

#### Appendix 8.1: Borehole Logs for the Permitted Borrow Pit



#### LEGEND

**Borehole Locations** 

Borehole •

REFERENCE

COORDINATE SYSTEM: TM65 IRISH GRID GEOLOGICAL DATA COPYRIGHT GSI 2015

1:1,503

CLIENT AUGHINISH ALUMINA LTD

PROJECT AUGHINISH BORROW PIT

TITLE BORROW PIT - BOREHOLE LOCATION MAP

CONSULTANT



FIGURE X

PROJECT No. 1667376



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All dimensions in metres Scale 1:93.75	Client Aughinish Alum	a Method/ Plant Used	Beretta T44	Logged By C. Maguire



Appendix 8.2: Soil Quality Sampling Report (2016/2017)

June 2017

## **AUGHINISH ALUMINA LIMITED**

## SOIL QUALITY MONITORING REPORT, AUGHINISH, CO. LIMERICK

Submitted to: Aughinish Alumina Limited, Aughinish Island, Askeaton, Co. Limerick

REPORT



Report Number. Distribution:

1663245.R01.A2

Aughinish Alumina Limited - 1 copy (pdf) Golder Associates Ireland Limited - 1 copy (pdf)





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APPENDIX B Analytical Report





Aughinish Alumina Limited (AAL) requested Golder Associates Ireland Limited (Golder) to undertake a soil sampling and testing programme for its licensed facility on Aughinish Island, Askeaton, County Limerick (the Site). This work was undertaken to satisfy the requirements of Schedule C.6 - Soil Monitoring of the Industrial Emissions Licence (IEL) Reference Number P0035-06. The IEL specifies that soil monitoring be conducted every five years for relevant hazardous substances as specified in the *Aughinish Alumina: Baseline Soil and Groundwater Report*<sup>1</sup>.

#### 1.1 Background

AAL produces alumina (Al<sub>2</sub>O<sub>3</sub>) by treating bauxite ore, using the Bayer process which involves the dissolution of aluminium hydrate (Al<sub>2</sub>O<sub>3</sub>.3H<sub>2</sub>O) from the bauxite under high pressure in sodium hydroxide (caustic soda).

Waste products from the refining process are bauxite residue and salt cake which comprises oxides of aluminium, iron and titanium and salt deposits and takes the form of a sand and red mud or salt cake respectively. Contained within the bauxite residue is a residual quantity of sodium aluminate which exists in this residue as a caustic solution. The bauxite residue and salt cake are deposited in an engineered contained facility, the Bauxite Residue Disposal Area (BRDA). Most of the waste types deposited in the BRDA are classified as non-hazardous according to the European Waste Catalogue. Salt cake is classified as hazardous and is deposited in a specially engineered cell with the BRDA. The BRDA falls within the scope of Directive 2006/21/EC on the management of waste from the extractive industries. The BRDA is a Category A waste facility.

The refined product is alumina. This is precipitated as white slurry and dried to form a fine white granular powder which is exported to aluminium smelters for processing into aluminium metal.

#### **1.2** Site History – Soils

Prior to the construction of the plant which commenced in 1978, the area was a green field site. The topography of the proposed Plant Area in the northeast of the island was dominated by two limestone outcrops with elevations of 28.7 metres above ordnance datum (m AOD) and 19 m AOD. The outcrops were located in the middle of the current Plant Area, separated by a northeast-southwest trending valley, dipping towards the southwest. It is considered that this area would have been largely undeveloped or utilised for any purpose at this time.

Two phases of baseline soil data collection were completed prior to the construction and commissioning of the AAL plant. In 1978, a total of 25 soil samples were collected at a depth of between 0 and 100 cm<sup>2</sup> and were analysed for pH, phosphorous, potassium and magnesium. In 1979 a total of 514 samples were collected in an area covering an 8 km radius around the AAL plant<sup>3</sup>. Soils were systematically sampled at 20 m<sup>2</sup> gridline intersections. The samples were collected using a stainless steel sampler, where 20 cores (0 – 5 cm) were taken within a defined area and composited to give one sample. Samples were analysed for pH, phosphorous, potassium and occasionally arsenic.

During construction of the plant, the area underwent extensive regrading works. The two outcrops were blasted and the 2 million m<sup>3</sup> of crushed rock was used to infill the centre valley. Construction of the plant and ancillary structures took place between 1978 and 1983. The plant was commissioned in 1983. During this construction, the majority of soils present were stripped or covered over by either sealed concrete slabs in the Plant Area or engineered containment and bauxite residue in the BRDA area. It is thus considered that very little soil remains present at the Site and no direct comparison can be made between the results of the soil sampling in 2016 and the baseline soil data collected in 1978-1979.



<sup>&</sup>lt;sup>1</sup> Golder Associates, June 2014 (Report reference 13514150608.501/A.0)

<sup>&</sup>lt;sup>2</sup> An Foras Taluntais (1979), Soil Survey Report on Aughinish Island, Co. Limerick

<sup>&</sup>lt;sup>3</sup> Fleming GA & Parle PJ, 1983, Baseline Survey in the vicinity of Aughinish Island.



#### 1.2.1 Site Soils and Geology

The soils and sub-soils data (Teagasc) shows that the site is underlain by a combination of marine estuarine silts and clays, and glacial till derived from Carboniferous Limestones.

The bedrock geology of the site is understood to be comprised of Waulsortian Limestones in the northern and eastern parts of the site. These limestones are pale-grey, sparry, fossiliferous (bryozoan) poly-mud micritic limestones, often massive knoll forms, with crinoidal or pale cherty shaley interbeds (GSI, 1999). Dolomitisation is frequent in these limestones and is often associated with fracture zones. The development of karst features has been identified within bedrock in the immediate vicinity of area.

The southern (and western) parts of the site are underlain by the Rathkeale Formation. These rocks are dark-grey argillaceous limestones and shaley mudstones. This Formation is poorly exposed and is thought to have a maximum thickness of about 460 m.

#### 2.0 METHODOLOGY AND APPROACH

The conditions of IEL P0035-06 specify that soil monitoring should be carried out for 'relevant hazardous substances' every five years. Relevant Hazardous Substances under Articles 3 and 22 of Regulation (EC) No 1272/2008 are those substances or mixtures which, as a result of their hazardousness, mobility, persistence and biodegradability (as well as other characteristics), are capable of contaminating soil or groundwater and are used, produced and/or released by the installation. The relevant hazardous substances specified for the Site are outlined below:

- Arsenic;
- Cadmium;
- Lead;
- Mercury;
- Nickel;
- Sodium hydroxide^;
- Compounds present in heavy fuel oil;
- Sulphuric acid^;
- Compounds present in antifoam;
- Compounds present in petrol;
- Compounds present in diesel; and
- Sodium aluminate^.

^These substances are non-hazardous but are outlined for consideration due to the quantities of use on the Site and the concentrated nature of their source.

### 2.1 Soil Sampling and Testing Methodology

Golder attended the Site in late 2016 and early 2017 and collected 20 soil samples. Sample locations were recorded using a GPS rover linked to the Irish National Grid (ING) base station at Shannon and the locations are shown in the Drawings Appendix at the back of the report. The sample details are provided in Table 1, below, and the full trial pit logs are included in Appendix A. Samples were collected using trial pitting methods to a maximum depth of approximately 50 cm and composite samples were compiled from each sampling location by homogenising the excavated material. The excavated material was comprised of sands, silts, and clays with many organics and root hairs and often contained large cobbles. Many trial pits were terminated at 0.2-0.3 m due to bedrock or large cobbles. Samples SL13 and SL14 contained shell fragments. Appropriate sub-samples were dispatched to Exova Jones Environmental Laboratory in the UK for a suite of testing to characterise the material in accordance with the substances specified above.



#### SOIL QUALITY MONITORING REPORT- AUGHINISH

#### Table 1: Soil Monitoring Samples – Aughinish

Sample	Easting	Northing	Material	
SL-01	128370.794	154347.707	light brown slightly clayey sandy SILT	end of dig at 0.2 m (bedrock or large cobble)
SL-02	128628.362	153968.882	brown slightly sandy silty CLAY	end of dig at 0.2 m (bedrock or large cobble)
SL-03	128879.825	153688.531	light brown slightly clayey gravelly coarse SAND	bedrock at 0.2 m
SL-04	129001.079	153556.935	light brown slightly clayey gravelly coarse SAND	bedrock at 0.2 m
SL-05	128946.384	153326.264	light brown slightly clayey gravelly coarse SAND	bedrock at 0.25 m
SL-06	128910.733	152923.841	brown clayey sandy SILT	bedrock at 0.13 m
SL-07	128654.586	152598.566	light brown silty gravelly coarse SAND	large cobbles, end of dig at 0.4 m
SL-08	128106.016	152121.912	brown slightly sandy silty CLAY	large cobbles, end of dig at 0.4 m
SL-09	128579.088	151304.271	brown slightly sandy silty loose CLAY	large cobbles, end of dig at 0.4 m
SL-10	128688.837	150938.445	brown slightly gravelly sandy CLAY	large cobbles, end of dig at 0.3 m
SL-11	127539.915	150916.401	dark brown/black slightly sandy silty (cohesive) CLAY	odour, end of dig at 0.5 m
SL-12	127037.139	151497.803	blue/grey slightly sandy clayey SILT	end of dig at 0.5 m
SL-13	126549.807	152458.988	grey loose silty fine to coarse SAND	many shells, end of dig at 0.5 m
SL-14	127271.517	152765.477	light brown/grey cohesive slightly sandy SILT	some shells, end of dig at 0.5 m
SL-15	127673.827	153175.535	brown slightly sandy silty CLAY	large cobbles, hit rock at 0.3 m
SL-16	127988.416	153960.558	brown silty sandy CLAY	hit rock at 0.3 m
SL-17	126979.354	151570.483	dark brown slightly sandy silty CLAY	some shells, hit rock at 0.48 m
SL-18	127671.661	153236.998	brown cohesive slightly sandy silty CLAY	large cobbles, end of dig at 0.48 m
SL-19	127923.309	153464.621	brown sandy silty CLAY	hit rock at 0.18 m
SL-20	127309.60	151139.6	Cohesive soft brown slightly gravelly sandy CLAY with pockets of bluish grey SILT/CLAY	End of dig at 0.85 m





#### 3.0 RESULTS

As noted in Section 1.2, no specific on-site soil sampling locations were identified for baseline sampling and hence only the regional composition in the vicinity to the site has been historically characterised. Given that samples at defined locations have been collected in December 2016 – April 2017, these can be considered a baseline for future soil monitoring at the same locations. The analytical results can be broadly categorised into metals, semi-volatile organic compounds (SVOCs), gasoline range organics (GRO), extractable petroleum hydrocarbons (EPH), and nonyl phenol ethoxylates. Summary statistics for the samples have been prepared in Table 1 and the analytical report is in Appendix B.

The operation of the Site uses caustic soda in the majority of processes but also uses acid in some processes; hence an understanding of the pH is an important indicator of the impact of the Site. The soil pH ranged from 6.07 to 8.53, with the majority of results around pH 8. This does not show any significant acidification or alkalinisation in soils from industrial activities to date.

Samples were analysed for aluminium, arsenic, cadmium, lead, mercury, nickel, sodium, and total sulphate. Aluminium is the third most abundant element in the Earth's crust and concentrations in soils can range from 4% to 5% regionally<sup>4</sup>. One sample, SL-01, contained an elevated aluminium concentration compared with the other samples (40,630 mg/kg (4.06%) vs median of 9,223 mg/kg (0.9%)). One sample, SL-10, contained an elevated lead concentration compared with the other samples (1195 mg/kg vs median concentration of 14 mg/kg). Samples SL-01 and SL-10 did not exhibit visible anthropogenic influence from the sampling logs. Concentrations of arsenic ranged from 2.9 to 23.1 mg/kg, which is below the geochemical signature for the area<sup>5</sup>. No mercury was detected in any samples.

Five samples exhibited potential evidence of impact from industrial activities with regards to hydrocarbons, albeit at low concentrations. SL-16 exhibited very low concentrations of polycyclic aromatic hydrocarbons (PAHs, maximum concentrations of <1 mg/kg), which are chemicals that are released from burning organic substances such as coal, oil, and gasoline. Samples SL-11, SL-12, SL-17, and SL-19 had extractable petroleum hydrocarbon results above detection (maximum concentration of 276 mg/kg). Gasoline range organics and sVOCs were detected in sample SL-19 at low concentrations (C4-C12 concentration = 0.416 mg/kg, sVOC 1,3 Cyclooctadiene concentration = 1.498 mg/kg).

Nonyl phenol ethoxylates are non-ionic surfactants that are used in lubricating oil additives, detergents, and emulsifiers that are of environmental concern due to their ability to mimic the hormone oestrogen, which is of special concern to the reproduction of aquatic organisms. They have a low mobility in soils and sediments and can bioaccumulate. No nonyl phenol ethoxylates were detected in any samples.

The Site has been operational for 34 years and thus these results do not constitute a pre-operational baseline. These results can be utilised as a starting point for comparison purposes and soil monitoring should be carried out in five years in accordance with the conditions of the licence.



<sup>&</sup>lt;sup>4</sup> Teagasc (2007) Soil Geochemical Atlas of Ireland.

<sup>&</sup>lt;sup>5</sup> Fleming. G.A, Parle. P.J (1983); Baseline Survey in the vicinity of Aughinish Island.



Parameter	Units	Minimum	Maximum	Mean*	Median*	
рН	pH units	6.07	8.53	7.9	8.1	
Total Sulphate	mg/kg	100	2092	494	327	
Aluminium	mg/kg	1,196	40,630	11,026	10,657	
Arsenic	mg/kg	2.9	23.1	10.3	10.2	
Cadmium	mg/kg	<0.1	2.3	0.78	0.6	
Lead	mg/kg	<5	1195	87	18	
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	
Nickel	mg/kg	8.1	67.3	28.4	24.8	
Sodium	mg/kg	121	602	238	188	
Extractable Petroleum Hydrocarbons (EPH, C8-C40)	mg/kg	detected in samples SL11 (276 mg/kg), SL12 (146 mg/kg), SL-17 (181 mg/kg), and SL-19 (125 mg/kg)				
Gasoline Range Organics (GRO)	µg/kg	Only detected in sample SL-19 (C4-C12 = 416 $\mu$ g/kg)				
Nonyl phenol ethoxylates	mg/kg	<0.5	<0.5	<0.5	<0.5	
sVOCs	µg/kg	Detected in sample SL-16 (speciated polycyclic aromatic hydrocarbons) and SL-19 (1,3-cyclooctadiene)				

#### Table 2: Soil Sampling Summary Statistics (20 samples) - Aughinish Alumina Ltd, 2016/2017

\*values below detection were not considered for mean and median concentrations

### 4.0 CONCLUSIONS AND RECOMMENDATIONS

The conditions of Licence P0035-06 specify that soil monitoring should be carried out for 'relevant hazardous substances' every five years. A programme of soil sampling and analysis was undertaken in late 2016 and early 2017 for purposes of establishing an understanding of existing soil quality for future monitoring purposes. Samples were analysed for metals, semi-volatile organic compounds (SVOCs), gasoline range organics (GRO), extractable petroleum hydrocarbons (EPH), and nonyl phenol ethoxylates. The soil pH ranged from 6.07 to 8.53, which does not show any significant acidification or alkalinisation. An elevated aluminium concentration above median values was observed in sample SL-01 and an elevated lead concentration above median values was observed in sample SL-01. Low concentrations of EPH and very low concentrations of sVOCs were observed in samples SL11, SL12, SL16, SL-17, and SL-19. GRO was detected in sample SL-19 at a low concentration (<1 mg/kg). No nonyl phenol ethoxylates were observed in any samples.

The Site has been operational for 34 years and thus these results do not constitute a pre-operational baseline. Soil sampling should be carried out in five years in similar locations and analysed for the same group of parameters to compare results against this starting point.





## **Report Signature Page**

**GOLDER ASSOCIATES IRELAND LIMITED** 

M. Buckwalter Davis

Ruth Treacy .

Martha Buckwalter-Davis Geochemist

Ruth Treacy Environmental Consultant

MBD/RT/pw

23 June 2017

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

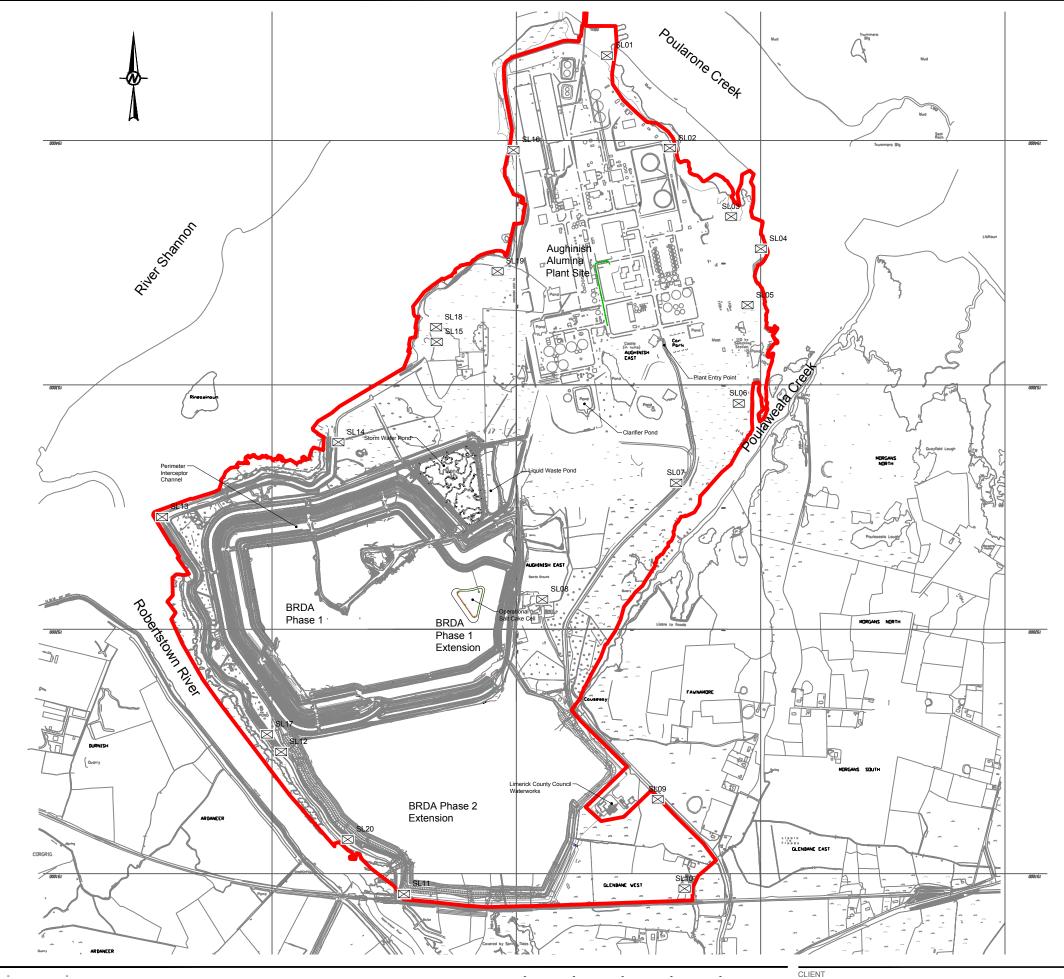




## **DRAWINGS**

**Drawing 01: Soil Sampling Location Plan** 





- 016/16	-	-	-	-	-	-	-	CL
- CTSV2	-	-	-	-	-	-	-	. A
E	2017-06-09	Revised following additional sampling location SL20	DC	ВК	RW	RW	2017-06-09	. ^
D D	2017-02-17	Revised following additional sampling location SL19	LMK	ВК	RW	RW	2017-02-20	CC
C	2017-02-16	Revised following addition of two sampling locations	ВК	ВК	RW	RW	2017-02-16	
B	2017-01-27	Revised following survey of sampling points	ВК	ВК	RW	RW	2017-01-27	
A A	2016-12-02	Soil Sampling Location Plan	ВК	ВК	RW	RW	2016-12-12	
Rev.	YYYY-MM-DD	DESCRIPTION	PREPARED	DESIGN	REVIEW	APPROVED	DATE	

AUGHINISH ALUMINA LIMITED

CONSULTANT



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#### **KEY PLAN**

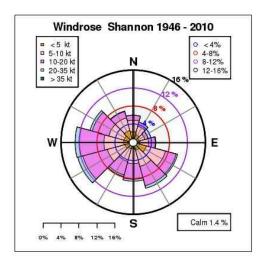
#### NOTES

- Site survey based on topographical survey conducted for Proposed Mud Extension, Island Mac Teige, from Gerard Dore Surveyors, dated 23 November 2007
   Windrose for Shannon Weather Station from met.ie



SL  $\bowtie$ 

SOIL SAMPLE LOCATION IE LICENCE BOUNDARY





#### PROJECT

IEL COMPLIANCE FOR SOIL MONITORING AT AUGHINISH ALUMINA LTD

TITLE

#### UPDATED SOIL SAMPLING LOCATION PLAN

PROJECT No.	Scale	Rev. 1 of 1	Drawing
1663245	A3 as shown	E	1



# **APPENDIX A**

**Trial Pit Logs** 



	sord : SL01		
Site Location:	Aughinish Alumina	Client :	AAL
Date:	13-Dec-16	Job No. :	1663245
und Level (mOD):	4.453		
PS Coordinates :	128370.794, 1543	47.707	Golder
ather Conditions:	o/c 10%, cold, dry, su	inny spells	Associates
Depth (m)	Ma	aterial Descriptio	n
0 - 0.1	TOPSOIL		
0.1 - 0.2	lighht brown slightly cla	yey sandy SILT	
	Organics/root hairs throu	ughout	
		ial Pit SL01	
Vater Strike (m) :		Sar	mple     Sample
	N/A	Sar	nber Depth
		Sar	
Recorded By :	N/A Lorcan McKenna	Sar	nber Depth
Recorded By :	N/A	Sar	nber Depth
Recorded By : Comments :	N/A Lorcan McKenna	Sar	nber Depth
Recorded By : Comments :	N/A Lorcan McKenna	Sar	nber Depth

	cord :	SL02	
Site Location:	Aughinish Alumina	Client :	AAL
Date:	13-Dec-16	Job No. :16	63245
Ind Level (mOD):			
PS Coordinates :	128628.362, 153968	8.882	Golden
ather Conditions:	o/c 10%, cold, dry, su	nny spells	Issociat
Depth (m)		erial Description	
0 - 0.1	TOPSOIL		
0.1 - 0.25	brown slightly sandy silty	CLAY	
	organics/root hairs throug	ghout	
A set in a set	A DANS THE PROPERTY OF		9
	Frai pit SL02		
Vater Strike (m) :		Sample	Sample
	N/A		Depth
		Sample	-
Recorded By :	N/A Lorean MeKenna	Sample Number	Depth
Recorded By :	N/A	Sample Number	Depth
Recorded By : Comments :	N/A Lorean MeKenna	Sample Number	Depth

Trial Pit Re	cord :	SL	.03	
Site Location:	Aughinsh Alumina	Client :	,	4AL
Date:	13-Dec-16	Job No. :	16	53245
ound Level (mOD): GPS Coordinates :		38.531		<b>Golder</b> ssociate
eather Conditions:	o/c 10%, cold, dry, su	nny spells	A	ssociate
Depth (m)	Ма	terial Descri	ption	
0 - 0.1	TOPSOIL		•	
0.1 - 0.2	light brown slightly claye	y gravelly coa	arse SAND	
	organics/root hairs throug	ghout		
	<image/> <image/>			
Water Strike (m) :	N/A		Sample	Sample
			Number	Depth
Recorded By :	Lorcan McKenna	_	SL03	0.2 m
Comments : Bedrock	End of dig @ 0.2m			

	cord :	SI	_04	
Site Location:	Aughinsh Alumina	Client :		AAL
Date:	13-Dec-16	Job No. :	166	63245
und Level (mOD): SPS Coordinates :	<u>5.484</u> 129001.079, 1535	56.935		0.11
	o/c 10%, cold, dry, su			Golder ssociate
Depth (m)	Ma	iterial Descr	iption	
0 - 0.1	TOPSOIL		•	
0.1 - 0.2	light brown slightly claye	ey gravelly coa	arse SAND	
	organics/root hairs throu	ghout		
		ł		
Water Strike (m) :		r	Sample	Sample
		t state in the second sec	Sample       Image: Content of the second seco	Sample Depth 0.2 m
Recorded By :	N/A	#	Number	Depth

Trial Pit Re	cord :	SL05		
Site Location:	Aughinsh Alumina	Client :		AAL
Date:	13-Dec-16	Job No. :	16	63245
ound Level (mOD):				
GPS Coordinates :	128946.384, 15332	26.264		<b>Golder</b> ssociat
eather Conditions:	o/c 10%, cold, dry, su	nny spells		ssociat
Depth (m)	Ma	terial Description	on	
0 - 0.1	TOPSOIL	-		
0.1 - 0.25	light brown slightly claye	y gravelly coarse	SAND	
	organics/root hairs throug	jhout		
	<image/> <caption></caption>			
Water Strike (m) -				Samule
Water Strike (m) :			ample	Sample
			umber	Sample Depth 0.3 m
Recorded By :	N/A	N	umber	Depth

	cord :	SL	06
Site Location:	Aughinish Alumina	Client :	AAL
Date:	13-Dec-16	Job No. :	1663245
ound Level (mOD):	11.921		
GPS Coordinates :	128910.733, 15292	3.841	Golder
eather Conditions:	o/c 10%, cold, dry, sur	ny spells	Associate
Depth (m)	Mi	aterial Descrip	otion
0 - 0.075	TOPSOIL		
0.075 - 0.13	brown clayey sandy SILT		
	organics/root hairs throug	hout	
	Trial Pit - SLO	6	
Water Strike (m) :			Sample Sample
	N/A		lumber Depth
			lumber Depth
Recorded By :	N/A		lumber Depth
Recorded By : Comments :	N/A Lorean MeKenna		lumber Depth

	cord :	SLO	7	
Site Location:	Aughinish Alumina	_Client :	ŀ	AL
Date:	13-Dec-16	Job No. :	166	53245
ound Level (mOD):				
GPS Coordinates :	128654.586, 15259	8.566		Golder ssociates
eather Conditions:	o/c 10%, cold, dry, sur	nny spells	A	SUCIALE
Depth (m)	Ma	aterial Descrip	tion	
0 - 0.1	TOPSOIL			
0.1 - 0.4	light brown silty gravelly o	coarse SAND		
	organics/root hairs throug	hout and occas	ional large	cobbles
	Trial Pit - SLO			
Water Strike (m) :		s	ample umber	Sample
Water Strike (m) : Recorded By :		s	umber	Sample Depth 0.4 m

Trial Pit Re	cord :		SL08	
Site Location:	Aughinish Alumina	Client :		AAL
Date:	13-Dec-16	Job No.	. 16	63245
round Level (mOD): GPS Coordinates :	<u>15.184</u> 128106.016, 15213	21.912		Golder
Veather Conditions:	o/c 10%, cold, dry, su	nny spells		ssociate
Depth (m)	М	aterial Des	cription	
0 - 0.1	TOPSOIL		•	
0.1 - 0.4	brown slightly sandy silty	/ CLAY		
	organics/root hairs and o	ccasional lar	ge cobbles	
	<image/>			
Water Strike (m) :	N/A		Sample	Sample
Recorded By :	Lorean McKenna		Number SL08	<b>Depth</b> 0.4 m
Comments : Large cobble	End of dig @ 0.4m	_		

Trial Pit Re	cord :	SI	L09	
Site Location:	Aughinish Alumina	Client :		AAL
Date:	14-Dec-16	Job No. :	16	63245
ound Level (mOD):	5.759			
GPS Coordinates :	128579.088, 15130	4.271		Golder
eather Conditions:	o/c 10%, cold, dry, sur	ny spells		Golder ssociates
Depth (m)	Ma	aterial Descr	iption	
0 - 0.1	TOPSOIL			
0.1 - 0.4	brown slightly sandy silty	loose CLAY		
	many organics/root hairs	and large cob	bles	
Water Strike (m) :	N/A		Sample	Sample
		L	Number	Depth
	Lorcan McKenna	c	L09	0.4 m
Recorded By :		— P		0.4 111
	End of dig @ 0.4m			0.4 m

Trial Pit Record :			10	SL10		
Site Location:	Aughinish Alumina	Client :		AAL		
Date:	14-Dec-16	Job No. :	16	63245		
ound Level (mOD): GPS Coordinates :		8.445		Golder		
eather Conditions:	o/c 10%, cold, dry, sur	nny spells		ssociates		
Depth (m)		aterial Descri	ption			
0 - 0.1	TOPSOIL					
0.1 - 0.3	brown slightly gravelly sa	ndy CLAY				
	many organics/root hairs	and large cobb	les			
	1					
	Trial Pit - SL1	0				
Water Strike (m) :		-	Sample	Sample		
Water Strike (m) :		_ [	Sample Number	Sample Depth		
	N/A	- [:	-			
		- [:	Number	Depth		
Recorded By :	N/A Lorean MeKenna	- [:	Number	Depth		
Recorded By : Comments :	N/A	- [:	Number	Depth		
Recorded By :	N/A Lorean MeKenna	- [:	Number	Depth		
Recorded By : Comments :	N/A Lorean MeKenna	- [:	Number	Depth		

ughinish Alumina 14-Dec-16 53 127539.915, 1509 10%, cold, dry, su M DIL rown/black slightly organics/root hairs	unny spells <b>faterial Descri</b> y sandy silty (co	16	AAL 63245 Golder ssociates
53 127539.915, 1509 10%, cold, dry, su M DIL rown/black slightly	16.401 unny spells <b>Iaterial Descri</b> y sandy silty (co	ption	Golder ssociates
127539.915, 1509 10%, cold, dry, su M DIL rown/black slightly	unny spells <b>faterial Descri</b> y sandy silty (co	ption	
M DIL rown/black slightly	<b>faterial Descri</b> y sandy silty (co	ption	
DIL rown/black slightly	y sandy silty (co		ΛΥ 
DIL rown/black slightly	y sandy silty (co		ΛY
		ohesive) CLA	AY
organics/root hairs	s and odour		
Frail Pit - St.	11		
0.5m		Sample	Sample
		Number	Depth
Lorcan McKenna	SI	L11	0.5 m
dig @ 0.5m			
	_		
	<i>Lorcan McKenna</i> f dig @ 0.5m	Lerean McKenna S	Lerean McKenna SL11

Trial Pit Re	cord :	SI	.12	
Site Location:	Aughinish Alumina	Client :		AAL
Date:	14-Dec-16	Job No. :	16	63245
ound Level (mOD): GPS Coordinates :	<u>    1.706</u>	97.803		Colder
eather Conditions:	o/c 10%, cold, dry, sur	nny spells		Golder ssociates
Depth (m)	Ma	aterial Descr	iption	
0 - 0.1	TOPSOIL			
0.1 - 0.5	blue/grey slightly sandy c	layey SILT		
	many organics/root hairs			
	Trial Pit - SL1			
Water Strike (m) :		_	Sample	Sample
			Number	Depth
Recorded By :	Lorean McKenna		L12	0.5 m
Comments :	End of dig @ 0.5m	_  -		
		— F		

Trial Pit Re	cord :	SL13	
Site Location:	Aughinish Alumina	Client :	AAL
Date:	14-Dec-16	Job No. :	1663245
ound Level (mOD):			
GPS Coordinates :	126549.807, 15245	8.988	Golder
eather Conditions:	o/c 10%, cold, dry, sur	nny spells	Associates
Depth (m)	Ma	aterial Description	on
0 - 0.1	TOPSOIL		
0.1 - 0.5	grey loose silty fine to coa	arse SAND	
	many shells and some org	Jailles	
	Trial Pit - SL1	3	
Water Strike (m) :		Sar	nple Sample
	N/A	Sar	nber Depth
		Sar	
Recorded By :	N/A	Sar	nber Depth
Recorded By :	N/A Lorean MeKenna	Sar	nber Depth
Recorded By :	N/A Lorean MeKenna	Sar	nber Depth

Trial Pit Re	cord :	SL14	
Site Location:	Aughinish Alumina	_Client :	AAL
Date:	14-Dec-16	_Job No. :	1663245
und Level (mOD): GPS Coordinates :			Colder
ather Conditions:	o/c 10%, cold, dry, sur	iny spells	<b>Golder</b> Associates
Depth (m)	Ma	aterial Description	on
0 - 0.1	mottled TOPSOIL		
0.1 - 0.5	light brown/grey cohesive	slightly sandy SII	T
	organics and some shells		
	Fral Pit - SL1	4	
Water Strike (m) :	N/A		nple Sample nber Depth
Recorded Bv :	Lorean McKenna	SL14	nberDepth0.5 m
Comments :	End of dig @ 0.5m		

	cord :	SL1	5	
Site Location:	Aughinish Alumina	_Client :	ŀ	AL
Date:	13-Dec-16	Job No. :	166	53245
ound Level (mOD):	9.363			
GPS Coordinates :		5.535		Golder
eather Conditions:	o/c 10%, cold, dry, sur	nny spells		Golder ssociate
Depth (m)	Ma	aterial Descrip	tion	
0 - 0.1	TOPSOIL			
0.1 - 0.3	brown slightly sandy silty	CLAY		
	organics/root hairs and (la	arge) cobbles		
	Frial Pit - SL1	5		
Water Strike (m) :		S	ample	Sample
	N/A	S	umber	Depth
		S	umber	-
Recorded By :	N/A	S	umber	Depth
Recorded By : Comments :	N/A Lorean MeKenna	S	umber	Depth

Trial Pit Re	cord :	SL1	5	
Site Location:	Aughinish Alumina	_Client :	AAL	
Date:	13-Dec-16	Job No. :	1663245	
ound Level (mOD): GPS Coordinates :		0 558		
	o/c 10%, cold, dry, sur	(	Golder	tes
Depth (m)	M;	aterial Descript	ion	
0 - 0.1	TOPSOIL			
0.1 - 0.3	brown silty sandy CLAY			
	organics/root hairs throug	hout		
Water Strike (m) :	Trial Pit - SL1		ample Sample	2
Water Strike (m) :		Sa	imple Sample Tomber Depth	
		Sa	imber Depth	

Trial Pit Re	cord :	SL17	
Site Location:	Aughinish Alumina	Client :	AAL
Date:	14-Feb-17	Job No. :	1663245
round Level (mOD): GPS Coordinates :		1570.483	Golder
Weather Conditions:	o/c 60%, mild, dry, sur	nny spells	Associates
Depth (m)	Ma	aterial Descripti	on
0 - 0.1	TOPSOIL	-	
0.1 - 0.3	grey cohesive slightly san	dy (fine) SILT	
0.3 - 0.48	dark brown/brown slightly		/
	organics/root hairs throug	hout and occasio	nal shells
		soit	Sample - SL17
Trial Pit - S	SL17		
Trial Pit - S Water Strike (m) :			mple Sample mber Depth
Water Strike (m) :			mber Depth

	Trial Pit Re	cora :	SL18	
	Site Location:	Aughinish Alumina	Client :	AAL
	Date:	14-Feb-17	Job No. :	1663245
	ound Level (mOD):			
(	GPS Coordinates :	E: 127671.661, N: 15	3236.998	Golder
N	eather Conditions:	o/c 60%, mild, dry, su	inny spells	Golder
	Depth (m)	M	aterial Descripti	on
	0 - 0.1	TOPSOIL		
	0.1 - 0.4	brown cohesive slightly s	andy silty CLAY	
		organics/root hairs throu	ghout and small/n	nedium limestone cobbles
A DESCRIPTION OF THE OWNER OF THE				

Trial Pit - SL18

A Rey O

Soil Sample - SL18

Water Strike (m) : N/A

Recorded By : \_\_\_\_\_\_ Lorean McKenna

Comments : End of dig @ 0.4m Large cobbles/ROCK \_\_\_\_\_

Sample	Sample
Number	Depth
SL18	0.4 m

	cord :	SL1	
Site Location:	Aughinish Alumina	Client :	AAL
Date:	17-Feb-17	Job No. :	1663245
ound Level (mOD):	13.125		
GPS Coordinates :	E: 127923.309, N: 15	3464.621	Golder
eather Conditions:	o/c 60%, mild, dry, su	nny spells	Associate
Depth (m)		aterial Descript	ion
0 - 0.1	TOPSOIL		
0.1 - 0.17	brown sandy silty CLAY		
	organics/root hairs throug	ghout and many	angular cobbles
Trial Pit - Sl	-18	Soi	I Sample - SL18
	- <b>18</b> N/A	S;	ample Sample
Water Strike (m) :	N/A	Sa Nu	ample Sample umber Depth
Water Strike (m) :		S;	ample Sample umber Depth
Water Strike (m) : Recorded By : Comments :	N/A	Sa Nu	ample Sample umber Depth
Water Strike (m) : Recorded By :	N/A Lorean MeKenna	Sa Nu	ample Sample umber Depth
Water Strike (m) : Recorded By : Comments :	N/A Lorean MeKenna	Sa Nu	ample Sample umber Depth

Trial Pit Re	cord :	SL	20	
Site Location:	Aughinish Alumina	Client :		AAL
Date:	12-Apr-17	Job No. :	1	663245
ound Level (mOD): GPS Coordinates :	E:127309.60, N:15			Golder
	o/c 80%, mild, showers,			
<b>Depth (m)</b> 0 - 0.2	M TOPSOIL	aterial Descrip	otion	
0 - 0.2	Cohesive soft brown sligh bluish grey SILT/CLAY	tly gravelly san	dy CLAY v	vith pockets of
	organics/root hairs through	ghout and many	/ angular (	cobbles
Trial Pit - S	L20	So	oil Sample	e - SL20
Water Strike (m) :	0.8 m		Sample	Sample
Recorded By :	Darren Crowe		lumber 20	<b>Depth</b> 0.2 - 0.85 m
Comments :	End of dig @ 0.85m			



# APPENDIX B Analytical Report



Appendix B			Sample ID Depth	SL01 0.20	SL02	SL03	SL04	SL05 0.30	SL06	SL07	SL08	SL09 0.40	SL10 0.30	SL11 0.50	SL12 0.50	SL13 0.50	SL14 0.50	SL15 0.30	SL16 0.30	SL-17	SL-18	SL-19
			Sample Type	Soil																		
			Sampled Date	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	14/02/2017	14/02/2017	17/02/2
		Sam	ple Received Date	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	16/02/2017	16/02/2017	21/02/2
Test	Method	Units	LOD																			
Aluminium	TM30/PM15	mg/kg	<50	40630	14960	5770	1196	1984	1893	3799	9072	13450	5387	14600	18630	6331	11940	16060	9374	12360	13400	7061
Arsenic <sup>#</sup> Cadmium <sup>#</sup>	TM30/PM15 TM30/PM15	mg/kg mg/kg	<0.5 <0.1	12.4 0.8	9 0.8	6.1 0.3	3.5 0.4	2.9	3.4 0.5	10.7 0.7	11.9	18.5 1.5	9.9 0.9	13.7 0.3	10.2 <0.1	6.7 0.3	10.5 0.4	19.4 2.3	10.1 0.9	10.8 0.2	23.1 2.2	4.2 <0.1
Lead <sup>#</sup>	TM30/PM15	mg/kg	<5	14	18	9	<5	<5	<5	14	13	19	1195	38	18	13	13	21	12	23	19	19
Mercury <sup>#</sup> Nickel <sup>#</sup>	TM30/PM15 TM30/PM15	mg/kg mg/kg	<0.1 <0.7	<0.1 49.4	<0.1 42	<0.1 16.9	<0.1 8.3	<0.1 8.8	<0.1 8.1	<0.1 20.9	<0.1 39	<0.1 34.1	<0.1 16.4	<0.1 23.6	<0.1 34.6	<0.1 14.7	<0.1 25.6	<0.1 59.8	<0.1 32.4	<0.1 23.9	<0.1 67.3	<0.1
Sodium	TM30/PM15	mg/kg	<5	294	163	181	179	173	154	136	184	191	168	263	564	602	234	189	188	275	121	195
Total Sulphate as SO4 #	TM50/PM29	mg/kg	<50	240	330	179	168	186	267	100	468	796	552	2092	750	909	318	559	339	948	323	153
SVOC MS																						-
Phenols 2-Chlorophenol <sup>#</sup>	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Methylphenol	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Nitrophenol 2,4-Dichlorophenol <sup>#</sup>	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10
2,4-Dimethylphenol	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol 2,4,6-Trichlorophenol	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10
4-Chloro-3-methylphenol	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Methylphenol	TM16/PM8 TM16/PM8	ug/kg	<10	<10 <10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10 <10	<10	<10 <10	<10	<10 <10	<10
4-Nitrophenol Pentachlorophenol	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
Phenol#	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
PAHs 2-Chloronaphthalene <sup>#</sup>	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene #	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene Acenaphthylene	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
Acenaphthene	TM16/PM8 TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fluorene Phenanthrene <sup>#</sup>	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
Anthracene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fluoranthene * Pyrene *	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	118 102	<10 <10	<10 <10	<10 <10
Benzo(a)anthracene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	111	<10	<10	<10
Chrysene Benzo(bk)fluoranthene	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	120 173	<10 <10	<10 <10	<10 <10
Benzo(a)pyrene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	75	<10	<10	<10
Indeno(123cd)pyrene Dibenzo(ah)anthracene	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	44 19	<10 <10	<10 <10	<10 <10
Benzo(ghi)perylene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	47	<10	<10	<10
Benzo(b)fluoranthene Benzo(k)fluoranthene	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	125 48	<10 <10	<10 <10	<10
Phthalates		ug/kg		<10	<10	<10	<10	<10	<10	<10	<10		<10	<10		<10	<10	<10	40	<10	<10	<10
Bis(2-ethylhexyl) phthalate Butylbenzyl phthalate	TM16/PM8 TM16/PM8	ug/kg ug/kg	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<10
Di-n-butyl phthalate	TM16/PM8	ug/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<10
Di-n-Octyl phthalate Diethyl phthalate	TM16/PM8 TM16/PM8	ug/kg ug/kg	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<100 <100	<10 <10
Dimethyl phthalate #	TM16/PM8	ug/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<10
Other SVOCs 1,2-Dichlorobenzene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene #	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene 1,4-Dichlorobenzene	TM16/PM8 TM16/PM8	ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10
2-Nitroaniline	TM16/PM8	ug/kg ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene 3-Nitroaniline	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10
4-Bromophenylphenylether #	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Chloroaniline 4-Chlorophenylphenylether	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
4-Nitroaniline	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Azobenzene Bis(2-chloroethoxy)methane	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10
Bis(2-chloroethyl)ether	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Carbazole Dibenzofuran <sup>#</sup>	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
Hexachlorobenzene	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene # Hexachlorocyclopentadiene	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
Hexachloroethane	TM16/PM8	ug/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Isophorone <sup>#</sup>	TM16/PM8 TM16/PM8	ug/kg ug/kg	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
N-nitrosodi-n-propylamine <sup>#</sup> Nitrobenzene <sup>#</sup>	TM16/PM8	ug/kg ug/kg	<10	<10	<10	<10	<10 <10	<10	<10	<10	<10 <10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Surrogate Recovery 2-Fluorobiphenyl Surrogate Recovery p-Terphenyl-d14	TM16/PM8 TM16/PM8	%	<0 <0	90 119	103 123	98 116	94 122	94 121	104 90	119 97	91 118	106 126	99 119	114 128	117 123	126 136	99 108	94 115	104 127	46 89	57 92	85 118
		70	<:0	119	123	110	122	121	30	31	110		119	120	123	130	100	115	127	09	32	118
SVOC TICs	TM16/PM8 TM16/PM8	None	-100	ND	See Atta 1498																	
1,3-Cyclooctadiene	1 IVI 10/PM8	ug/kg	<100	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	149
EPH (C8-C40) #	TM5/PM8	mg/kg	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	276	146	<30	<30	<30	<30	181	<30	125
GRO (>C4-C8)#	TM36/PM12	ug/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	164
GRO (>C8-C12) #	TM36/PM12	ug/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	252
<u>GRO (&gt;C4-12)</u> #	TM36/PM12	ug/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	416
Natural Moisture Content	PM4/PM0	%	<0.1	28.4	25.8	12.2	13.5	14	11	11.3	24.6	31.6	19.7	77.1	38.9	37.1	43	35.6	24.6	52.5	20	48.9
рН#	TM73/PM11	pH units	<0.01	8.18	8.12	8.36	7.93	8.26	8.18	8.53	8.12	7.89	7.99	6.07	7.8	8.2	8.15	7.69	8.23	7.75	7.44	7.91
v					•	•	•	-	•	•	•	•	•	•	•	•	•	•	•	•		

L-19	SL-20
0-0.17	0.2-0.85
Soil	Soil
	12/04/2017
2/2017	18/04/2017
2/2011	10/04/2017
061	12630
4.2	8.3
:0.1	0.2
19	13
:0.1 6.9	<0.1 26.1
195	314
153	218
<10	<10
<10	<10
<10 <10	<10 <10
<10	<10
<10	<10
<10	<10
<10 <10	<10 <10
<10	<10
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<10	<10
<10	<10
<10	<10
<10 <10	<10 <10
<10	<10
<10	<10
85 118	55
. 10	96
Attached	ND
498	-
125	<30
0	~30
164	<100
252	<100
416	<100
8.9	35.5
7.91	8.44



Golder Associates Ltd Town Centre House

Dublin Road

Naas Co Kildare Ireland

# Exova Jones Environmental

Registered Address : Exova (UK) Ltd, Lochend Industrial Estate, Newbridge, Midlothian, EH28 8PL

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

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



Attention :	Martha Buckwalter-Davis
Date :	16th May, 2017
Your reference :	1663245
Our reference :	Test Report 16/18828 Batch 1 17/4060 Batch 1 17/4274 Batch 1 17/7103 Batch 1
Location :	
Date samples received :	
Status :	Final report
Issue :	1

**Compiled By:** 

5.60-20

Simon Gomery BSc Project Manager

Client Name: Reference: Location: Contact: Golder Associates Ltd 1663245

Martha Buckwalter-Davis

#### Report : Solid

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

J E Job No. 16/18828 16/18828 16/18828 16/18828 16/18828 16/18828 16/18828 16/18828 16/18828 16/18828 J E Sample No 1-3 4-6 7-9 10-12 13-15 16-18 19-21 22-24 25-27 28-29 Sample ID SL01 SL02 SL03 SL04 SL05 SL06 SL07 SL08 SL09 SL10 0.20 Depth 0.30 0.20 0.20 0.30 0 10 0 40 0 40 0 40 0.30 Please see attached notes for all abbreviations and acronyms COC No / misc Containers VJ V.I V.I V.I V.I V.I V.I V.I V.I V.I Sample Date 15/12/2016 15/12/2016 15/12/2016 15/12/2016 15/12/2016 15/12/2016 15/12/2016 15/12/2016 15/12/2016 15/12/2016 Sample Type Soil Soil Soi Soil Soil Soil Soil Soil Soil Soil Batch Number 1 1 1 1 1 1 1 1 1 Method LOD/LOR Units No. Date of Receipt 19/12/2016 19/12/2016 19/12/2016 19/12/2016 19/12/2016 19/12/2016 19/12/2016 19/12/2016 19/12/2016 19/12/2016 TM30/PM15 Aluminium 40630 14960 5770 1196 1984 1893 3799 9072 13450 5387 <50 mg/kg TM30/PM1 Arsenic<sup>#</sup> 124 9.0 6.1 3.5 29 3.4 107 11.9 18.5 99 <0.5 mg/kg TM30/PM1 Cadmium<sup>#</sup> 0.8 0.8 0.3 04 04 05 07 10 1.5 ΛQ <0.1 mg/kg TM30/PM1 ead 14 18 q ~5 -5 -5 14 13 19 1195 -5 mg/kg TM30/PM1 Mercurv<sup>1</sup> -01 -01 -01 -01 -01 <0.1 -01 -01 <0.1 -01 -01 mg/kg TM30/PM1 Nickel 49.4 42 0 16.9 83 88 8 1 20.9 39.0 34 1 164 <0.7 mg/kg TM30/PM1 Sodium 294 163 181 179 173 154 136 184 191 168 <5 mg/kg TM50/PM2 240 330 179 267 468 796 552 <50 Total Sulphate as SO4 # 168 186 100 mg/kg SVOC TICs ND ND ND ND ND TM16/PM8 ND ND ND ND ND None TM5/PM8 <30 <30 <30 <30 <30 <30 <30 <30 <30 <30 <30 mg/kg EPH (C8-C40)# TM36/PM12 GRO (>C4-C8) # uq/kq <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 TM36/PM12 GRO (>C8-C12) # <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 uq/kq TM36/PM12 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 <100 GRO (>C4-12)# ug/kg PM4/PM0 28.4 25.8 11.0 11.3 % Natural Moisture Content 12.2 13.5 14.0 24.6 31.6 19.7 < 0.1 8.18 8.12 8.36 7.93 8.26 8.18 8.53 8.12 7.89 7.99 <0.01 pH units TM73/PM1 ъH<sup>#</sup> pH<sup>#</sup> <0.01 TM73/PM1 pH units

Client Name: Reference: Location: Contact: Golder Associates Ltd 1663245

Martha Buckwalter-Davis

#### Report : Solid

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

J E Job No.	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	17/4060	17/4060	17/4274	17/7103			
J E Sample No.	30-32	33-35	36-38	39-41	42-44	45-47	1-3	4-6	1-3	1-2			
Sample ID	SL11	SL12	SL13	SL14	SL15	SL16	SL-17	SL-18	SL-19	SL-20			
Depth	0.50	0.50	0.50	0.50	0.30	0.30	0.48	0.4	0.10-0.17		Please se	e attached n	otes for all
COC No / misc												ations and a	
Containers	٧J	٧J	٧J	٧J	٧J	٧J	٧J	٧J	٧J	٧J			
Sample Date	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	14/02/2017	14/02/2017	17/02/2017	12/04/2017			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1	1	1	1	1			
Date of Receipt				19/12/2016	19/12/2016			16/02/2017		18/04/2017	LOD/LOR	Units	Method No.
Aluminium	14600	18630	6331	119/12/2010	16060	9374	12360	13400	7061	12630	<50	mg/kg	TM30/PM15
Arsenic <sup>#</sup>	13.7	10.2	6.7	10.5	19.4	10.1	10.8	23.1	4.2	8.3	<0.5	mg/kg	TM30/PM15
Cadmium <sup>#</sup>	0.3	<0.1	0.3	0.4	2.3	0.9	0.2	2.2	<0.1	0.2	<0.1	mg/kg	TM30/PM15
Lead <sup>#</sup>	38	18	13	13	21	12	23	19	19	13	<5	mg/kg	TM30/PM15
Mercury #	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	TM30/PM15
Nickel <sup>#</sup>	23.6	34.6	14.7	25.6	59.8	32.4	23.9	67.3	16.9	26.1	<0.7	mg/kg	TM30/PM15
Sodium	263	564	602	234	189	188	275	121	195	314	<5	mg/kg	TM30/PM15
Total Sulphate as SO4 #	2092	750	909	318	559	339	948	323	153	218	<50	mg/kg	TM50/PM29
SVOC TICs	ND	ND	ND	ND	ND	ND	ND	ND	See Attached	ND		None	TM16/PM8
EPH (C8-C40) <sup>#</sup>	276	146	<30	<30	<30	<30	181	<30	125	<30	<30	mg/kg	TM5/PM8
GRO (>C4-C8) #	<100	<100	<100	<100	<100	<100	<100	<100	164	<100	<100	ug/kg	TM36/PM12
GRO (>C8-C12) #	<100	<100	<100	<100	<100	<100	<100	<100	252	<100	<100	ug/kg	TM36/PM12
GRO (>C4-12) <sup>#</sup>	<100	<100	<100	<100	<100	<100	<100	<100	416	<100	<100	ug/kg	TM36/PM12
Natural Moisture Content	77.1	38.9	37.1	43.0	35.6	24.6	52.5	20.0	48.9	35.5	<0.1	%	PM4/PM0
рН#	6.07	7.80	8.20	8.15	7.69	8.23	7.75	7.44	7.91	-	<0.01	pH units	TM73/PM11
pH <sup>#</sup>	-	-	-	-	-	-	-	-	-	8.44	<0.01	pH units	TM73/PM11

Client Name: Reference: Location: Contact: Golder Associates Ltd 1663245

Martha Buckwalter-Davis

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J E Job No.	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828			
J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-29			
Sample ID	SL01	SL02	SL03	SL04	SL05	SL06	SL07	SL08	SL09	SL10			
•													
Darréh	0.00	0.30	0.20	0.00	0.20	0.40	0.40	0.40	0.40	0.00			
Depth	0.20	0.30	0.20	0.20	0.30	0.10	0.40	0.40	0.40	0.30		e attached ne ations and ac	
COC No / misc											abbievie		Jonyma
Containers	VJ												
Sample Date	15/12/2016	15/12/2016		15/12/2016		15/12/2016				15/12/2016			
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1	1	1	1	LOD/LOR	Units	Method
Date of Receipt	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016			No.
SVOC MS													
Phenols													
2-Chlorophenol <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Methylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Nitrophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dichlorophenol <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4,5-Trichlorophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4,6-Trichlorophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chloro-3-methylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Methylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Nitrophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Pentachlorophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phenol <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg ug/kg	TM16/PM8
Phenoi	10	<10	10	10	210	210	210	210	<10	10	\$10	aging	10110/1-100
2-Chloronaphthalene #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Chloronaphthalene #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg ug/kg	TM16/PM8
Naphthalene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
•	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		TM16/PM8
Acenaphthylene												ug/kg	TM16/PM8
Acenaphthene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Fluorene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	
Phenanthrene #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Anthracene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Fluoranthene <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Pyrene #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(a)anthracene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Chrysene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(bk)fluoranthene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(a)pyrene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Indeno(123cd)pyrene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(ghi)perylene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(b)fluoranthene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(k)fluoranthene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phthalates													
Bis(2-ethylhexyl) phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Butylbenzyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Di-n-butyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Di-n-Octyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Diethyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Dimethyl phthalate #	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8

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		/		/							1		
J E Job No.	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828			
J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-29			
Sample ID	SL01	SL02	SL03	SL04	SL05	SL06	SL07	SL08	SL09	SL10			
Depth	0.20	0.30	0.20	0.20	0.30	0.10	0.40	0.40	0.40	0.30	Please se	e attached n	otes for all
COC No / misc											abbrevia	ations and ad	cronyms
Containers	VJ	VJ	V J	VJ	VJ	VJ	VJ	VJ	VJ	V J			
Sample Date	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016			
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1	1	1	1	LOD/LOR	OD/LOR Units N	
Date of Receipt SVOC MS	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016			No.
Other SVOCs													
1,2-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
1,2,4-Trichlorobenzene <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
1,3-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
1,4-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Nitroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dinitrotoluene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,6-Dinitrotoluene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
3-Nitroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Bromophenylphenylether #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chloroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chlorophenylphenylether	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Nitroaniline	<10 <10	ug/kg	TM16/PM8 TM16/PM8										
Azobenzene Bis(2-chloroethoxy)methane	<10 <10	<10 <10	<10	<10 <10	ug/kg ug/kg	TM16/PM8 TM16/PM8							
Bis(2-chloroethyl)ether	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Carbazole	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Dibenzofuran <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachlorobutadiene#	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachlorocyclopentadiene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Isophorone #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
N-nitrosodi-n-propylamine #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Nitrobenzene # Surrogate Recovery 2-Fluorobiphenyl	<10 90	<10 103	<10 98	<10 94	<10 94	<10 104	<10 119	<10 91	<10 106	<10 99	<10 <0	ug/kg %	TM16/PM8 TM16/PM8
Surrogate Recovery p-Terphenyl-d14	90 119	103	90 116	94 122	94 121	90	97	118	106	119	<0	%	TM16/PM8
earrogate receivery prospheriy arr	110	120	110	122	121	00	57	110	120	110	~0	70	

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J E Job No.	16/18828	16/18828	16/18828	16/18828	16/18828	16/18828	17/4060	17/4060	17/4274	17/7103			
J E Sample No.	30-32	33-35	36-38	39-41	42-44	45-47	1-3	4-6	1-3	1-2			
											l		
Sample ID	SL11	SL12	SL13	SL14	SL15	SL16	SL-17	SL-18	SL-19	SL-20	l		
	-	-					-				1		
											l		
Depth	0.50	0.50	0.50	0.50	0.30	0.30	0.48	0.4	0.10-0.17			e attached n	
COC No / misc											abbrevia	ations and ac	cronyms
Containers	VJ	1											
Sample Date	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	14/02/2017	14/02/2017	17/02/2017	12/04/2017	1		
Sample Type	Soil	1											
Batch Number	1	1	1	1	1	1	1	1	1	1	,		Mark a d
											LOD/LOR	Units	Method No.
Date of Receipt	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	19/12/2016	16/02/2017	16/02/2017	21/02/2017	18/04/2017			INU.
SVOC MS													
Phenols											1		
2-Chlorophenol <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Methylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Nitrophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dichlorophenol <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4,5-Trichlorophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4,6-Trichlorophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chloro-3-methylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Methylphenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Nitrophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Pentachlorophenol	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phenol <sup>#</sup>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
PAHs													
2-Chloronaphthalene#	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Methylnaphthalene#	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Naphthalene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Acenaphthylene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Acenaphthene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Fluorene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phenanthrene#	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Anthracene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Fluoranthene <sup>#</sup>	<10	<10	<10	<10	<10	118	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Pyrene <sup>#</sup>	<10	<10	<10	<10	<10	102	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(a)anthracene	<10	<10	<10	<10	<10	111	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Chrysene	<10	<10	<10	<10	<10	120	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(bk)fluoranthene	<10	<10	<10	<10	<10	173	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
													TM16/PM8
Benzo(a)pyrene	<10	<10	<10	<10	<10	75	<10	<10	<10	<10	<10	ug/kg	
Indeno(123cd)pyrene	<10	<10	<10	<10	<10	44	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10	19	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(ghi)perylene	<10	<10	<10	<10	<10	47	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(b)fluoranthene	<10	<10	<10	<10	<10	125	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(k)fluoranthene	<10	<10	<10	<10	<10	48	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phthalates													
Bis(2-ethylhexyl) phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Butylbenzyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Di-n-butyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Di-n-Octyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Diethyl phthalate	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Dimethyl phthalate <sup>#</sup>	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
											1		
											1		ł

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	40/40000	40/40000	40/40000	10/10000	40/40000	40/40000	47/4000	17/1000	47/4074	47/7400	1		
J E Job No. J E Sample No.	16/18828 30-32	16/18828 33-35	16/18828 36-38	16/18828 39-41	16/18828 42-44	16/18828 45-47	17/4060 1-3	17/4060 4-6	17/4274 1-3	17/7103 1-2			
o E dumpie no.	00 02	00 00	00 00	00 41	12 11	10 11	10	40	10	12			
Sample ID	SL11	SL12	SL13	SL14	SL15	SL16	SL-17	SL-18	SL-19	SL-20			
Depth	0.50	0.50	0.50	0.50	0.30	0.30	0.48	0.4	0.10-0.17			e attached n	
COC No / misc											abbrevia	ations and ad	cronyms
Containers	V J	V J	V J	V J	V J	V J	V J	V J	V J	V J			
Sample Date	15/12/2016	15/12/2016			15/12/2016			14/02/2017		12/04/2017			
Sample Type Batch Number	Soil 1	Soil 1	Soil 1	Soil 1	Soil 1	Soil 1	Soil 1	Soil 1	Soil 1	Soil 1			Marthand
Date of Receipt	19/12/2016				19/12/2016					18/04/2017	LOD/LOR	Units	Method No.
SVOC MS	13/12/2010	13/12/2010	13/12/2010	13/12/2010	13/12/2010	13/12/2010	10/02/2011	10/02/2011	21/02/2011	10/04/2017			-
Other SVOCs													
1,2-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
1,2,4-Trichlorobenzene#	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
1,3-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
1,4-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Nitroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dinitrotoluene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,6-Dinitrotoluene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
3-Nitroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Bromophenylphenylether #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chloroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chlorophenylphenylether	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Nitroaniline	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Azobenzene Bis(2-chloroethoxy)methane	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10	ug/kg	TM16/PM8 TM16/PM8
Bis(2-chloroethyl)ether	<10 <10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg ug/kg	TM16/PM8 TM16/PM8
Carbazole	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Dibenzofuran #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachlorobutadiene#	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachlorocyclopentadiene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Hexachloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Isophorone #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
N-nitrosodi-n-propylamine #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Nitrobenzene #	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Surrogate Recovery 2-Fluorobiphenyl	114	117	126	99	94	104	46	57	85	55	<0	%	TM16/PM8
Surrogate Recovery p-Terphenyl-d14	128	123	136	108	115	127	89	92	118	96	<0	%	TM16/PM8

Job number:	17/4274	Method:	SVOC
Sample number:	3	Matrix:	Solid
Sample identity:	SL-19		
Sample depth:	0.10-0.17		
Sample Type:	Soil		
Units:	ug/kg		
Noto: Only complex with TIC	a (if requested) are reported. If TIC	a wore requested	

Note: Only samples with TICs (if requested) are reported. If TICs were requested but no compounds found they are not reported.

CAS No.	Tentative Compound Identification	Retention Time (minutes)	% Match	Concentration
1700-10-3	1,3-Cyclooctadiene	9.796	91	1498

Client Name: Golder Associates Ltd

**Reference:** 1663245

Location:

**Contact:** Martha Buckwalter-Davis

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
16/18828	1	SL01	0.20	1-3	GRO	Sample holding time exceeded
16/18828	1	SL01	0.20	1-3	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL02	0.30	4-6	GRO	Sample holding time exceeded
16/18828	1	SL02	0.30	4-6	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL03	0.20	7-9	GRO	Sample holding time exceeded
16/18828	1	SL03	0.20	7-9	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL04	0.20	10-12	GRO	Sample holding time exceeded
16/18828	1	SL04	0.20	10-12	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL05	0.30	13-15	GRO	Sample holding time exceeded
16/18828	1	SL05	0.30	13-15	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL06	0.10	16-18	GRO	Sample holding time exceeded
16/18828	1	SL06	0.10	16-18	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL07	0.40	19-21	GRO	Sample holding time exceeded
16/18828	1	SL07	0.40	19-21	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL08	0.40	22-24	GRO	Sample holding time exceeded
16/18828	1	SL08	0.40	22-24	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL09	0.40	25-27	GRO	Sample holding time exceeded
16/18828	1	SL09	0.40	25-27	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL10	0.30	28-29	GRO	Sample holding time exceeded
16/18828	1	SL10	0.30	28-29	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL11	0.50	30-32	GRO	Sample holding time exceeded
16/18828	1	SL11	0.50	30-32	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL12	0.50	33-35	GRO	Sample holding time exceeded

Notification of Deviating Samples

Matrix : Solid

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.

Only analyses which are accredited are recorded as deviating if set criteria are not met.

Client Name: Golder Associates Ltd

**Reference:** 1663245

Location:

**Contact:** Martha Buckwalter-Davis

Matrix : Solid

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
16/18828	1	SL12	0.50	33-35	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL13	0.50	36-38	GRO	Sample holding time exceeded
16/18828	1	SL13	0.50	36-38	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL14	0.50	39-41	GRO	Sample holding time exceeded
16/18828	1	SL14	0.50	39-41	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL15	0.30	42-44	GRO	Sample holding time exceeded
16/18828	1	SL15	0.30	42-44	GRO	Solid Samples were received at a temperature above 9°C.
16/18828	1	SL16	0.30	45-47	GRO	Sample holding time exceeded
16/18828	1	SL16	0.30	45-47	GRO	Solid Samples were received at a temperature above 9°C.

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.

Only analyses which are accredited are recorded as deviating if set criteria are not met.

#### NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 16/18828 17/4060 17/4274 17/7103

#### SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

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

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

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

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

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCI (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

#### WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

#### **DEVIATING SAMPLES**

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

#### SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

#### DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

#### BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

#### NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

## ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS) accredited - UK.
SA	ISO17025 (SANAS) accredited - South Africa.
В	Indicates analyte found in associated method blank.
DR	Dilution required.
М	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
СО	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
ТВ	Trip Blank Sample
OC	Outside Calibration Range

## Method Code Appendix

#### JE Job No: 16/18828 17/4060 17/4274 17/7103

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.				
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM16	Modified USEPA 8270. Quantitative determination of Semi-Volatile Organic compounds (SVOCs) by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM16	Modified USEPA 8270. Quantitative determination of Semi-Volatile Organic compounds (SVOCs) by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
ТМЗО	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM36	Modified US EPA method 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM50	Acid soluble sulphate (Total Sulphate) analysed by ICP-OES	PM29	Dried and ground solid sample is boiled with dilute hydrochloric acid, the resulting liquor is then analysed.	Yes		AD	Yes
ТМ73	Modified US EPA methods 150.1 and 9045D and BS1377:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No



# **Certificate of Analysis**

#### **Report No.:** 16-58582-1

Issue No.: Date of Issue	1 12/01/2017
Customer Details:	Jones Environmental Forensics Limited, Unit 3, Deeside Point, Deeside Indust. Estate Zone 3, Chester, Flintshire CH5 2UA
Customer Contact:	Paul-Lee Boden
Customer Order No.:	E20816000325
Customer Reference:	16-18828
Quotation Reference:	160816/10
Description:	16 soil samples
Date Received:	21/12/2016
Date Started:	06/01/2017
Date Completed:	11/01/2017
Test Methods:	Details available on request (refer to SOP code against relevant result/s)
Notes:	None

Approved By:

Matthew Hickson, Laboratory Manager

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. Observations and interpretations are outside of the scope of UKAS accreditation. Results reported herein relate only to the items supplied to the laboratory for testing.

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# **Results Summary**

#### Report No.: 16-58582-1

Customer Reference: 16-18828 Customer Order No: E20816000325

	Customer Sample No					2	5	8	11	14	17	20	23	26	29	31
	RPS Sample No					317915	317916	317917	317918	317919	317920	317921	317922	317923	317924	317925
	Sample Type					SOIL	SOIL	SOIL	SOIL	SOIL						
	Sample Depth (m)			0.2	0.3	0.2	0.2	0.3	0.1	0.4	0.4	0.4		0.5		
	Sampling Date			13/12/2016	13/12/2016	13/12/2016	13/12/2016	13/12/2016	13/12/2016	13/12/2016	13/12/2016	13/12/2016		14/12/2016		
Determinand	CAS No	Codes	SOP	Units	RL											
nonyl phenol ethoxylates			in house	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50



# **Results Summary**

### Report No.: 16-58582-1

Customer Reference: 16-18828 Customer Order No: E20816000325

		Customer Sample No						37	40	43	46
	RPS Sample No						317926	317927	317928	317929	317930
	Sample Type						SOIL	SOIL	SOIL	SOIL	SOIL
					Sample	e Depth (m)	0.5	0.5	0.5	0.3	0.3
					Sar	mpling Date	14/12/2016	14/12/2016	14/12/2016	13/12/2016	13/12/2016
	Determinand	CAS No	Codes	SOP	Units	RL					
nonyl	phenol ethoxylates			in house	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50



#### Report No.: 16-58582-1

Customer Reference: 16-18828 Customer Order No: E20816000325

## Comments

Job	Description	Job Comments
16-58582		Nonyl Phenol Ethoxylate: The standard used for the analysis of nonylphenol ethoxylates (non-ionic detergents) is SURFAC NO100, an isononylphenol ethoxylate with 10 moles of ethylene oxide (supplied by Surfachem Group Limited).



# **Report Information**

#### **Key to Report Codes**

U	UKAS Accredited
Μ	MCERTS Accredited
S	Subcontracted to approved laboratory
US	Subcontracted to approved laboratory UKAS Accredited for the test
MS	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
SI	Subcontracted to internal RPS Group laboratory
USI	Subcontracted to internal RPS Group laboratory UKAS Accredited for the test
MSI	Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test
I/S (in results)	Insufficient Sample
U/S (in results)	Unsuitable Sample
S/C (in results)	See Comments
ND (in results)	Not Detected
DW (in units)	Results are expressed on a dry weight basis

Where the dry solids value of a sample is low (<50%), reporting limits are automatically raised for all determinants analysed on an asreceived basis.

### Soil Typing

Type 1	Clay - Brown
Type 2	Clay - Grey/Black
Туре 3	Sand
Type 4	Top Soil (Standard)
Type 5	Top Soil (High Peat)
Type 6	Made Ground (>50% Clay)
Type 7	Made Ground (>50% Sand)
Туре 8	Made Ground (>50% Top Soil)
Туре Х	Other

## Sample Retention and Disposal

Samples will generally* be retained for the following times prior to disposal:				
Perishables, e.g. foodstuffs	1 month (if frozen) from the issue date of this report			
Waters	2 weeks from the issue date of this report			
Other Liquids	1 month from the issue date of this report			
Solids (including Soils)	1 month from the issue date of this report			

\*Sample retention may be subject to agreement with the customer for particular projects



# **Certificate of Analysis**

Report No.:	17-59874-1
Issue No.: Date of Issue	1 27/02/2017
Customer Details:	Exova (UK) Ltd, Unit 3, Deeside Point, Deeside Indust. Estate Zone 3, Chester, Flintshire, CH5 2UA
Customer Contact:	Laura Lamond
Customer Order No.:	E20817000354
Customer Reference:	17-4060
Quotation Reference:	170220/10
Description:	2 soil samples
Date Received:	20/02/2017
Date Started:	21/02/2017
Date Completed:	22/02/2017
Test Methods:	Details available on request (refer to SOP code against relevant result/s)
Notes:	None
	1000

Approved By:

Matthew Hickson, Laboratory Manager

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# **Results Summary**

# Report No.: 17-59874-1

Customer Reference: 17-4060 Customer Order No: E20817000354

				Customer	Sample No	2	5
				RPS	Sample No	322478	322479
				Sa	mple Type	SOIL	SOIL
				Sa	mpling Date	14/02/2017	14/02/2017
Determinand	CAS No	Codes	SOP	Units	RL		
dry solids (at 105øC)			208	% w/w		60.8	78.6
nonyl phenol ethoxylates			in house	mg/kg DW	0.5	< 0.50	< 0.50



#### Report No.: 17-59874-1

Customer Reference: 17-4060 Customer Order No: E20817000354

## Comments

Job	Description	Job Comments
17-59874		The standard used for the analysis of nonylphenol ethoxylates (non-ionic detergents) is SURFAC NO100, an isononylphenol ethoxylate with 10 moles of ethylene oxide (supplied by Surfachem Group Limited).



# **Report Information**

#### **Key to Report Codes**

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Μ	MCERTS Accredited
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SI	Subcontracted to internal RPS Group laboratory
USI	Subcontracted to internal RPS Group laboratory UKAS Accredited for the test
MSI	Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test
I/S (in results)	Insufficient Sample
U/S (in results)	Unsuitable Sample
S/C (in results)	See Comments
ND (in results)	Not Detected
DW (in units)	Results are expressed on a dry weight basis

Where the dry solids value of a sample is low (<50%), reporting limits are automatically raised for all determinants analysed on an asreceived basis.

### Soil Typing

Type 1	Clay - Brown
Type 2	Clay - Grey/Black
Туре 3	Sand
Type 4	Top Soil (Standard)
Type 5	Top Soil (High Peat)
Туре 6	Made Ground (>50% Clay)
Type 7	Made Ground (>50% Sand)
Туре 8	Made Ground (>50% Top Soil)
Туре Х	Other

## Sample Retention and Disposal

Samples will generally* be retained for the following times prior to disposal:				
Perishables, e.g. foodstuffs	1 month (if frozen) from the issue date of this report			
Waters	2 weeks from the issue date of this report			
Other Liquids	1 month from the issue date of this report			
Solids (including Soils)	1 month from the issue date of this report			

\*Sample retention may be subject to agreement with the customer for particular projects



# **Certificate of Analysis**

<b>Report No.:</b>	17-59958-1
Issue No.: Date of Issue	1 06/03/2017
Customer Details:	Exova (UK) Ltd, Unit 3, Deeside Point, Deeside Indust. Estate Zone 3, Chester, Flintshire, CH5 2UA
Customer Contact:	Laura Lamond (3)
Customer Order No.:	E20817000381
Customer Reference:	17-4274
Quotation Reference:	170220/10
Description:	1 soil sample
Date Received:	22/02/2017
Date Started:	23/02/2017
Date Completed:	06/03/2017
Test Methods:	Details available on request (refer to SOP code against relevant result/s)
Notes:	None
	110.0

Approved By:

Matthew Hickson, Laboratory Manager

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# **Results Summary**

## Report No.: 17-59958-1

Customer Reference: 17-4274 Customer Order No: E20817000381

Customer Sample No	2
RPS Sample No	322794
Sample Type	SOTI

				54	inpic Type	JOIL
Determinand	CAS No	Codes	SOP	Units	RL	
dry solids (at 105øC)			208	% w/w		76.9
nonyl phenol ethoxylates			in house	mg/kg DW	0.5	< 0.50



#### Report No.: 17-59958-1

Customer Reference: 17-4274 Customer Order No: E20817000381

## Comments

RPS Sample Number	Customer Number	Sample Comments
322794		The standard used for the analysis of nonylphenol ethoxylates (non-ionic detergents) is SURFAC NO100, an isononylphenol ethoxylate with 10 moles of ethylene oxide (supplied by Surfachem Group Limited)



# **Report Information**

#### **Key to Report Codes**

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SI	Subcontracted to internal RPS Group laboratory
USI	Subcontracted to internal RPS Group laboratory UKAS Accredited for the test
MSI	Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test
I/S (in results)	Insufficient Sample
U/S (in results)	Unsuitable Sample
S/C (in results)	See Comments
ND (in results)	Not Detected
DW (in units)	Results are expressed on a dry weight basis

Where the dry solids value of a sample is low (<50%), reporting limits are automatically raised for all determinants analysed on an asreceived basis.

### Soil Typing

Type 1	Clay - Brown
Type 2	Clay - Grey/Black
Туре 3	Sand
Type 4	Top Soil (Standard)
Type 5	Top Soil (High Peat)
Туре 6	Made Ground (>50% Clay)
Type 7	Made Ground (>50% Sand)
Type 8	Made Ground (>50% Top Soil)
Туре Х	Other

## Sample Retention and Disposal

Samples will generally* be retained for the following times prior to disposal:			
Perishables, e.g. foodstuffs	1 month (if frozen) from the issue date of this report		
Waters	2 weeks from the issue date of this report		
Other Liquids	1 month from the issue date of this report		
Solids (including Soils)	1 month from the issue date of this report		

\*Sample retention may be subject to agreement with the customer for particular projects



# **Certificate of Analysis**

Report No.:	17-61283-1
Issue No.: Date of Issue	1 03/05/2017
Customer Details:	Exova (UK) Ltd, Unit 3, Deeside Point, Deeside Indust. Estate Zone 3, Chester, Flintshire, CH5 2UA
Customer Contact:	Paul Lee-Boden (4)
Customer Order No.:	E20817000778
Customer Reference:	17-7103
Quotation Reference:	170220/10
Description:	1 soil sample
Date Received:	21/04/2017
Date Started:	26/04/2017
Date Completed:	02/05/2017
Test Methods:	Details available on request (refer to SOP code against relevant result/s)
Notes:	None
	110.0

Approved By:

Matthew Hickson, Laboratory Manager

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# **Results Summary**

## Report No.: 17-61283-1

Customer Reference: 17-7103 Customer Order No: E20817000778

				Customer	Sample No	17-7103/2
				Custome	r Sample ID	SL-20
				RPS	Sample No	327128
				Sa	mple Type	SOIL
Determinand	CAS No	Codes	SOP	Units	RL	
dry solids (at 105øC)		Ν	208	% w/w		72.8
nonyl phenol ethoxylates		Ν	in house	mg/kg DW	0.5	< 0.50



#### Report No.: 17-61283-1

Customer Reference: 17-7103 Customer Order No: E20817000778

## Comments

RPS Sample Number	Customer Number	Sample Comments
327128		The standard used for the analysis of nonylphenol ethoxylates (non-ionic detergents) is SURFAC NO100, an isononylphenol ethoxylate with 10 moles of ethylene oxide (supplied by Surfachem Group Limited).



# **Report Information**

## **Key to Report Codes**

U	UKAS Accredited
М	MCERTS Accredited
Ν	Not accredited
S	Subcontracted to approved laboratory
US	Subcontracted to approved laboratory UKAS Accredited for the test
MS	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
SI	Subcontracted to internal RPS Group laboratory
USI	Subcontracted to internal RPS Group laboratory UKAS Accredited for the test
MSI	Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test
I/S (in results)	Insufficient Sample
U/S (in results)	Unsuitable Sample
S/C (in results)	See Comments
ND (in results)	Not Detected
DW (in units)	Results are expressed on a dry weight basis

Where the dry solids value of a sample is low (<50%), reporting limits are automatically raised for all determinants analysed on an asreceived basis.

### Soil Typing

Туре 1 Туре 2	Clay - Brown Clay - Grey/Black
Туре 3	Sand
Type 4	Top Soil (Standard)
Type 5	Top Soil (High Peat)
Туре 6	Made Ground (>50% Clay)
Type 7	Made Ground (>50% Sand)
Туре 8	Made Ground (>50% Top Soil)
Туре Х	Other

## Sample Retention and Disposal

Samples will generally* be retained for the following times prior to disposal:			
Perishables, e.g. foodstuffs 1 month (if frozen) from the issue date of thi			
Waters	2 weeks from the issue date of this report		
Other Liquids	1 month from the issue date of this report		
Solids (including Soils)	1 month from the issue date of this report		

\*Sample retention may be subject to agreement with the customer for particular projects

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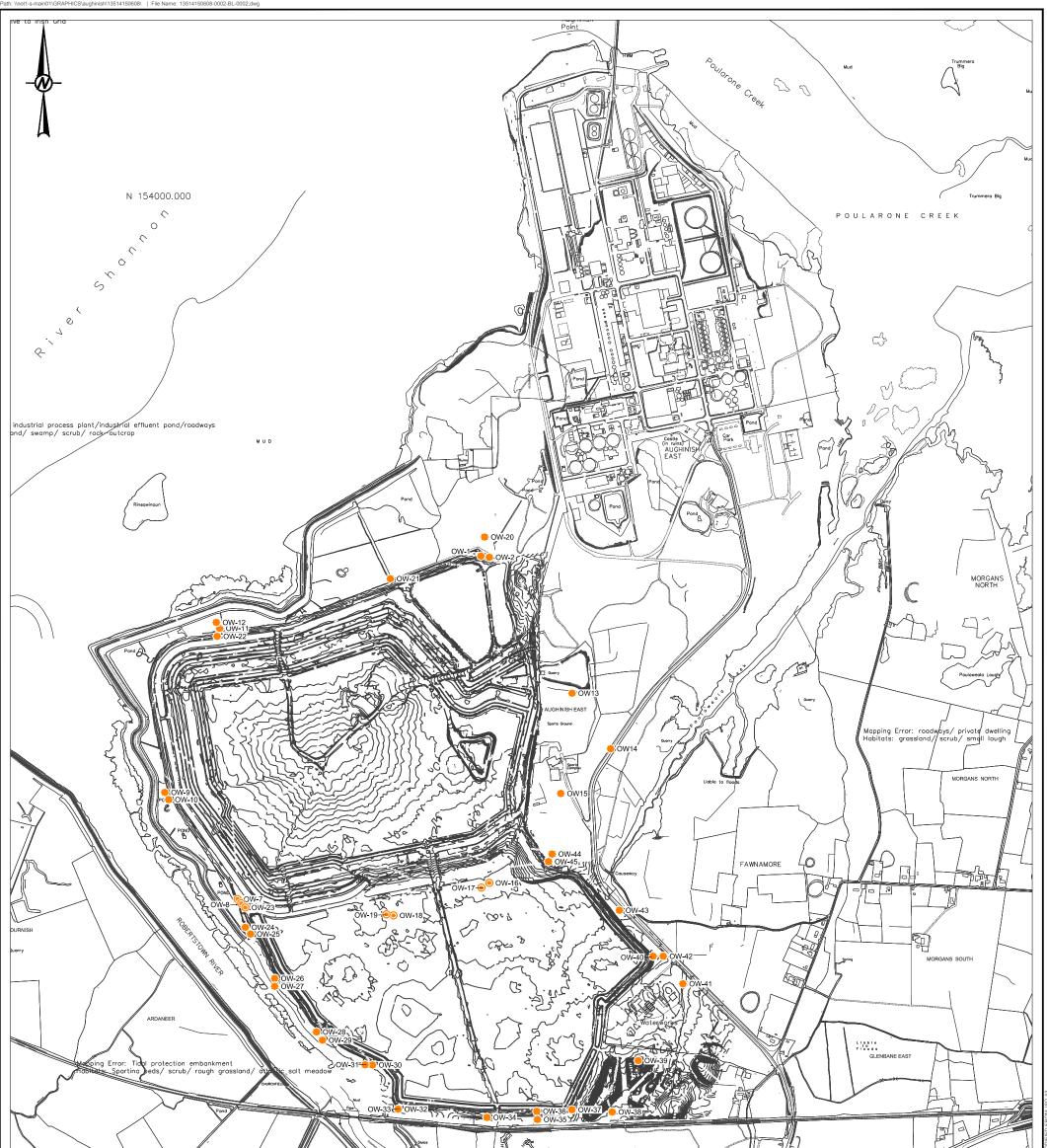
solutions@golder.com www.golder.com

Golder Associates Ireland Limited Town Centre House Dublin Road Naas Co. Kildare Ireland T: +353 45 810200





## Appendix 8.3: Observation Well Locations and Borehole Logs



ARDANEER Ard Inthin LEGEND		y Spring Tides	studies/ atlantic sc Liable to Ploodi	0 1:12,	.500 	250	500 METRES	B P
GROUNDWATER MONITORING WELLS								
FORMER OW MONITORING LOCATIONS								
	A 2014-06-01 FIRST ISSUE			AD	RL	GDLT	DH	
	Rev. YYYY-MM-DD DESCRIPTION			PREPAR	RED DESIGN	REVIEW	APPROVED	
	CLIENT AUGHINISH ALUMINA LIMITE	D	PROJECT BASELINE S	OIL AND	) GROUNE	WATER F	REPORT	
	CONSULTANT	NOTTINGHAM OFFICE Browns Lane Business Park Stanton-on-the-Wolds UK	TITLE SITE LAYOU	JT				
	Associates	[+44] (0) 115 937 1111 www.golder.com	PROJECT No. 13514150608	CON1	TROL		Rev. o	of DRAWING



## AUGHINISH ALUMINA LIMITED

# AUGHINISH PROJECT

# RED MUD POND AREA 54A CONSTRUCTION RECORD STAGE II

August 1982



Engineering and Resources Consultants Limited Eastern Road Bracknell Berkshire RG12 2UZ Telephone Bracknell (0344) 24151 Telex 847253 (Answerback SML ERCON BRACKL) Telegrams Ercon Bracknell Berkshire

Australian Office PO Box 707K Newcastle NSW2300 Australia

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## Report 7758/13

using glacial till compacted in 250 mm thick layers. A running surface of 150 mm thickness of modified Class II crushed rock was placed over the reinstated sections. Polyfelt fabric was placed beneath the running surface.

#### 9 OBSERVATION WELLS

Twelve observation wells were installed in pairs at six positions around the RMP (see Dwg No 502). Working platforms were constructed from rockfill at each of the positions. Of each pair of wells, one was constructed to monitor groundwater flow in the limestone and the other to monitor flow in the overburden (see Dwg No 516).

Wells in limestone were constructed by drilling at least 1 m into limestone and grouting in a 100 mm diameter galvanised steel liner using 0.5 water/cement ratio cement grout. A 100 mm diameter hole was then drilled inside the liner to 4 m below the base of the liner. A 5.8 m length of 75 mm inside diameter (id) slotted well screen, wrapped in a single thickness of 150 micron nylon mesh was installed to the drilled depth with 75 mm id PVC plain well liner to the surface.

Wells in overburden were constructed by drilling a 200 mm minimum dia hole to rockhead. A bentonite seal was constructed to 500 mm above rock level. Slotted well screen, 75 mm id, was cut to length so that the top of the screen was installed to 500 mm below the base of the estuarine deposits. The screen was wrapped in a single thickness of 150 mm nylon mesh and installed with 75 mm id plain well liner to the surface. Sand backfill was placed around the well screen and clayey silt was tamped down around the plain section of the liner. Further details of the construction of the individual wells are presented in Appendix A which also includes records of the ground conditions encountered during drilling.

#### 10 ANCILLARY WORKS

#### 10.1 Crest road

During construction the crest road was partially constructed to prevent disturbance of the embankment crest. A 150 mm thickness of Class II crushed limestone (see Fig 2) was placed over Polyfelt fabric and blinded with crushed limestone dust. At the end of construction work a 50 mm thickness of Class V crushed rock was placed to bring the crest road up to final level (see Dwg No 511). Where a thickness in excess of 50 mm was required, modified Class II crushed rock was used. The completed road was graded to a fall of 1 in 50 to the outside of the embankment and rolled.

A road edging of 150 mm thick concrete blocks was placed on the impermeable membrane on the crest of the LWP side of the embankment between the LWP and the SWP (see Dwg No 511) and the road constructed overlapping the membrane. The fabric used beneath road construction was extended over the impermeable membrane.

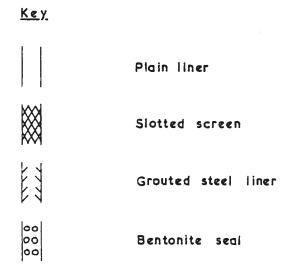
White painted marker stones were placed at 20 m intervals along the road edges on both sides of the crest road.

## 10.2 Surface water interception trench

A 500 mm deep surface water interception trench was dug across the east face above the LWP (see Dwg No 510). The trench was piped under the roadways to either side.

## APPENDIX A

OBSERVATION WELLS - CONSTRUCTION DETAILS



#### Notes.

- 1. All depths shown are relative to top of concrete surround.
- 2. For details of observation well construction see Drawing No. 54 - G - 516
- 3. Slotted screen is not shown where inside permanent steel liner.
- 4. Descriptions of ground conditions are generally based on drillers description.

Traced Approved

Drawn Checked

Loc. No.

#### OBSERVATION WELLS - CONSTRUCTION DETAILS

WELL NO 1 (Glacial till)

Drilling

Drilled 2.9.81 - 3.9.81

Depth drilled 7.3 m

Cased 250 mm 7.3 m

#### Installation

Installed 20.10.81

Problems were encountered in flushing out the hole prior to installation. Piping during withdrawl of temporary casing caused filter sand to come 1.3 m back up hole and lining sank 500 mm.

#### WELL NO 2 (Limestone)

#### Drilling

Drilled 1.9.81 Depth drilled 9.5 m Cased 200 mm 7.6 m

150 mm 9.4 m

Brown limestone and a small cavity, probably a partly open fissure, was encountered at 8.4 m whilst drilling for permanent lining installation so drilling was continued to 9.5 m.

Grouting 19.10.81 - 20.10.81

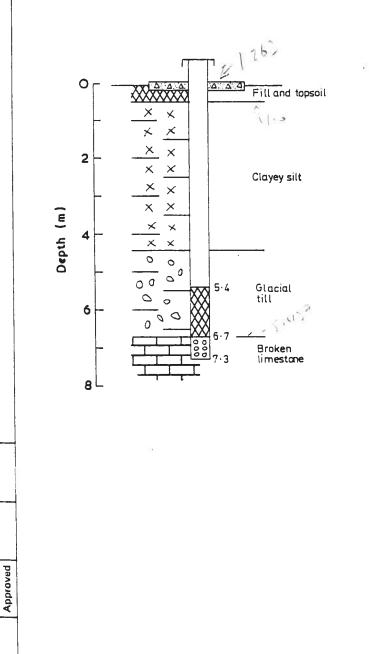
Since grout loss resulted in a larger quantity of grout than anticipated being used, grouting was not completed in one operation. The top 3.4 m of the hole was grouted up the following day.

Drilling of response length 14.11.81

A pocket of clayey material was encountered just below the base of the permanent liner. Drilling was carried out to 14.0 m but the hole filled back to 13.1 m with fine clayey silty material. Water bubbled from the adjacent Well No 1 during drilling.

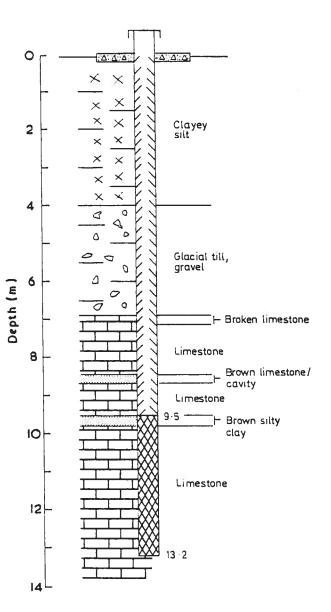
#### Installation of screen 27.11.81

The hole had filled back to 12.5 m so material was flushed out to 14.0 m. However screen could not be advanced below 13.2 m.



WELL Nº 1





Traced

Drawn Checked

AI

#### WELL NO 3 (Glacial till)

#### Drilling

Drilling started in 300 mm diameter. 250 mm casing could not be advanced below 3.7 m due to the presence of boulders in the glacial till although two attempts were made. Drilling then proceeded with 213 mm diameter but 200 mm casing could not be advanced below 5.5 m. Again two attempts were made. The hole was then abandoned. A second attempt was made at a position 6 m to the north, starting in 438 mm diameter and was successful.

1st attempt 22.10.81 - 30.10.81

Depth drilled 7.6 m

Cased 250 mm 3.7 m

200 mm 5.5 m

2nd attempt 9.11.81 - 11.11.81

Depth drilled 16.2 m

Cased 325 mm 10.1 m

250 mm 16.2 m

#### Installation 11.11.81

Excess bentonite was placed so the screen was shortened by 300 mm to allow for the variation. Filter sand plugged up inside the temporary casing and pulled the screen back 300 mm. WELL NO 4 (Limestone)

Drilling 31.10.81 - 4.11.81

Depth drilled 17.5 m

Cased 250 mm 4.6 m

200 mm 9.1 m

Drilling started in 438 mm diameter and continued to 7.3 m. However the rockfill beneath the rig started to fall in and since only 250 mm diameter casing was available this was used to line the hole to prevent undermining. The casing could only be advanced to 4.6 m due to the presence of boulders in the glacial till. 200 mm diameter casing could only be advanced to 9.1 m and had to be driven to achieve this depth. Drilling continued to 17.5 m and since the hole remained open overnight installation was allowed to proceed.

Grouting 5.11.81

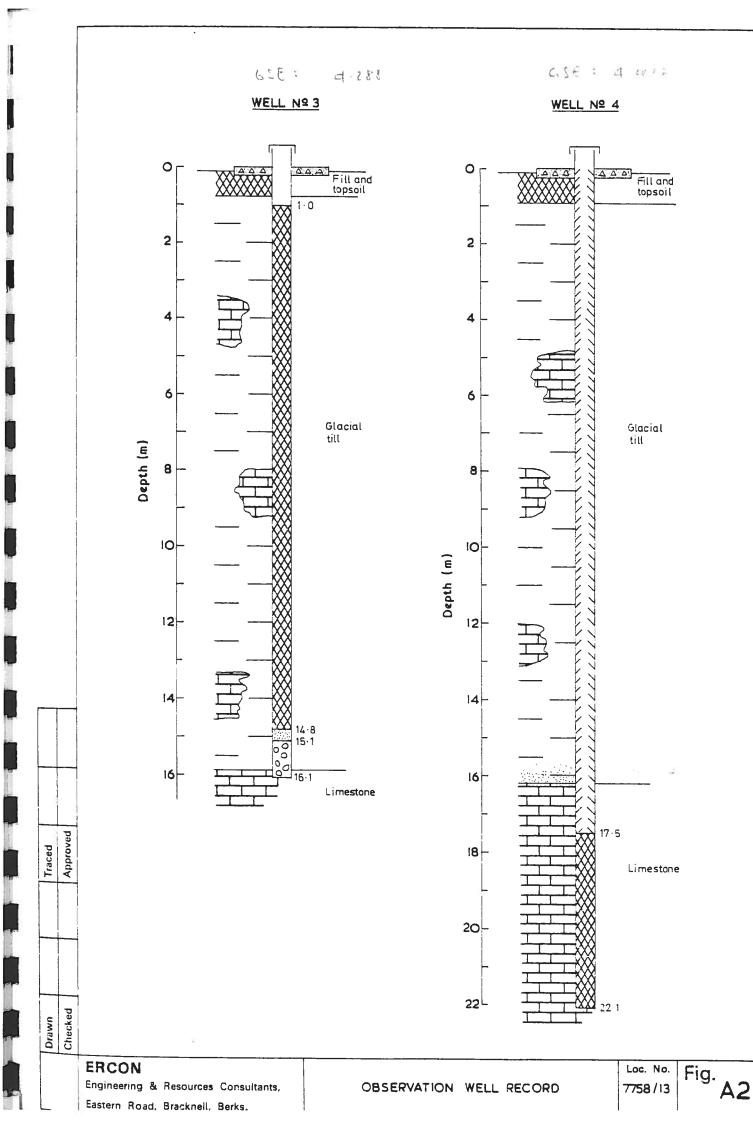
The hole was thoroughly flushed out before installation. The 9.1 m length of 200 mm diameter casing could not be withdrawn and had to be left in the hole.

Drilling of response length 16.11.81

Overdrilled to 22.5 m

Installation of screen 30.11.81

Installed to 22.1 m



#### WELL NO 5 (Glacial till)

#### Drilling

A boulder was encountered at 2.4 m. This pushed the casing off at an angle to the vertical and drilling could not proceed below 6.9 m. A second attempt was made at a position about 3 m to the south and was successful.

1st attempt 22.9.81

Depth drilled 6.9 m

Casing 250 mm 3.0 m

200 mm 6.9 m

2nd attempt 25.9.81 - 28.9.81

Depth drilled 7.9 m

Cased 250 mm 5.2 m

200 mm 7.6 m

#### Installation 29.9.81

Immediately after installation the well was dipped and it was found that 2 m of material had collected at the base of the well. A small sample of the material was obtained and was found to consist of the finer portion of the filter sand. Since the sample contained material coarser than 150 micron, the specified mesh size, it was suspected that the nylon mesh of the screen was too coarse. Subsequent tests on samples of mesh confirmed this. An attempt was made on 17.11.81 to flush out the material. This proved unsuccessful so the well was replaced.

Redrilling 18.11.81 - 20.11.81

200 mm diameter casing was screwed down around the defective well to 7.6 m but could not be advanced below this. Material inside the casing was drilled out and most of the old screen and liner was removed. A short length remained but was eventually drilled out.

## Installation 20.11.81 - 21.11.81

Since the hole was not cased to full depth, problems were encountered with clearing out the hole. However, this was achieved and the screen was installed to the required depth. During pulling of temporary casing the screen was pulled back 200 mm. WELL NO 6 (Limestone)

Drilling 23.9.81 - 24.9.81

Depth drilled 9.1 m

Cased 300 mm 5.2 m

200 mm 5.4 m

150 mm 8.2 m

Casing was pushed off at an angle by a boulder (2<sup>0</sup> to vertical) but drilling could still proceed. After pulling the outer casing it was found that the 150 mm casing remaining was reasonably straight.

#### Grouting

#### 1st attempt 30.9.81

Grouting was attempted using grout mixed at the site batcher plant and delivered down a 13 mm diameter pipe. However, the pipe became blocked by pieces of aggregate contaminating the grout before any grout was introduced to the hole.

#### 2nd attempt 8.10.81

A further attempt was made using batcher mixed grout which was passed through a sieve to remove any aggregate. The grout proved to be insufficiently mixed but by passing it through the sieve to break up balls of unmixed cement and by recirculating through the pump, a satisfactory grout was achieved. Grout was pumped down the permanent steel liner until it reappeared at the surface. Further grout was pumped down to restore the level after the temporary liner was pulled.

Drilling of response length 16.11.81

Drilled to 13.4 m Art the det

Installation of screen 30.11.81

WELL Nº 5 WELL Nº 6 0 0 A A A 0 A A Fill and topsoil Fill and topsoil 1-8 2 2 Glacial till Glacial till Fine silty sand c a 0 0 Depth (m) 4 0 4 Sand and Sand and 0 gravel fine gravel ٥ ¢ 0 0 Generally grey fine to coarse ٥ 6 00 6 Depth (m) 0 0 0 0 0 0 0 0 0 0 gravel with pockets 0 0 0 Gravel with 0 6 or bands of light ο a ٥ 7·2 7·4 0 000 clay bands brown clay 0 0 0 0 C 0 0 ٥ 0 7.9 Limestone 8 8 9.1 10 Limestone 12 Approved 13-1 Traced 14 Checked Drawn Fig. Loc. No. ERCON OBSERVATION WELL RECORD 7758/13 Engineering & Resources Consultants,

WELL NO 7	(Glacial till)									
Drilled	19.9.81 - 22.9.81									
Depth drilled	11.3 m									
Cased 250 mm	10.7 m									
200 mm	11.0 m									
Installed	15.9.81									

WELL NO 8 (Limestone)

Drilled 16.9.81 - 18.9.81

Depth drilled 11.7 m

Cased 250 mm 7.9 m

150 mm 11.7 m

Boulders were encountered from 6.4 to 7.0 m.

Grouted 14.10.81

Drilling of response length 14.11.81

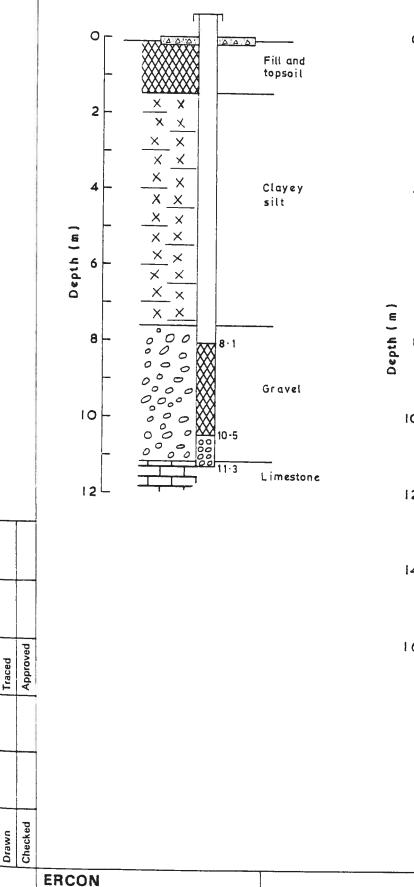
The hole was overdrilled to 18.2 m. Well jointed/fissured limestone was encountered. During drilling of the latter part of the hole (below 16 m) water bubbled from the adjacent Well No 7. The hole was dipped after two days and it was found that a fragment of broken rock had become dislodged and had jammed at 14.1 m. This was rodded down and became stuck at 15.7 m which was the required depth of the hole.

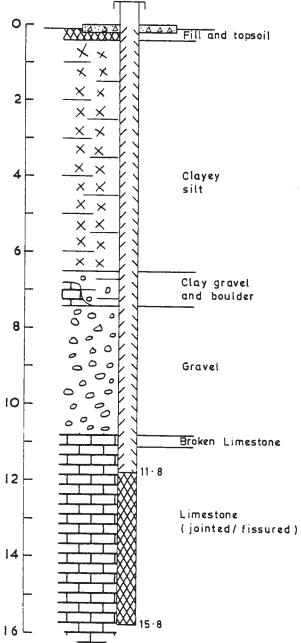
Installation of screen 30.11.81

Installed to the required depth (15.8 m below top of concrete)

WELL Nº 7

WELL Nº 8





OBSERVATION WELL RECORD

Loc. No. Fig.

WELL NO 9 (Glacial till)

Drilled 2.10.81 - 5.10.81

Depth drilled 13.5 m

Cased 250 mm 5.1 m

200 mm 7.6 m

Casing could not be advanced below 7.6 m but since the hole remained open overnight it was agreed that installation could proceed.

Installation 18.11.81

The hole was thoroughly cleaned out before installation. Excess bentonite was placed so the screen was lifted 200 mm.

WELL NO 10 (Limestone)

Drilled 6.10.81 - 12.10.81

Depth drilled 14.2 m

Cased 250 mm 5.7 m

200 mm 7.0 m

150 mm 10.7 m

Bit became blocked at 10.0 m and again at 12.5 m necessitating withdrawal of tools.

Grouted 14.10.81

Drilling of response length 17.11.81

Drilled to 18.3 m

Installation of screen 1.12.81

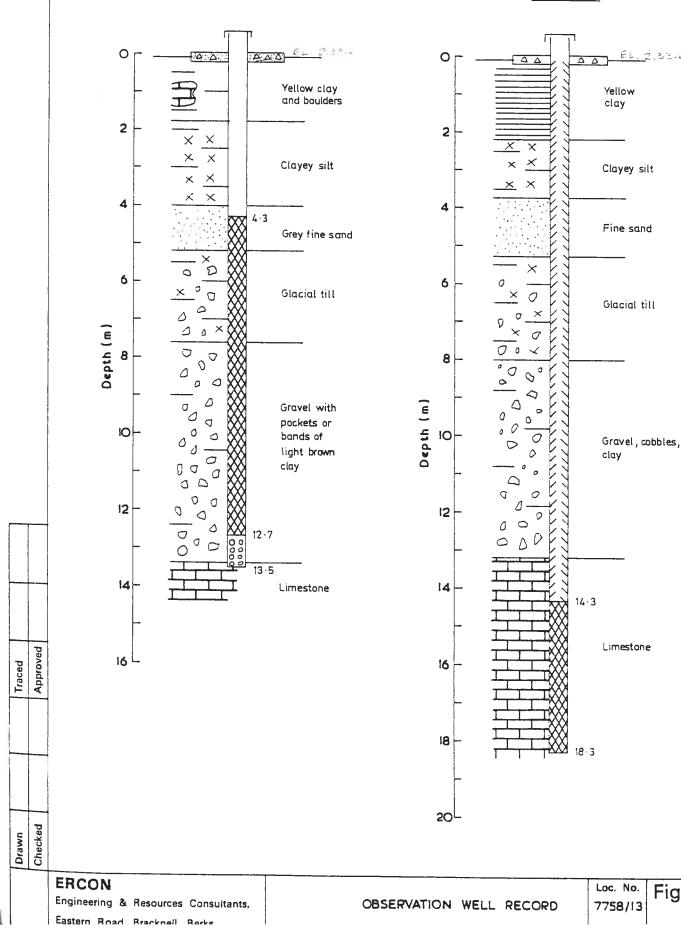
Installed to 18.3 m





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WELL NO 11 (Glacial till)

Drilled 4.9.81 - 8.9.81

Depth drilled 28.0 m

Cased 250 mm 16.8 m

200 mm 26.8 m

250 mm diameter casing could not be advanced below 16.8 m due to a piece of timber encountered at this depth. Problems were also encountered with advancing casing below 25.6 m due to the presence of boulders.

#### Installation 15.10.81 - 16.10.81

The screen sank about 100 mm on pulling the first length of temporary casing. Clayey silt backfill was tamped down around the liner using a small plate to which lengths of rod could be added. A rising head permeability test carried out on 2.11.81 showed the well to be blocked. It was found that a lump of clayey silt material had become lodged at 19 m. This was cleared by blowing out the well using an air-line. A sample jar was lost down the well restricting the depth to 26.2 m. WELL NO 12 (Limestone)

Drilled 9.9.81 - 15.9.81

Depth drilled 28.1 m

Cased 250 mm 21.6 m

150 mm 26.2 m

Grouted 16.10.81 - 17.10.81

Grout was pumped down the permanent liner until grout appeared at the surface. The 150 mm diameter casing was then pulled and further grout was pumped in until the grout level was near ground level. However, it required a large quantity of grout to achieve this and when pumping stopped the grout level dropped indicating that grout was running away through the ground. The consistency of the grout was thickened to a 0.4 water/cement ratio and the grout loss was reduced by doing this. By this time grout at the base of the hole started to go off and pumping through the permanent liner had to be abandoned due to a pressure build up. Grout was then pumped through a 50 mm diameter hose down the outside of the permanent liner. The 250 mm diameter casing was pulled and the grout level again was brought to ground level. The grout level was still found to drop when pumping stopped. For this reason a 4 m length of 200 mm diameter casing was left in the hole so as to keep the hole open if the grout level dropped overnight. The grout level dropped to 1.5 m below ground level and was topped up the following day. A total of 6 tonnes (120 bags) of cement was used and the grouting operation took nearly 5 hours.

#### Drilling of response length

#### lst attempt 12.11.81 - 13.11.81

Drilling out the grout inside the permanent liner was slow for this well. After drilling 1.4 m through limestone to 29.5 m, gravel was encountered for the remainder of the response length. Drilling continued to 32.1 m but was dipped afterwards and found to have fallen in back to 29.7 m. The limestone into which the liner is grouted must either be the caprock over an infilled solution feature or a large boulder in the overburden.

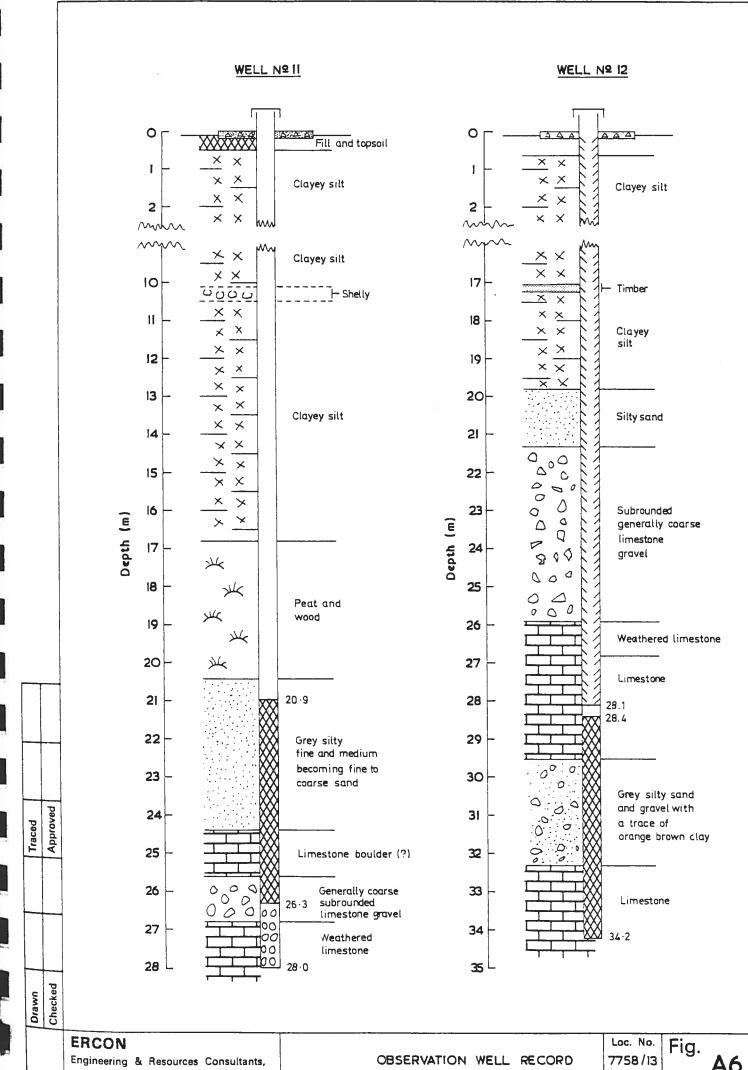
2nd attempt 26.11.81

An attempt was made to install a screen in limestone by drilling using air/foam flush. Limestone was again encountered at 32.3 m and drilling was continued to 37.8 m.

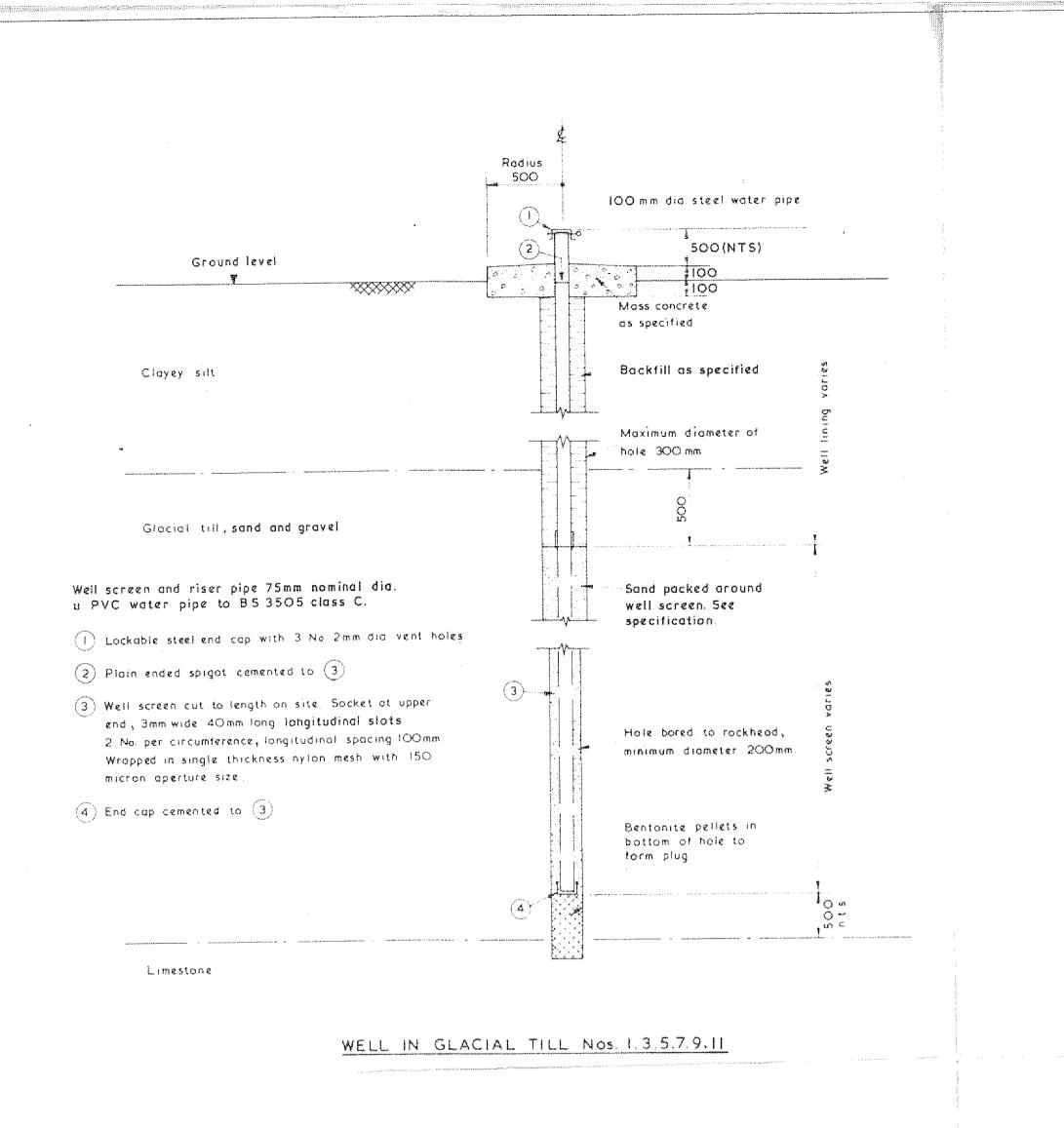
Installation of screen 26.11.81

A 5.8 m length of screen was installed but during installation the hole filled back to 34.2 m. The screen was installed to this depth.

#### DT/MS/7758



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T	A	в	1	E

	11111-1 1111-1111-111-111-111-111-111-1	*****************			TABLE							
			DETAIL	LS OF OBSI	ERVATION	WELLS AS I	NSTALLED		)	· ·		
Well Number	1	2	З	4	5	6	7	8	9	10	11	12
Τγρε	GΤ	LS	GT	L S	GT	LS	GΤ	LS	GT .	LS	GT	L 5
Depth to base of hole (m)	7.3	13.2	16 • 1	22 · 1	7+9	13.4	11.3	15.8	13.5	18·3	28.0	34 • 2
Depth to base of clayey silt (m)	4·4	4.0	0.9 +	0.9+	۱ · 5 +	1.5+	7.6	6.5	4.0	3.8	20 • 4	19-8
Depth to top of limestone (m)	6 · 7	6-9‡	15.9	16.5	7.6	7.9	11.5	10.8	13-4	13.5	26.8	25.9*
Depth to top of bentonite (m)	6 · 7		15.1		7 · 4		10+5		12.7		26.3	
Depth to base of steel liner (m)		9.5		17.5		9 · 1		11.8		14 · 3		28.1
Depth to base of slotted screen (m)			7.2	13.4	10.5	[5+8	12.7	18.3	26.3	34+2		
Depth to top of slotted screen (m)	5 · 4	7.4	1.0	16.3	i · 8	7.6	8 - 1	10-0	4.3	12.5	20.9	28.4

4

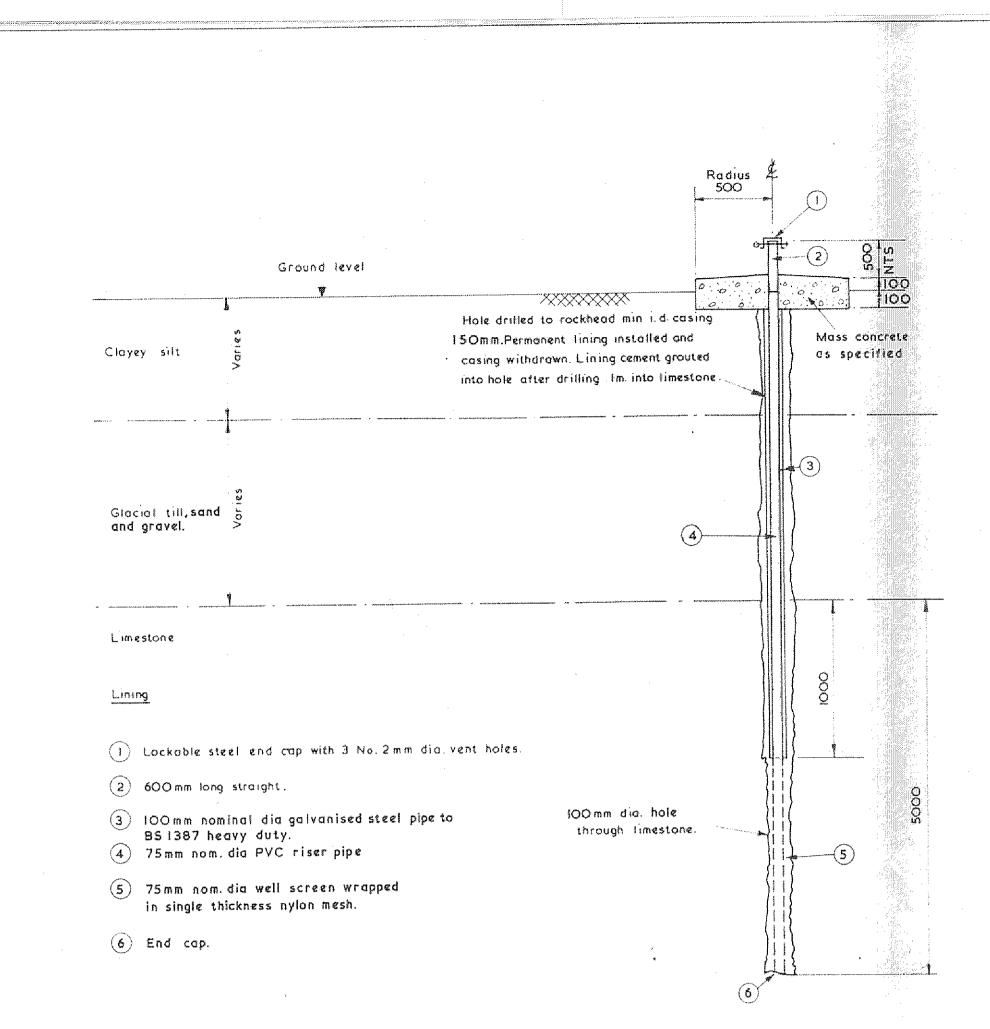
<u>key</u>

GT Indicates well in Glacial till

LS Indicates well in Limestone.

All tobulated depths are relative

to top of concrete surround.



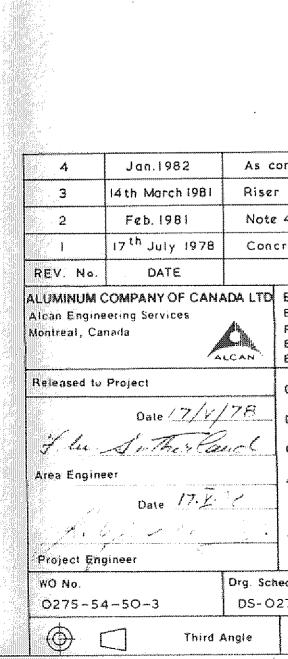
WELL IN LIMESTONE Nos. 2, 4, 6.8, 10,12

 No clayey silt encountered. Depth shown indicates base of fill and topsoil.

Fissures or infilled pockets present in limestone linked to ----overburden (indicated by bubbling from adjacent wells during drilling)

. New contraction

\* After drilling through limestone to 29-5 m sand and gravel was encountered. Limestone was again penetrated at 32.3 m.



## Notes

- 1. Figured dimensions only to be taken from this drawing.
- 2. The positions of observation wells shown on drawing No. DI-0275-54-G-502. Detailed positions will be os instructed by the Engineer.
- 3. Wells are to be clearly numbered on site in 80mm high (minimum) figures to the approval of the Engineer
- 4 2
- 5. All dimensions are in mm unless otherwise specified.
- 6. All levels are related to mean sea level which is 2.67m above old Irish O.S. low water (DUBLIN) datum
- 7. All works to be carried out in accordance with the specification.

"This document was prepared under contract 027554000 Dated 12th March 1979 between Alumina Contractors Limited and Engineering and Resources Consultants Limited"

·														
onstructed														
pipe material specified for wells	in glacial till.													
4 deleted. Submersible pump delete	ed, Dimensions revi	ised, well	lland 12 ad	ded.	,									
ete class deleted														
	DESCRIPTION	N												
ERCON Engineering and Resources Consultants Foundation House Eastern Road Bracknell Berks U.K.	RED MUD POND, AREA 54A													
Designed PLH	OBSERVATION WELL													
Drawn MAP	DETAILS													
Checked Willer			·······			· · · · · · · · · · · · · · · · · · ·								
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Approved Date 22 MP Tec 198	AUGHINISH ALUMINA LIMITED													
edule No. Scale 275-54-G-501 I: 25	Date	Drg D 1	0275	54	G	516	R04							
Dimensions in millimetres (mm) e	cept as noted		daarii ah				Sing and the							

PROJECT:	Installation of Additional Observation Wells	

## RECORD OF BOREHOLE OW 24

SHEET 1 OF 2

LOCATION: Ch 100 approx. (adjacent to sump at west tie-in) Phase 2 BRDA BORING DATE: 20 to 21/12/2010

щ		Ð	SOIL PROFILE			SAMPLES		ES	7	DYNA RESIS	MIC PEN TANCE,	ETRATI BLOWS	ON /0.3m	Ì	HYDRA	AULIC C k, cm/s	ONDUCT	TIVITY,	Т	L G	INSTALLA	TION
DEPTH SCALE	RES	BORING METHOD		LOT		NO T			ELEVATION		0 4		50 8		10	) <sup>-6</sup> 1(	) <sup>-5</sup> 1	0 <sup>-4</sup> 10	) <sup>-3</sup> ⊥	ADDITIONAL LAB. TESTING	GROUNDW	
EPTH	MET	SING	DESCRIPTION		ELEV. DEPTH	GEOTECH NO.	ENV NO.	түре	ILEV/	SHEAF Cu, kP	R STREN a	IGTH I	natV. + remV.⊕	Q - ● U - O	W		ONTENT	PERCEN		DDIT AB. TE	OBSERVA	
ä		BOF		STR/	(m)	GEO	Ξ		ш				75 10		vvp			5 2				
	0		GROUND SURFACE		0.00																Top of Pipe Elev. 1.72	
	1		Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of arisings where possible)						1												Concrete for headworks	
	2								0 -1													
	3	AM Civil 1 td )							-2												Bentonite surrounding solid pipe	
	5	Rotary Coring (Tricone method) Hilliard Ltri (Drilling Subcontractor retained by BAM Civil Ltd.)							-3													
INPUT:	6	Hilliard Ltd (Dr							-5												Sand	
2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPUT:	8								-6												Gravel surrounding soild pipe	284224428422422422422422422 2842242242242242242242242242242242242242
V INSTALLATIONS.GPJ GL	9		Weathered LIMESTONE		-7.17 8.50				-7												Gravel surrounding slotted pipe	
ASE 2 BRDA OV	10 -				<u>-8.17</u> 9.50																	
Н РН			CONTINUED NEXT PAGE	1							•											
2 AUGHINIS	DEF 1 : 5		SCALE							Î	Go Asso	older ocia	tes								LOGGED: CHECKED:	

PROJECT: Installation of Additional Observation Wells
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## RECORD OF BOREHOLE OW 24

SHEET 2 OF 2

LOCATION: Ch 100 approx. (adjacent to sump at west tie-in) Phase 2 BRDA BORING DATE: 20 to 21/12/2010

		8	SOIL PROFILE			SA	MPL	ES		DYNA	MIC PEN TANCE,		ION		HYDR	AULIC C k, cm/s	ONDUC	TIVITY,	Т	(1)		
	DEP IN SUALE METRES	BORING METHOD		OT		ġ			ELEVATION					80	1			0 <sup>-4</sup> 1	0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	INSTALLA AND	TION
Ĩ	ETR	∑ ∑	DESCRIPTION	A PL	ELEV.	CH	ENV NO.	түре	EVAJ	SHEA	R STREN	IGTH	nat V. + rem V. ⊕	Q - ●				PERCE		DITIO	GROUNDW OBSERVAT	ATER
	12 11 12	ORIN		STRATA PLOT	DEPTH (m)	GEOTECH NO.	N N N	≿	EL	Cu, kP	a		rem V. 🕀	U - O	w		W		WI	ADI	OBSERVA	IONS
		8		ST	()	ß				2	25 5	50	75 1	00		5 1	0 1	15 2	20			
ŀ	10		CONTINUED FROM PREVIOUS PAGE LIMESTONE																			
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F	11																					
F			3AM (						-10													
F		thod)	A p																			
E		e me	etaine																			
E	12	Tricor																			Gravel surrounding	
E		Rotary Coring (Tricone method)	Sontra																		slotted pipe	
Ē		ary Co	<del>ባ</del>						-11													
F		Rota																				
F			. (C																			
F	13		Hillard Ltd. (Drilling Subcontractor retained by BAM Gwil Ltd.																			
E			Ī						-12													
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Ē	14				-12.67																	
F	14				14.00																	-
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DR	10																					-
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NO-													1									-
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SE 2 E	20																					-
2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS, GPJ GLDR, LDN, GDT 27/2/12 DATA INPUT:										_												
INISH	<b>DC</b>												tes								100055	15.4
AUGH			H SCALE								Go	oldei	to 5								LOGGED:	
2	1:	50									<b>ASS</b>	UCIA	ucs.								CHECKED:	гu

PROJECT: Installation of Additional Observation We	ells <b>R</b>
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## RECORD OF BOREHOLE OW 25

LOCATION: Ch 100 approx. (adjacent to sump at west tie-in) Phase 2 BRDA BORING DATE: 22/12/2010

SHEET 1 OF 1

	ц	8	1	SOIL PROFILE			SA	MPL	ES	_	DYNA RESIS	VIC PEN TANCE,	IETRAT BLOWS	ION 5/0.3m	Ì	HYDR	AULIC C k, cm/s	ONDUCT	FIVITY,	Т	'Q		
	DEP IN SUALE METRES	BORING METHOD			ŌŢ		ġ			ELEVATION					30	1(		) <sup>-5</sup> 1(	0 <sup>-4</sup> 1	0 <sup>-3</sup> L	ADDITIONAL LAB. TESTING	INSTALLAT AND	ION
	ETR	U U	)	DESCRIPTION	STRATA PLOT	ELEV.	GEOTECH NO.	ENV NO.	щ	LAVE									PERCE		TES	GROUNDWA	
ļ	īΣ	A N		DESCRIPTION	RAT,	DEPTH	OTE	EN<	түре	ELE	Cu, kP	а		nat V. + rem V. ⊕	U - Ō	Wr					ADC LAB.	OBSERVATI	UNS
Ľ	-	BC	í		STI	(m)	Ű				2	5 5	50	75 1	00					20		T ( D)	
				GROUND SURFACE																		Top of Pipe Elev. 1.94	
F	0			Combination of estuarine clavs and	<b>1</b> 9,	0.00																	
E				glacial till. Transition unknown. (Taken from driller's logs and inspection of		-																Concrete for headworks	
E				arisings where possible)	$\mathbf{P}$					1												noudworkb	
E					Æ	-																	-
ŀ																						Bentonite surround to	-
F	1					4																soild pipe	
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E	2		Ę		₹9. X																	Gravel surround to	
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F		(poq)	d by			c				-1													
F		eme	taine																				
F		ricon	tor re		ð,	2																	
F	3	Rotary Coring (Tricone method)	Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)		لې مې																		
F		5 G	0 Q Q		<u>₹0</u>																		
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RDA							1																-
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2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR.LDN.GDT 27/2/12 DATA INDIT:						1	<u> </u>					 1		1		I							
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AUG			10	VALE								GC	oldei										
2 F	1:	50										ASS	ncis	ues								CHECKED: F	νC

PROJECT: Installation of Additional Observation Wells

## RECORD OF BOREHOLE OW 26

SHEET 1 OF 1

LOCATION: Ch 300 approx. (west wall) Phase 2 BRDA

BORING DATE: 20/12/2010

ſ	ш	6	) )	SOIL PROFILE			SA	MPL	.ES		DYNA	MIC PEN TANCE,	ETRATI	ON /0.3m	)	HYDRAULIC CONDUCTIVITY, k, cm/s				. (1)			
	DEPTH SCALE METRES	BORING METHOD		DESCRIPTION			ġ	ENV NO.		TION					0	1(			0 <sup>-4</sup> 1	0 <sup>-3</sup> L	ADDITIONAL LAB. TESTING	INSTALLATI AND	
Ē	NETR	2 U Z	2			ELEV.	GEOTECH NO.		ТҮРЕ	ELEVATION			IGTH I	⊥ nat V. + rem V. ⊕		W	ATER C	I ONTENT	F PERCE	NT	DITIO 3. TES	GROUNDWA OBSERVATIO	
		BOR			STRATA PLOT	DEPTH (m)	EOTI	ĒŊ	F	Ц						vvp		—0 <sup>W</sup>			LAE		
ŀ					S		0				2	5 5	0 7	75 10	00	ť	5 1	<u>0</u>	15 2	20		<del>Top of Pipe</del> Elev. 2.02	
F	0			GROUND SURFACE Combination of estuarine clays and	<u> 9</u> ,	0.00																	
F				Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of																		Concrete for headworks	4 4 -
F				arisings where possible)						1													· · · · -
-																						Bentonite	-
	- 1				Ŕ																	surround to	-
E					ð,																	solid pipe	-
F					ζ.																	Sand	1 († 1
F					Т П П					0													
F			÷		×	-																Gravel	
E	- 2		ivil Lto																			surround to	
E			AM C		X	1																solid pipe	
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F		e met	taineo		<b>ACO</b>																		
F	3	ricon	ctor re		ð,																		
F		Rotary Coring (Tricone method)	Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)		ξ. Σ	-																	
F		ry Co	Subc							_													
		Rota	Drilling			1				-2													
			Ltd. (D		×.×																	Gravel	
	4		lliard		₩.X																	surround to	
			Ï		×9×																	slotted pipe	
						-				-3													
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E					X X X X X X X X X X X X X X X X X X X																	Bentonite plug	_
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IA IN	7																						-
DA																							-
7/2/12																							-
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ЗF																							-
GPJ																							-
SNOL																							
- TLAT	9																						-
NSTA																							-
- Mo																							-
RDA																							-
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2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPUT:	10																						
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AUGH	DE		нS	CALE								Go Asso	lder	tos								LOGGED: JI	
2	1:	<b>9</b> 0										<b>MSS</b> (	JUIA	acs								CHECKED: P	U U

PROJECT: Installation of Additional Observation Wells

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

## RECORD OF BOREHOLE OW 27

LOCATION: Ch 300 approx. (west wall) Phase 2 BRDA

BORING DATE: 17 to 20/12/2010

SHEET 1 OF 2

ш	Q	SOIL PROFILE				/IPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m HYDRAULIC CONDUCTIV k, cm/s						TIVITY,	Т	. (1)				
DEPTH SCALE METRES	BORING METHOD		LOT		Ö			ELEVATION		$20   40   60   80   10^6   10^7$			0-4 1	o <sup>.3</sup> ⊥	ADDITIONAL LAB. TESTING	INSTALLATION AND					
PTH : METF	NG N	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	GEOTECH NO.	ENV NO.	ц	LEVA	SHEAR	STREN	GTH r	nat V. + em V.⊕	Q - ●	N	ATER C		PERCE		DDITI B. TE	GROUNDWATER OBSERVATIONS	
DE	BOR		STRA	(m)	GEOT	""	-	ш	2				00	W	p — 5 1	0 <sup>W</sup>		WI 20	LAI		
		GROUND SURFACE			-		+			<u>, , ,</u>	0 /		,0							<del>Top of Pipe</del> Elev. 1.83	
- 0 - - -		Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of arisings where possible)		0.00				1												Concrete for headworks	
- 7	Retary Corring (Tritoone method) Hilliard Lut, (Drilling Subcontractor retained by BAM Civil Ltd.)							-1 -2 -3 -4 -5												Bentonite surround to solid pipe	
- 8		Weathered LIMESTONE		-7.55 9.00				-7												Sand	
-								-8												Gravel surround to slotted pipe	
- - 10			臣臣				+														
		CONTINUED NEXT PAGE																			
DE 1 :		SCALE						(	Ð	Go	Ider	tes								LOGGED: JM CHECKED: PC	

PROJECT: Installation of Additional Observation Wells

## RECORD OF BOREHOLE OW 27

SHEET 2 OF 2

LOCATION: Ch 300 approx. (west wall) Phase 2 BRDA

BORING DATE: 17 to 20/12/2010

8	SOIL PROFILE							Т	. (1)	INSTALLATION							
METRES BORING METHOD		TOJI	LEV. EPTH (m)	N NO.	j ш	ELEVATION	20	40	60	80	10	) <sup>-6</sup> 1	0 <sup>-5</sup> 1 1 ONTENT	0 <sup>-4</sup> 1	0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER
ME	DESCRIPTION	STRATA PLOT	EPTH (m)		TYPE	ELEV		STRENGTH			vvp		—0 <sup>W</sup>		WI	ADDI LAB. 1	OBSERVATIONS
	CONTINUED FROM PREVIOUS PAGE		. ,	ō			25	50	75	100	<u></u>	5 -	10 1	5 2	20		
10         11         11           11         12         12           12         Relary Coring (Tricone method)         11           14         14         12	Weathered LIMESTONE		<u>13.55</u> 15.00			-9 -10 -11 -12 -13											Gravel surround to slotted pipe
16 17 18 19 20																	
DEPTH : 1 : 50	I SCALE	. 1				. (	Ĵ.	Gold	er iates		•					•	LOGGED: JM CHECKED: PC

	6	SOIL PROFILE			SAI	MPL	ES		DYNA	MIC PEN TANCE,	ETRATIO	ON /0.3m	)	HYDRA	ULIC C k, cm/s	ONDUCT	TIVITY,	T	.0	
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	GEOTECH NO.	ENV NO.	түре	ELEVATION	2 SHEAF Cu, kP	R STREN a	0 6 LIGTH r r	60 8 ⊥ nat V. + rem V. ⊕	Q - ● U - O	10 W/ Wp	10 ATER CO	D <sup>-5</sup> 10 L ONTENT O <sup>W</sup>	PERCE	WI	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
$\vdash$			ن		U		+		2	5 5	0 7	<u>75 1</u>	00	5	1	0 1	5 2	20		Top of Pipe Elev. 2.43
2 AUGHINSH PHASE 2 BRDA OW INSTALLATIONS GPU GLDR_LDN.GDT 277/12 DATA INPUT: 1 0 6 6 8 2 2 9 9 5 5 7 7 9 9 5 10 7 10 10 10 10 10 10 10 10 10 10 10 10 10	Rotary Caring (Tricone method)	GROUND SURFACE Combination of estuarine clays and glacial till. Transition unknown, (Taken from driller's logs and inspection of arisings where possible)		-4.15 6.00				1 -1 -2 -3 -4												Elev. 2.43 Concrete for headworks Bentonite surround to solid pipe Sand Gravel surround to solid pipe Gravel surround to slotted pipe Bentonite plug
DE DE	PTI 50	H SCALE							Ì	Go	lder ocia	tes								LOGGED: JM CHECKED: PC

#### PROJECT: Installation of Additional Observation Wells RECORD OF BOREHOLE OW 28

LOCATION: Ch 500 approx. (west wall near ramp to flap valve) Phase 2 BRDA BORING DATE: 17/12/2010

SHEET 1 OF 1 DATUM: AMSL

PROJECT: Installation of Additional Observation Wells	<b>RECORD OF BOREHOLE</b>	OW 29
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LOCATION: Ch 500 approx. (west wall near ramp to flap valve) Phase 2 BRDA BORING DATE: 16 to 17/12/2010

SHEET 1 OF 2

щ		DO	SOIL PROFILE			SA	MPL	ES	_	DYNAI RESIS	MIC PEN TANCE,	ETRATIO BLOWS/	ON ⁄0.3m	)	HYDR/	AULIC C k, cm/s	ONDUC	TIVITY,	Т	10		
DEPTH SCALE METRES		BORING METHOD		LOT		Ö	÷		ELEVATION		0 4			10	10			0-4 1	o <sup>.₃</sup> ⊥	ADDITIONAL LAB. TESTING	INSTALLATIC AND	
PTH (		Ъ	DESCRIPTION	STRATA PLOT	ELEV.	GEOTECH NO.	ENV NO.	ТҮРЕ	EVA	SHEAF			nat V. + em V. ⊕	Q- ●	w		ONTENT	PERCE		DITIO	GROUNDWAT OBSERVATIO	
DEF		BORI		TRA <sup>-</sup>	DEPTH (m)	EOT	Ľ.	F	Ш						vvr		—0 <sup>W</sup>			LAE		
	╉			ò		U				2	55	0 7	<u>'5 10</u>	00	Ę	5 1	<u>10 1</u>	15 2	20	┢──┤	<del>Top of Pipe</del> Elev. 2.32	
F	0		GROUND SURFACE Combination of estuarine clays and	Xa	0.00															┟──┤	Elev. 2.32	
F			glacial till. Transition unknown. (Taken from driller's logs and inspection of	× OX																	Concrete for	
E			arisings where possible)	<b>X</b> ×																	headworks	
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-	4	Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)																			Bentonite	
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NS.C				×					-7												solid pipe	
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STALL	9				]	1																
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2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPUT: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	₀┝			臣臣	1	-																8 <b>8</b> -
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AUG-			SCALE								Go Asso	lder	toc								LOGGED: JN	
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PROJECT: Installation of Additional Observation Wells	ORD OF BOREHOLE OW 29
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SHEET 2 OF 2

LOCATION: Ch 500 approx. (west wall near ramp to flap valve) Phase 2 BRDA BORING DATE: 16 to 17/12/2010

ſ	ш	8	SOIL PROFILE			SA	MPL	ES		DYNA	MIC PEN TANCE,		ON /0.3m		HYDR	AULIC C k, cm/s	ONDUC <sup>-</sup>	TIVITY,	Т	. (1)	
	DEPTH SCALE METRES	BORING METHOD		ŌŢ		ġ			ELEVATION					0	1			0-4 1	o-₃ ⊥	ADDITIONAL LAB. TESTING	INSTALLATION AND
	PTH S	2 UD	DESCRIPTION	TA PL	ELEV.	ECH	ENV NO.	ТҮРЕ	EVA.				⊥ nat V. + rem V. ⊕		w	ATER C	ONTENT	PERCE		DITIO 8. TE	GROUNDWATER OBSERVATIONS
	DEF	BORI		STRATA PLOT	DEPTH (m)	GEOTECH NO.	ĒN	F	Ш						vv	• <b> </b>				LAE	
ŀ			CONTINUED FROM PREVIOUS PAGE	S		0				2	5 5	0 7	75 10	00		5 1	0 1	15 2	20		
þ	- 10		Weathered LIMESTONE																		
F																					
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ŀ		Rotary Coring (Tricone method)	ained																		
ŧ		ricone	tor ret																		Gravel
Ē		ring (T	ontrac																		surround to slotted pipe
þ		IN Co	5 Subo						-11											1	
F	- 13	Rote	Driling																		
E			Ltd. (	幸																	
þ			Hilliard Lid. (Drilling Subcontractor retained by BAM Civil Lid.)																		
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2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPU	20																				
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NGH	DE		H SCALE								Go	lder	40-								LOGGED: JM
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D OF BOREHOLE	OW 30
	D OF BOREHOLE

SHEET 1 OF 1

LOCATION: Ch 700 approx. (west wall near Poulaweala Creek) Phase 2 BRDA BORING DATE: 15 to 16/12/2010

		8	SOIL PROFILE			SA	MPL	ES		DYNA	/IC PEN TANCE,		ON /0.3m		HYDRA	ULIC Co k, cm/s	ONDUC.	TIVITY,	Т	. (1)		
CAL	METRES	BORING METHOD		ы		ġ			ELEVATION	2				30	10		) <sup>-5</sup> 1	0 <sup>-4</sup> 1	0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	INSTALLAT AND	
LT S	ETR	М Ш	DESCRIPTION	STRATA PLOT	ELEV.	GEOTECH NO.	ENV NO.	ТҮРЕ	EVAJ				nat V. + rem V.⊕	1	I I			PERCE		DEC	GROUNDW/ OBSERVAT	
DEP	2	ORIN		RAT	DEPTH (m)	OTE	N N N	≽	ELI	Cu, kP	а	r	rem V. ⊕	U - O	Wp	H				ADI LAB	OBJERVAT	ONS
		â		ST	(11)	GE				2	55	0 7	75 10	00	5	1	0 1	15 2	20		Top of Pipe	
⊢	0		GROUND SURFACE	×~	0.00			_													Top of Pipe Elev. 2.97	NIN
F			Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of arisings where possible)	N.X	0.00																Concrete for	
F			from driller's logs and inspection of arisings where possible)	<u>ج</u>	]																headworks	
F				ŝ					2													- 1 <sup>-</sup>
F				Š	1																Bentonite surround to	-
F	1			No.																	solid pipe	-
F				æ																		-
F				QX X																	Sand	동원 -
F				<del>o</del> <sup>×</sup>					1													
F		:	(f	*a																	Gravel	
E	2			××																	surround to	
E				×	1																solid pipe	
E		(jg	n a	₽×																		
F		met		É					0													
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E		Rotary Coring (Tricone method)							-1													
E		-	Filliard Ltd. (Unling Subconfractor relaried by BAM CVII.L.N.)	×,	-				-1													
E	4	-		ð,																	Gravel surround to	
F				Ğ×																	slotted pipe	
F				ĥ																		
F				<u>X</u>	-				-2													
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E	5				1																	
E				$\mathbb{P}^{\times}$	-																	
F				æ																		
F				Ď,	1				-3												Bentonite plug	-
F	_			X9×	-3.40																Demonite plug	-
F	6			- <u> </u>	6.00																	_
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2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPU																						
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AUGH			ISCALE								Go	lder	+								LOGGED:	
2 F	1:	50									ASS	JCIA	ies								CHECKED: F	чC

PROJECT: Installation of Additional Observation Wells <b>RECORD OF</b>	- BOREHOLE	OW 31
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SHEET 1 OF 2

LOCATION: Ch 700 approx. (west wall near Poulaweala Creek) Phase 2 BRDA BORING DATE: 14 to 15/12/2010

DATUM: AMSL

	Ģ	2	SOIL PROFILE			SA	MPLES			DYNA	AIC PEN TANCE,		0N /0.3m		HYDR/	AULIC Co k, cm/s	ONDUCT	TIVITY,	Т		
DEPTH SCALE METRES				Ъ.		Ö,			TION					10		x, cm/s ) <sup>-6</sup> 1(			0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	INSTALLATION AND
PTH S METF			DESCRIPTION	STRATA PLOT	ELEV. DEPTH	GEOTECH NO.	ENV NO.		ELEVATION	SHEAF	STREN	IGTH I	nat V. + rem V. ⊕	Q - ●		ATER CO			NT	B. TE	GROUNDWATER OBSERVATIONS
DE		200		STRA	(m)	GEOT	Ξ  <sup>6</sup>	-	Ξ		a 5 5			0-0		5 1			WI 20	<b>L</b> AR	
		_	GROUND SURFACE	0,7		0		╈		2	5 5	0 1		50			0 1	5 2	20		Top of Pipe Elev. 3.08
- 0 - - -			Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of arisings where possible)		0.00				0												Concrete for headworks
1 2 3 4 5 6 7	Rotary Coring (Tricone method)	Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)	from driller's logs and inspection of	ľv –					2 1 -1 -2 -3 -4												Bentonite surround to solid pipe
- 8 - 8 			Weathered LIMESTONE		- <u>5.90</u> 8.50				-6												Gravel Surround to
- 9 			CONTINUED NEXT PAGE						-7											-	slotted pipe
				<u> </u>				_		<u></u> 6			1	1		I		I	1	I	
DE 1 :		нs	CALE							Ð	Go Asso	lder Ocia	tes								LOGGED: JM CHECKED: PC

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

PROJECT: Installation of Additional Observation Wells	<b>RECORD OF BOREHOLE</b>	OW 31
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LOCATION: Ch 700 approx. (west wall near Poulaweala Creek) Phase 2 BRDA BORING DATE: 14 to 15/12/2010

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

SHEET 2 OF 2

	ç	2	SOIL PROFILE			SA	MPL	ES		DYNA	MIC PEN TANCE,	ETRATI	DN (	)	HYDR	AULIC Ç	ONDUCT	TIVITY,	т			
DEPTH SCALE METRES	BORING METHOD	2		F	1			_	NO					$\sim$						ADDITIONAL LAB. TESTING	INSTALLA	
H SC TRE	ME	N N		PLC	ELEV.	хн	ġ	ш	ELEVATION	2							0 <sup>-5</sup> 10			TION	AND GROUNDW	
ME			DESCRIPTION	ATA	DEPTH	TEC	ENV NO.	түре	ĒLĒ	Cu, kP	a	igih r	nat V. + em V.⊕	Q - O			ONTENT			AB. 7	OBSERVAT	IONS
ā	Ğ	<u>S</u>		STRATA PLOT	(m)	GEOTECH NO.	ш	Ċ.	_	2	5 5	io 7	<b>7</b> 5 10	00					20	ב י		
			CONTINUED FROM PREVIOUS PAGE			-										<u> </u>						
- 10			Weathered LIMESTONE																			18 18 -
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-									-8													
-				臣																		
- 11 -																						
-																						
-		Ltd.		파	-8.90																	
-		l Civi	LIMESTONE (some fractures)		11.50				-9													
-		BAN																			Gravel	
- - 12 -	ethod	ed by																			surround to slotted pipe	
_	ue m	retain																			siotteu pipe	
-	Trico	ictor i																				
_	ring (	ontra							-10													
-	Rotary Coring (Tricone method)	Subc																				
- 13 -	Rota	rilling																				
-		d. D																				
-		ard Li																				
-		Ē							-11													
-					-11.40																	
- - 14 -		ľ	LIMESTONE (very fractured), hole collapsed between 14 and 15m depth		14.00																	NOJENOJ
-			collapsed between 14 and 15m depth																			-
-																						-
-									-12													-
-					-12.40																	-
- 15 -					15.00																	-
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PROJECT: Installation of Additional Observation Wells	۲		l
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#### LOCATION: Ch 900 approx. (south west corner) Phase 2 BRDA

RECORD OF BOREHOLE OW 32

BORING DATE: 13 to 14/12/2010

SHEET 1 OF 2

		8	SOIL PROFILE			SA	MPL	ES		DYNA	MIC PEN TANCE,		ON /0.3m		HYDR	AULIC C k, cm/s	ONDUC	TIVITY,	Т	. (1)		
DEPTH SCALE	RES	BORING METHOD		LOT		N			ELEVATION		0 4			10	1			0-4 1	0 <sup>-3</sup> L	ADDITIONAL LAB. TESTING	INSTALLA AND	
PTH	METF	NG N	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	GEOTECH NO.	ENV NO.	түре	LEVA	SHEAF	R STREN a	IGTH r	natV.+ emV.⊕	Q - ● U - O	w		ONTENT			B. TE	GROUNDW OBSERVAT	
DE		BOR		STRA	(m)	GEOT		-	ш					00	VV		0 <sup>W</sup>		WI 20	βĄ		
			GROUND SURFACE	0,		Ŭ					5 5	0 1		50		5					<del>Top of Pipe</del> Elev. 2.60	
-	0		Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of arisings where possible)		0.00				2												Concrete for headworks	4
	1																					
									1													
	2								0													-
-																						
	3								-1													
-	4	1	iwi Ltd.)						-2												Bentonite surround to solid pipe	
		method)	ained by BAM C																			
	5	Rotary Coring (Tricone method)	subcontractor ret						-3													
-	6	Rotary	id Litt. (Drilling S																			
	0		T						-4													
	7								-5													-
GDT 27/2/12																					Sand	
U GLDR_LDN	8								-6												Gravel surround to solid pipe	
LATIONS.GP.	9				-6.91																	
2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN GDT 27/2/12 DATA INPUT	-		Weathered LIMESTONE		9.00				-7												Gravel surround to slotted pipe	
E 2 BR																						
PHAS	10		CONTINUED NEXT PAGE																			
HININH	DEI	PTH	1 SCALE						·	Â		Ider								-	LOGGED:	JM
2 AUG	1:									J	Go Asso	DCia	tes								CHECKED:	

PROJECT: Installation of Additional Observation Wells

### RECORD OF BOREHOLE OW 32

LOCATION: Ch 900 approx. (south west corner) Phase 2 BRDA

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

BORING DATE: 13 to 14/12/2010

SHEET 2 OF 2

	ç	J,	SOIL PROFILE			SA	MPLE	s		DYNA	VIC PEN TANCE,	ETRATIO	DN /0.0m		HYDRAULIC k, cm/	CONDUC	TIVITY,	т			
DEPTH SCALE METRES				DT O		ġ			lion					30				0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	INSTALLAT AND	ON
AETR		NG NG	DESCRIPTION	LA PL	ELEV.	ECH P	ENV NO.	TYPE	ELEVATION					Q - ● U - O	WATER	CONTENT	PERCE		DITIO 3. TES	GROUNDWA OBSERVATI	
DE		BURI		STRATA PLOT	DEPTH (m)	GEOTECH NO.	Ë	F	Ш						Wp —				LAE		
			CONTINUED FROM PREVIOUS PAGE	0		0		┥		2	5 5	<u>io 7</u>	<u>'5 1</u>	00	5	10 1	15 2	20			
- 10 -			Weathered LIMESTONE					1	-8												
-																					
-																					
- 11 - -									-9												
-		Civil Ltd.)																			
- - - 12	(poq)	d by BAM																			
- -	cone met	or retained			10.11				-10											Gravel surround to slotted pipe	
- -	oring (Tr	bcontract	LIMESTONE (very fractured with hole collaping below 14.5m depth)		-10.41 12.50																
- - 13 -	Rotary C	orilling Su							-11												
-		Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)																			
- -		Hill																			
- 14 -									-12												
-																					
- - - 15					-12.91																-
- -					15.00																-
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LOCATION: Ch 900 approx. (south west corner) Phase 2 BRDA

RECORD OF BOREHOLE OW 33

BORING DATE: 12 to 13/12/2010

SHEET 1 OF 1

Γ	щ	B	1	SOIL PROFILE			SA	MPL	ES	_	DYNA RESIS	MIC PEN TANCE,	ETRATI	ON /0.3m	Ì	HYDR/	AULIC Co k, cm/s	ONDUC.	TIVITY,	Т	.0		
	DEPTH SCALE METRES	BORING METHOD			LOT		Ö			ELEVATION					10	10		) <sup>-5</sup> 1	0-4 1	o <sup>-3</sup> ⊥	ADDITIONAL LAB. TESTING	INSTALLAT AND	
	METF	0 N	2	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	GEOTECH NO.	ENV NO.	түре	LEVA	SHEAF	R STREN	IGTH I	nat V. + rem V.⊕	Q - ●	W			PERCE		DDITI B. TE	GROUNDW/ OBSERVAT	
	DE	BOR	5		STRA	(m)	GEOT	Ш	н	ш				75 10		Wp 6	) —			WI 20	PA		
	0			GROUND SURFACE													, .					Top of Pipe Elev. 2.64	
				Combination of estuarine clays and glacial till. Transition unknown. (Taken from driller's logs and inspection of arisings where possible)		0.00				2												Concrete for headworks Bentonite	
	1									1												surround to solid pipe Sand	2902/11 2902/11 1111111
	2	Rotary Coring (Tricone method)	Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)							0 -1												Gravel surround to solid pipe	
	4		Hilliard Ltd							-2 -3												Gravel surround to slotted pipe	
	6					- <u>3.95</u> 6.00																Bentonite plug	
DT 27/2/12 DATA INPUT:	7																						
NS.GPJ GLDR_LDN.G	8																						
2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPU	9 10																						
2 AUGHINISH PH	DE 1 :		- IS	CALE	<u> </u>	<u> </u>	I	1			Î	Go	lder ocia	tes	<u> </u>	I			<u> </u>	<u> </u>	L	LOGGED: J	

PROJECT: Installation of Additional Observation Wells	
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#### RECORD OF BOREHOLE OW 35

LOCATION: Ch 1350 approx. (south wall) Phase 2 BRDA

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

BORING DATE: 09/12/2010

SHEET 1 OF 1

	8	SOIL PROFILE			SA	MPLE	s		DYNAM	AIC PEN	ETRATIO BLOWS/	DN /0.3m		HYDR/	AULIC C k, cm/s	ONDUCT	FIVITY,	Т	(1)		
DEPTH SCALE METRES	BORING METHOD		ОТ		ġ			ELEVATION	2				30	10		0 <sup>-5</sup> 10	0 <sup>-4</sup> 1	0 <sup>-3</sup> ⊥	ADDITIONAL LAB. TESTING	INSTALLAT AND	ION
TH S ETR	δ	DESCRIPTION	STRATA PLOT	ELEV.	GEOTECH NO.	ENV NO.	Щ	EVAT				iat V. + em V. ⊕				ONTENT	PERCE		DITIC	GROUNDW/ OBSERVAT	
DEP.	ORIN	DESCRIPTION	RAT,	DEPTH (m)	OTE	EN	түре	ELE	Cu, kPa	a	r	em V. 🕀	U-Ō						ADC LAB.	OBSERVAT	UN5
	ă		ST	(11)	В				2	55	0 7	5 1	00		5 1			20			
- 0		GROUND SURFACE						2												Top of Pipe Elev. 2.63	P. J. P. J.
-		Combination of estuarine clays and glacial till. Transition unknown. (Taken		0.00				2												Concrete for	
- 0 - - - -		from driller's logs and inspection of arisings where possible)																		headworks	4 4 -
-		analiga where possible)																			- é é
-																					-
- - 1								1												Bentonite	_
- - - 1 -																				surround to	-
-																				solid pipe	-
-																					-
-																					
- - 2								0												Sand	- ta -
-	Ltd.)																				
-	O C																			Gravel	
-	() BAN																			surround to solid pipe	
-	ethoc ed by																				
- 3	Rotary Coring (Tricone method) Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)							-1													
-	(Trioc																				
-	oring																				
-	ary C a Sub																				
-	Rot																				
- 4	Ltd. (							-2													
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PROJECT: Installation of Additional Observation Wells

#### RECORD OF BOREHOLE OW 36

LOCATION: Ch 1350 approx. (south wall) Phase 2 BRDA

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

BORING DATE: 08 to 09/12/2010

SHEET 1 OF 2

	8	SOIL PROFILE			SA	MPLES		DYNA	MIC PEN TANCE,		ON /0.2m		HYDRA		ONDUC <sup>-</sup>	TIVITY,	т	(1)		
DEPTH SCALE METRES	BORING METHOD		Б		Ö		ELEVATION					80	10				0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	INSTALLATION AND	
PTH S METR	2 UD	DESCRIPTION	STRATA PLOT	ELEV.	GEOTECH NO.	ENV NO. TYPE	EVA	SHEA	R STREM	NGTH	⊥ nat V. + rem V. ⊕	Q - ●	W	ATER C	ONTENT		INT	DITIO 3. TES	GROUNDWATER OBSERVATIONS	
DEF	BORI		TRA	DEPTH (m)	EOT	Га Г											WI	<b>A</b> B		
		GROUND SURFACE	0)		0			2	25 5	50 1	75 1	00	5	5 1	0 1	15 :	20		Top of Pipe Elev. 2.62	
- 0		Combination of estuarine clays and glacial till. Transition unknown. (Taken	<b>1</b> 9.	0.00			2												Concrete for	÷ -
-		from driller's logs and inspection of arisings where possible)	х Ф																headworks	·   -
-		ansings where possible)	Å																	
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- 5	Rotary Coring (Tricone method)	ractor	Č,				-3													_
-	Coring		<u>P</u>																	
-	Rotary	S Bu	Ć																	-
-		р и и	Ð.,																	
- 6		Hilliard Let. (Drilling Subcontractor retained by BAM Civil Let.)	åg. X				-4												Sand	<u>े</u> न
-		I	È																Sand Gravel Surround to Surrou	<u>250055005500 ~~ </u>
-		Weathered LIMESTONE		-4.46 6.50															Gravel surround to	1 1
_			臣																solid pipe	
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- 9			野				-7													1
-			野																	2005
			臣					1												
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DE	PTF	I SCALE					(		ASS	older	•								LOGGED: JM	
1:	50								Ass	ocia	tes								CHECKED: PC	

PROJECT: Installation of Additional Observation Wells

### RECORD OF BOREHOLE OW 36

LOCATION: Ch 1350 approx. (south wall) Phase 2 BRDA

2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

BORING DATE: 08 to 09/12/2010

SHEET 2 OF 2

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щ		BORING METHOD	SOIL PROFILE			SA	MPLES		RESIS	MIC PEN TANCE,	BLOWS	0N /0.3m	Ì	HYDR/	k, cm/s	ONDUC	IIVIIY,	T	<u>ا</u> ب	INSTALLA	
SCAI		Ē		þ.		ġ		ELEVATION	2	0 4	10 E	50 8	во	1(	0 <sup>-6</sup> 1	0 <sup>-5</sup> 1	0 <sup>-4</sup> 1	0 <sup>-3</sup> ⊥	STIN	AND	HON
ETR		≥ 0	DESCRIPTION	A PL	ELEV.	CH	ENV NO	.AV	SHEAF					W		ONTENT			TE	GROUNDW	
DEPTH SCALE METRES		NRIN N	DESCRIPTION	STRATA PLOT	DEPTH	GEOTECH NO.	ENV NO. TYPE	ELE	Cu, kP	а		rem V. 🕀	Q - • U - O	W					ADDITIONAL LAB. TESTING	OBSERVAT	IUNS
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- 10	Г		Weathered LIMESTONE		-			-8													
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-		0 VI																		slotted pipe	
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-	Cor	Subco																			
- 13	tan	ling S						-11													
-	[	Ē																			-
-		Hilliard Ltd. (Drilling Subcontractor retained by BAM Civil Ltd.)		$\vdash$																	
-		Hilliar			-11.66																-
-		-	POSSIBLE VOID - containing sand		13.70																-
- - 14			and water LIMESTONE (fractured), collapsing to		-11.96 14.00			-12													-
-			13m depth.	Ľ	14.00																-
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PROJECT: Installation of Additional Observation Wells RECORD OF BOREHOLE OW	42
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LOCATION: Ch 2175 approx. (in field adjacent to perimeter wall) Phase 2 BRDABORING DATE: 16 to 17/06/2011

SHEET 1 OF 2

ш		8		SOIL PROFILE			SA	MPL	ES		DYNAM RESIS	MIC PEN TANCE,	ETRATI BLOWS	ON /0.3m	Ì	HYDR	AULIC C k, cm/s	ONDUC	TIVITY,	Т	.0		
DEPTH SCALE	SES	BORING METHOD			LOT		Ö			ELEVATION	2				10	1			0-4 1	o <sup>.₃</sup> ⊥	ADDITIONAL LAB. TESTING	INSTALLA AND	
PTH	METF	NG N		DESCRIPTION	STRATA PLOT	ELEV. DEPTH	GEOTECH NO.	ENV NO.	ТҮРЕ	LEVA	SHEAF			natV.+ remV.⊕	Q - ●	w		ONTENT		NT	DDITI B. TE	GROUNDW OBSERVAT	
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			6	GROUND SURFACE	0)		0				2	5 5	0 7	75 10	00	;	5 '	10 1	15 2	20		<del>Top of Pipe</del> Elev. 6.51	
Ē	0		E	Brown gravelly sandy CLAY/SILT with cccasional cobbles - glacial till. (taken rom driller's logs and inspection of rrisings where possible)	X X X X X X X X X X	0.00																Concrete for	
E			fi	rom driller's logs and inspection of	<u>کې</u>																	headworks	4 4 -
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E	5	Rotary Coring (Tricone method)	Hiiliara Lra. (Urilling subcontractor retained by BANI Civil Lta.)							1													
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INST,					F																	C	
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2 BRD																						sioned hibe	
HASE:	10		+	CONTINUED NEXT PAGE						-4												<u></u>	
2 AUGHINSH PHASE 2 BRDA OW INSTALLATIONS GPJ GLDR_LDN GDT 272/12 DATA INPU					L		L				<u>A</u>												
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PROJECT: Installation of Additional Observation Wells	<b>RECORD OF BOREHOLE</b>	OW 42
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SHEET 2 OF 2

DATUM: AMSL

LOCATION: Ch 2175 approx. (in field adjacent to perimeter wall) Phase 2 BRDABORING DATE: 16 to 17/06/2011

	Т	Q	SOIL PROFILE			SA	MPL	ES		DYNA	MIC PEN	ETRAT	ION	)	HYDR	AULIC C	ONDUC	TIVITY,	т			
DEPTH SCALE	2	BORING METHOD		ЭТ					NO					80	1	k, cm/s		0-4	10-3	ADDITIONAL LAB. TESTING	INSTALLATI AND	ION
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DEP	Σ	DRIN	DESCRIPTION	RAT/	DEPTH	OTE	EN<	ТҮРЕ	ELE	Cu, kP	'a		rem V. e	+ Q-● ● U-O	w		O <sup>W</sup>			LAB.	OBSERVATIO	ONS
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#### RECORD OF BOREHOLE OW 45

LOCATION: Ch 2650 approx. (east wall near ramp no. 4) Phase 2 BRDA

BORING DATE: 22 to 23/12/2010

SHEET 1 OF 2

u.		Ð	SOIL PROFILE			SA	MPL	ES		DYNAI RESIS	MIC PEN TANCE,	ETRATI BLOWS	ON /0.3m	)	HYDR	AULIC C k, cm/s	ONDUC	TIVITY,	Т	.0		
	METRES	BORING METHOD		LOT		ġ			ELEVATION		0 4			30	1			0 <sup>-4</sup> 1	o <sup>-₃</sup> ⊥	ADDITIONAL LAB. TESTING	INSTALLAT AND	
HLd	METI	ING P	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	GEOTECH NO.	ENV NO.	ТҮРЕ	LEVA		R STREN a	IGTH r	natV. + remV.⊕	Q - ● U - O	W			PERCE		DDITI B. TE	GROUNDWA OBSERVATI	ATER IONS
Ľ		BOR		STRA	(m)	GEOI	E		ш					00	vv	p ┣─── 5			WI 20	ΓA		
			GROUND SURFACE			Ŭ										Ĭ					<del>Top of Pipe</del> Elev. 15.95	
	0		Brown gravelly sandy CLAY/SILT with occasional cobbles - glacial till. (taken from driller's logs and inspection of arisings where possible)		0.00				15												Concrete for headworks	
12 DATA INPUT: היין ידיייייין יייייייין יייייין ייייייין יייייי	1 2 3 4 5 6 7	Rotary Cofing (Tritone method)	Hilled Civil Lid. (Dhilling Subcontractor relationed by BAM Civil Lid.)		10.55				14 13 12 11 10 9												Bentonite surround to solid pipe	
3DT 27/2/1									8												Sand	. 20%20 . 20%20
2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR_LDN.GDT 27/2/12 DATA INPU	8				- - - -				7												Gravel surround to solid pipe	
TALLATIONS.	9																				Gravel	
									6												surround to slotted pipe	
2 BRD				F																		
IASE	10		CONTINUED NEXT PAGE		5.55	$\vdash$		$\vdash$														Kalend .
AUGHINISH PF	DEI 1::		I SCALE	<u> </u>	<u>I</u>	I	<u> </u>			Ì	Go	lder	tes	<u>I</u>	1	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>	LOGGED: J CHECKED: F	

PROJECT:	Installation of Additional Observation Wells	RE
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2 AUGHINISH PHASE 2 BRDA OW INSTALLATIONS.GPJ GLDR\_LDN.GDT 27/2/12 DATA INPUT:

#### RECORD OF BOREHOLE OW 45

LOCATION: Ch 2650 approx. (east wall near ramp no. 4) Phase 2 BRDA

BORING DATE: 22 to 23/12/2010

SHEET 2 OF 2

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1     - Converse recommendation states     0 </td <td>SCA</td> <td></td> <td>MEI</td> <td></td> <td>LOT</td> <td></td> <td>Ň</td> <td></td> <td>VTI0</td> <td>2</td> <td>20 4</td> <td>40 6</td> <td>50 E</td> <td>30</td> <td>I I</td> <td><sup>6</sup> 10</td> <td>0<sup>-5</sup> 1</td> <td>0<sup>-4</sup> 1</td> <td>0<sup>-3</sup></td> <td>STIL</td> <td>AND</td> <td></td>	SCA		MEI		LOT		Ň		VTI0	2	20 4	40 6	50 E	30	I I	<sup>6</sup> 10	0 <sup>-5</sup> 1	0 <sup>-4</sup> 1	0 <sup>-3</sup>	STIL	AND	
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DEPTH SCALE METRES		BORING METHOD		STRATA PLOT	ELEV.	н	ш	BLOWS/0.3m		20	40	60				0-6	10 <sup>-5</sup>	10-4			ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATIC	
DEPTI		ORING	DESCRIPTION	RATA	DEPTH	NUMBER	TYPE	OWS	Cu, kł	Pa Pa	-NGTF	H na re	at V. + m V. ⊕	Q - ● U - O							ADDI LAB. 1	110mm	۱
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DEPTH SCALE METRES	BORING METHOD		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEA Cu, kF	R STRE 'a	NGTH	⊥ nat V. + rem V. €	30 · Q - • · U - O 30	w w	⊳ <b>⊢</b>	NTEN OW		NT	ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION 110mm
— o			Ground Surface								40		50			.0 .	30 4			
- 2 - 2 			Topsoil Broken Limestone	02020202020202020202020202020202020202	0.15	5														Concrete Plug
4 6 8 10	O'Driscoll	Air Rotary	Pale Grey Limestone		3.15															14/10/05 ∑ Riser with Gravel
- - - - - - - - - -		-	End of MONITORING WELL.		12.14	4														Gravel
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METRES		BURING ME	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEA Cu, kł	20 IR STRE Pa 20	40 ENGTH 40	60 nat V. rem V.	80 + Q - ● Đ U - ○ 80	w w	0 <sup>-6</sup> 10 ATER CO	PERCEN	NT MI	ADDITIONAL LAB. TESTING	standpip installatio 110mn	ON
0			Ground Surface	$\sim$	0.00															
			MADEGROUND comprising of broken limestone and concrete																Concrete Plug	
2			Broken Limestone		2.40															
4	O'Driscoll	Air Rotary	Pale Grey Limestone						÷										Riser with Gravel Screen with Gravel	
10			End of MONITORING WELL.		9.75	5														
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щ		дo	SOIL PROFILE			SA	MPI	ES	DYNA RESIS	MIC PE STANCE	NETRAT	ON 5/0.3m	$\boldsymbol{\lambda}$	HYDRA	ULIC Co k, cm/s	ONDUC	FIVITY,	Т	٦D	PIEZOMETER OR
DEPTH SCALE METRES		BORING METHOD		PLOT	ELEV.	۲.		0.3m					80	10			0 <sup>-4</sup> 10		ADDITIONAL LAB. TESTING	STANDPIPE
DEPTH ME		RING	DESCRIPTION	STRATA PLOT	DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEA Cu, kF	R STRE Pa	NGTH	nat V. ⊣ rem V. €	- Q - ● 9 U - O			ONTENT			ADDI <sup>-</sup> AB. T	110mm
		BO		STF	(m)	2		BLO	2	20	40	50	80	10			0 40			
0			Ground Surface Topsoil	114		_														
- - - - - - - - - - - - - - - - - - -	O'Driscoll	Air Rotary			0.15	5														Concrete Plug
- 8    - 10  			End of MONITORING WELL.		10.40	<u>,</u>														Screen with Gravel
BUCKEHOLE BUCKEHOLES LOGS OUI 2009.GFV GLUX CAN.GDI 3/11/09 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1																				-
DE		TH : 100	SCALE						Ø	G	olde socia	r <u>Mes</u>								GED: AS ED: RW

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	гнор	SOIL PROFILE		1	SA	MPL	_			NETRATI BLOWS		Z			ONDUC		Ţ	AL NG	PIEZOMETER	
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	түре	BLOWS/0.3m	SHEA Cu, kF	R STRE Pa	I NGTH r r	iat V. + em V.⊕	Q - • U - O	w w	ATER C		0 <sup>-4</sup> 10 PERCEN		ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION 110mm	N
0		Ground Surface		0.00	5															
		Broken Limestone	10000000000000000000000000000000000000	) ) ) – 1.50	D														Concrete Plug	
2 4	O'Driscoll Air Rotary	Pale Grey Limestone																	Riser with Gravel	
8 10 12																				
14	I	End of MONITORING WELL.		14.00	D															
16 18 20 DE 1 :																				
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		1		1						olde socia			I	<u> </u>	I				GED: AS	_

	٥	SOIL PROFILE			SA				I: -90°	NETRATI , BLOWS	ON	<u>۱</u>	HYDR	AULIC C	ONDUC	TIVITY,	т		PIEZOMETE	R
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	BER	TYPE	BLOWS/0.3m	SHEA Cu, kł	20 I R STRE Pa	40 6 L NGTH r r	60 8 ⊥ nat V. + rem V. ⊕	30 Q - • U - O 30	1 W	0 <sup>-6</sup> 1 /ATER C	0 <sup>-5</sup> 1 I ONTEN O <sup>W</sup>	10 <sup>-4</sup> 10 T PERCE		ADDITIONAL LAB. TESTING	or standpipe installatio 110mm	≣ DN
0		Ground Surface	<u><u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u></u>	0.00	0															
		Topsoil Broken Limestone	20000 20000 20000	0.60	)														Concrete Plug	
2 4 6 8 10 10	O UNSCOIL Air Rotary	Pale Grey Limestone		1.80															Riser with Gravel	
12 14 16		End of MONITORING WELL.		18.35	3														Screen with Gravel	

			No.: Aughinish Alumina J: Aughinish	R	ECC	R	D	OF				ING 13/10/0		LL:	W	7				HEET 1 OF 1 ATUM:	
			SOIL PROFILE			SA			IATION DYNA		NETRAT	ION	<u>\</u>	HYDR	AULIC C	ONDUC	TIVITY,	т		PIEZOMETER	
DEPTH SCALE METRES	BORING METHOD		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	BER	ТҮРЕ	BLOWS/0.3m	SHEA Cu, kF	20 R STRE 'a	40 I NGTH	60 I nat V. + rem V. ∉	B0 - Q - ● - U - ○ B0	w w	I IATER C p	0 <sup>5</sup> ONTEN ⊖ <sup>W</sup>	T PERCE		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION 110mm	
- 0			Ground Surface Topsoil	1 A L																80 <b>0</b> 1	899
- 2			Broken Limestone		0.15	5														Concrete Plug	
4 	O'Driscoll	Air Rotrary	Pale Grey Limestone		3.18															Riser with Gravel	
- - - - - - - - - - - - - - - - - - -			End of MONITORING WELL.		14.9	3	-													Screen with Gravel	
BOREHOLE BOREHOLES LOGS OCT 2005.GPJ GLDR CAN.GDT 3/1/05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0																					
DE DE 1	PTH : 10		CALE				•		Î	G	olde socia	r Ates						С		GED: AS GED: RW	

	JECT No.: Aughinish Alumina ATION: Aughinish	F	RECO	DR	D	OI			TOR DATE:			LL:	W	8				HEET 1 OF 1 ATUM:	
HOD F	SOIL PROFILE			S			DYNA RESIS		NETRATI , BLOWS	ON /0.3m	$\overline{\lambda}$	HYDR	AULIC C k, cm/s	ONDUC	TIVITY,	T	<sup>R</sup> F	PIEZOMETER OR	
DEPTH SCALE METRES BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV DEPTI (m)		TYPE	BLOWS/0.3m	SHEA Cu, kF	R STRE 'a	NGTH r	nat V. + em V. ⊕	Q - • U - O	w w	ATER C		0 <sup>-4</sup> 10 PERCEN		ADDITIONAL LAB. TESTING	STANDPIPE INSTALLATION 110mm	N
- 0 - 2 - 4 - 6 - 8	Ground Surface																	Concrete Plug	
· 12 · 14 · 16	End of MONITORING WELL.		18.1															Screen with Gravel	

			<sup>•</sup> No.: Aughinish Alumina N: Aughinish	R	ECC	RI	D	OF			<b>FOR</b> DATE:			LL:	WS	)				HEET 1 OF 1 ATUM:	
							IN	CLIN	NATION	-90°											
			SOIL PROFILE			SA	MPL	ES	DYNA RESIS	MIC PEI TANCE	NETRATI , BLOWS	ON /0.3m	$\overline{)}$	HYDRAU	JLIC CO k, cm/s	ONDUC1	TVITY,	T	<u>ں</u> ۔	PIEZOMETE	ΞR
	BORING METHOD			PLOT	ELEV.	R		0.3m			1	1	30	1 1	10 <sup>-6</sup> 10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup>				ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION	
	RING	2 NIX	DESCRIPTION	STRATA PLOT	DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEAI Cu, kP	R STRE a	NGTH nat V. + Q - ● rem V. ⊕ U - O		WATER CONTENT PERCENT					ADDI AB. T	110mm		
_	ă	í 		ST	(m)	-		B	2	0	40 6	60 8	30	10				0			
0		$\dashv$	Ground Surface Topsoil		0.15	5															Γ
	O'Driscoll	Air Rotary	Pale Grey Limestone																	Backfilled	
2	ō	Air																			
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			T No.: Aughinish Alumina NY: Aughinish	RE	ECO	R	) (	DF			' <b>ORI</b> DATE:			-L:	W	9a				HEET 1 OF 1 ATUM:	
							IN	CLIN	NATION	l: -90°											
	ç	2	SOIL PROFILE			SA	MPL		DYNA	MIC PE		ON /0.2m	)	HYDF	AULIC k, cm	CONDU	JCTIVITY	, т		PIEZOMETER	R
DEPTH SCALE METRES				LOT		2		.3m			40 60 80			1		10 <sup>-5</sup>	10-4	10 <sup>-3</sup>	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATIO	
EPTH MET		צואפ	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEA Cu, kł	R STRE Pa	NGTH	nat V. + rem V. €	Q - ● U - O			CONTE	NT PERC		ADDIT AB. TE	110mm	
	Č	2		STR	(m)	z		BLO		20	40 (	50 8	30		10	20	30	40			
0			Spoil Heap	$\boxtimes$	0.00	2											_				
2			MADEGROUND comprising of broken rock																	Concrete Plug	
	9 O'Driscoll Ali Deboo	Air Rotary	Pale Grey Limestone															Riser with Gravel			
-			Soft Brown Bedrock	Ż	11.00															i.	
- 12 - 12 - 14 - 14 - 16 - 18 - 20 DE			Pale Grey Limestone																	Screen with Gravel	
- - - - - - - - - 20			End of MONITORING WELL.		18.42	2															
DE 1 :			SCALE						Ć	G	olde socia	r Mes						(		ged: As (ed: RW	



Appendix 8.4: Geophysical Survey for the Permitted Borrow Pit (2017)

### Borrow Pit Design

(February 2017)



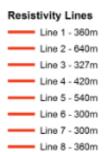




## **Aughinish: Location of Resistivity Lines**

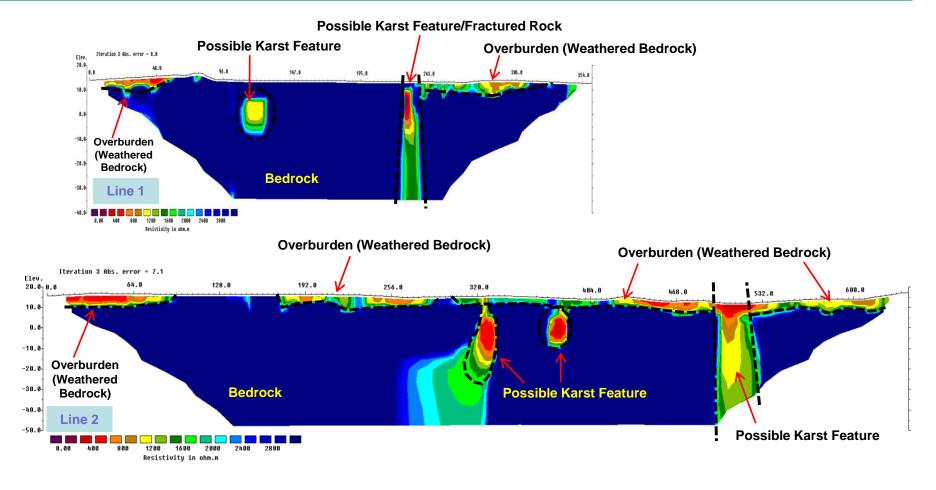


Lines 1 & 2 are from west to east - looking north Lines 3 & 4 are from south to north - looking west Lines 5, 6, 7 & 8 are from north to south looking east





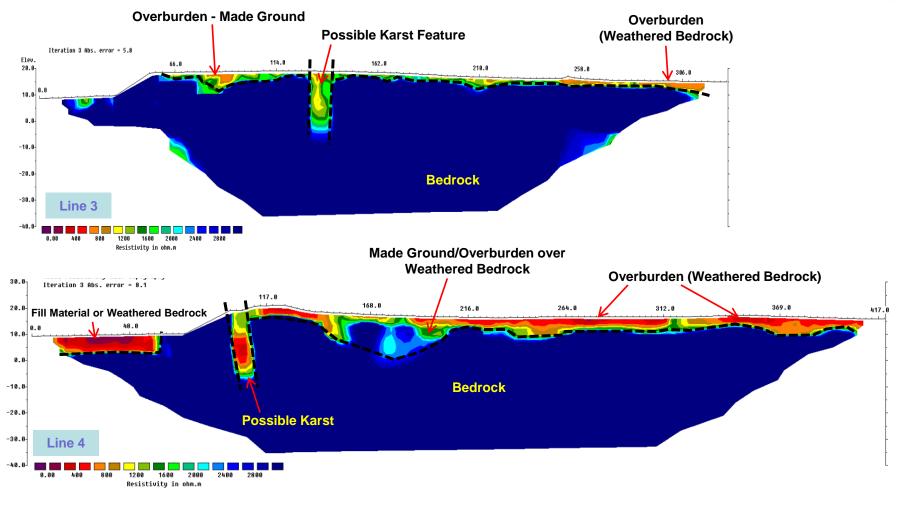
### Aughinish: Lines 1 & 2 (W-E, Looking North)



200 ohm metre contour intervals



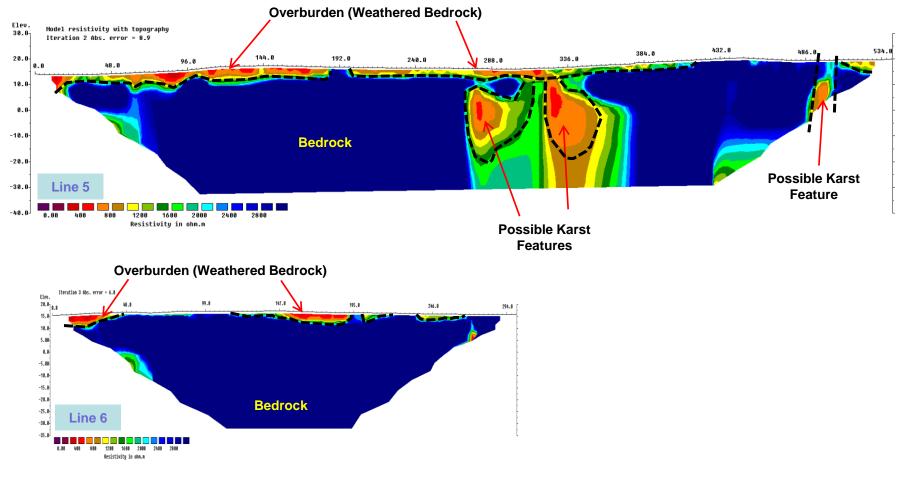
### Aughinish: Lines 3 & 4 (S-N, Looking West)



200 ohm metre contour intervals



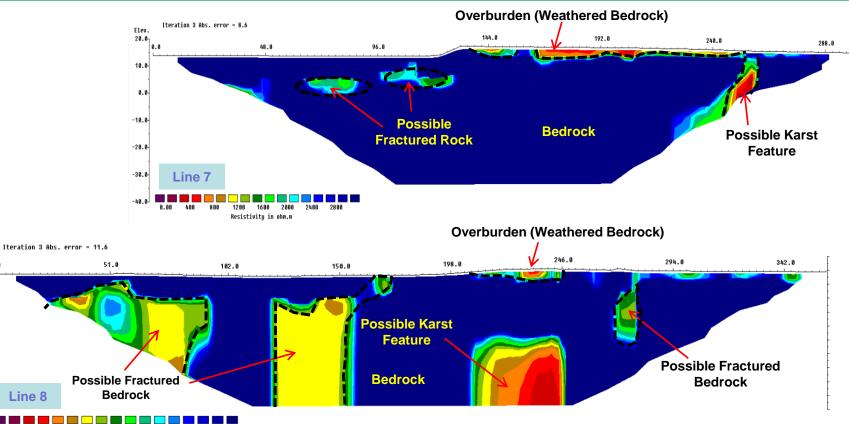
# Aughinish: Lines 5 & 6 (N-S, Looking East)



200 ohm metre contour intervals



### Aughinish: Lines 7 & 8 (N-S, Looking East)



1200 1600 2000 2400

Resistivity in ohm.m

2800

200 ohm metre contour intervals



Elev. 20.0

15.0 10.0 5.00 0.0

-5.00

-10.0 -15.0

-20.0

-25.0

-30.0

-35.0-

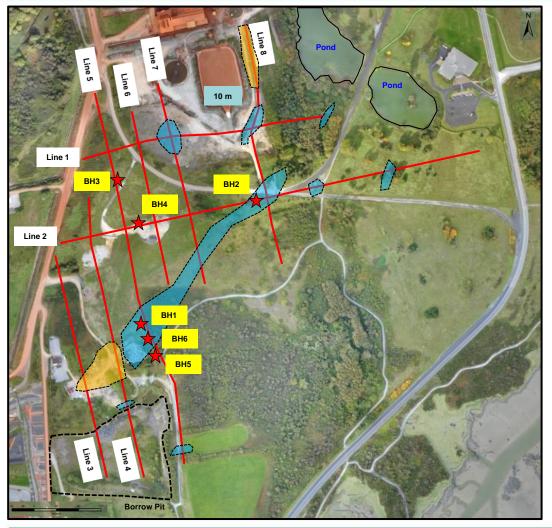
0.00

400

800

0.0

### **Aughinish: Karst & Fractured Bedrock**



### SUMMARY

- NE/SW trending area of possible karst trending towards/from the pond(s) to an area just north of the existing borrow area.
- The Resistivity Survey indicates that there may be a possible connection – conduit for water to flow between the ponds and the borrow area.
- The Resistivity Survey shows that most of the bedrock has an apparent resistivity of >2,000 ohm metres and can be expected to be of good quality. Where resistivity values are less than ca. 400 ohm metres, lesser quality rock, fractured rock and/or karst features can be expected. The significance of these features is often much smaller than area shown in the resistivity survey sections.
  - 6 BHs (**red star**) were drilled, with cavities encountered in BH1, BH2, BH3, BH5 & BH6



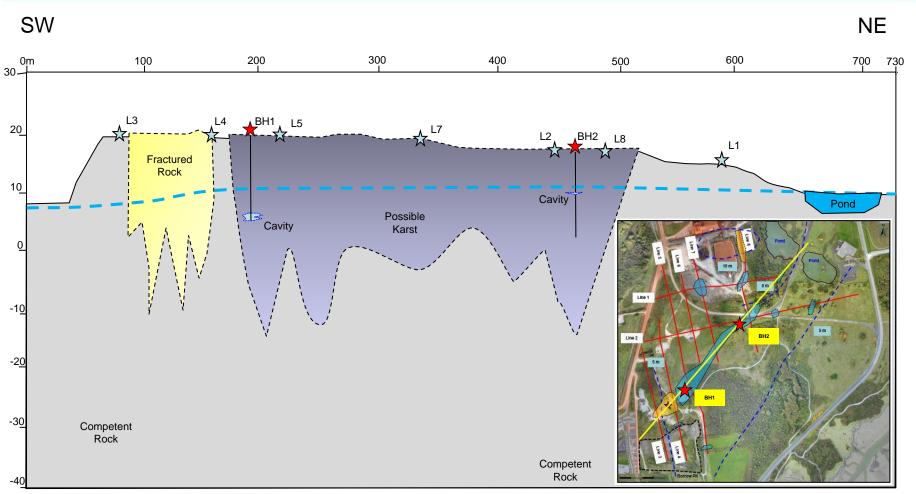
Possible karst feature

Possible fractured bedrock





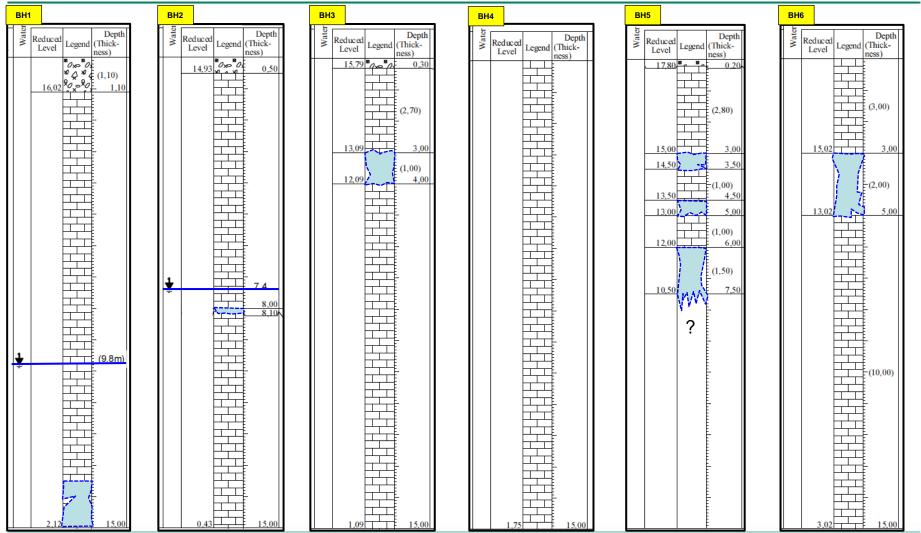
## **Cross Section Looking NW**







## **BH Logs (Cavities in Blue)**



BH5 was abandoned due to poor ground conditions

