on-site conditions.

5.0 HYDROGEOLOGY

The following sources were used to describe and assess the existing hydrogeological conditions at the Site:

- The Groundwater Section of the Geological Survey of Ireland (November 1998),
- Groundwater quality and hydrostatic data from monitoring boreholes installed during September 1998 in connection with the land restoration project, and
- Slug testing (rising/falling head tests) of boreholes in April/May 2007.

5.1 Aquifer Classification

The Geological Survey of Ireland (GSI) divides the North County Dublin/Meath area into four principle hydrogeological regions: The Lower Palaeozoic; The Kingscourt Outlier; the Balbriggan Area; and the Carboniferous Lowlands comprising two main aquifers (the Calp Limestone and the Dinantian Limestones).

The Site is located on the Carboniferous Lowlands region (specifically the Walshestown, Balrickard and Loughshinny Formations of the Calp Limestone), which are considered to be Locally Important Aquifers. Details of these formations are summarised in Table 2, below.

Table 2. Geological Formations at The Naul and their aquifer classification (Source: GSI, 2001)

Formation	Description	Aquifer Classification
WALSHESTOWN FORMATION	Black shales with ironstone, and subordinate siltstone and rippled fine sandstone bands, calcareous mudstone and biosparite	Main aquifer used for public supply in Co. Meath. Classified as Locally Important
BALRICKARD FORMATION	Feldspathic micaceous sandstone with shale and argillaceous fossiliferous micrite	Moderately good (Locally Important)
LOUGHSHINNY FORMATION	Dark grey micrites, turbiditic calcarenites and interbedded shales	Moderately good (Locally Important)
NAUL FORMATION	Calcarenite and calcisiltite with minor chert and occasional thin shales	Moderately good (Locally Important)
LUCAN FORMATION	Dark grey, well bedded, cherty, graded limestones and calcareous shales	Main aquifer used for public supply in Co. Meath. Classified as Locally Important

5.2 Groundwater Vulnerability

The vulnerability of groundwater to contamination is determined by the thickness and type of overburden that overlies the aquifer. The Geological Survey of Ireland works on this premise and categorise groundwater vulnerability into four groups: *Extreme; High; Moderate; and Low* as detailed in Table 3, below.

Table 3. Vulnerability mapping Guidelines (Source: Groundwater Protection Schemes – Dept. of the Environment, EPA & GSI 1999)

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and thickness			Unsaturated Zone	Karst Features
	High Permeability (sand/gravel)	Moderate Permeability (e.g. sandy subsoil)	Low Permeability (e.g. clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Immediately north of the Site there is a veneer of dark-coloured glacial clay ("Blue Clay") up to 6m in thickness overlying the sandstones and shale. In turn there is a more extensive deposit of moraine overlying the Blue Clay, also towards the north of the Site. These deposits provide a certain level of protection to the underlying Limestone Aquifer, and in accordance with Table 3, likely provides for a vulnerability rating of low (L) to moderate (M).

5.3 Hydraulic Conductivity of the Geological Deposits

The glacial deposits overlying the bedrock are generally consolidated and have a fine, clayey matrix. It is understood that a 'falling head' test for permeability was carried out in 2003 by IGSL on behalf of Priority Construction and White Young Green on samples taken from the

Blue Clay. This value was 2.7 x 10^{-10} m/s. The blue clay deposit has been used as the borrow source for much of the cell construction at the site.

Further CQA testing was undertaken by Golder on liner material in-situ in Cells 2, 3 and the Cell 3 extension. Test methodologies consisted of triaxial permeability tests. Results of this testing on these deposits resulted in hydraulic conductivity (often referred to as permeability) values ranging from 1.1 x 10^{-10} to 8.6 x 10^{-11} m/s.

The shale bedrock is a fine-grained rock which is likely to have a low inter-granular (or matrix) permeability. However, it has fine joints and fractures through which water may be able to flow, increasing the permeability of the unit as a whole. Where the shales are more highly weathered they appear to be less siliceous and have weathered to soft clay. These areas are likely to have a lower permeability and may act as local aquitards, limiting water movement.

The limestone bedrock, which is also likely to have low matrix permeability, may be more permeable than the shale rock as a result of the development of fissure and fracture flow zones. Groundwater flow paths, travel times, and well yields can be very variable in such lithologies depending on the presence or absence of fractures.

Rising and falling head tests were carried out on three of the boreholes at the site by White Young Green (1995) to measure the permeability of the bedrock. Satisfactory results were obtained from one borehole (BH5, installed into shale bedrock), from which a permeability of 1.3 x 10^{-6} m/sec was calculated.

Slug tests (both falling and rising head tests) were carried out by Golder (April/May 2007) on boreholes BH10a, BH12, BH13, and BH14, specifically to support this study. The permeability figures obtained are presented in Table 4, below:

Table 4. Summary of Slug Test Results

Borehole	Geological Unit	Test Method	Hydraulic conductivity (m/s)
BH10a	Limestone	Falling Head Test (Hvorslev Methodolgy)	3.55 x 10-7 m/s
		Rising Head Test (Bower & Rice Methodology)	6.52 x 10-8 m/s (Auto Computer Fit) 2.08 x 10-7 m/s (Manual Fit)
BH12	Limestone	Rising Head Test (Bower & Rice Methodology)	1.06 x 10-8 m/s
BH13	Shale	Rising Head Test (Bower & Rice Methodology)	2.32 x 10-8 m/s
BH14	Limestone	Falling Head Test (Hvorslev Methodology)	1.81 x 10-6 m/s
		Rising Head Test (Bower & Rice Methodology)	5.97 x 10-7 m/s (Auto Computer Fit) 1.12 x 10-6 m/s (Manual Fit)

It should be noted that the results of the falling and rising head tests represent the permeability of the deposit immediately around the borehole. Although the permeability of the limestone appears to be similar to that calculated for the shale, on-site observations suggest that the limestone is well fractured in places, and as such, it could be anticipated that in areas the hydraulic conductivity may be greater in this unit.

5.4 Quarry de-watering

Up until 21 May 2007, groundwater has been abstracted at two points within the Site (Drawing RA03 Revision A). The pump installed in the shale sump to the north of the site discharged at an estimated mean rate of 1,575m^3/week to a silt settling pond. This water was then discharged to the adjacent water course. The pump in the limestone sump to the south of the site discharged an estimated mean rate of 1,485m^3/week. The water was discharged to the drain to the east of the site. These abstractions were necessary in order to allow 'dry' material to be excavated from the quarry. The abstracted water was not used at the site.

Former dewatering would have had the affect of lowering the groundwater table immediately in the vicinity of the quarry. When dewatering ceased in May 2007 in the shale sump, groundwater levels were recorded at 88.29mAOD. Since then, one month later and on 21

June 2007, groundwater levels have risen to 94.22mAOD, which is some 10m below the base of the landfill liner (restored formation level). It should be understood that groundwater pumping may resume depending on the needs of the ongoing quarrying and landfilling operations.

5.5 Groundwater Levels and Flow

In order to supplement the number of groundwater monitoring locations, further drilling was undertaken and supervised by a Golder engineer in March/April 2007. The aim of the works was to further characterise the groundwater flow regime, and to estimate the permeability of the bedrock. A series of rotary core and air rotary boreholes were drilled around the perimeter of the Site. This work consisted of the following:

- Replacement of the damaged borehole BH10. A new borehole, BH10a, was drilled to a final depth of 68m below ground level (bgl). It should allow groundwater quality and levels to be monitored to the south of the Site.

- Installation of a new monitoring borehole, BH14. This is adjacent to the south-western corner of the Site, and was drilled to a final depth of 38m bgl.

- Installation of a new monitoring borehole, BH12. This was designed to monitor groundwater in the limestone only, and was drilled to a depth of 65m bgl, with a screened section from 50m to 65m bgl.

- Installation of a new monitoring borehole, BH13. This was designed to monitor groundwater in the shale only, and was drilled to a depth of 48m bgl, with a screened section between 30m to 40m bgl. It should be noted that this borehole was backfilled from 48m to 40m bgl with bentonite grout to ensure that the installation was only in the shale bedrock.

- Installation of a new monitoring borehole, BH11a (installed to replace BH11). This is in the north western corner of the Site and was designed to monitor groundwater in the shale. This was drilled to a depth of 30m bgl, and was screened between 20m to 30m bgl.

The collection of groundwater level data from these boreholes commenced as they were commissioned and will continue in accordance with the Licence requirements for environmental monitoring.

Groundwater levels have been monitored by Patel Tonra Ltd. on a quarterly basis since 2003. The location of the monitoring boreholes is shown on Figure RA04 Revision A, and the full set of data is included in Appendix 3. A summary of the groundwater level data is included in Table 5 below.

Table 5: Summary of Groundwater Level Data

Borehole Ref.	Borehole Top of Casing (m AOD)	Depth of Borehole (m)	Geological Unit Screened	Groundwater Level (m AOD)		
				Min	Mean	Max
BH4	97.22	9.0	Limestone	90.96	93.9	97.22
BH5	118.70	34.9	Shale	90.84	95.03	99.92
BH6 [1)]	117.31	19.5	Shale	117.31	117.31*	117.31
BH8	136.73	4.5	Overburden	132.37	133.17*	133.59
BH9	128.81	49.0	Shale	101.02	102.76	103.97
BH11	121.50	45.7	Shale	90.52	95.42	100.01
BH10a [2)]	137.14	68.0	Limestone	N/A	88.54	N/A
BH11a [2)]	100.01	30.0	Shale	N/A	92.72	N/A
BH12 [2)]	146.99	65.0	Limestone	N/A	94.24	N/A
BH13 [2)]	146.92	35.0	Shale	N/A	111.75*	N/A
BH14 [2)]	125.06	38.0	Limestone	N/A	92.47	N/A

**Groundwater levels above the baseline level of 104.5m AOD (ref: WML).*

1) *Location was observed to be Artesian. Therefore level presented is equivalent to the top of casing.*

2) *One dip event, no range of data yet available at this recent installation.*

Until March 2007, there were six boreholes on-Site which functioned as groundwater monitoring points (BH4, BH5, BH6, BH8, BH9 and BH11). A further borehole, BH10 was dry. It is noted that BH8 appeared to intercept perched groundwater in the shale, presenting groundwater levels which were above those recorded in all other on-site boreholes.

It is noted from the above data that neglecting the three possibly perched groundwater boreholes in the shale, there does not appear to be a pronounced difference between groundwater levels in the shale and those in the limestone (Drawing RA04). Groundwater levels appear to collectively contour and locally provide for a dip in the water table (crossing both units) suggesting flow to the abstraction sumps (now redundant). The groundwater contour plot presented suggests that most boreholes at the site are currently up gradient to the former abstraction sumps.

In order to create a more regional picture of the recent groundwater flow regime, groundwater monitoring data collected at the Site on the 11 October 2005, was combined with groundwater

data collected by RPS Consultants at a nearby site in Toomin on the 12 October 2005. This provided a wider coverage of the area, and allowed a regional groundwater flow direction to be inferred. The groundwater contours from October 2005 are shown on Drawing RA04 Revision A. The approximate gradient of this groundwater flow is 1:35.

On the basis of this information, the inferred regional groundwater flow direction is from the west to the east. This tends to follow local topography as the land dips gently to the east, and suggests some contribution to local watercourses along the lengths of the stream. BH6 at the northern tip of the site is known to exhibit artesian conditions. This is consistent with groundwater baseflow to the stream at the northern end of the site.

5.5.1 Long Term Change

Following the on going completion and restoration of the landfill, it has become unnecessary to continue pumping groundwater from the two sump locations. At present the groundwater level at the site is depressed by the recently terminated dewatering of the bedrock from the sump in the shale and the sump in the limestone (Drawing RA05 Revision A). This indicates that under present circumstances all monitoring wells on the perimeter of the site are up gradient of the landfill, and the sumps are likely to represent the down gradient locations in terms of current groundwater quality. Since the abstractions have ceased, the groundwater level has been observed to rise locally in the shale sump (in a dedicated installed monitoring point formed from concrete rings). This is expected to continue until the regime beneath the site returns to the regional flow direction to the east, and is currently having the effect of changing the groundwater flow behaviour in the vicinity of the site. One month after pumping has ceased in the shale sump, groundwater levels have raised by approximately 6m (Appendix 3). They remain about 10m below the formation level of the landfill.

The return to the natural groundwater flow conditions at the site will be less favourable in terms of the risk assessment modelling than the 'pumped conditions'. Following recovery of the groundwater table (and a return of flow locally to the east), both the unsaturated zone will have reduced (thereby reducing the pathway length to the water table), and the dilution available in the aquifer will reduce as radial flow to the sumps is replaced by natural groundwater underflow. Within the LandSim model, a 1m unsaturated zone only has been relied upon throughout the full life-cycle of the landfill. Given where the water table is at present, there is an element of conservatism (or worst case) to this approach.

5.6 Groundwater Quality

A summary of the groundwater monitoring programme forming Schedule D.4 of the Waste Licence is set out in Table 6 below. Groundwater quality monitoring data has been collected on a quarterly basis since 2003. The full set of data is included in Appendix 3, and a summary of selected parameters is included in Table 7. Mean values recorded are in all cases below their respective EU Drinking Water Standards (DWS).

Table 6: Groundwater Monitoring Regime

Suite	Monitoring Location	Measurement or Analysis Required	Frequency
Water Level	BH4, BH5, BH6, BH8, BH9, BH11	Elevation (m AOD)	Quarterly
Field Measurements	BH4, BH5, BH6, BH8, BH9, BH11	Conductivity, Temperature, pH	Quarterly
Laboratory Analysis	BH4, BH5, BH6, BH8, BH9, BH11	'Murphy Suite'	Quarterly

Table 7: Summary of Groundwater Quality Data

BH ID	Ammoniacal Nitrogen as N (mg/l)				Cl (mg/l)				Sulphate as SO_4 (mg/l)				Cd (mg/l)			
	n	Min.	Max.	Mean	*n*	Min	Max.	Mean	*n*	Min	Max.	Mean	*n*	Min	Max.	Mean
BH4	15	0.1	0.4	0.35	15	18	42	18.6	15	18	61	33.5	4	0.0002	0.0039	0.00133
BH5	15	0.1	0.8	0.227	15	22	31	23.67	15	18	36	24.8	4	0.0002	0.0054	0.0022
BH6	15	0.1	0.4	0.29	15	18	29	20.67	15	35	61	46.6	4	0.0002	0.0049	0.0015
BH8s	15	0.1	0.9	0.31	15	24	60	43.93	15	38	102.7	187	4	0.0002	0.0036	0.00118
BH9	15	0.1	0.3	0.13	15	18	40	22.67	15	31	73	42.1	4	0.0002	0.0037	0.00115
BH10	0	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-
BH11	15	0.2	1	0.41	15	15	41	27.6	15	8	72	27.6	4	0.0005	0.0145	0.0071

6.0 HYDROLOGY

6.1 Rainfall and Evaporation

Total long-term rainfall and potential evapotranspiration for the area are reported by Met Eireann at Dublin Airport for the period 1961 to 1990. The site is located 19 km north of Dublin Airport where average annual rainfall is reported as being 732mm per year and potential evapotranspiration is reported as being 418.4 mm per year. The difference in the two values of 313.6 mm per year provides a first order estimate of the effective rainfall to grass-covered areas around the Site.

6.2 Surface Drainage

In terms of surface water features, there are several streams which rise within 500m of the site (see Drawing RA01 Revision A). A stream runs along the northern boundary, flowing east towards the Rogerstown Estuary. To the south of the site, another stream rises in farmland; this also flows east towards the estuary. To the west of the site, another stream rises and flows west before turning south and eventually east, again finally flowing towards the estuary. A spring has been reported in the golf course to the south of the site. This spring supplies a small lake.

6.3 Surface Water Quality

Surface water quality data has been collected by Patel Tonra Limited on a six-monthly basis as part of the Waste Licence conditions since 2003. The sample locations are upstream and downstream of the Site, and are shown on Figure RA01 Revision A. The full set of data is included in Appendix 4, and a summary of selected parameters in comparison to selected standards is included in Table 8 below. In all cases it can be observed that mean concentrations are below the threshold quoted.

Table 8: Summary of Surface Water Quality Data 2004 – 2007

	Sulphate (mg/l))	Chloride (mg/l)	Ammoniacal Nitrogen (mg/l)	Cadmium (mg/l)	Nickel (mg/l)
Surface Water Regulations Class 3*	200	250	3.11	0.005	-
SW1					
Min	31	18	0.1	Not Monitored	Not Monitored
Max	299	53	0.3	Not Monitored	Not Monitored
Mean	165	39.75	0.1375	Not Monitored	Not Monitored
Std dev	189.5046	9.9535	0.0144	Not Monitored	Not Monitored
SW2					
Min	110	30	0.1	Not Monitored	Not Monitored
Max	254	61	0.3	Not Monitored	Not Monitored
Mean	182	39.625	0.125	Not Monitored	Not Monitored
Std dev	101.8234	9.54594	0.01071	Not Monitored	Not Monitored

*SI No. 294/1989 – European Communities (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations 1989

7.0 CONCEPTUAL SITE MODEL

7.1 Definitions

In the definition that has become accepted by the environmental and waste industries, there are three components to any risk assessment:

- The *source* is the potentially contaminative components of the leachate that will be generated by the percolation of infiltrating precipitation through the waste;
- The *pathways* are any routes linking the source with the receptors including the landfill liner, the unsaturated zone, and the saturated zone in which attenuation processes may occur; and
- The *receptors* are groundwater and surface water bodies that are connected to the source by the pathways, such as surface watercourses, local supply boreholes, or springs.

Should either one of the source, pathway, or receptor be absent from the site setting, negligible risk will be posed to the groundwater and surface water environment. The three components of the risk posed from the disposal of waste at site are described in the following sections.

7.2 Source Term

The source term is the potentially contaminating components of the leachate that may be generated from the decomposition of waste within the Site. Where available, site specific leachate quality data is used as a source term.

Leachate quality monitoring has been undertaken at one (1 No) location on a bi-annual basis since 2004 (LC1). The location of the monitoring point is shown in Figure RA05 Revision A. The full set of results is included in Appendix 3 and summarised in Table 9 below.

Table 9: Summary of Leachate Quality Data 2004 – 2007

	Sulphate (mg/l))	Chloride (mg/l)	Ammoniacal Nitrogen (mg/l)	Cadmium (mg/l)	Nickel (mg/l)
LC1					
Min	1847	1771	2	Not Monitored	Not Monitored
Max	2901	2871	10.8	Not Monitored	Not Monitored
Mean	2363.7	2319.4	7.9	Not Monitored	Not Monitored
Std dev	361.6	435.8	2.88	Not Monitored	Not Monitored

Ammoniacal nitrogen, chloride and sulphate are currently included in the environmental monitoring programme, and can be used as indicators of the presence of leachate. Ammonium concentrations can be observed to be very low within the site leachates, which will reflect the lack of biodegradable wastes. Sources of chloride have likely derived from

materials accepted from Spencer Dock in Dublin, while the sulphates have likely originated from C&D Trommell Fines previously accepted to the site. The latter have not been accepted to the site since around the end of 2006. The full range of chloride and sulphate concentrations determined to date in the site leachates will be modelled in all current and future areas of the site.

Nickel and cadmium have not previously been included in the monitoring regime, but will be modelled to assist in determining the impact from a potential List I and List II substance which may be present in the site.

As set out by Council Decision 2003/33/EC, it is possible to take waste up to three times the inert Waste Acceptance Criteria strength into an inert landfill site. It is understood that this has been occurring periodically at the Murphy Environmental site for specific waste streams. As a consequence, the maximum leachate concentrations considered within the site simulation (LandSim model) for cadmium and nickel has been selected at three times the Co concentrations as outlined for inert wastes. The Co concentrations are equivalent to those that would be present in the first liquid to emerge from maximum strength inert wastes as part of a percolation test. This is considered to be a very conservative approach to determining likely leachate strengths at three times the relevant WAC values.

The parameters selected for modelling provide for a range of contaminant behaviours from a conservative unretarded anion (chloride) to a heavily retarded metal (cadmium). PAHs specifically have not been modelled. PAHs consist of a large range of substances which have differing characteristics. It is suggested that the parameters selected provide for a range of contaminant transport behaviours which will cover most aspects of specific PAH compounds.

7.3 Pathways

Following the recent cessation of active groundwater control at the site (likely to be temporary only) and associated rise in groundwater level, within the model a 1m unsaturated zone only has been relied upon within the LandSim model. On this basis, any leachate forming within the waste mass could have the potential to migrate through the following pathways:

- leachate seepage via the base and sidewalls of the Site into the unsaturated zone and then any groundwater contained within the underlying strata. Migration via the side walls into any perched units are assumed to ultimately also contribute to the main water table beneath the site; and
- leachate breakthrough at the interface of the cap and then as overland flow into any local surface water drainage channels.

The first pathway could be considered to be characteristic of normal operating conditions at the site. Sidewall leachate migration in relation to basal leakage is typically insignificant, particularly when leachate heads are low. The latter pathway would only be possible if leachate heads were not controlled within the waste, and the basal liner could support large

enough leachate heads to allow for breakout at the surface. Often in deep clay lined landfills (i.e. no synthetic lining component) the leachate may accumulate on the base until leakage equals cap infiltration. At this time an equilibrium is reached and the leachate head will accumulate no further. In any case, it is assumed here that breakout via the cap would be prevented in the long term by active leachate management as necessary.

7.3.1 Pathway through the Landfill Containment Engineering

Based on the above understanding, leachate could potentially seep through the engineered containment system. This would be driven by the accumulation of leachate on the base of each landfill cell, resulting in a head gradient across the basal lining. This would allow leachate to migrate outwards into the unsaturated backfill deposits below.

Any leachate seeping through the landfill liner will be attenuated by dispersion and sorption processes. The amount of sorption onto the clay liner that may occur will depend on the partition coefficients (Kd) of the contaminants present in the leachate with respect to the clay properties.

7.3.2 Pathway through the Unsaturated Zone

The quarrying activities at the Site have resulted in the excavation of in-situ shale into the limestone unit. The basal formation level of the landfill is to be brought to 104.5 m AOD using the existing quarry wastes in compliance with the Waste Licence requirements. It is assumed that the rise in groundwater level, following the cessation of active dewatering at the site, will result in the preservation of an unsaturated zone beneath the clay liner of at least 1m in thickness. Any contaminant attenuation within the backfilled unsaturated materials will be conservatively neglected within the model.

7.3.3 Pathway through the aquifer

The bottom of the quarry lies largely on the base of the shale, which until recently has been subject to de-watering activities. The two abstraction sumps at the site previously formed the elevation of the saturated bedrock directly beneath the landfill. This has now risen by several meters within the past month, and is envisaged to return to tie in with the natural groundwater drainage towards the east. The saturated material will consist largely of in-situ shale and limestone as well as backfilled material sourced on-site (broken and weathered shale). Figure RA06 Revision A is a geological cross section, showing the recent site conditions with regard to groundwater levels and restoration levels.

7.4 Receptors

7.4.1 Compliance Points

The guidance document *Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Levels* (Environment Agency, 2003a) states that:

"Member States shall take the necessary steps to:

a) Prevent the introduction into groundwater of substances in List I; and

b) Limit the introduction into groundwater of substances in List II so as to avoid pollution of this water by these substances."

Therefore the following compliance points for List I and List II substances are used in the risk assessment.

7.4.1.1 Groundwater Receptor

In respect of potential leakage through the basal or sidewall lining system, the compliance point for the List I substances will be at the point of entry into the main groundwater table below the site.

The compliance point for List II substances will be groundwater at the down gradient Site boundary. For the purposes of the risk assessment it is assumed that BH4 or BH11a is the boundary receptor (i.e. following the gradual return to drainage towards the east).

7.4.1.2 Surface Water Receptors

The proximity of the Site to local watercourses suggests that these will also be potential secondary receptors where groundwater provides an element of baseflow. Within this context, compliance with the protection of groundwater at the Site boundary should be protective of surface water features. Surface water, as such, has therefore not been considered further.

8.0 MODELLING METHODOLOGY

8.1 Introduction

The probabilistic software proposed for the Murphy Environmental Site Hydrogeological Risk Assessment is LandSim v2.5.17. LandSim has been developed by Golder for the Environment Agency (England & Wales). This approach will allow the computer simulation of leakage through the base of various phases to be modelled on the basis of key landfill design parameters and its setting.

Few of the input parameters (such as cap infiltration) are known exactly. However, each parameter can be described by a range of possible/probable values incorporating the available information. During each simulation the parameters are assigned a value from within the defined ranges. After say 500 iterations, a range of possible predicted leakage or outcome values are obtained and it becomes possible to quantify the likelihood of a certain outcome.

This approach uses statistical distributions or probability density functions (PDF's) to characterise some of the input parameters. Each time a calculation is carried out, one value from the defined input distributions is chosen by the computer code and for example a concentration at the receptor is calculated. Each result is stored such that after repeating the same calculation many times, an output distribution for the concentration at the receptor is obtained. The distribution output is given in terms of percentiles (%iles). These %iles specify the probability with which a certain value (e.g., leakage rate) will not be exceeded. For instance, if the 95%ile of a leakage rate distribution is given as 0.1 m^3/day, there is a 95% chance that the actual leakage rate will be below or equal to 0.1 m^3/day. It follows that there is also a 5% chance that the actual leakage rate will be above this.

8.2 Key LandSim Input Parameters and Modelling Rational

8.3 Landfill Phases or Cells

Within the software, each phase the current and proposed landfill will be considered separately within the quantitative modelling. The existing engineered cells (Cell 1, 2 and 3 – separated by 1m high bunds) are considered as Phase 1. The areas that will be developed in the near future to the east and north are considered Phase 2. The areas to the south are considered Phase 3. Since risks associated with these areas in terms of leachate quality and depth are conceptual, there is no reason to assume that source terms or potential migration characteristics will be significantly different in each phase. The model allows for a cumulative impact from the completed site as a whole at the down stream boundary.

8.3.1 Source term

The source terms to be used for individual phases at the site are summarised in Table 10 below.

Table 10. Leachate source concentrations

Phase		Contaminant Concentration (mg/l)				
		Chloride[1]	Sulphate[1]	Cadmium[2]	Nickel[2]	Justification
Phase 1, 2 and 3	Min	1771	1847	0.0006	0.0036	Chloride and Sulphate values are min., mean and max. concentrations as monitored in Phase 1 Leachate Sump (LC1). Max. Cadmium and Nickel values are chosen as three times the Co concentrations as per EU Council Decision
	Likely	2319	2264	0.006	0.036	
	Max	2871	2901	0.06	0.36	
		(Triangular)	(Triangular)	(Log triangular)	(Log triangular)	

[1] Concentrations taken from bi-annual leachate monitoring of LC1. Min and Max values are taken as actual minimum and maximum concentrations recorded during the monitoring period

[2] Concentrations taken as three times the inert Co concentrations as per Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (2003/33/EC).

Data are entered into the software as probability density functions (PDFs). PDFs can be entered as either linear distributions, or typically if the data range exceeds an order of magnitude, as log distributions. PDFs are produced either using the modeller's judgement and by using statistical techniques (e.g. histograms) depending on the quantity of the data.

Within LandSim, leachate concentrations will also be designed to decline with time as leachable contaminants are flushed from the waste mass. The magnitude of the decline will be influenced by the thickness of the waste and the infiltration rate through time. The restoration plans as provided by Murphy Environmental allow for an indication of the proposed thickness of waste at Hollywood.

8.3.2 Cell geometry

The cell geometries used in the LandSim model are listed in Table 11 below.

Table 11. Landfill dimension

Phase	Floor Area [X] m^2	Cap Area [X] m^2
Phase 1	26,000	42,800
Phase 2	40,800	46,100
Phase 3	81,000	102,900

[X] Plan areas determined by AutoCAD from conceptual site layout. Inter-cell berms are circa 1m high in Phase 1 and are likely to be similar in Phases 2 and 3.

The capping system for the future phases is conceptual at this stage. It is understood that it will be compliant with Waste Licence W0129-01.

The waste thickness values used in Landsim are derived by comparing at the final restoration elevation and subtracting the finished cell floor level and allowing the highest and lowest

points of the restoration surface to represent the thickest and thinnest parts of the waste body. Table 12 presents the estimated future waste thicknesses.

Table 12. Estimated final waste thicknesses

	Floor Level mAOD	Distribution chosen	Justification
Phase 1 (Cell 1,2,3)	105.5	Uniform (16.5,29.5)	Estimated as approximate maximum difference between post settlement restoration plan and existing Phase 1 design floor level
Phase 2	105.5	Uniform (2.5,19.5)	Estimated as approximate maximum difference between post settlement restoration plan and proposed Phase 2 design floor level
Phase 3	105.5	Uniform (9.5,42.5)	Estimated as approximate maximum difference between post settlement restoration plan and proposed Phase 3 design floor level

8.3.3 Leakage from the different phases

Leakage rates can be calculated from contained landfill areas if details of the lining system and leachate heads are known. The current Phase 1 construction relies on a low permeability basal and side-wall liner. The current and future phases of the site will be modelled using the available CQA data from the site to date. It is assumed within the model that the same clay source will be used throughout the development, and that these will remain the same properties as those installed to date.

It is assumed that leachate heads will be controlled at ≤1m in Phases 2 and 3 throughout the lifecycle of the site, and a 1m head will be introduced to the model in these areas. In Phase 1, leachate heads are modelled as a range between 1m and 3m (with 1m as the most likely value). The latter recognises the current short term leachate heads in Cell 1 at the site.

8.3.4 Hydrogeological regime

8.3.4.1 Recharge

As part of the requirements for a Groundwater Risk Assessment, likely recharge rates to the site should be provided that highlights the likely leachate production rates per year. Table 13 below provides potential rainfall infiltration rates to various elements of the current and future site. These data are based on phase footprint areas and infiltration rates. During the active period of the site, the difference between total and effective rainfall data (1961-1990, recorded at Dublin Airport) has been used for infiltration rates to the waste mass, and during the post closure phase 50mm/year infiltration rate has been used as being representative of that through the final cap (150 to 300mm topsoil and subsoil 700 to 850mm so that total thickness will be no less than 1 metre).

Table 13. Predicted site infiltration volumes (annual)

	Estimated cap area (m^2)	Leachate production rates per year (m^3)		Justification
		Site active (@0.5228m/yr)	Capped site (@ 0.05m/yr)	Difference between total and effective rainfall m/yr on exposed waste and mean estimated infiltration m/yr through CQA cap
Phase 1 (Cell 1,2,3)	42,800	22384.4	2140	
Phase 2	46,100	24110.3	2305	
Phase 3	102,900	53816.7	5145	

8.3.5 Pathways and receptors

Characteristic CQA data for the clay liner used in Phase 1 of the landfill has been utilised from Cells 2 and 3. PDF's were generated from the data provided that relate to the hydraulic properties of the liner system (Appendix 2). Table 14 summarises the distributions used in the LandSim model. It is assumed that the same clay source will be used in future phases.

Table 14. Clay liner properties

Parameter	Distribution chosen	Justification
Hydraulic conductivity (m/s)	Triangular (9.4E-11, 2.2E-10, 3.7E-10)	Range of data from CQA information.
Moisture content (fraction)	Triangular (0.13, 0.166, 0.22)	Range of data from CQA information

Basal leakage from both the current and future landfill phases at Murphy Environmental will typically seep down through the basal liner and into the unsaturated portion of the made ground (in this case made ground will be site material used to restore and level the quarry floor). It is assumed that the groundwater level recovery will be such that at least a 1m unsaturated zone will remain below the base of the liner at all times. Values used to represent the unsaturated zone within the model are provided in Table 15 below.

Table 15. Unsaturated zone properties

Parameter	Distribution chosen	Justification
Pathway length (m)	Single (1)	Assumed minimum following groundwater recovery
Moisture content (fraction)	Uniform (0.01, 0.035)	Golder judgement for seepage through fractured strata/backfill

Leachate may enter the groundwater and would be expected to migrate along the known regional groundwater flow direction to the east. Parameters to describe the aquifer pathway are derived from the available site specific data for the relevant units. Distributions chosen are presented in Table 16 below.

Table 16. LandSim inputs to represent the aquifer pathway (bedrock)

Parameter	Distribution chosen	Justification
Aquifer hydraulic conductivity	Log uniform (1E-6, 1E-5)	Based on site specific slug test data and taking into account the potential for a more permeable fracture network
Porosity (%)	Uniform (0.05, 0.1)	Derived from mean values for shale and limestone in Freeze and Cherry 1979
Hydraulic gradient	Single (0.03)	Based on regional water table gradient

8.3.6 Retardation and decay

Partition coefficient (kd) data for contaminant transport modelling that will be used for the site is presented in Table 16 below.

Table 16. Partition coefficient data used in modelling the landfill liner

Contaminant	Kd (l/kg)	Distribution	Justification
Cadmium	600	Single	Golder judgement based on values in ConSim Help files
Nickel	20, 66	Uniform	ConSim Help files
Chloride	0	Single	Treated as unretarded
Sulphate	0	Single	

It should be noted that no contaminant retardation has been allowed for within either the unsaturated zone or the aquifer. This is conservatively based on the fact that most flow will probably be via fractures and retardation would be minimal. Not of the contaminants modelled are organic and none will be subject to biodegradation processes. These have therefore also been neglected within the model in all pathways.

9.0 RESULTS

The impacts determined from the scenario described above are provided below.

9.1 List I substances

The drinking water quality standard for cadmium is 0.005mg/l. In all cases the model predicts that the concentrations of cadmium reaching the water table are lower than this threshold. The maximum value reported beneath the site had a concentration of 0.004mg/l at the 95%ile (beneath Phases 1 and 3). The most likely values (50%ile) discharge concentrations ranged from 0.001mg/l to 0.0006mg/l.

9.2 List II and non listed substances

Table 18 below presents the concentrations predicted at the downstream site boundary. These are cumulative results from all landfill phases.

Table 18. List II and non listed concentration in the aquifer at the site boundary

	Time to peak conc. (years)	50%ile concentration	Time to peak conc. (years)	95%ile concentration
Chloride	77	53	66	172
Nickel	1600	0.0009	1374	0.003
Sulphate	86	59	74	179

The EU Drinking Water Standards (DWS) for chloride, nickel and sulphate are 250mg/l, 0.05mg/l, and 250mg/l respectively. It can be observed that the 95%ile results (can be view as worst case result from the model) are all less than their corresponding DWS values. The 50%ile values, which can be viewed as the most likely result from the model, are all considerably lower than the 95%ile output and the corresponding DWS.

10.0 CONCLUSIONS AND RECOMMENDATIONS

Golder have completed an assessment of the risks posed to the water environment from the current and future landfilled areas at the Murphy Environmental Landfill Site at Hollywood. The landfill has been developed since 2003 and all areas to date have CQA installed clay lining systems. Future phases at the site will have an equivalent lining system. The risks have been assessed for specified leachate heads on a phase by phase basis and with respect to a cumulative impact for the total development.

10.1 Leachate and Groundwater Composition

Available analysis of the leachate in the site suggests that concentrations for some parameters can be above those typical of inert landfills in general. However, within this context leachate concentrations may vary significantly from one phase to another, as the site progresses, due to the waste streams accepted and within the context of the inert waste list acceptable.

Routine leachate quality data for the site is available. Ammonium concentrations are very low, reflecting the lack of biodegradable materials accepted to the site. Most analysis is for inorganic parameters. One PAH measurement had a less than detect return (<0.2mg/l).

Groundwater in boreholes surrounding the site is currently judged to have good groundwater quality. Historically all wells are likely to have been up gradient of the landfill as water was abstracted from the centre of the quarry site at two sump locations. As and when abstraction is terminated, natural flow in the immediate vicinity is expected to gradually resume towards the east in line with the regional trend.

10.2 Leakage Rates

Based on the works completed, the performance of the current and future phases identified was derived from predicted leakage. These calculations were based on up to a potential 3m head in Phase 1, and a 1m head in future areas across the site. It is concluded that the leakage rate from the site will be directly proportional to the leachate head on the site base.

10.3 Impact on Water Environment

The LandSim modelling undertaken has simulated leachate strengths up to what are considered to be greater than those likely generated by waste streams at three times the WAC limit value for inert landfills. Impacts associated with this source term have been determined probabilistically in conjunction with the likely long term shape to the water table beneath the site.

Output from the LandSim v2.5 contaminant transport modelling using the above hydrogeological understanding, is consistent with no discernible discharge of List I substances (cadmium) and no cumulative concentration of non-List I contaminants (chloride, sulphate or nickel) in the aquifer beyond their respective Drinking Water Standards.

10.4 Review

A limitation of this assessment includes an absolute source term for the future site in particular. Golder believes that this has been constrained as well as possible given the need to determine leachate strengths at three times the WAC values and the early stage of the site development to date. More source term information will become available as the site grows and this can be fed back into the Hydrogeological Risk Assessments. It is recommended that these are undertaken every five years to allow for an on going review and verification of the model.

11.0 REFERENCES

Geology of Meath: A Geological Description, with accompanying Bedrock Geology 1:100,000 Scale Map, Sheet 13, Meath. GSI Publication, 2001

Council Decision 2003/33/EC ***(2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC***

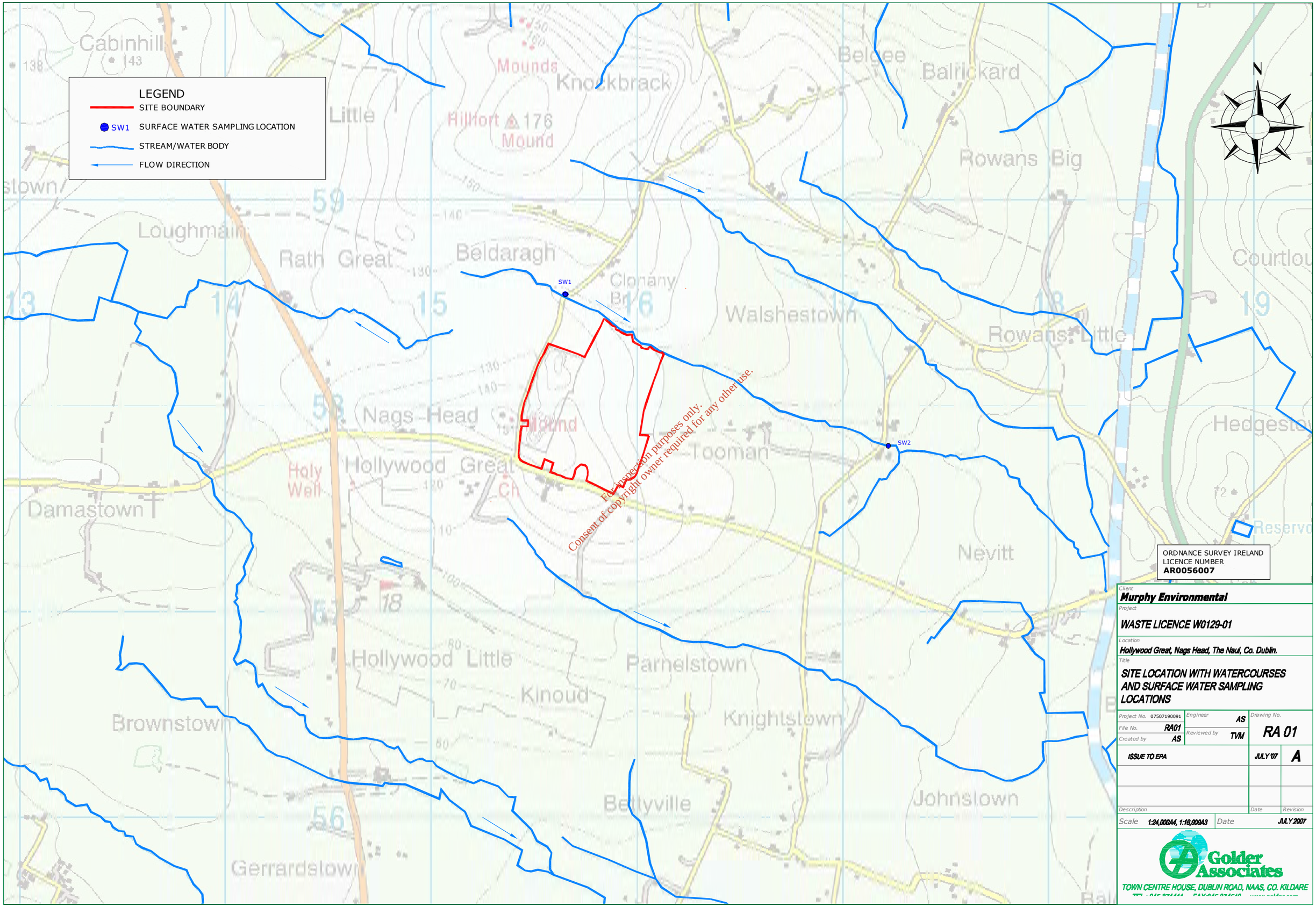
Report No. G.031.02 'Report to Environment and Resource Management Ltd. On "Geotechnical Laboratory and Field Testing of Clay Liner System for Cell 2 at Hollywood Great Inert Landfill Facility, Naul, Co. Dublin", GeoTesting Ltd, June 2004

'Construction validation report: preparatory works and lining system landfill for inert waste Cell 3 Waste Licence Register WO129-01' Golder Associates, May 2006

'CQA report on the construction of the clay liner system for the Cell 3 extension, Hollywood landfill facility, Naul, Co. Dublin' Golder Associates, February 2007

APPENDIX 1

DRAWINGS



ORDNANCE SURVEY IRELAND
LICENCE NUMBER
AR0056007

Client
Murphy Environmental

Project
WASTE LICENCE W0129-01

Location
Hollywood Great, Nags Head, The Naul, Co. Dublin.

Title
SITE LOCATION WITH WATERCOURSES AND SURFACE WATER SAMPLING LOCATIONS

Project No. 07507190091	Engineer AS	Drawing No.	
File No. RA01	Reviewed by TVM	RA 01	
Created by AS			
ISSUE TO EPA		JULY '07	A
Description		Date	Revision

Scale 1:24,000A4, 1:18,000A3 Date JULY 2007

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE

PHASE 1

PHASE 2

PHASE 3

LEGEND

- SITE CONTOURS
- PHASE 1 BOUNDARY AREA (4.28Ha)
- PHASE 1 FLOOR AREA (2.60Ha)
- PHASE 2 BOUNDARY AREA (4.61Ha)
- PHASE 2 FLOOR AREA (4.08Ha)
- PHASE 3 BOUNDARY AREA (10.29Ha)
- PHASE 3 FLOOR AREA (8.11Ha)
- LAND HOLDING

Client
Murphy Environmental

Project
WASTE LICENCE WO129-01

Location
Hollywood Great, Nags Head, The Naul, Co. Dublin.

Title
SITE LAYOUT WITH EXISTING PHASE 1, AND PROPOSED PHASES 2 AND 3

Project No. 07507190091	Engineer AS	Drawing No. RA02	
File No. RA02	Reviewed by TVM		
Created by AS			
ISSUE TO EPA		JULY 07	A
Description		Date	Revision

Scale 1:1500A1 Date JULY 2007

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE

CORED
BOREHOLE
BH12
TOC 146.994mOD
WL 94.244mOD
LIMESTONE

AIR ROTARY
BOREHOLE
BH13
TOC 146.922mOD
WL 111.750mOD
SHALE/PERCHED

BH8
TOC 136.73mOD
WL 133.17mOD
SHALE
PERCHED

BH9
TOC 128.81mOD
WL 102.91mOD
49m DEEP
SHALE

BH6
117.31m TOC
>117.31m ARTESIAN
19.5m DEEP
BLACK SHALE

AIR ROTARY
BOREHOLE
BH10
WELL DRY

AIR ROTARY
BOREHOLE
BH10a
TOC 137.14mOD
WL 88.535mOD
LIMESTONE

SUMP
WL 85.11mOD
09/05/07

LC1

LC3

LC2

SUMP
WL 88.29mOD
09/05/07

BH5
TOC 118.70mOD
WL 90.84mOD
34.9m DEEP
BLACK SHALE

BH11
TOC 121.50mOD
WL 90.96mOD
50m DEEP
BLACK SHALE

BH11a
TOC 100.01mOD
WL 92.72mOD
SHALE

BH14
TOC 125.064mOD
WL 92.469mOD
LIMESTONE

BH4
TOC 97.22mOD
WL 92.417mOD
9m DEEP
LIMESTONE

LEGEND

- SITE CONTOURS
- LAND HOLDING
- GROUNDWATER CONTOURS FOR 08/05/2007
- IMPLIED GROUNDWATER FLOW DIRECTION
- EXISTING BOREHOLE
- LC1 LEACHATE MONITORING POINT

Client: **Murphy Environmental**

Project: WASTE LICENCE WO129-01

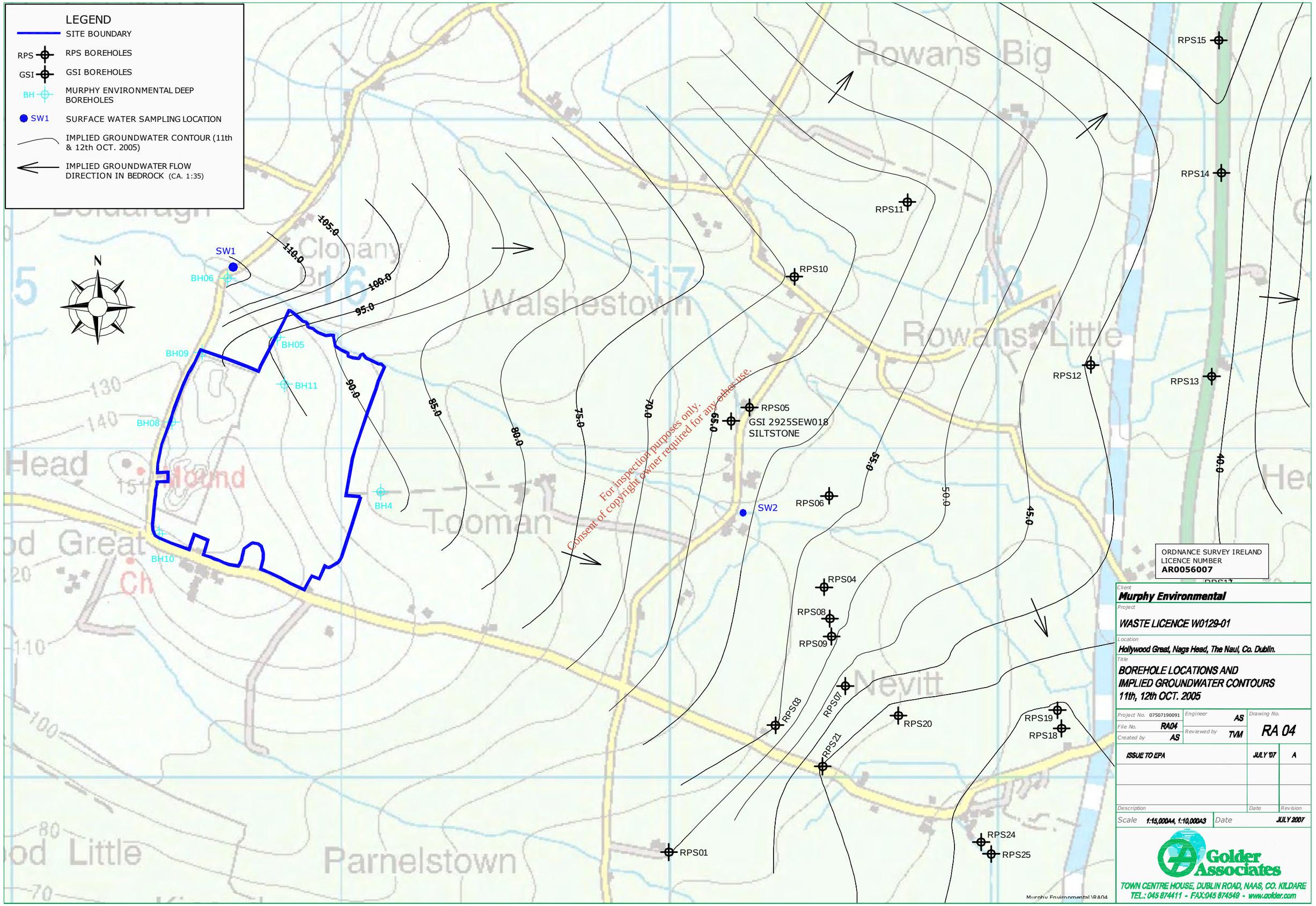
Location: Hollywood Great, Nags Head, The Naul, Co. Dublin.

Title: **IMPLIED GROUNDWATER CONTOURS**

Project No. 07507190091	Engineer AS	Drawing No. RA03	
File No. RA03	Reviewed by TVM		
Created by AS			
ISSUE TO EPA		JULY '07	A
Description		Date	Revision

Scale 1:1500A1 1:3000A3 Date JULY 2007

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE



ORDNANCE SURVEY IRELAND
LICENCE NUMBER
AR0056007

Client
Murphy Environmental

Project
WASTE LICENCE W0129-01

Location
Hollywood Great, Nags Head, The Naul, Co. Dublin.

Title
BOREHOLE LOCATIONS AND IMPLIED GROUNDWATER CONTOURS 11th, 12th OCT. 2005

Project No. 07507190091	Engineer AS	Drawing No. RA 04	
File No. RA04	Reviewed by TVM		
Created by AS			
ISSUE TO EPA		JULY '07	A
Description		Date	Revision

Scale 1:15,000A4, 1:10,000A3 | Date JULY 2007

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

Murphy Environmental \RA04

CORED
BOREHOLE
BH12
TOC 146.994mOD
WL 94.244mOD
LIMESTONE

AIR ROTARY
BOREHOLE
BH13
TOC 146.922mOD
WL 111.750mOD
SHALE/PERCHED

BH8
TOC 136.73mOD
WL 133.17mOD
SHALE
PERCHED

BH9
TOC 128.81mOD
WL 102.91mOD
49m DEEP
SHALE

BH6
117.31m TOC
>117.31m ARTESIAN
19.5m DEEP
BLACK SHALE

AIR ROTARY
BOREHOLE
BH10
WELL DRY

AIR ROTARY
BOREHOLE
BH10a
TOC 137.14mOD
WL 88.535mOD
LIMESTONE

SUMP
WL 85.11mOD
09/05/07

LC1

PHASE 1
(CELLS 1,2,3)

BH5
TOC 118.70mOD
WL 90.84mOD
34.9m DEEP
BLACK SHALE

SUMP
WL 88.29mOD
09/05/07

A

A'

BH11
TOC 121.50mOD
WL 90.96mOD
50m DEEP
BLACK SHALE

BH11a
TOC 100.01mOD
WL 92.72mOD
SHALE

BH14
TOC 125.064mOD
WL 92.469mOD
LIMESTONE

BH4
TOC 97.22mOD
WL 92.417mOD
9m DEEP
LIMESTONE

LEGEND

- SITE CONTOURS
- LAND HOLDING
- GROUNDWATER CONTOURS FOR 08/05/2007
- IMPLIED GROUNDWATER FLOW DIRECTION
- EXISTING BOREHOLE
- LC1 LEACHATE MONITORING POINT
- MADEGROUND (STOCKPILES)
- OVERBURDEN
- SHALE
- LIMESTONE

Client: **Murphy Environmental**

Project: **WASTE LICENCE WO129-01**

Location: **Hollywood Great, Nags Head, The Naul, Co. Dublin.**

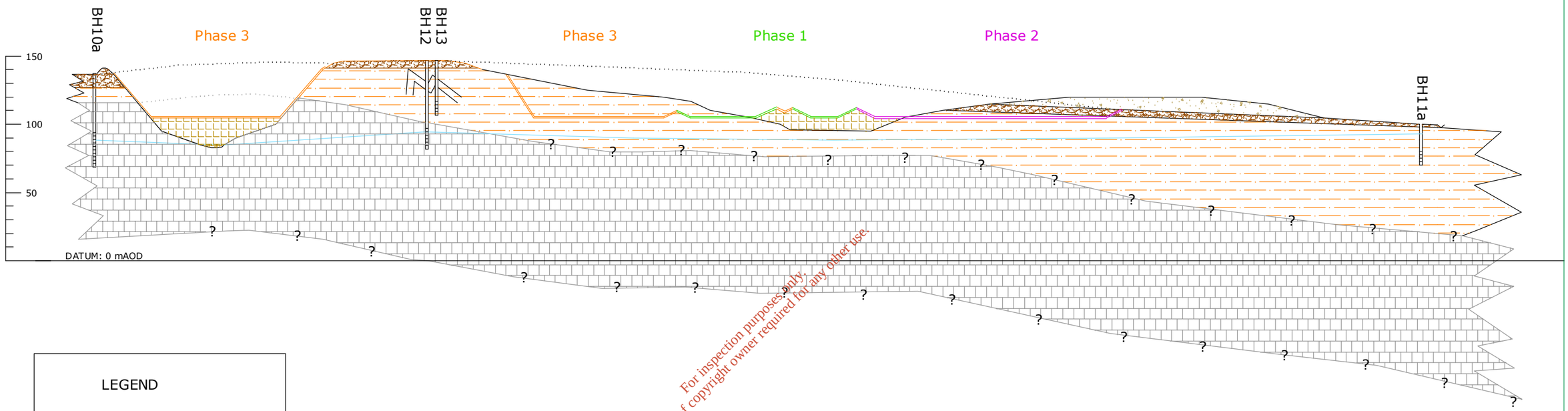
Title: **SITE GEOLOGY WITH IMPLIED GROUNDWATER CONTOURS AND SECTION LINE**

Project No. 07507190091	Engineer AS	Drawing No. RA05	
File No. RA05	Reviewed by TVM		
Created by AS			
ISSUE TO EPA		JULY '07	A
Description		Date	Revision
Scale 1:1500A1 1:3000A3	Date JULY 2007		

Golder Associates
TOWN CENTRE HOUSE, DUBLIN ROAD, NAAS, CO. KILDARE
TEL +045 874A11 - FAX+045 874540 - www.golder.com

A

A'



LEGEND

- MADEGROUND (STOCKPILES)
- OVERBURDEN
- SHALE
- LIMESTONE
- PROPOSED ROCK BACKFILL
- IMPLIED GROUNDWATER SURFACE (8 MAY 2007)

Client: **Murphy Environmental**

Project: **WASTE LICENCE WO129-01**

Location: **Hollywood Great, Nags Head, The Naul, Co. Dublin.**

Title: **CROSS SECTION A - A'**

Project No. 07507190091	Engineer AS	Drawing No. RA06	
File No. RA06	Reviewed by TVM		
Created by AS			
ISSUE TO EPA		JULY '07	A
Description		Date	Revision

Scale 1:1500A1 1:3000A3 Date JULY 2007

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

APPENDIX 2

CQA RESULTS

Cell 1 **WYG/Priority Construction/IGSL**

Sample	Layer	Sample Type	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
			Initial	Final	Initial	Final		
TPA	-	-	-	-	-	-	-	2.7×10^{-10}

Cell 2 - Summary of Results of Triaxial Permeability Tests

Sample	Layer	Sample Type	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
			Initial	Final	Initial	Final		
HOL S2	2.5kg	Bulk	1.73	1.79	21	20	35	8.6×10^{-11}
HOL S3	2.5kg	Bulk	1.87	1.9	13	16	35	1.1×10^{-10}
HOL 2006	Layer 1	U100	1.969	2.022	12.8	15.2	50	1.9×10^{-10}
HOL 2007	Layer 1	U100	1.833	1.895	12.8	15.3	50	2.0×10^{-10}
HOL 2008	Layer 1	U100	2.126	1.983	11.5	15	50	3.0×10^{-10}
HOL 2009	Layer 2	U100	1.854	1.903	15.3	17	50	2.5×10^{-10}
HOL 2010	Layer 2	U100	1.902	1.924	13.1	16.4	50	6.3×10^{-10}
HOL 2017	Layer 2	U100	1.88	1.91	15	16	90	1.3×10^{-10}
HOL 2018	Layer 3	U100	1.84	1.86	16	17	90	2.1×10^{-10}
HOL 2019	Layer 3	U100	1.78	1.8	17	18	90	4.6×10^{-10}
HOL 2020	Layer 3	U100	1.85	1.87	15	16	90	3.2×10^{-10}
HOL 2035	Layer 4	U100	1.87	1.89	14	16	90	1.8×10^{-10}

Cell 3 - Summary of Results of Triaxial Permeability Tests

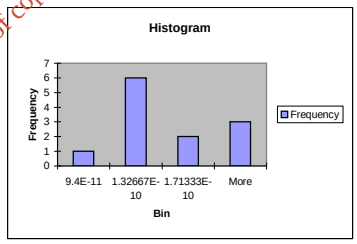
Sample	Layer	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
		Initial	Final	Initial	Final		
HYD 6100	Layer 1	1.77	1.86	18	22	90	2.1×10^{-10}
HYD 6101	Layer 1	1.87	1.94	17	19	90	1.8×10^{-10}
HYD 6102	Layer 1	1.86	1.9	14	19	90	1.1×10^{-10}
HYD 6103	Layer 2	1.88	1.94	16	17	90	1.2×10^{-10}
HYD 6104	Layer 2	1.9	1.94	13	17	90	2.1×10^{-10}
HYD 6105	Layer 2	1.82	1.87	16	20	90	1.1×10^{-10}
HYD 6106	Layer 3	1.87	1.91	16	16	90	1.0×10^{-10}
HYD 6107	Layer 3	1.94	1.99	14	16	90	1.4×10^{-10}
HYD 6108	Layer 3	1.9	1.95	13	17	90	1.5×10^{-10}
HYD 6109	Layer 4	1.95	1.98	13	15	90	9.8×10^{-11}
HYD 6110	Layer 4	1.91	1.94	13	16	90	9.4×10^{-11}
HYD 6111	Layer 4	1.95	2	14	15	90	1.1×10^{-10}

Cell 3 Extension - Co-efficient of Permeability Determinations (from site after placement)

Sample	Layer	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
		Initial	Final	Initial	Final		
HYD 7001	Layer 1 (TP) *	1.58	1.57	19	20	90	2.38×10^{-10}
HYD 7002	Layer 1	1.59	1.58	17	18	90	2.57×10^{-10}
HYD 7003	Layer 2	1.7	1.71	15	16	90	3.1×10^{-10}
HYD 7004	Layer 3	1.7	1.7	15	16	90	2.41×10^{-10}
HYD 7005	Layer 4	1.7	1.7	12	13	90	3.7×10^{-10}

Column1	
Mean	**2E-10**
Standard Error	2E-11
Median	1.7E-10
Mode	1.1E-10
Standard Deviation	8.3E-11
Sample Variance	6.9E-21
Kurtosis	-0.376
Skewness	0.71505
Range	2.8E-10
Minimum	9.4E-11
Maximum	3.7E-10
Sum	3.3E-09
Count	18
Confidence Level(95.0%)	4.1E-11

Bin	*Frequency*
9.4E-11	1
1.33E-10	6
1.71E-10	2
More	



Triangular (9.4e-11, 2.2e-010, 3.7e-10)

APPENDIX 3

MONITORING RESULTS

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-4
Location of Monitoring Point: East of site – *ca.* 520m

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	<0.2	0.014	0.003	0.025	0.003	0.002	0.003	0.004	0.001	0.002	0.002	0.003	<0.001	0.005	0.004	0.005	0.006
Potassium	mg/l	N/A	N/A	1.3	1.4	1.6	1.6	1.6	1.8	1.6	1.2	1.2	1.2	1.6	1.4	1.4	1.6	1.5	1.6	1.6
Sodium	mg/l	200	80	11.3	13.8	10.6	7.5	11	7.1	49	13	13	13	10.5	12.5	8.5	15	10	14	13
Total 6 PAHs1	mg/l	0.0001	N/A	-	-	-	-	-	<0.2	<0.2				<0.00001	<0.00006	<0.00006	<0.00006	<0.00006	<0.00001	<0.00001
Total Phenols	mg/l	N/A	0.1	<0.01	0.04	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01
Barium*	mg/l	N/A	N/A	-	-	-	-	-	<0.05	<0.05	0.05	0.05	0.04	0.04	0.04	<0.001	0.04	0.04	0.06	0.04
Calcium	mg/l	N/A	N/A	116.4	108.4	110.2	78.31	100.7	108	99.9	125	109	95	108	120	34	128	119	170	152
Iron	mg/l	0.2	N/A	<0.001	0.059	0.002	0.001	0.005	0.007	0.061	0.006	0.005	<0.005	<0.005	0.005	<0.002	<0.002	<0.002	0.044	0.018
Manganese	mg/l	0.05	N/A	0.004	0.151	0.068	0.081	0.203	0.254	0.047	0.216	0.216	0.139	0.149	0.008	<0.001	<0.001	0.003	<0.001	0.001
Total Organic Carbon	mg/l	N/A	50	14	3	<2	6	4	2	<2	<2	<2	6	5	<2	7	<2	2	4	4
Chloride	mg/l	250	75	19	25	19	20	18	20	22	20	29	24	20	35	42	27	29	57	45
Sulphate	mg/l	250	150	19	20	18	19	28	22	28	33	40	31	19	51	61	56	57	100	107
Total Oxidized Nitrogen	mg/l	N/A	N/A	<0.3	<0.3	<0.03	1.9	0.4	0.4	1.3	0.5	2.6	1.1	<0.3	3.9	5.6	3.9	3.3	8.6	9.1
Conductivity	mS/cm	2.5	1	0.577	0.578	0.444	0.565	0.561	0.586	0.722	0.645	0.666	0.612	0.571	0.702	0.751	0.612	0.636	0.842	0.708
Dissolved Oxygen	mg/l	N/A	N/A	4.4	8.5	9.1	7.1	3.3	5.7	5.5	-	4.8	4.1	5.4	5.5	4.9	2.3	4.34	3.87	3.44
pH	pH	6.5<pH<9.5	6<pH<9	7.73	7.47	7.33	7.1	7.06	7.56	8.05	7.5	7.73	6.59	7.42	6.9	7.46	7.27	7.53	7.86	7.71
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.3
Cyanide	mg/l	0.05	N/A	0.27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	>0.05
Chemical Oxygen Demand	mg/l	N/A	N/A	-	-	158														
Odour	N/A	N/A	N/A	-	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Colour	N/A	N/A	N/A	-	Orange	Brown	Reddish Brown	Brown	Brown / Sediment	Brown	Brown	Light brown / Sediment	Light brown to clear	Reddish	Brown	Red / High Sediment	Orange / High Sediment	Brown	Brown / High Sediment	Clear
Water Level	mOD	N/A	N/A	97.22	96.27	95.85	95.89	94.57	94.01	94.2	93.96	93.78	93.12	93.52	92.89	92.89	92.34	91.92	93.14	92.87
Temperature	°C	N/A	N/A	-		9	10	9.2	-	9	9	9	9	10	9	9.7	13.4	11.5	10.5	13.3
Mercury	mg/l	0.001	N/A	<0.00005	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-
Total Solids	mg/l	N/A	N/A	-	-	-	1007	-	-	-	361	-	-	-	790	-	-	-	1141	-
Boron	mg/l	N/A	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.022	-	-	-	0.031	-
Magnesium	mg/l	N/A	N/A	5.47	-	-	5.46	-	-	-	6.47	-	-	-	6.57	-	-	-	-	-
Total Chromium	mg/l	0.05	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.01	-	-	-	0.007	-
Total Phosphorus	mg/l	N/A	N/A	<0.05	-	-	0.06	-	-	-	<0.05	-	-	-	0.48	-	-	-	0.79	-
Cadmium	mg/l	0.005	0.004	<0.0004	-	-	<0.0004	-	-	-	0.0039	-	-	-	0.001	-	-	-	<0.0004	-
Copper	mg/l	2	0.5	<0.005	-	-	0.005	-	-	-	<0.005	-	-	-	<0.001	-	-	-	<0.0001	-
Lead	mg/l	0.01	N/A	0.006	-	-	<0.005	-	-	-	<0.005	-	-	-	<0.001	-	-	-	<0.0001	-
Zinc	mg/l	N/A	N/A	<0.005	-	-	<0.005	-	-	-	0.005	-	-	-	0.014	-	-	-	0.012	-
Fluoride	mg/l	1.5	N/A	<0.5	-	-	0.3	-	-	-	0.4	-	-	-	0.3	-	-	-	<0.1	-
Orthophosphates	mg/l	N/A	N/A	<0.03	-	-	<0.03	-	-	-	<0.03	-	-	-	0.03	-	-	-	0.05	-
Faecal Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	<15	-	-	-	<1	-	-	-	<1	-
Total Coliforms	cfus/100ml	0	N/A	-	-	-	2	-	-	-	<1	-	-	-	54	-	-	-	10	-
Organochlorine Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Organophosphorus Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Semi Volatile Organics	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic Compounds	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
List I and II Substances***	µg/l	N/A	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-5
Location of Monitoring Point: Within site – north

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	<0.002	0.006	0.006	0.007	0.008	0.005	0.006	<0.002	0.009	0.007	0.007	0.008	0.007	0.006	0.009	0.006	0.008
Potassium	mg/l	N/A	N/A	1.4	1.2	1.4	1.6	1.4	1.8	1.6	1.4	1.2	1.2	1.4	1.3	1.4	1.3	1.3	1.7	1.5
Sodium	mg/l	200	80	25	19	20.4	32	20.5	13.5	18	43	17	22	18	18	14	19	14	19	15
Total 6 PAHs1	mg/l	0.001	N/A	-	-	-	-	-	<0.2	<0.2					<0.00006	<0.00006	<0.00006	<0.00001	<0.00001	<0.00001
Total Phenols	mg/l	N/A	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium*	mg/l	N/A	N/A	-	-	-	-	-	0.05	0.05	0.07	0.07	0.057	0.067	0.06	0.07	0.07	0.07	0.078	0.053
Calcium	mg/l	N/A	N/A	106.5	116.3	117.5	104.8	101.8	105.6	92.49	117	108	106.1	119	111	116	113	131	123	112
Iron	mg/l	0.2	N/A	<0.001	0.023	<0.001	0.001	<0.001	0.006	0.051	0.005	<0.005	<0.005	0.005	<0.002	<0.002	<0.002	<0.002	0.05	<0.002
Manganese	mg/l	0.05	N/A	0.137	0.164	0.178	0.217	0.197	0.173	0.159	0.19	0.175	0.179	0.212	0.199	0.182	0.172	0.267	0.152	0.282
Total Organic Carbon	mg/l	N/A	50	44	2	3	4	5	3	<2	3	5	11	7	3	5	<2	4	3	5
Chloride	mg/l	250	75	22	31	24	25	23	23	22	22	24	23	23	23	24	24	22	26	26
Sulphate	mg/l	250	150	18	20	21	20	23	24	22	36	28	29	28	27	26	26	24	27	21
Total Oxidized Nitrogen	mg/l	N/A	N/A	<0.3	<0.3	<0.3	5.5	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3	0.8	0.6	<0.3
Conductivity	mS/cm	2.5	1	0.485	0.656	0.615	0.648	0.634	0.642	0.765	0.74	0.671	0.654	0.66	0.665	0.666	0.582	0.62	0.643	0.57
Dissolved Oxygen	mg/l	N/A	N/A	4.5	9.1	8.9	7.1	3.8	5	6.3	-	2.8	4.1	5.2	4.5	3.2	2.46	4.16	4.58	5.23
pH	pH	6.5<pH<9.5	6<pH<9	7.64	7.31	6.97	6.96	7.06	7.27	7.74	7.13	7.36	7.02	7.06	6.52	6.93	6.95	7.71	7.33	7.07
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.3	<0.2	0.4	<0.2	<0.2	<0.2	<0.2	0.2	0.4	0.2	<0.2	0.2	<0.2	0.8	0.2	<0.2	0.3
Cyanide	mg/l	0.05	N/A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.05	<0.05	<0.05
Chemical Oxygen Demand	mg/l	N/A	N/A	-	-	334														
Odour	N/A	N/A	N/A	-	None	None	None	None	None	None	Oily odour	None	None	None	None	None	None	None	None	None
Colour	N/A	N/A	N/A	-	Clear	Clear	Clear	Blackish Grey	Clear	Dark brown / Black	Dark Black	Black / Oily sheen	Black / Oily Sheen	Black	Black	Black / High Sediment	Black / Oily sheen	Black / Oily sheen	Black	Black / Oily sheen
Water Level	mOD	N/A	N/A	99.92	99.39	98.98	99.32	98.28	96.36	95.22	94.45	93.51	93.12	92.87	92.95	92.32	91.82	91.12	91.47	103.82
Temperature	°C	N/A	N/A	-	-	-	9.3	10	10	9	10	9	11	10	9	8.6	14.5	10.8	10.3	13
Mercury	mg/l	0.001	N/A	<0.00005	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-
Total Solids	mg/l	N/A	N/A	-	-	888	538	-	-	-	691	-	-	-	1955	-	-	-	748	-
Boron	mg/l	N/A	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.022	-	-	-	0.028	-
Magnesium	mg/l	N/A	N/A	8.52	-	-	10.66	-	-	-	12.57	-	-	-	11.18	-	-	-	-	-
Total Chromium	mg/l	0.05	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.01	-	-	-	0.009	-
Total Phosphorus	mg/l	N/A	N/A	1.19	-	-	2.38	-	-	-	0.96	-	-	-	2.49	-	-	-	3.64	-
Cadmium	mg/l	0.005	0.004	<0.0004	-	-	<0.0004	-	-	-	0.0054	-	-	-	0.003	-	-	-	0.0007	-
Copper	mg/l	2	0.5	<0.005	-	-	0.005	-	-	-	<0.005	-	-	-	0.009	-	-	-	0.006	-
Lead	mg/l	0.01	N/A	<0.005	-	-	0.001	-	-	-	0.001	-	-	-	0.005	-	-	-	<0.001	-
Zinc	mg/l	N/A	N/A	0.017	-	-	<0.005	-	-	-	<0.005	-	-	-	0.01	-	-	-	0.17	-
Fluoride	mg/l	1.5	N/A	<0.5	-	-	0.5	-	-	-	0.5	-	-	-	0.5	-	-	-	0.3	-
Orthophosphates	mg/l	N/A	N/A	<0.03	-	-	<0.03	-	-	-	1.43	-	-	-	2	-	-	-	2.81	-
Faecal Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	<15	-	-	-	<1	-	-	-	<1	-
Total Coliforms	cfus/100ml	0	N/A	-	-	-	1	-	-	-	<1	-	-	-	4	-	-	-	12	-
Organochlorine Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Organophosphorus Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Semi Volatile Organics	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic Compounds	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
List I and II Substances***	µg/l	N/A	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-6
Location of Monitoring Point: North of site – *ca.* 240m

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.091	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Potassium	mg/l	N/A	N/A	5.6	6.6	7	6.8	6.4	8	6.8	8.2	7.2	7	6.4	6.1	6	5.7	5.5	6.1	6.8
Sodium	mg/l	200	80	24.5	19.5	27.5	21	21	14	18.5	22	19	21	18.5	17.5	20	23	16.5	18.5	17.5
Total 6 PAHs1	mg/l	0.0001	N/A	-	-	-	-	-	<0.2	<0.2					<0.00006	<0.00006	<0.00006	<0.00001	<0.00001	<0.00001
Total Phenols	mg/l	N/A	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium*	mg/l	N/A	N/A	-	-	-	-	-	0.05	0.05	0.08	0.21	0.05	0.06	0.05	0.06	0.05	0.05	0.1	0.06
Calcium	mg/l	N/A	N/A	117	107.8	121.1	61.02	105.9	117.2	102.6	130.1	88.83	95.32	113.1	105.9	125.8	111.7	110	113.7	102.6
Iron	mg/l	0.2	N/A	0.007	0.021	<0.001	<0.001	<0.001	0.005	0.055	0.005	0.196	<0.005	0.011	<0.002	<0.002	<0.002	<0.002	0.056	0.138
Manganese	mg/l	0.05	N/A	0.025	0.257	0.207	0.303	0.365	0.427	0.039	0.453	0.406	0.17	0.309	0.282	0.277	<0.001	<0.001	0.139	0.15
Total Organic Carbon	mg/l	N/A	50	36	<2	<2	<2	4	2	<2	<2	<2	4	6	<2	3	<2	<2	0.002	3
Chloride	mg/l	250	75	18	29	20	22	20	21	19	20	20	19	20	20	21	21	20	25	21
Sulphate	mg/l	250	150	51	61	44	45	46	54	49	45	41	47	48	46	51	36	35	33	38
Total Oxidized Nitrogen	mg/l	N/A	N/A	<0.3	<0.3	<0.3	0.6	<0.3	<0.3	<0.3	0.4	<0.3	<0.3	<0.3	<0.3	0.3	<0.3	<0.3	<0.3	<0.3
Conductivity	mS/cm	2.5	1	0.725	0.747	0.553	0.737	0.724	0.767	0.879	0.793	0.737	0.739	0.731	0.745	0.745	0.624	0.647	0.664	0.603
Dissolved Oxygen	mg/l	N/A	N/A	4.6	8.3	9.3	7.2	4.3	6.7	6	-	4.3	8	5.4	5.9	5.54	3.39	1.55	5.56	4.41
pH	pH	6.5<pH<9.5	6<pH<9	7.49	7.47	7.17	7.21	7.04	7.47	8.18	7.52	7.75	6.79	7.54	6.89	7.12	7.06	7.22	7.66	7.53
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.3	0.4	0.3	0.4	<0.2	0.3	0.2	0.4	0.4	0.3	<0.2	0.3	0.2	0.2	0.4	0.3	0.3
Cyanide	mg/l	0.05	N/A	0.28	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand	mg/l	N/A	N/A	-	-	37														
Odour	N/A	N/A	N/A	-	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Colour	N/A	N/A	N/A	-	Clear	Slightly Brown	Clear	Black	Black / Sediment	Black	Black Oily Film	Black Oily Film	Black Oily Film	Black Oily Film	Clear	Clear	Clear / Trace of Sediment	Light brown / yellow	Black / Oily sheen	Black
Water Level	mOD	N/A	N/A	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31
Temperature	°C	N/A	N/A	-	-	-	9.1	9	9	9	8	8	11	10	8	10.4	12.7	10.6	10.4	10.8
Mercury	mg/l	0.001	N/A	<0.00005	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-
Total Solids	mg/l	N/A	N/A	-	-		1668	-	-	-	414	-	-	-	358	-	-	-	452	-
Boron	mg/l	N/A	N/A	<0.05	-	-	<0.05	-	-	-	0.06	-	-	-	0.076	-	-	-	0.086	-
Magnesium	mg/l	N/A	N/A	17.01	-	-	19.24	-	-	-	21.66	-	-	-	19.07	-	-	-	-	-
Total Chromium	mg/l	0.05	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.01	-	-	-	0.009	-
Total Phosphorus	mg/l	N/A	N/A	0.08	-	-	1.37	-	-	-	0.11	-	-	-	0.07	-	-	-	0.33	-
Cadmium	mg/l	0.005	0.004	<0.0004	-	-	0.0007	-	-	-	0.0049	-	-	-	<0.001	-	-	-	<0.0004	-
Copper	mg/l	2	0.5	<0.005	-	-	0.005	-	-	-	<0.005	-	-	-	0.013	-	-	-	<0.001	-
Lead	mg/l	0.01	N/A	<0.005	-	-	0.001	-	-	-	<0.005	-	-	-	<0.001	-	-	-	<0.001	-
Zinc	mg/l	N/A	N/A	<0.005	-	-	<0.005	-	-	-	0.007	-	-	-	0.017	-	-	-	0.012	-
Fluoride	mg/l	1.5	N/A	<0.5	-	-	0.3	-	-	-	0.4	-	-	-	0.4	-	-	-	0.3	-
Orthophosphates	mg/l	N/A	N/A	<0.03	-	-	<0.03	-	-	-	<0.03	-	-	-	0.03	-	-	-	0.04	-
Faecal Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	<15	-	-	-	<1	-	-	-	<1	-
Total Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	1	-	-	-	7	-	-	-	30	-
Organochlorine Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Organophosphorus Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Semi Volatile Organics	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic Compounds	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
List I and II Substances***	µg/l	N/A	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-8
Location of Monitoring Point: Within site - west

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	<0.001	Dry	<0.001	<0.001	<0.001	Dry	<0.001	<0.001	0.001
Potassium	mg/l	N/A	N/A	2.3	8.8	5.6	2.6	4.4	4.6	3.4	3.8	2	Dry	5.6	3.8	3.8	Dry	5.1	2.2	5.5
Sodium	mg/l	200	80	26	20	29.5	29.5	23.5	17.5	23.5	36	25	Dry	26.5	26.5	27.5	Dry	18	26	24
Total 6 PAHs1	mg/l	0.0001	N/A	-	-	-	-	-	<0.2	<0.2			Dry		<0.00006	<0.00006	Dry	<0.00001	<0.00001	<0.00001
Total Phenols	mg/l	N/A	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	Dry	<0.01	<0.01	<0.01	Dry	<0.01	<0.01	<0.01
Barium*	mg/l	N/A	N/A	-	-	-	-	-	0.05	<0.05	0.08	0.04	Dry	0.088	0.074	0.053	Dry	0.054	0.063	0.069
Calcium	mg/l	N/A	N/A	40.84	86.89	53.32	33.19	71.56	43.91	40.46	78.01	42.81	Dry	109.6	74.65	44.73	Dry	79.68	66.42	173.3
Iron	mg/l	0.2	N/A	0.042	0.028	0.022	0.008	<0.001	0.032	0.097	0.007	<0.005	Dry	0.011	0.008	<0.002	Dry	<0.002	0.057	0.022
Manganese	mg/l	0.05	N/A	0.087	0.177	0.105	0.146	0.219	0.207	0.002	0.034	0.021	Dry	0.054	0.099	0.005	Dry	0.012	0.172	1.276
Total Organic Carbon	mg/l	N/A	50	5	8	6	5	7	8	7	5	6	Dry	12	5	5	Dry	8	6	10
Chloride	mg/l	250	75	58	24	46	57	26	49	53	42	58	Dry	31	39	60	Dry	28	64	40
Sulphate	mg/l	250	150	66	187	73	33	134	59	50	122	52	Dry	172	171	74	Dry	142	83	181
Total Oxidized Nitrogen	mg/l	N/A	N/A	10.7	4.4	10	10	8.2	11	10.8	7.9	9.7	Dry	16.2	8	8.9	Dry	5.1	7.9	<0.3
Conductivity	mS/cm	2.5	1	0.442	0.618	0.373	0.422	0.557	0.44	0.54	0.606	0.455	Dry	0.748	0.633	0.211	Dry	0.525	0.505	0.792
Dissolved Oxygen	mg/l	N/A	N/A	4.8	7.8	9	7.1	3.5	5.8	5.2	-	5.8	Dry	5.7	4.6	5.88	Dry	3.89	3.16	0.78
pH	pH	6.5<pH<9.5	6<pH<9	6.79	6.77	6.33	6.22	6.34	6.43	6.67	6.47	6.74	Dry	6.73	5.9	6.11	Dry	6.6	7.4	7.03
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.2	0.3	0.9	0.3	<0.2	0.9	0.7	<0.2	<0.2	Dry	<0.2	<0.2	<0.2	Dry	<0.2	0.3	0.3
Cyanide	mg/l	0.05	N/A	0.47	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	Dry	<0.05	<0.05	<0.05	Dry	<0.05	<0.05	<0.05
Chemical Oxygen Demand	mg/l	N/A	N/A	-	-	190							Dry				Dry			
Odour	N/A	N/A	N/A	-	None	None	None	None	None	None	None	None	Dry	None	None	None	Dry	None	None	None
Colour	N/A	N/A	N/A	-	Very Brown / High Sediment	Brown / High Sediment	Brown	High Sediment	Brown / High Sediment	Brown / High Sediment	Brown / High Sediment	Brown / High Sediment	Dry	Brown	Brown	Dark Brown / High Sediment	Dry	Brown	Dark Brown	Dark Brown / High Sediment
Water Level	mOD	N/A	N/A	133.36	133.49	133.59	133.45	132.88	133.44	133.38	133.15	133.44	Dry	132.38	133.23	133.53	Dry	133.46	133.38	133.12
Temperature	°C	N/A	N/A	-	-	-	10	10	11	10	10	9	Dry	12	9	11.1	Dry	13.6	9.9	17
Mercury	mg/l	0.001	N/A	<0.00005	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-
Total Solids	mg/l	N/A	N/A	-	-		579	-	-	-	382	-	-	-	2710	-	-	-	6723	-
Boron	mg/l	N/A	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.026	-	-	-	0.03	-
Magnesium	mg/l	N/A	N/A	6.69	-	-	7.45	-	-	-	12.86	-	-	-	13.14	-	-	-	-	-
Total Chromium	mg/l	0.05	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.004	-	-	-	0.002	-
Total Phosphorus	mg/l	N/A	N/A	<0.05	-	-	0.27	-	-	-	0.18	-	-	-	2.02	-	-	-	5.51	-
Cadmium	mg/l	0.005	0.004	0.0004	-	-	<0.0004	-	-	-	0.0036	-	-	-	<0.001	-	-	-	<0.0004	-
Copper	mg/l	2	0.5	<0.005	-	-	<0.005	-	-	-	0.005	-	-	-	<0.001	-	-	-	0.003	-
Lead	mg/l	0.01	N/A	<0.005	-	-	<0.005	-	-	-	<0.005	-	-	-	<0.001	-	-	-	0.001	-
Zinc	mg/l	N/A	N/A	0.021	-	-	<0.005	-	-	-	0.014	-	-	-	0.021	-	-	-	0.014	-
Fluoride	mg/l	1.5	N/A	<0.5	-	-	0.1	-	-	-	<0.1	-	-	-	<0.01	-	-	-	<0.1	-
Orthophosphates	mg/l	N/A	N/A	<0.03	-	-	<0.03	-	-	-	0.03	-	-	-	0.12	-	-	-	0.05	-
Faecal Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	<15	-	-	-	1	-	-	-	<1	-
Total Coliforms	cfus/100ml	0	N/A	-	-	-	13	-	-	-	<1	-	-	-	3	-	-	-	15	-
Organochlorine Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Organophosphorus Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Semi Volatile Organics	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic Compounds	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
List I and II Substances***	µg/l	N/A	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-9
Location of Monitoring Point: Within site – north west

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	<0.05	<0.002	<0.002	0.006	<0.002	0.004	0.005	0.024	<0.001	0.006	0.003	0.003	0.002	0.005	0.004	0.004	0.003
Potassium	mg/l	N/A	N/A	0.7	1	0.6	0.6	0.8	1	0.8	0.4	0.8	0.8	0.7	0.6	0.5	0.6	0.6	0.7	0.8
Sodium	mg/l	200	80	14.5	17.5	26.5	44.5	19	8.7	13.8	27	19	16	15	14.5	15.5	18.5	12.5	14	14
Total 6 PAHs1	mg/l	0.0001	N/A	-	-	-	-	-	<0.2	<0.2					<0.00006	<0.00006	<0.00006	<0.00001	<0.00001	<0.00001
Total Phenols	mg/l	N/A	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium*	mg/l	N/A	N/A	-	-	-	-	-	<0.05	<0.05	<0.05	0.015	0.005	0.006	0.004	0.003	0.005	0.004	0.016	0.008
Calcium	mg/l	N/A	N/A	78.73	87.83	97.42	81.15	81.57	89.39	85.78	111	93	83	97.59	88.55	94.36	95.32	93.27	90.25	96.51
Iron	mg/l	0.2	N/A	0.49	0.023	0.004	<0.001	<0.001	0.004	0.054	0.003	<0.005	<0.005	0.006	0.009	0.01	<0.002	<0.002	0.039	0.018
Manganese	mg/l	0.05	N/A	0.022	0.055	0.033	0.08	0.067	0.02	0.007	0.066	0.147	0.024	0.007	0.021	0.022	<0.001	<0.001	0.034	0.114
Total Organic Carbon	mg/l	N/A	50	27	3	3	4	6	3	2	3	3	7	6	3	4	2	4	2	4
Chloride	mg/l	250	75	40	31	19	20	18	20	20	20	29	21	20	21	22	21	18	22	22
Sulphate	mg/l	250	150	34	59	44	34	35	31	46	50	73	42	35	37	39	38	34	25	42
Total Oxidized Nitrogen	mg/l	N/A	N/A	<0.3	<0.3	<0.3	0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Conductivity	mS/cm	2.5	1	0.516	0.569	0.419	0.525	0.52	0.502	0.638	0.633	0.626	0.529	0.504	0.519	0.251	0.449	0.458	0.488	0.443
Dissolved Oxygen	mg/l	N/A	N/A	5.2	8.3	9.1	7	4.3	5.4	5.6	-	3.2	3.4	5.6	5.5	2.67	1.61	2.74	1.82	0.81
pH	pH	6.5<pH<9.5	6<pH<9	7.22	7.14	6.8	6.67	6.57	7.04	7.17	7	7.25	6.27	6.94	6.52	6.76	6.9	7.01	7.54	6.92
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	0.2	<0.2	0.4	<0.2
Cyanide	mg/l	0.05	N/A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand	mg/l	N/A	N/A	-	-	15														
Odour	N/A	N/A	N/A	-	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Colour	N/A	N/A	N/A	-	Clear	Clear	Clear	Clear	Slightly Brown	Clear	Light Yellow	Clear / Light brown	Light brown	Light brown	Clear - Yellow	Clear - Yellow	Clear - Yellow	Light Brown	Clear	Clear
Water Level	mOD	N/A	N/A	103.22	102.64	102.37	103.97	103.37	102.22	103.21	103.92	103.41	102.46	101.4	102.87	102.71	102.39	101.2	104.06	103.79
Temperature	°C	N/A	N/A	-	-	-	9.1	10	10	9	10	9	10	10	10	11.4	13.5	12	10.6	17
Mercury	mg/l	0.001	N/A	<0.00005	-	-	<0.00005		-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-
Total Solids	mg/l	N/A	N/A	-	-		346		-	-	334	-	-	-	334	-	-	-	341	-
Boron	mg/l	N/A	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.013	-	-	-	0.018	-
Magnesium	mg/l	N/A	N/A	3.65	-	-	6.66	-	-	-	5.87	-	-	-	4.03	-	-	-	-	-
Total Chromium	mg/l	0.05	N/A	<0.001	-	-	<0.05	-	-	-	<0.05	-	-	-	0.006	-	-	-	0.006	-
Total Phosphorus	mg/l	N/A	N/A	<0.05	-	-	0.27	-	-	-	0.15	-	-	-	0.23	-	-	-	0.6	-
Cadmium	mg/l	0.005	0.004	<0.0004	-	-	<0.0004	-	-	-	0.0037	-	-	-	<0.001	-	-	-	0.0005	-
Copper	mg/l	2	0.5	<0.005	-	-	<0.005	-	-	-	0.005	-	-	-	<0.001	-	-	-	<0.001	-
Lead	mg/l	0.01	N/A	<0.005	-	-	<0.005	-	-	-	<0.001	-	-	-	<0.005	-	-	-	<0.001	-
Zinc	mg/l	N/A	N/A	0.023	-	-	<0.005	-	-	-	0.009	-	-	-	0.018	-	-	-	0.014	-
Fluoride	mg/l	1.5	N/A	<0.5	-	-	0.4	-	-	-	0.2	-	-	-	0.1	-	-	-	<0.1	-
Orthophosphates	mg/l	N/A	N/A	<0.03	-	-	<0.03	-	-	-	0.074	-	-	-	<0.003	-	-	-	<0.03	-
Faecal Coliforms	cfus/100ml	0	N/A	-	-	-	5	-	-	-	<15	-	-	-	<1	-	-	-	10	-
Total Coliforms	cfus/100ml	0	N/A	-	-	-	60	-	-	-	<1	-	-	-	1	-	-	-	880	-
Organochlorine Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Organophosphorus Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Semi Volatile Organics	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic Compounds	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
List I and II Substances***	µg/l	N/A	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-10
Location of Monitoring Point: Within site – south west

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Potassium	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Sodium	mg/l	200	80	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total 6 PAHs1	mg/l			Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Phenols	mg/l	N/A	0.1	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Barium*	mg/l			Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Calcium	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Iron	mg/l	0.2	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Manganese	mg/l	0.05	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Organic Carbon	mg/l	N/A	50	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Chloride	mg/l	250	75	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Sulphate	mg/l	250	150	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Oxidized Nitrogen	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Conductivity	mS/cm	2.5	1	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Dissolved Oxygen	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
pH	pH	6.5<pH<9.5	6<pH<9	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Cyanide	mg/l	0.05	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Chemical Oxygen Demand	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Odour	N/A	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Colour	N/A	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Water Level	mOD	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Temperature	°C	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Mercury	mg/l	0.001	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Solids	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Boron	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Magnesium	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Chromium	mg/l	0.05	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Phosphorus	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Cadmium	mg/l	0.005	0.004	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Copper	mg/l	2	0.5	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Lead	mg/l	0.01	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Zinc	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Fluoride	mg/l	1.5	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Orthophosphates	mg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Faecal Coliforms	cfus/100ml	0	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Total Coliforms	cfus/100ml	0	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Organochlorine Pesticides	µg/l	0.1	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Organophosphorus Pesticides	µg/l	0.1	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Semi Volatile Organics	µg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Semi Volatile Organic Compounds	µg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
List I and II Substances***	µg/l	N/A	N/A	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Client: Murphy Environmental
Site: Hollywood W0129-01
Monitoring Point: BH-11
Location of Monitoring Point: Within site – north east

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for WL 151-1	Q2, 2003 (Baseline)	Q3, 2003	Q4, 2003	Q1, 2004	Q2, 2004	Q3, 2004	Q4, 2004	Q1, 2005	Q2, 2005	Q3, 2005	Q4, 2005	Q1, 2006	Q2, 2006	Q3, 2006	Q4, 2006	Q1, 2007	Q2, 2007
Arsenic	mg/l	0.01	N/A	<0.05	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.299	0.078	0.071	0.047	0.011	0.012	0.025	0.025	0.014	0.12
Potassium	mg/l	N/A	N/A	1.4	1.4	1.4	0.8	1.6	1.8	1.4	4.6	3	4.2	2.9	2	5.6	8.4	13	36	7.4
Sodium	mg/l	200	80	12	15	13	8.8	13.5	7.8	11.4	38	15	26	17	16	14	19	16.5	23.5	14.5
Total 6 PAHs1	mg/l	0.0001	N/A	-	-	-	-	-	<0.2	<0.2					<0.00006	<0.00006	<0.00006	<0.00001	<0.00001	<0.00001
Total Phenols	mg/l	N/A	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium*	mg/l	N/A	N/A	-	-	-	-	-	<0.05	<0.05	<0.05	0.019	0.028	0.023	0.019	0.022	0.023	0.022	0.039	0.019
Calcium	mg/l	N/A	N/A	47.12	41.25	45.18	41.47	45.26	49.44	49.37	67	55	74	68	58	74.97	68.89	70.83	72.41	67.01
Iron	mg/l	0.2	N/A	0.49	0.023	0.004	<0.001	<0.001	<0.001	0.046	0.002	<0.005	0.009	0.015	0.021	<0.002	<0.002	<0.002	0.05	0.009
Manganese	mg/l	0.05	N/A	0.09	0.099	0.098	0.149	0.174	0.136	0.07	0.358	0.242	0.378	0.371	0.312	0.426	0.364	0.379	0.023	0.339
Total Organic Carbon	mg/l	N/A	50	5	<2	<2	3	4	<2	<2	<2	4	44	6	3	3	<2	4	4	3
Chloride	mg/l	250	75	41	31	18	18	16	16	15	20	27	28	20	19	19	19	17	24	19
Sulphate	mg/l	250	150	72	42	34	43	54	29	22	19	15	27	13	8	12	11	13	9	12
Total Oxidized Nitrogen	mg/l	N/A	N/A	<0.3	<0.3	<0.3	0.4	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Conductivity	mS/cm	2.5	1	0.373	0.328	0.251	0.336	0.341	0.338	0.389	0.5	0.41	0.53	0.447	0.43	0.438	0.441	0.491	0.69	0.421
Dissolved Oxygen	mg/l	N/A	N/A	5	7.4	9.3	7	4.8	6.3	6.1	-	3.5	3.4	5.6	3.8	1.68	2.81	2.85	3.28	1.98
pH	pH	6.5<pH<9.5	6<pH<9	6.81	6.88	7.29	6.41	6.67	6.86	7.1	7.95	6.88	6.82	6.86	6.49	6.69	6.96	7.45	8.47	6.93
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.7	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	0.2	0.3	1	0.3	<0.2	0.2	<0.2	0.3	0.3	<0.2
Cyanide	mg/l	0.05	N/A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand	mg/l	N/A	N/A	-	-	27														
Odour	N/A	N/A	N/A	-	None	None	None	None	None	None	None	None	Slight Odour	Slight "eggy smell"	Slight "eggy smell"	Slight "eggy smell"	Slight "eggy smell"	Slight "eggy smell"	Slight "eggy smell"	Slight "eggy smell"
Colour	N/A	N/A	N/A	-	Slightly Brown	Slightly Brown	Black	Blackish Grey	Clear	Brown	Clear	Clear	Slightly cloudy	Slightly cloudy	Clear	Clear	Slightly yellow	Yellow particles	Browm/ Red High Sediment	Clear
Water Level	mOD	N/A	N/A	100.07	99.59	99.24	99.44	98.28	95.73	94.08	96.78	95.9	95.53	95.31	92.28	91.78	91.26	90.52	90.94	108.37
Temperature	°C	N/A	N/A	-	-	-	9.2	11	10	9	10	9	10	10	9	10.4	12.8	10.9	9.9	12.4
Mercury	mg/l	0.001	N/A	<0.00005	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-	-	-	<0.00005	-
Total Solids	mg/l	N/A	N/A	-	-		454	-	-	-	260	-	-	-	253	-	-	-	445	-
Boron	mg/l	N/A	N/A	<0.05	-	-	<0.05	-	-	-	<0.05	-	-	-	0.023	-	-	-	0.029	-
Magnesium	mg/l	N/A	N/A	4.57	-	-	4.37	-	-	-	9.21	-	-	-	9.13	-	-	-	-	-
Total Chromium	mg/l	0.05	N/A	<0.001	-	-	<0.05	-	-	-	<0.05	-	-	-	0.006	-	-	-	0.008	-
Total Phosphorus	mg/l	N/A	N/A	<0.05	-	-	0.17	-	-	-	0.16	-	-	-	0.09	-	-	-	1.36	-
Cadmium	mg/l	0.005	0.004	0.0145	-	-	0.0092	-	-	-	0.0042	-	-	-	<0.001	-	-	-	<0.0004	-
Copper	mg/l	2	0.5	<0.005	-	-	<0.005	-	-	-	0.005	-	-	-	<0.001	-	-	-	<0.001	-
Lead	mg/l	0.01	N/A	<0.005	-	-	<0.005	-	-	-	<0.005	-	-	-	<0.001	-	-	-	<0.001	-
Zinc	mg/l	N/A	N/A	0.016	-	-	0.153	-	-	-	0.008	-	-	-	0.022	-	-	-	0.016	-
Fluoride	mg/l	1.5	N/A	<0.5	-	-	0.1	-	-	-	0.1	-	-	-	0.1	-	-	-	0.2	-
Orthophosphates	mg/l	N/A	N/A	<0.03	-	-	<0.03	-	-	-	0.12	-	-	-	0.06	-	-	-	0.1	-
Faecal Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	<15	-	-	-	<1	-	-	-	<1	-
Total Coliforms	cfus/100ml	0	N/A	-	-	-	<1	-	-	-	3	-	-	-	92	-	-	-	1	-
Organochlorine Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Organophosphorus Pesticides	µg/l	0.1	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-
Semi Volatile Organics	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic plus TICS	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
Semi Volatile Organic Compounds	µg/l	N/A	N/A	-	-	-	<1	-	-	-	<0.001	-	-	-	<0.001	-	-	-	<0.001	-
List I and II Substances***	µg/l	N/A	N/A	-	-	-	<0.01	-	-	-	<0.00001	-	-	-	<0.00001	-	-	-	<0.00001	-

Client: **Murphy Environmental**
Site: **Hollywood W0129-01**
Monitoring Point: **SW1**
Location of Monitoring Point: **Clonany Bridge (North (upstream) of site, *ca.* 280m)**

Parameter	Units	Surface Water Regulations Class 3	Salmonid Water Regulations	Q2, 2003 (Baseline)	Q4, 2003	Q2, 2004	Q4, 2004	Q2, 2005	Q4, 2005	Q2, 2006	Q4, 2006	Q2, 2007
Chloride	mg/l	250	N/A	53	38	18	43	39	45	41	41	45
Conductivity	mS/cm	1	N/A	0.446	0.545	0.251	0.579	0.499	0.958	0.29	0.653	0.691
Dissolved Oxygen	mg/l	N/A	>9	5.7	5.3	5.3	5.9	6.6	5.4	9.33	7.74	8.3
pH	pH	5.5 – 9.0	6 – 9	7.7	7.74	7.29	7.93	7.91	7.48	8.07	7.93	8.2
Ammoniacal Nitrogen	mg/l NH_4-N	3.11	0.7	0.3	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Suspended Solids	mg/l	-	25	60	<10	16	<10	85	15	33	<10	68
Chemical Oxygen Demand	mg/l	40	N/A	16	<15	<15	18	<15	31	<15	17	16
Temperature	°C	>25	N/A	-	-	-	10	-	11	9.1	12	8.4
Total 6 PAHs1	mg/l	0.001	N/A	-	-	-	<0.2	-	-	-	-	-
Sodium	mg/l	N/A	N/A	-	-	19	-	-	25	-	-	11.88
Magnesium	mg/l	N/A	N/A	-	-	<0.05	-	-	16.82	-	-	25
Maganese	mg/l	1	N/A	-	-	0.006	-	-	0.308	-	-	0.229
Orthophosphate	mg/l	N/A	N/A	-	-	0.72	-	-	0.05	-	-	<0.03
Sulphate	mg/l	200	N/A	-	-	31	-	-	299	-	-	164
Total Alkalinity	mg/l	N/A	N/A	-	-	210	-	-	180	-	-	280

Client: **Murphy Environmental**
Site: **Hollywood W0129-01**
Monitoring Point: **SW2**
Location of Monitoring Point: **Joinery Bridge (East (downstream) of site, *ca.* 1630m)**

Parameter	Units	Surface Water Regulations Class 3	Salmonid Water Regulations	Q2, 2003 (Baseline)	Q4, 2003	Q2, 2004	Q4, 2004	Q2, 2005	Q4, 2005	Q2, 2006	Q4, 2006	Q2, 2007
Chloride	mg/l	250	N/A	42	41	30	38	34	61	38	33	40
Conductivity	mS/cm	1	N/A	0.375	0.457	0.671	0.7	0.753	1.223	0.668	0.798	0.629
Dissolved Oxygen	mg/l	N/A	>9	6	9.4	5.3	6.1	7.6	5.9	9.13	8.66	10.45
pH	pH	5.5 – 9.0	6 – 9	7.8	7.57	8.24	8.15	8.12	7.57	8.12	8.12	8.17
Ammoniacal Nitrogen	mg/l NH_4-N	3.11	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2
Total Suspended Solids	mg/l	-	25	<10	<10	<10	<10	17	31	131	<10	<10
Chemical Oxygen Demand	mg/l	40	N/A	<15	<15	<15	<15	<15	18	<15	<15	<15
Temperature	^{o}C	>25	N/A	-	-	10	-	-	-	10.7	11.5	10.6
Total 6 PAHs1	mg/l	0.001	N/A	-	-	-	<0.2	-	-	-	-	-
Sodium	mg/l	N/A	N/A	-	-	15.5	-	32.5	-	-	-	12.04
Magnesium	mg/l	N/A	N/A	-	-	<0.05	-	17.76	-	-	-	19.5
Maganese	mg/l	1	N/A	-	-	0.011	-	0.018	-	-	-	0.005
Orthophosphate	mg/l	N/A	N/A	-	-	0.29	-	<0.03	-	-	-	<0.03
Sulphate	mg/l	200	N/A	-	-	110	-	254	-	-	-	154
Total Alkalinity	mg/l	N/A	N/A	-	-	270	-	130	-	-	-	230

Client: **Murphy Environmental**
Site: **Hollywood W0129-01**
Monitoring Point: **LC-1**
Location of Monitoring Point: **Within Cell 1**

Parameter	Units	Surface Water Regulations Class 3	Q3, 2004	Q2, 2005	Q3, 2005	Q1, 2006	Q3, 2006	Q1, 2007	Q2, 2007
Potassium	mg/l	N/A	150	60	42	81	103	95	88
Sodium	mg/l	N/A	650	900	2500	2720	1500	1250	900
Total Phenols	mg/l	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride	mg/l	250	2090	2787	2871	1864	2555	2298	1771
Sulphate	mg/l	200	1847	2901	2585	2032	2101	2117	2263
Total Oxidised Nitrogen	mg/l	N/A	<0.3	2	<0.3	<0.3	<0.3	<0.3	<0.3
Conductivity	mS/cm	1	8.725	13.16	10.89	11.8	-	9.2	4.32
pH	pH	5.5 – 9.0	7.48	5.59	4.64	6.21	6.35	7.12	6.08
Ammoniacal Nitrogen	mg/l NH_4-N	3.11	8.7	2	7.8	7.3	9	10	10.8
Chemical Oxygen Demand	mg/l	40	61	-	56	18	78	68	112
Odour	N/A	N/A	None	None	None	Musty	None	Slight Organic smell	Slight Organic smell
Colour	N/A	N/A	Orange, high sediment	Bright yellow - orange / high sediment	Orange tint. High solids, cloudy	Orange	Orange, high sediment	Orange Sediment	Cloudy
Leachate Level	m	N/A	-	-	93.1	-	93.27	92.5	93.3
Temperature	^{o}C	N/A	11	11	13	12	15.2	13	17.2
Total 6 PAHs	mg/l	0.001	<0.2	-	-	-	-	-	-
Barium	mg/l	1	<0.05	-	-	-	-	-	-

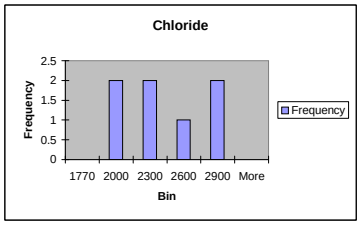
APPENDIX 4

PDFS

Chloride	
Mean	2319.428571
Standard Error	164.7244246
Median	2298
Mode	#N/A
Standard Deviation	435.8198623
Sample Variance	189938.9524
Kurtosis	-1.782120004
Skewness	0.032690771
Range	1100
Minimum	1771
Maximum	2871
Sum	16236
Count	7

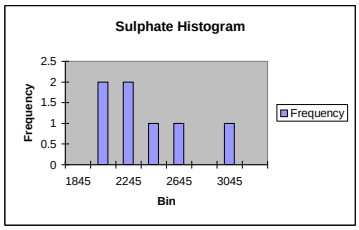
Bin	Frequency
1770	0
2000	2
2300	2
2600	1
2900	2
More	0

Triangular Distribution (1771, 2319, 2871)



Sulphate	
Mean	2263.714286
Standard Error	136.6871148
Median	2117
Mode	#N/A
Standard Deviation	361.6401131
Sample Variance	130783.5714
Kurtosis	0.32411138
Skewness	0.985287646
Range	1054
Minimum	1847
Maximum	2901
Sum	15846
Count	7

Bin	Frequency
1845	0
2045	2
2245	2
2445	1
2645	1
2845	0
3045	1
More	0

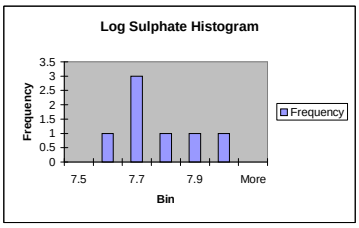


Log Sulphate	
1847	7.52131798
2901	7.972810784
2585	7.857480787
2032	7.616775809
2101	7.650168701
2117	7.657755271
2263	7.724446646

Log Sulphate	
Mean	7.714393711
Standard Error	0.058042393
Median	7.657755271
Mode	#N/A
Standard Deviation	0.153565737
Sample Variance	0.023582436
Kurtosis	-0.04093037
Skewness	0.748244514
Range	0.451492804
Minimum	7.52131798
Maximum	7.972810784
Sum	54.00075598
Count	7

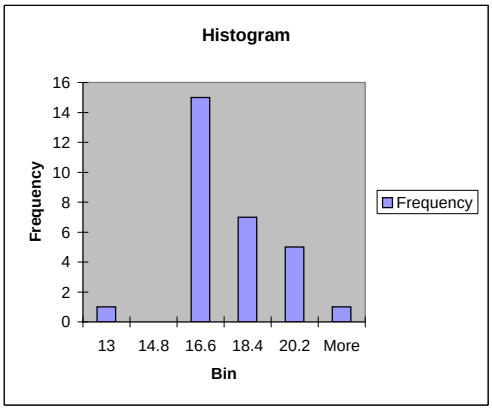
Bin	Frequency
7.5	0
7.6	1
7.7	3
7.8	1
7.9	1
8	1
More	0

Log Triangular (1847, 2208,2901)



Moisture Content (%)
20
16
15.2
15.3
15
17
16.4
16
17
18
16
16
22
19
19
17
17
20
16
16
17
15
16
15
20
18
16
16
13

Column1	
Mean	16.89310345
Standard Error	0.359868991
Median	16
Mode	16
Standard Deviation	1.937953824
Sample Variance	3.755665025
Kurtosis	0.700133245
Skewness	0.789498098
Range	9
Minimum	13
Maximum	22
Sum	489.9
Count	29
Confidence Level(95.0%)	0.737158201



Bin	Frequency	Cumulative %
13	1	3.45%
14.8	0	3.45%
16.6	15	55.17%
18.4	7	79.31%
20.2	5	96.55%
More	1	100.00%

Triangular (0.13, 0.166, 0.22)

Cell 1 **WYG/Priority Construction/IGSL**

Sample	Layer	Sample Type	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
			Initial	Final	Initial	Final		
TPA	-	-	-	-	-	-	-	2.7×10^{-10}

Cell 2 - Summary of Results of Triaxial Permeability Tests

Sample	Layer	Sample Type	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
			Initial	Final	Initial	Final		
HOL S2	2.5kg	Bulk	1.73	1.79	21	20	35	8.6×10^{-11}
HOL S3	2.5kg	Bulk	1.87	1.9	13	16	35	1.1×10^{-10}
HOL 2006	Layer 1	U100	1.969	2.022	12.8	15.2	50	1.9×10^{-10}
HOL 2007	Layer 1	U100	1.833	1.895	12.8	15.3	50	2.0×10^{-10}
HOL 2008	Layer 1	U100	2.126	1.983	11.5	15	50	3.0×10^{-10}
HOL 2009	Layer 2	U100	1.854	1.903	15.3	17	50	2.5×10^{-10}
HOL 2010	Layer 2	U100	1.902	1.924	13.1	16.4	50	6.3×10^{-10}
HOL 2017	Layer 2	U100	1.88	1.91	15	16	90	1.3×10^{-10}
HOL 2018	Layer 3	U100	1.84	1.86	16	17	90	2.1×10^{-10}
HOL 2019	Layer 3	U100	1.78	1.8	17	18	90	4.6×10^{-10}
HOL 2020	Layer 3	U100	1.85	1.87	15	16	90	3.2×10^{-10}
HOL 2035	Layer 4	U100	1.87	1.89	14	16	90	1.8×10^{-10}

Cell 3 - Summary of Results of Triaxial Permeability Tests

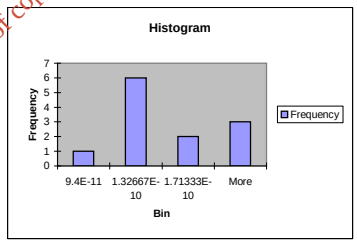
Sample	Layer	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
		Initial	Final	Initial	Final		
HYD 6100	Layer 1	1.77	1.86	18	22	90	2.1×10^{-10}
HYD 6101	Layer 1	1.87	1.94	17	19	90	1.8×10^{-10}
HYD 6102	Layer 1	1.86	1.9	14	19	90	1.1×10^{-10}
HYD 6103	Layer 2	1.88	1.94	16	17	90	1.2×10^{-10}
HYD 6104	Layer 2	1.9	1.94	13	17	90	2.1×10^{-10}
HYD 6105	Layer 2	1.82	1.87	16	20	90	1.1×10^{-10}
HYD 6106	Layer 3	1.87	1.91	16	16	90	1.0×10^{-10}
HYD 6107	Layer 3	1.94	1.99	14	16	90	1.4×10^{-10}
HYD 6108	Layer 3	1.9	1.95	13	17	90	1.5×10^{-10}
HYD 6109	Layer 4	1.95	1.98	13	15	90	9.8×10^{-11}
HYD 6110	Layer 4	1.91	1.94	13	16	90	9.4×10^{-11}
HYD 6111	Layer 4	1.95	2	14	15	90	1.1×10^{-10}

Cell 3 Extension - Co-efficient of Permeability Determinations (from site after placement)

Sample	Layer	Dry Density (Mg/m³)		Moisture Content (%)		Mean Effective Stress (kPa)	Coefficient of Permeability k_v, (m/s)
		Initial	Final	Initial	Final		
HYD 7001	Layer 1 (TP) *	1.58	1.57	19	20	90	2.38×10^{-10}
HYD 7002	Layer 1	1.59	1.58	17	18	90	2.57×10^{-10}
HYD 7003	Layer 2	1.7	1.71	15	16	90	3.1×10^{-10}
HYD 7004	Layer 3	1.7	1.7	15	16	90	2.41×10^{-10}
HYD 7005	Layer 4	1.7	1.7	12	13	90	3.7×10^{-10}

Column1	
Mean	**2E-10**
Standard Error	2E-11
Median	1.7E-10
Mode	1.1E-10
Standard Deviation	8.3E-11
Sample Variance	6.9E-21
Kurtosis	-0.376
Skewness	0.71505
Range	2.8E-10
Minimum	9.4E-11
Maximum	3.7E-10
Sum	3.3E-09
Count	18
Confidence Level(95.0%)	4.1E-11

Bin	*Frequency*
9.4E-11	1
1.33E-10	6
1.71E-10	2
More	



Triangular (9.4e-11, 2.2e-010, 3.7e-10)

APPENDIX 5

LANDSIM MODEL AND RESULTS

Calculation Settings

Number of iterations: 501

Results calculated using sampled PDFs

Full Calculation

Clay Liner:

Retarded values used for simulation

No Biodegradation

Unsaturated Pathway:

Unretarded values used for simulation

No Biodegradation

Saturated Vertical Pathway:

No Vertical Pathway

Aquifer Pathway:

Unretarded values used for simulation

No Biodegradation

Timeslices at: 30, 100, 300, 1000

Decline in Contaminant Concentration in Leachate

Cadmium	Non-Volatile
c (kg/l): 0.1589	m (kg/l): 0.0823
Chloride	Non-Volatile
c (kg/l): 0.2919	m (kg/l): 0.0298
Nickel	Non-Volatile
c (kg/l): -0.1479	m (kg/l): 0.0987
Sulphate	Non-Volatile
c (kg/l): 0.1209	m (kg/l): 0.0166

Background Concentrations of Contaminants

Justification for Contaminant Properties

All parameters assumed to be unretarded in fractured bedrock

All units in milligrams per litre

Phase: Existing Phase 1 (cell 1,2,3)

Infiltration Information

Cap design infiltration (mm/year):	NORMAL(50,5)
Infiltration to waste (mm/year):	NORMAL(523,52.3)
End of filling (years from start of waste deposit):	6

Justification for Specified Infiltration

Infiltration to open waste is based on difference between regional specific total rainfall and effective rainfall. Cap design infiltration is Golder judgement for CQA installed clay cap.

Duration of management control (years from the start of waste disposal): 20000

Cell dimensions

Cell width (m):	210
Cell length (m):	123.8
Cell top area (ha):	4.28
Cell base area (ha):	2.5998
Number of cells:	1
Total base area (ha):	2.5998
Total top area (ha):	4.28
Head of Leachate when surface water breakout occurs (m)	SINGLE(16.5)
Waste porosity (fraction)	UNIFORM(0.2,0.3)
Final waste thickness (m):	UNIFORM(16.5,29.5)
Field capacity (fraction):	UNIFORM(0.15,0.2)
Waste dry density (kg/l)	UNIFORM(1.25,1.75)

Justification for Landfill Geometry

Measured from site specific drawing of cell design to date

Source concentrations of contaminants

All units in milligrams per litre

Declining source term

Cadmium	LOGTRIANGULAR(0.0006,0.006,0.06)
	Substance to be treated as List 1
Chloride	TRIANGULAR(1771,2319,2871)
	Data are spot measurements of Leachate Quality
Nickel	LOGTRIANGULAR(0.0036,0.036,0.36)
	Data are spot measurements of Leachate Quality
Sulphate	TRIANGULAR(1847,2264,2901)
	Data are spot measurements of Leachate Quality

Justification for Species Concentration in Leachate

Sulphate and chloride concentrations based on PDF of leachate monitoring to data in Phase 1. Maximum nickel and cadmium concentrations are set at 3 times the maximum permissible leachate strength corresponding to the inert waste acceptance criteria.

Drainage Information

Fixed Head.

Head on EBS is given as (m): TRIANGULAR(1,1,3)

Justification for Specified Head

It is assumed that the leachate head on the base of Phase 1 will be kept at 3m or less above the site base. 1m is judged to be the most likely with respect to the Phase as a whole outside Cell 1.

Barrier Information

There is a single clay barrier

Justification for Engineered Barrier Type
Based on design specification to date

Design thickness of clay (m):	SINGLE(1)
Density of clay (kg/l):	UNIFORM(0.18,0.24)
Pathway moisture content (fraction):	TRIANGULAR(0.13,0.166,0.22)

Justification for Clay: Liner Thickness
Based on design specification to date

Hydraulic conductivity of liner (m/s):	TRIANGULAR(9.4e-011,2.2e-010,3.7e-010)
Pathway longitudinal dispersivity (m):	SINGLE(0.1)

Justification for Clay: Hydraulics Properties
Generated from site specific CQA data

Retardation parameters for clay liner

Uncertainty in Kd (l/kg):	
Cadmium	SINGLE(600)
Chloride	SINGLE(0)
Nickel	UNIFORM(20,66)
Sulphate	SINGLE(0)

Justification for Liner Kd Values by Species
Chloride and sulphate are unretarded and kd has been set at 0. Nickel kd is conservatively based on range in ConSim Help Files for sand and unspecified conditions. Kd for cadmium is Golder judgement based on data from ConSim Help Files.

Backfill and fractured bedrock pathway parameters

Modelled as unsaturated pathway

Pathway length (m):	SINGLE(1)
Flow Model:	porous medium
Pathway moisture content (fraction):	UNIFORM(0.01,0.035)
Pathway Density (kg/l):	UNDEFINED

Justification for Unsat Zone Geometry

Assumed to be 1m, and thus that the water table does not rise above this threshold following recovery.

Pathway hydraulic conductivity values (m/s): SINGLE(1e-007)

Justification for Unsat Zone Hydraulics Properties

High value conservatively assumed such that it does not impact on site leakage rates.

Pathway longitudinal dispersivity (m): SINGLE(0.1)

Justification for Unsat Zone Dispersion Properties

10% pathway length.

Retardation parameters for Backfill and fractured bedrock pathway

Modelled as unsaturated pathway

No retardation values used in this simulation.

Check 'Unretarded Contaminant Transport' setting under simulation preferences.

Aquifer Pathway Dimensions for Phase

Pathway length (m):	UNIFORM(166,344)
Pathway width (m):	SINGLE(241)

Phase: Proposed Phase 2

Infiltration Information

Cap design infiltration (mm/year):	NORMAL(50,5)
Infiltration to waste (mm/year):	NORMAL(523,52.3)
End of filling (years from start of waste deposit):	2

Justification for Specified Infiltration

Infiltration to open waste is based on difference between regional specific total rainfall and effective rainfall. Cap design infiltration is Golder judgement for CQA installed clay cap.

Duration of management control (years from the start of waste disposal): 20000

Cell dimensions

Cell width (m):	280
Cell length (m):	146
Cell top area (ha):	4.61
Cell base area (ha):	4.088
Number of cells:	1
Total base area (ha):	4.088
Total top area (ha):	4.61
Head of Leachate when surface water breakout occurs (m)	SINGLE(10.1)
Waste porosity (fraction)	UNIFORM(0.2,0.3)
Final waste thickness (m):	UNIFORM(2.5,19.5)
Field capacity (fraction):	UNIFORM(0.15,0.2)
Waste dry density (kg/l)	UNIFORM(1.25,1.75)

Justification for Landfill Geometry

Set to ensure surface breakout does not occur in contaminant transport model.

Source concentrations of contaminants

All units in milligrams per litre

Declining source term

Cadmium	LOGTRIANGULAR(0.0006,0.006,0.06)
	Substance to be treated as List 1
Chloride	TRIANGULAR(1771,2319,2871)
	Data are spot measurements of Leachate Quality
Nickel	LOGTRIANGULAR(0.0036,0.036,0.36)
	Data are spot measurements of Leachate Quality
Sulphate	TRIANGULAR(1847,2264,2901)
	Data are spot measurements of Leachate Quality

Justification for Species Concentration in Leachate

Sulphate and chloride concentration based on PDF of leachate monitoring data to date in Phase 1. Maximum nickel and cadmium concentration set at 3 times the maximum permissible leachate strength corresponding to the inert Waste Acceptance Criteria.

Drainage Information

Fixed Head.

Head on EBS is given as (m): SINGLE(1)

Justification for Specified Head

Based on 95%ile output from LandSim leachate drainage system performance

Barrier Information

There is a single clay barrier

Justification for Engineered Barrier Type
Based on proposed design specification

Design thickness of clay (m):	SINGLE(1)
Density of clay (kg/l):	UNIFORM(0.18,0.24)
Pathway moisture content (fraction):	TRIANGULAR(0.13,0.166,0.22)

Justification for Clay: Liner Thickness
Based on proposed future design specification

Hydraulic conductivity of liner (m/s):	TRIANGULAR(9.4e-011,2.2e-010,3.7e-010)
Pathway longitudinal dispersivity (m):	SINGLE(0.1)

Justification for Clay: Hydraulics Properties
Based on site specific CQA data from Phase 1.

Retardation parameters for clay liner

Uncertainty in Kd (l/kg):	
Cadmium	SINGLE(600)
Chloride	SINGLE(0)
Nickel	UNIFORM(20,66)
Sulphate	SINGLE(0)

Justification for Liner Kd Values by Species
Chloride and sulphate are unretarded and kd has been set at 0. Nickel kd is conservatively based on range in ConSim Help Files for sand and unspecified conditions. Kd for cadmium is Golder judgement based on data from ConSim Help Files.

Backfill and fractured bedrock pathway parameters

Modelled as unsaturated pathway

Pathway length (m):	SINGLE(1)
Flow Model:	porous medium
Pathway moisture content (fraction):	UNIFORM(0.01,0.035)
Pathway Density (kg/l):	UNDEFINED

Justification for Unsat Zone Geometry

Assumed to be 1m, and thus that the water table does not rise above this threshold following recovery.

Pathway hydraulic conductivity values (m/s): SINGLE(1e-007)

Justification for Unsat Zone Hydraulics Properties

High value conservatively assumed such that it does not impact on site leakage rates.

Pathway longitudinal dispersivity (m): SINGLE(0.1)

Justification for Unsat Zone Dispersion Properties

10% pathway length

Retardation parameters for Backfill and fractured bedrock pathway

Modelled as unsaturated pathway

No retardation values used in this simulation.

Check 'Unretarded Contaminant Transport' setting under simulation preferences.

Aquifer Pathway Dimensions for Phase

Pathway length (m):	UNIFORM(16.5,163.5)
Pathway width (m):	SINGLE(314)

Phase: Proposed Phase 3

Infiltration Information

Cap design infiltration (mm/year):	NORMAL(50,5)
Infiltration to waste (mm/year):	NORMAL(523,52.3)
End of filling (years from start of waste deposit):	7

Justification for Specified Infiltration

Infiltration to open waste is based on difference between regional specific total rainfall and effectve rainfall. Cap design infiltration is Golder judgement for CQA installed clay cap.

Duration of management control (years from the start of waste disposal): 20000

Cell dimensions

Cell width (m):	400
Cell length (m):	202.5
Cell top area (ha):	10.29
Cell base area (ha):	8.1
Number of cells:	1
Total base area (ha):	8.1
Total top area (ha):	10.29
Head of Leachate when surface water breakout occurs (m)	SINGLE(10.1)
Waste porosity (fraction)	UNIFORM(0.2,0.3)
Final waste thickness (m):	UNIFORM(9.5,42.5)
Field capacity (fraction):	UNIFORM(0.15,0.2)
Waste dry density (kg/l)	UNIFORM(1.25,1.75)

Justification for Landfill Geometry

Set to ensure leachate breakout does not occur in contaminant transport model

Source concentrations of contaminants

All units in milligrams per litre

Declining source term

Cadmium	LOGTRIANGULAR(0.0006,0.006,0.06)
	Substance to be treated as List 1
Chloride	TRIANGULAR(1771,2319,2871)
	Data are spot measurements of Leachate Quality
Nickel	LOGTRIANGULAR(0.0036,0.036,0.36)
	Data are spot measurements of Leachate Quality
Sulphate	TRIANGULAR(1847,2264,2901)
	Data are spot measurements of Leachate Quality

Justification for Species Concentration in Leachate

Sulphate and chloride concentration based on PDF of leachate monitoring data to date in Phase 1. Maximum nickel and cadmium concentrations set at 3 times the maximum permissible leachate strength corresponding to the inert Waste Acceptance Criteria.

Drainage Information

Fixed Head.

Head on EBS is given as (m): SINGLE(1)

Justification for Specified Head

Based on 95%ile output from LandSim model of conceptual leachate drainage system

Barrier Information

There is a single clay barrier

Justification for Engineered Barrier Type
Based on proposed design specification

Design thickness of clay (m):	SINGLE(1)
Density of clay (kg/l):	UNIFORM(0.18,0.24)
Pathway moisture content (fraction):	TRIANGULAR(0.13,0.166,0.22)

Justification for Clay: Liner Thickness
Based on proposed future design specification

Hydraulic conductivity of liner (m/s):	TRIANGULAR(9.4e-011,2.2e-010,3.7e-010)
Pathway longitudinal dispersivity (m):	SINGLE(0.1)

Justification for Clay: Hydraulics Properties
Based on site specific CQA data from Phase 1.

Retardation parameters for clay liner

Uncertainty in Kd (l/kg):	
Cadmium	SINGLE(600)
Chloride	SINGLE(0)
Nickel	UNIFORM(20,66)
Sulphate	SINGLE(0)

Justification for Liner Kd Values by Species
Chloride and suplhate are unretarded and kd has been set at 0. Nickel kd is conservatively based on range in ConSim Help Files for sand and unspecified conditions. Kd for cadmium is Golder judgement based on data from ConSim Help Files.

Backfill and fractured bedrock pathway parameters

Modelled as unsaturated pathway

Pathway length (m):	SINGLE(1)
Flow Model:	porous medium
Pathway moisture content (fraction):	UNIFORM(0.01,0.035)
Pathway Density (kg/l):	UNDEFINED

Justification for Unsat Zone Geometry

Assumed to be 1m, and thus that the water table does not rise above this threshold following recovery.

Pathway hydraulic conductivity values (m/s): SINGLE(1e-007)

Justification for Unsat Zone Hydraulics Properties

High value conservatively assumed such that it does not impact on site leakage rate.

Pathway longitudinal dispersivity (m): SINGLE(0.1)

Justification for Unsat Zone Dispersion Properties

10% pathway length

Retardation parameters for Backfill and fractured bedrock pathway

Modelled as unsaturated pathway

No retardation values used in this simulation.

Check 'Unretarded Contaminant Transport' setting under simulation preferences.

Aquifer Pathway Dimensions for Phase

Pathway length (m):	UNIFORM(11.5,248.5)
Pathway width (m):	SINGLE(435)

Formation pathway parameters

No Vertical Pathway

Bedrock (Shale/limestone) pathway parameters

Modelled as aquifer pathway.

Mixing zone (m):	UNIFORM(15,20)

Justification for Aquifer Geometry

Pathway length calculated by LandSim based on Phase arrangement in Domain Area Window. Pathway width measured from site drawing of current and future phases.

Pathway regional gradient (-):	SINGLE(0.03)
Pathway hydraulic conductivity values (m/s):	LOGUNIFORM(1e-006,1e-005)
Pathway porosity (fraction):	UNIFORM(0.05,0.1)

Justification for Aquifer Hydraulics Properties

Hydraulc conductivity based on site specific slug test data. Allowance has been made for the potential for a fracture network. Gradient information and been provided by a regional water table contour plot. Porosity is based on average values for shale and limestone from Freeze and Cherry 1979.

Pathway longitudinal dispersivity (m):	LOGUNIFORM(2,32.5)
Pathway transverse dispersivity (m):	LOGUNIFORM(0.6,9.75)

Justification for Aquifer Dispersion Details

Longitudinal dispersivity taken as 10% pathway length. Tranverse dispersivity taken as 3% of pathway length

Retardation parameters for Bedrock (Shale/limestone) pathway

Modelled as aquifer pathway.

No retardation values used in this simulation.

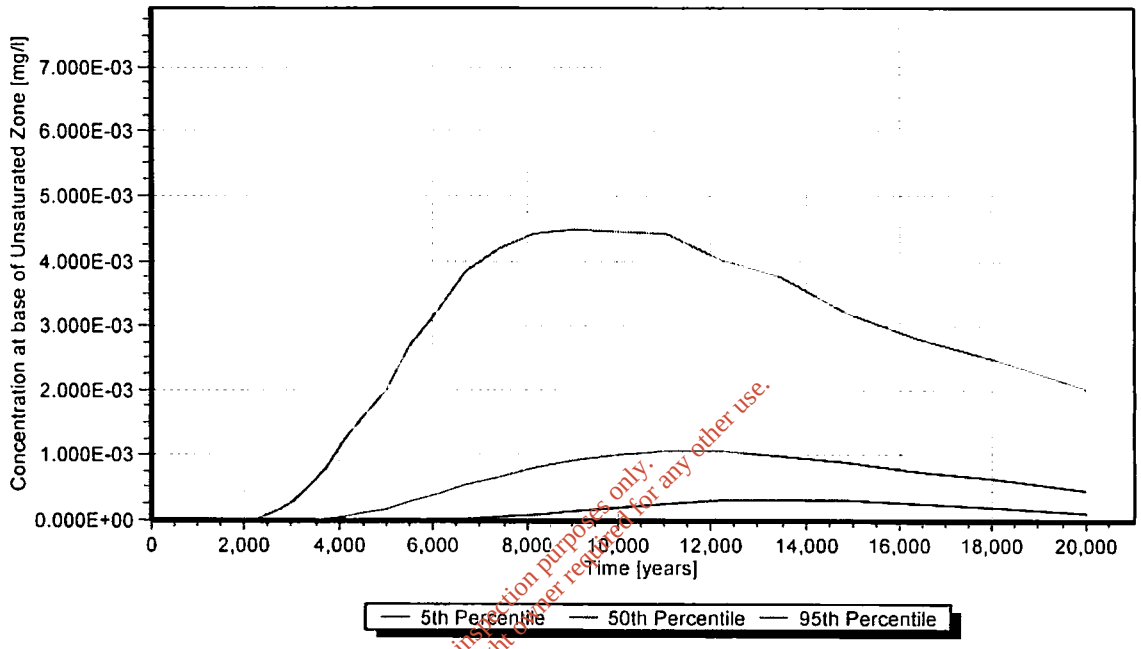
Check 'Unretarded Contaminant Transport' setting under simulation preferences.

LandSim Version 2.5

Project Name: Risk Assessment

Customer:Murphy Environmental

Results: Existing Phase 1 (cell 1,2,3), Cadmium Concentration at base of Unsaturated Zone [mg/l]



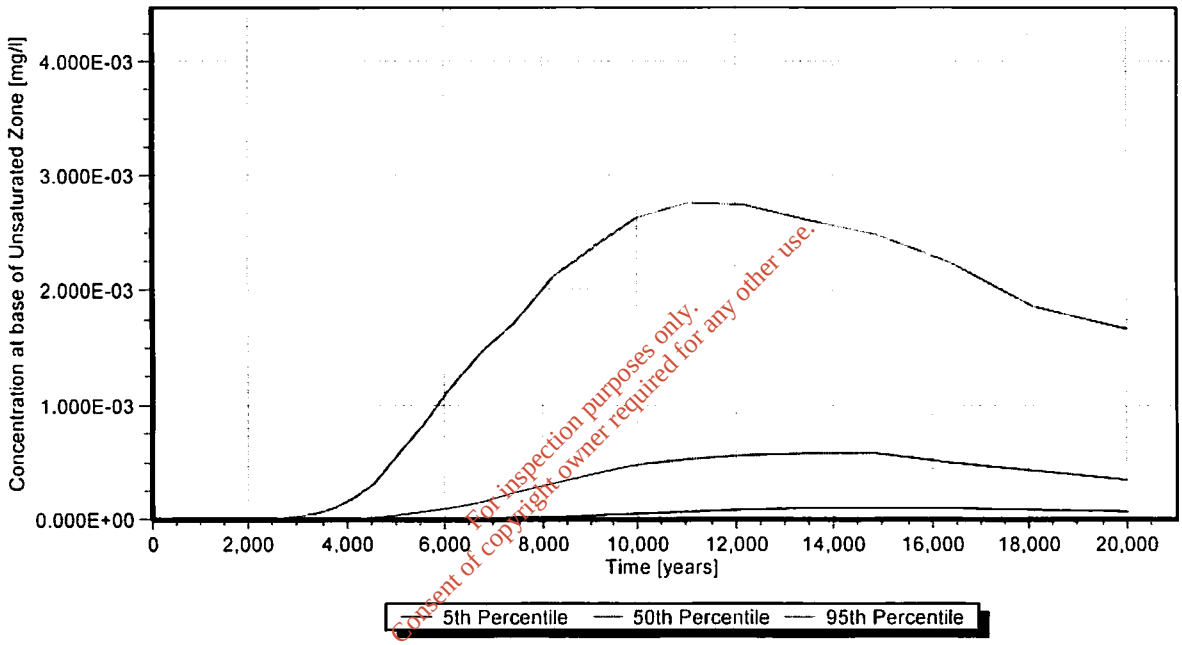
\Hollywood RA 2007 (SB) - 2.sim 22/06/2007 07:48:55

LandSim Version 2.5

Project Name: Risk Assessment

Customer:Murphy Environmental

Results: Proposed Phase 2, Cadmium Concentration at base of Unsaturated Zone [mg/l]



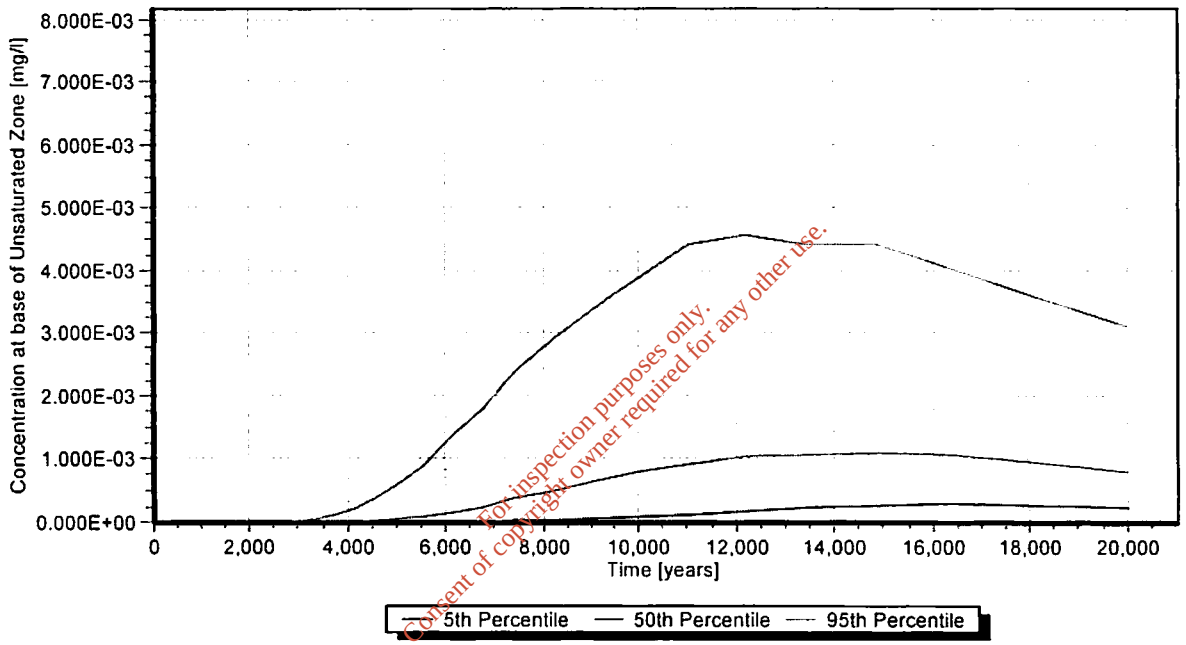
\Hollywood RA 2007 (SB) - 2.sim 22/06/2007 07:48:55

LandSim Version 2.5

Project Name: Risk Assessment

Customer:Murphy Environmental

Results: Proposed Phase 3, Cadmium Concentration at base of Unsaturated Zone [mg/l]



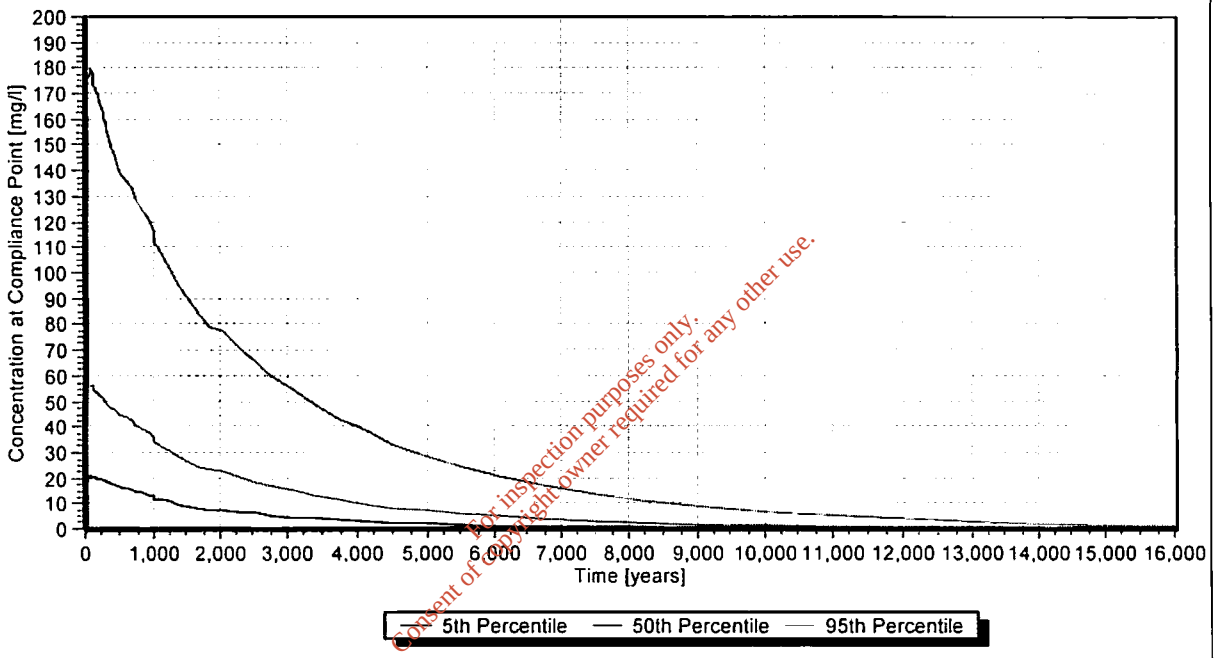
\Hollywood RA 2007 (SB) - 2.sim 22/06/2007 07:48:55

LandSim Version 2.5

Project Name: Risk Assessment

Customer:Murphy Environmental

Results: Sulphate Concentration at Compliance Point [mg/l]



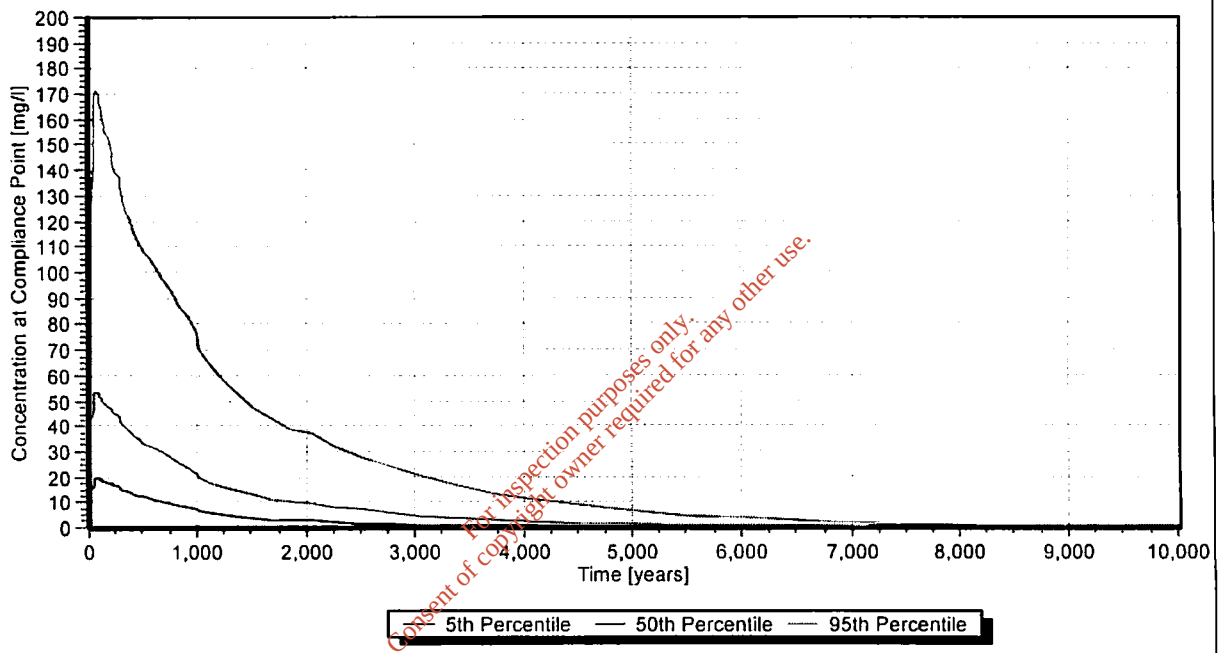
\Hollywood RA 2007 (SB) - 2.sim 22/06/2007 07:48:55

LandSim Version 2.5

Project Name: Risk Assessment

Customer:Murphy Environmental

Results: Chloride Concentration at Compliance Point [mg/l]



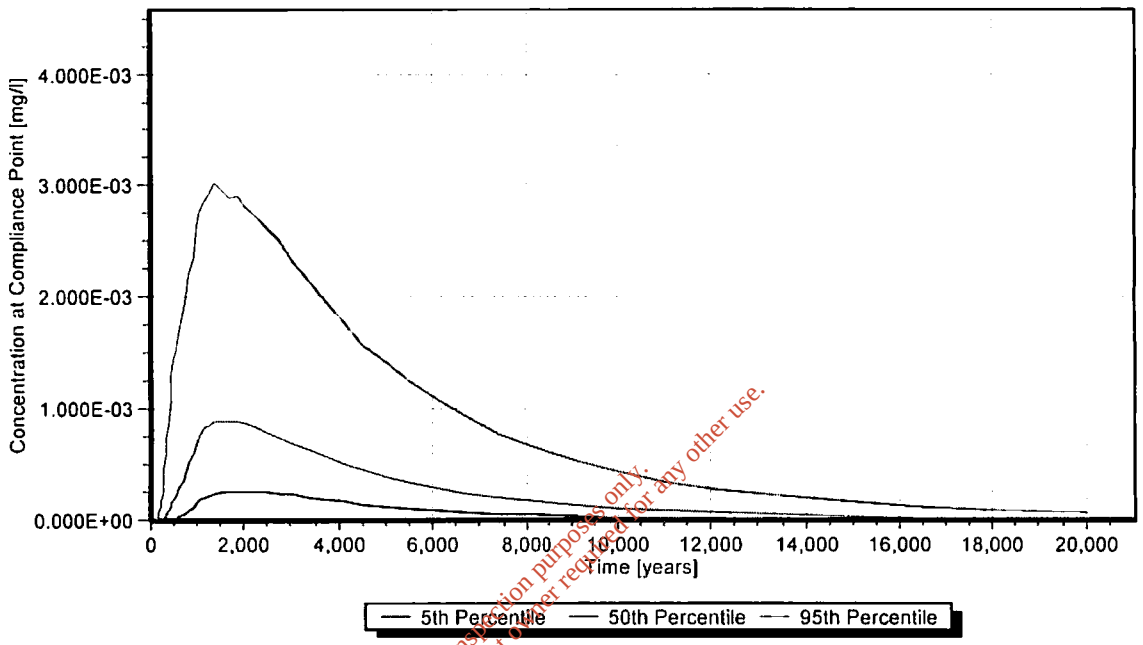
\Hollywood RA 2007 (SB) - 2.sim 22/06/2007 07:48:55

LandSim Version 2.5

Project Name: Risk Assessment

Customer:Murphy Environmental

Results: Nickel Concentration at Compliance Point [mg/l]



\Hollywood RA 2007 (SB) - 2.sim 22/06/2007 07:48:55

APPENDIX 6

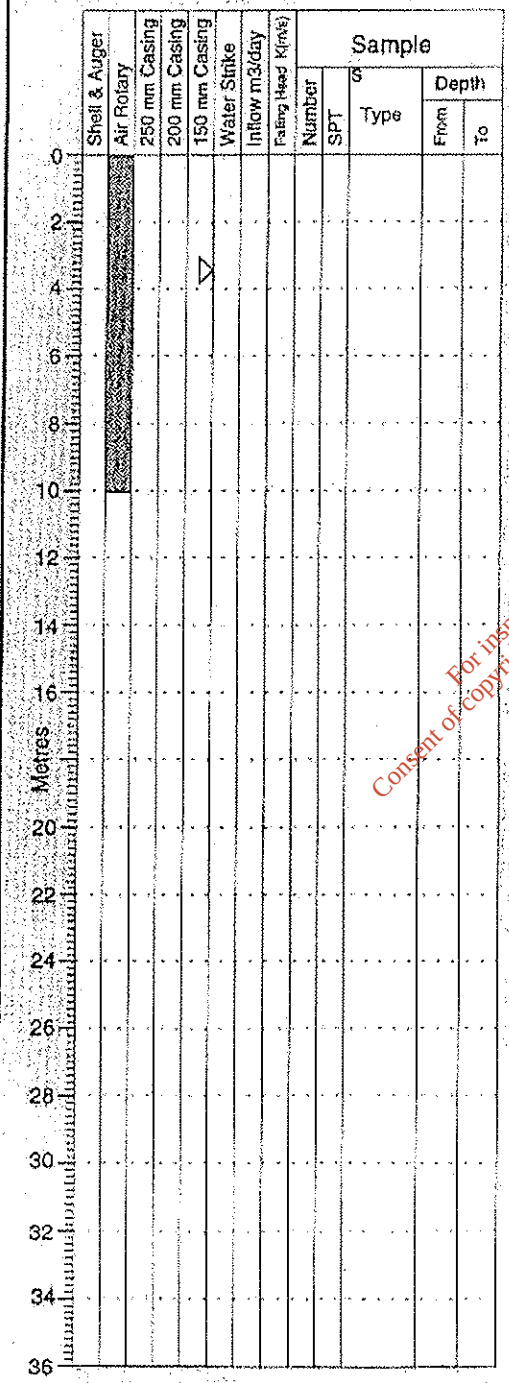
BOREHOLE LOGS

Monitoring Well Log

Monitoring Well BH 4

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

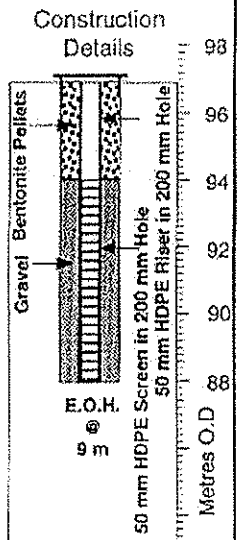
Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 326044 East 257842 North
Ground Surface Elev. : 96.9 m OD Malin Head
Logged by : Clare Glanville



Drilling Notes and Strata Description

0-3m TILL

3-10m Limestone BEDROCK



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

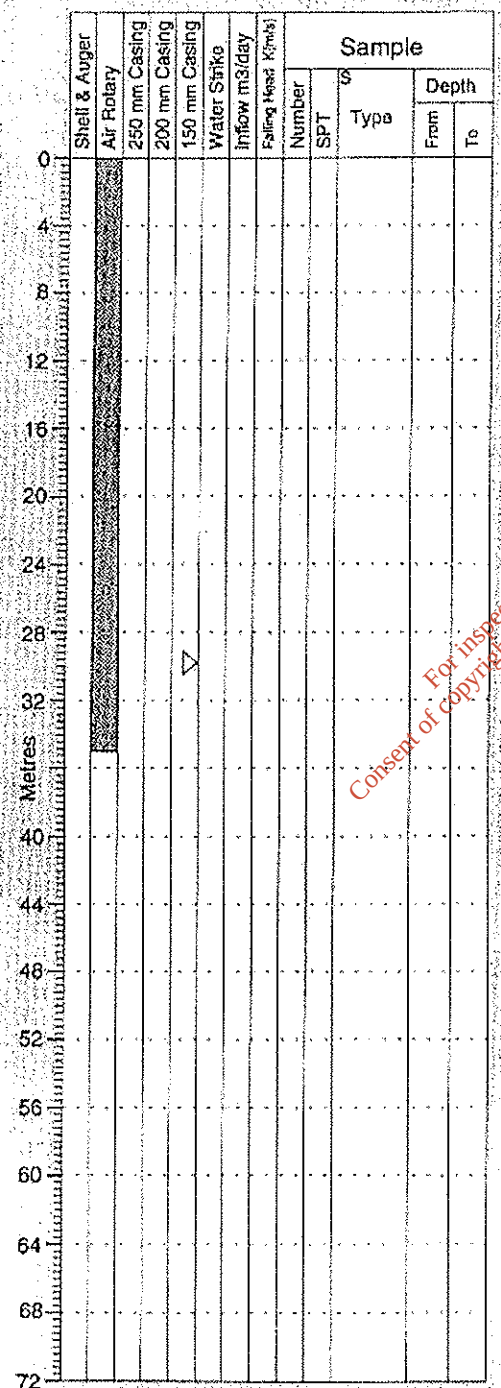
Figure No.

Monitoring Well Log

Monitoring Well BH 5

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315796 East 258328 North
Ground Surface Elev. : 118.2 m OD Malin Head
Logged by : Clare Glanville



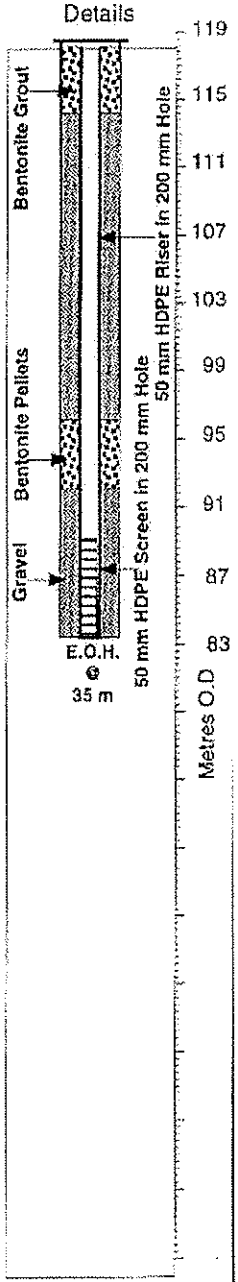
Drilling Notes and Strata Description

0 - 6 m Brown silty clayey matrixed TILL with gravel clasts

6 - 10 m Black Highly Weathered Shale , silty and clayey

10 - 35 m Black Weathered Shale

Construction Details



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

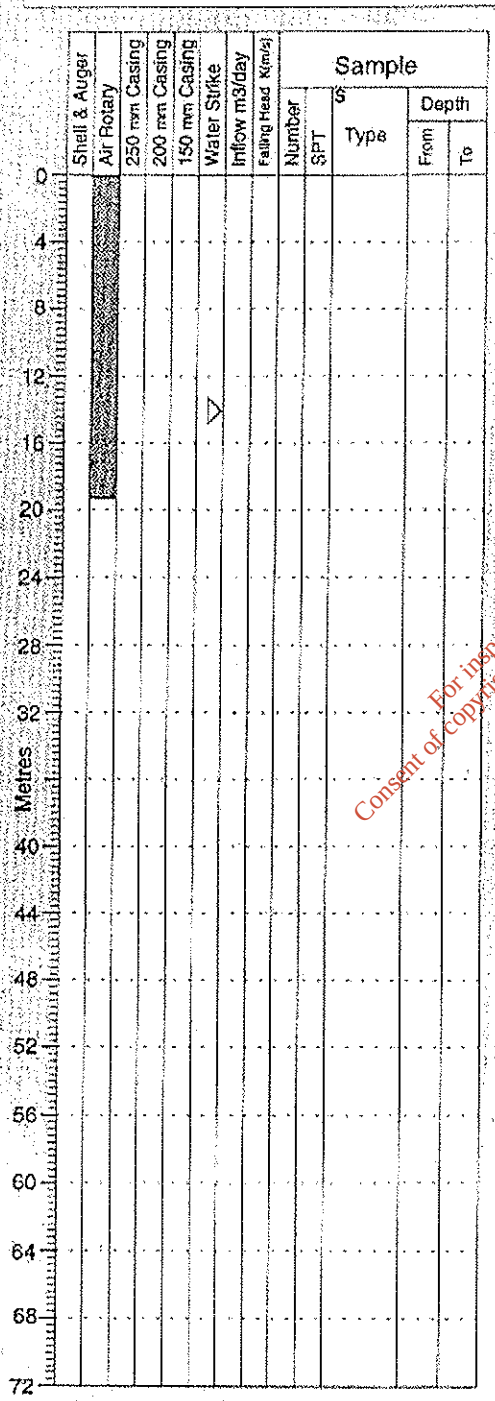
Figure No.

Monitoring Well Log

Monitoring Well BH 6

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315644 East 258506 North
Ground Surface Elev. : 117 m OD Malin Head
Logged by : Clare Glanville



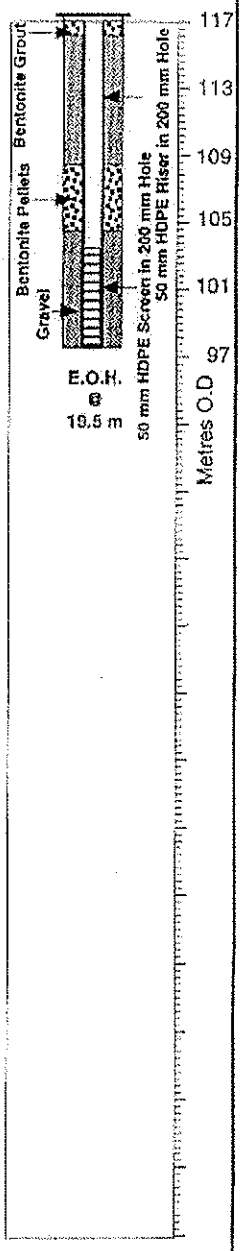
Drilling Notes and Strata Description

0 - 4 m Brown/Grey Clayey TILL

4 - 12 m Black Silty Clay with WEATHERED ROCK

12 - 19.5 m Black Shale BEDROCK

Construction Details



Sample / Test Legend
U - U100 Tubes
SS - Silt Spoon
SPT - Standard Penetration Test

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

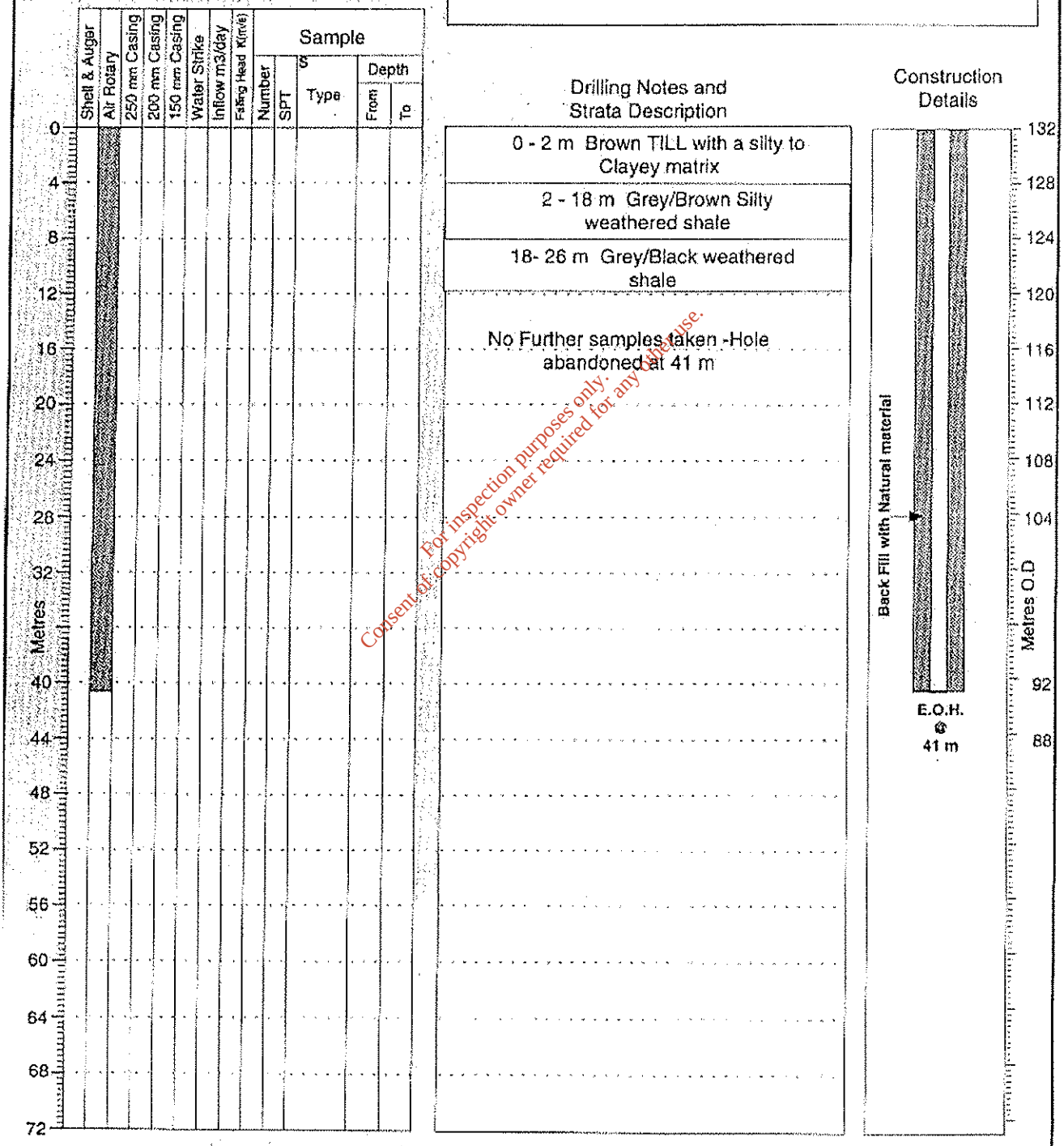
Figure No.

Monitoring Well Log

Monitoring Well BH 7

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 7/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : East North
Ground Surface Elev. : 132 m OD Malin Head
Logged by : Clare Glanville



Sample / Test Legend
U - U100 Tubes
SS - Silt Spoon
SPT - Standard Penetration Test

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Figure No.

Well Log

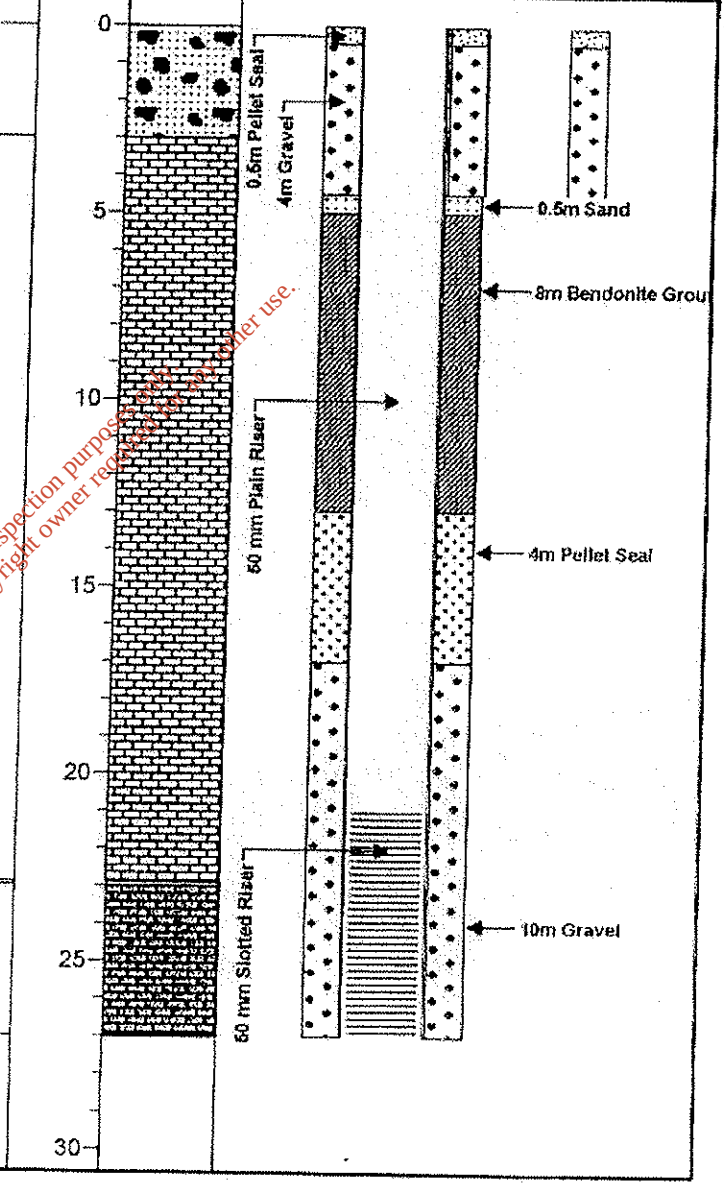
Well No. BH8 New | **Grid Reference** | | **Drill Date** 17/08/01

Project No. 1698 | **Client** Seamus Murphy

Well Type Groundwater Monitoring | **Location** Hollywood Great Quarry | **Geologist** F White

SUBSURFACE PROFILE

Description	Depth	Symbol	Well Construction
Ground Surface			
OVERBURDEN Overburden BOULDER CLAY			
SHALE Black SHALE bedrock			
SHALE Broken Black SHALE			
End of Borehole			



K.T.Cullen & Co. Ltd.

Drill Method Air Rotary | **Hole Size (mm)**

Casing Length (m) | **Ground Level (mOD)**

Driller Glover Site Investigations | **Static Water Level (bgl)**

Well Log

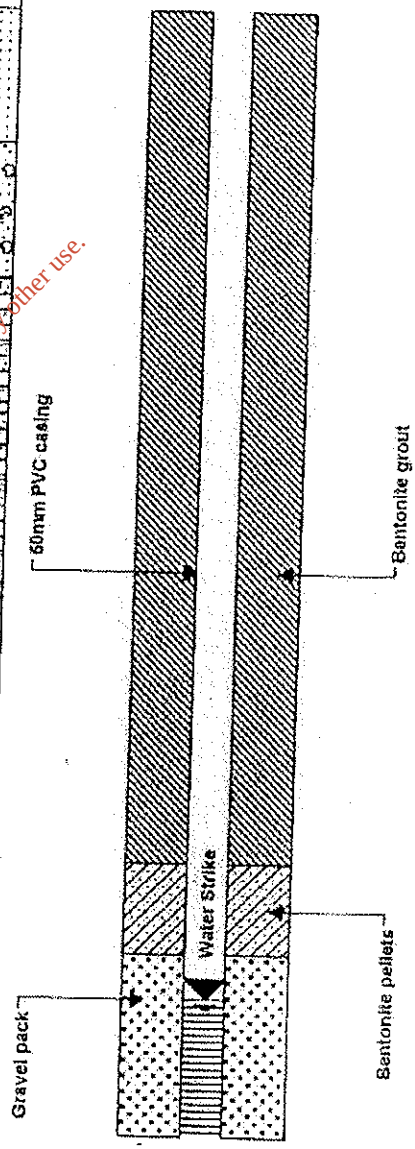
Well No. BH9 **Grid Reference**

Project No. 1698 **Client** Seamus Murphy **Drill Date** 3/8/01

Well Type **Location** Hollywood Great **Geologist** Ben Whitfield

SUBSURFACE PROFILE

Description	Depth	Symbol
Ground Surface		
Colluvium and highly weathered shale black loamy fine to medium sand easy drilling; moist		
light brown/dark brown gravelly medium clay; moist Gravel dominantly black shale Very moist thin layer 10.0 - 10.5 easy to medium drilling		
Shale bedrock black sand to gravel (granulated shale), moist medium drilling		
black sand to gravel, as above gravel sized chips dominant		
brown sand to gravel gravel shale and minor calcareous siltstone minor clay, moist		
black sand to gravel dominantly shale		
black coarse sand to gravel shale chips very moist@42 very easy drilling 40 - 41m Water table 44m Yield 500 gal/hr		
End of Borehole		



T.Cullen & Co. Ltd.

Drill Method Air rotary **Hole Size (mm)** 200

Casing Length (m) 50 **Ground Level (mOD)**

Driller Glovers Site Investigations **Static Water Level (bgl)**

Well Log

Well No. BH10 | Grid Reference

Project No. 1698 | Client Seamus Murphy | Drill Date 4/8/01

Well Type | Location Hollywood Great | Geologist C Connery

SUBSURFACE PROFILE

Description	Depth	Symbol	Well Construction
Ground Surface			
Boulder clay stiff brown very sandy gravelly clay containing cobbles and boulders	0		
Limestone Bedrock Limestone	5		
	10		
	15		
	20		
	25		
	30		
	35		
	40		
	45		
	50		
	55		
	60		
	65		
	70		
	75		
	80		
End of Borehole	85		

M.T.Cullen & Co. Ltd.

Drill Method Air rotary | Hole Size (mm) 200

Casing Length (m) 84 | Ground Level (mOD)

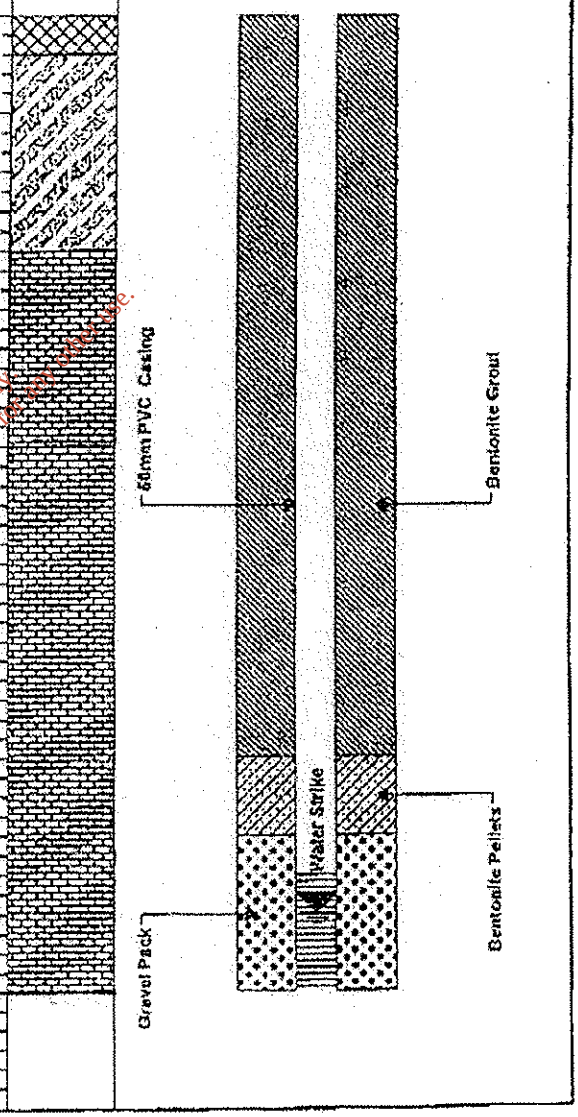
Driller Glovers Site Investigations | Static Water Level (bgl)

Well Log

Well No. BH1	Grid Reference	
Project No. 1698	Client Seamus Murphy	Drill Date 3/8/01
Well Type	Location Hollywood Great	Geologist Ben Whitfield

SUBSURFACE PROFILE

Description	Depth (m)	Symbol	Well Construction
Ground Surface			
Fill Fill			
Clay Firm to stiff grey brown sandy gravelly CLAY containing cobbles and boulders			
Shale Brown SHALE			
Shale Black SHALE			



White Young Green

Drill Method Air Rotary	Hole Size (mm) 200
Casing Length (m) 50	TOC (mOD)
Driller Glovers Site Investigations	Static Water Level (bgl)

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH10A

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 5/3/2007

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 137.140
0	Monitoring Borehole Air Rotary	Overburden-brown soil		0.00								Bentonite seal
5												
10		Weathered shale		10.00								
15												Riser pipe
20		Limestone		21.00								
25												
30												
35												Bentonite Plug
40												Riser pipe and gravel pack
45												
50												
55												Entry 5/3/07 Screen and gravel pack
60												
65												
70				68.00								EOH

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: CG
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 17/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH11A

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 2/5/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 100.01
0	Monitoring Borehole Air Rotary	Overburden/madeground		0.00								Cement Backfill
5		Weathered grey shale		2.00								
10		Fractured shale		8.00								Bentonite
15		Shale		12.00								
20		Heavily weathered shale		18.00								Gravel pack
25		Grey sandy shale		21.00								Screen and gravel pack
30				30.00								
35												
40												
45												
50												
55												
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 17/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH12

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 13/04/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		PAVEMENT SURFACE										Top of Pipe Elev. 146.994
0	Cored Rotary Core	Pavement										Concrete seal
		Overburden		0.30								
5		Broken and heavily weathered Shale		5.00								
10												
15												
20												
25												Backfill
30												
35												
40												
45												
		Dark grey bedded limestone with fractures		46.00								
50	Hammer											
55				54.50								EOH
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 17/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH12

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 1/5/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	Limestone Groundwater Monitoring Borehole Symetrex	PAVEMENT SURFACE										Top of Pipe Elev. 146.994
		Concrete										Concrete seal
		Overburden		0.30								
5		Shale		5.50								
10												
15												
20												
25												Backfill
30												
35												
40												
45												
		Limestone		46.00								Bentonite plug
50												Gravel Pack
55												Screen and gravel pack
60												
65				65.00								
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 17/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH13

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 15/04/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	Shale Groundwater Monitoring Point / Air Rotary	PAVEMENT SURFACE										Top of Pipe Elev. 146.922
		Pavement		0.30								Concrete seal
		Overburden										
5		Shale		5.50								
10												
15												Riser
20												
25												
30												Bentonite Plug Gravel Pack
35												Gravel Pack, 50mm Screen Water Level 16/04/07
40												
45												Bentonite Backfill
		Limestone		46.00								
				48.00								
50												
55												
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 17/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH14

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 2/3/2007

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: GEOTECH NO.	SAMPLES: ENV NO.	SAMPLES: TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 125.064
0	Monitoring Well / Air Rotary	Topsoil		0.00								Bentonite
5		Broken weathered shale		6.00								
10												Backfill
15												
20												Bentonite
25												Gravel Pack
30		Limestone		30.00								
35												Screen and gravel pack
				38.00								EOH 2000 gph est.
40												
45												
50												
55												
60												
65												
70												

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: TVM
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 17/7/07 DATA INPUT: