

Natural Resources Wales

St Asaph FRMS (PAR) – Ground

Investigation 2014

Factual Report

January 2015

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1.0 INTRODUCTION

1.1 Instruction

WYG Environment Planning Transport Ltd (WYG) were commissioned by National Resources Wales (NRW) to undertake intrusive ground investigation work at the St Asaph Flood Risk Management Scheme (St Asaph FRM) site. Contract instructions to proceed were included in an email from Abbey Downing dated 22nd September 2014 (ref: IMWA001310).

1.2 Brief

The aim of the ground investigation is to provide sufficient ground information for an outline scheme design to inform the business case for a proposed flood defence improvement scheme (PAR). The flood defence scheme is likely to comprise raising and widening existing flood defence embankments and may also include the construction of new defences set-back from the river's edge.

The scope of the site investigation works was devised by NRW's Engineering Consultant, Black & Veatch and detailed in the St Asaph FRM Main GI – Works Package Order. In summary, the scope comprised the following key elements:

- 7 No. Cable percussive boreholes to a maximum depth of 10m.
- 18 No. Windowless sample holes with supplementary dynamic probe holes to a maximum depth of 5m.
- 8 No. mechanically excavated trial pits to a maximum depth of 4m.
- In situ testing including standard penetration tests, hand shear vane and falling head testing.
- Collection of disturbed and undisturbed soil samples
- Collection of groundwater samples
- Geotechnical and chemical laboratory testing of soil and groundwater samples.
- Preparation of a Factual Report.

1.3 Report Scope

This report summarises the work undertaken and includes the following key elements:



- Full factual records of the site works carried out
- Ground conditions encountered
- In-situ test results
- Geotechnical and chemical laboratory test results

1.4 Limitations

This report has been prepared in accordance with the requirements of National Resources Wales. It is subject to the report conditions contained in Appendix A.

The information contained in this report is intended for the use of National Resources Wales. WYG can take no responsibility for the use of this information by any third party or for uses other than that described in this report.

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2.0 SITE INFORMATION

2.1 Location

The site comprises the embankments that run along the eastern and western banks of the River Elwy as it flows south to north through the city of St Asaph. The National Grid Reference (NGR) for the northern extent of the site is 321560E, 191540Nand the NGR for the southern extent of the site is 325880E, 189080N.

2.2 Site description

Due to the scale of this urban site, individual investigation positions were located in a variety of environments, including: recreational grounds and sports fields; rural areas; public footpaths; river banks; and private land. Permission to access to local council sites, private properties and agricultural land was sought prior to the commencement of work by Natural Resources Wales.

2.3 Geology and Hydrogeology

The BGS geology mapping (one-inch to one-mile sheet 107 Denbigh) indicates the bedrock underlying the site comprises the Warwickshire Group, which includes mudstones, siltstones and sandstones. The Warwickshire Group is classified as a Secondary A Aquifer.

The published geology indicates that the bedrock is overlain by superficial deposits including Alluvium, Glaciofluvial deposits and Devensian till. The till is described as diamicton meaning poorly sorted deposits that contain a wide range of particle sizes. The Alluvium and Glaciofluvial deposits are also listed as Secondary A Aquifers.

The information provided as part of the Works package Order highlighted that made ground will also be present primarily comprising the materials used to construct the existing embankments.

There are no Source Protection Zones (SPZs) within a 1 km radius of the site. The groundwater vulnerability in the area is listed as being intermediate to high.



3.0 SITE INVESTIGATION

The site investigation was undertaken between the 6th and 17th October 2014. Details of the fieldwork methods used are given in the Notes section at the end of this report. The scope of the completed investigation is given below:

- 6 No. Cable percussive boreholes designated BH01 to BH05 and BH07 to depths ranging between 5.0 and 10.0m.
- 5 No. Machine excavated trial pits designated TP1 to TP6 to depths ranging between 1.0m to 2.1m.
- 18 No. Windowless sampling holes designated WS01 to WS18 to depths ranging between 1.0m to of 6.0m
- 4 No. Hand excavated pits designated HP04, HP07, HP08 and HP09.
- In situ testing including standard penetration tests, hand shear vanes and falling head tests.
- Collection of disturbed and undisturbed soil samples
- Geotechnical and chemical laboratory testing of soil samples

The following variations to the planned scope of works were agreed with the Engineer's representative during the fieldworks:

- BH06 was replaced with WS17 due to access constraints associated with the original position.
- The original position of WS17 was replaced with a hand excavated pit (HP09) due to access constraints.
- TP04, TP07 and TP08 were replaced with hand pits due to access constraints.

Figure 2 shows the layout of the exploratory holes advanced during the site investigation. Exploratory hole logs including photographic plates and sections of exposed structures are presented in Appendix B.



4.0 GROUND CONDITIONS ENCOUNTERED

4.1 Strata encountered

In order to provide a concise strata summary it is necessary to broadly group strata observation data according to investigation methods and investigation targets. Across the entire St Asaph FRM site the sequence of strata encountered can be generalised as:

- Topsoil,
- Made Ground (bund material),
- Made Ground
- Alluvium,
- Fluvio-glacial Deposits,
- Glacial Till

In the following tables GL denotes Ground Level, * indicates that the base of stratum was not proven, - denotes the strata was not encountered.

Five machine dug trial pits were advanced adjacent to the existing flood bund to identify the interface between the Alluvium and the Fluvioglacial Deposits.

Table 1: Summary of Strata for the Machine Pits

Pit	Topsoil	Made Ground	Alluvium	Fluvioglacial Deposits
TP01	GL - 0.30	-	0.30 - 0.40	0.40 - 2.10*
TP02	GL - 0.35	-	0.35 – 0.55	0.55 – 1.00*
TP03	GL - 0.30	-	0.30 - 0.60	0.60 - 2.00*
TP05	GL - 0.35	-	-	0.35 - 1.40*
TP06	GL - 0.30	0.30 - 1.20	1.20 – 1.50	1.50 – 1.90*

*Base of stratum not proven

Four hand dug pits were advanced to investigate the existing flood defence bund and flood defence measures; Table 2 provides a summary of strata encountered in these pits.



Table 2: Summary of Strata depths (m) for Hand Dug Pits

Pit	Topsoil	Made Ground (Bund material)	Made Ground
HP04	-	-	GL – 1.20*
HP07	-	-	GL – 1.20*
HP08	-	-	GL – 0.75*
HP09	GL – 0.05	0.05 – 0.84*	-

*Base of stratum not proven

Eighteen windowless sample boreholes were advanced to investigate the existing flood defence bund and adjacent ground conditions; Table 3 provides a summary of strata encountered in these pits.

Borehole	Topsoil	Made Ground (Bund material)	Made Ground	Alluvium	Fluvioglacial Deposits
WS01	GL – 0.15	0.15 – 1.95	1.95 – 3.10	3.10 - 4.00	4.00 - 5.00*
WS02	GL – 0.25	0.25 – 2.00	2.00 – 2.95	-	2.95 - 6.60*
WS03	GL-0.10	0.10 – 2.70	-	2.70 – 2.80	2.80 - 4.00*
WS04	GL – 0.20	0.20 – 2.80	2.80 - 4.30	4.30 - 4.40	4.40 - 6.00*
WS05	GL – 0.15	0.15 – 2.35	-	2.35 – 2.50	2.50 - 4.00*
WS06	GL – 0.05	0.05 – 2.20		-	2.20 - 3.00*
WS07	GL-0.10	0.10 – 2.60	2.60 – 2.80	2.80 - 3.50	3.50 - 4.00*
WS08	GL – 0.15	0.15 – 1.40	1.40 - 2.00	-	2.00 - 3.00*
WS09	GL – 0.15	0.15 – 2.00		-	2.00 - 3.00*
WS10	GL – 0.25	0.25 – 1.45	1.45 – 2.80	2.80 - 3.15	3.15 – 3.70*
WS11	GL – 0.20	0.20 – 2.05	2.05 – 3.50	-	3.50 – 4.00*
WS12	GL – 0.15	-	0.15 – 1.60	-	1.60 – 3.00*
WS13	GL – 0.20	-	0.20 - 1.10	-	1.10 – 2.00*
WS14	GL – 0.10	0.10 - 2.10	2.10 - 2.60 [#]	-	-
WS15	GL – 0.15	-	0.15 – 0.40	-	0.40 - 1.00*
WS16	GL – 0.10	-	0.10 - 1.40	1.40 - 1.50	1.50 – 2.00
WS17	GL – 0.20	0.20 – 2.00	2.00 – 2.20	2.20 – 2.25	2.25 – 2.70*
WS18	GL – 0.25	-	0.25 – 0.50	-	0.50 – 2.00*

Table 3: Summary of Strata depths (m) for Windowless Sample Boreholes

*Base of stratum not proven

[#]Window sample refused



Six cable percussion boreholes were advanced to investigate the existing flood flood bund and adjacent ground conditions; Table 4 provides a summary of strata encountered in these pits.

Table 4: Summary of Strata depths (m) for Cable Percussion Boreholes

Borehole	Topsoil	Made Ground (Bund material)	Made Ground	Alluvium	Fluvioglacial Deposits	Glacial Till
BH01	GL – 0.20	0.20 - 1.20	1.20 - 2.80	2.80 - 3.50	3.50 – 6.30	6.30 - 10.0*
BH02	GL-0.10	0.10 - 3.70	-	-	3.70 – 7.10	7.10 - 8.45*
BH03	-	-	GL – 0.40	0.40 - 0.70	0.70 – 3.40	3.40 - 5.00*
BH04	GL-0.10	-	0.10 - 2.40	2.40 - 3.40	3.40 - 4.10	4.10 - 5.45*
BH05	GL – 0.20	-	0.20 - 1.50	-	1.50 – 5.20	5.20 - 6.00*
BH07	GL – 0.20	-	0.20 - 2.00	-	2.00 - 4.90	4.90 - 6.00*

*Base of stratum not proven

Details of each stratum are discussed in the subsequent sections below.



4.1.1 Topsoil

Twenty nine investigation positions encountered topsoil. This is generally described as consisting of dark brown to red brown, slightly sandy silt. The topsoils are frequently described as containing subordinate gravel fractions and plant roots or rootlets.

4.1.2 Made ground – Bund material

Each window sample position (except for WS12, WS13, WS15, WS16 and WS18) encountered the flood bund material. It was generally described as soft to very stiff, brown silty slightly sandy to sandy clay with fine to coarse grained angular to sub-rounded gravels consisting of mainly subordinate mudstones, sandstones and siltstones.

4.1.3 Made ground

Almost every position encountered material described as made ground. There was a wide range of materials encountered in the made ground; on the drilling of a number of holes in the town centre areas of historic landfill were also encountered. The general made ground material found was described as brown and black clays, silts, sands and gravels of sandstone. Thirteen investigation positions (BH4, BH5, BH7, TP06, HP07, WS10 – WS17) encountered landfill material which is a highly variable mixture of black, brown, locally orange sandy with fine to coarse angular to sub-angular gravel and cobbles. The gravel and cobble material identified includes, but is not limited to ash; slag; building materials (including asbestos containing materials); ceramics; pottery; glass; metals; plastics and coal.

4.1.4 Fluvioglacial Deposits

Fluvioglacial Deposits were encountered in twenty eight positions. The base of the Fluvioglacial Deposits was only encountered within the cable percussive boreholes at depths of 3.4 to 7.10m bgl. The deposits are generally described as being brown, clayey, silty, sandy, rounded to angular sandstone and mudstone gravel with occasional cobbles. Densities of the granular Fluvioglacial Deposits, as determined from the SPT data, have been assessed as loose to very dense typically increasing with depth.

4.1.5 Glacial Till

Glacial Till was encountered in all cable percussion borehole positions during the investigation. The deposits consisted of red brown occasionally mottled grey silty sandy gravelly clay with gravels consisting of



subordinate sandstone, mudstone and siltstone. The strength of the cohesive Glacial Till, as determined from the SPT data, have been assessed as firm to hard typically increasing with depth.

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4.2 Groundwater

4.2.1 Groundwater during investigation

Groundwater strikes were recorded in all six boreholes occurring within the Fluvioglacial Deposits. No groundwater strikes were recorded in the windowless sample holes, trial pits or hand dug pits. The groundwater data is summarised in Table 5 below.

Position	Water strike (m bgl)	Residual water level (m bgl)	Time after strike (mins)	Strata
BH01	4.50	4.40	20	Fluvioglacial Depostis
BH02	4.80	4.60	20	Fluvioglacial Depostis
BH03	1.80	1.75	20	Fluvioglacial Depostis
BH04	3.50	3.20	20	Fluvioglacial Depostis
BH05	2.80	2.40	20	Fluvioglacial Depostis
BH07	3.40	3.30	20	Fluvioglacial Depostis

Table 5: Summarised Water Strike Data

4.2.2 Groundwater monitoring

In each of the boreholes groundwater monitoring leveloggers were installed within the monitoring pipes to provide accurate and continuous data on the groundwater levels. The first batch of data has been downloaded and is available on a CD in Appendix F. The table below summarises the data available.

Table 6: Summarised Water Monitoring Data

Position	Minimum groundwater level (m bgl)	Maximum groundwater level (m bgl)	Strata
BH01	4.18	4.37	Fluvioglacial Depostis
BH02	4.18	4.40	Fluvioglacial Depostis
BH03	Not in:	Fluvioglacial Depostis	
BH04	2.48	2.74	Fluvioglacial Depostis
BH05	1.95	2.11	Fluvioglacial Depostis
BH07	3.25	3.59	Fluvioglacial Depostis



4.3 In Situ Testing

4.3.1 Falling Head Testing

Soak away tests were conducted at the six cable percussive borehole positions. Testing at, BH04, BH05 and BH07 were abandoned as it was not possible to fill the hole with water due to a very high infiltration rate. A permeability test was not carried out in BH03 due to the presence of potential contamination in the Fluvioglacial Deposits. The results are presented in Table 7 below and the detailed data and calculations are included in Appendix C.

Table 7: Falling Head Results

Position	Test	Soil Infiltration Rate	Stratum	Depth of Casing	Depth of Borehole			
		(m/s)		(m)	(m)			
BH01	1	4.8 x 10 ⁻⁵	Fluvioglacial Deposits	4.00	4.50			
BH02	1	2.2 x 10 ⁻⁵	Fluvioglacial Deposits	3.00	4.80			
BH03	1	No Test Undertaken	Fluvioglacial Deposits	-	-			
BH04	1	Failed	Fluvioglacial Deposits	3.20	4.00			
BH05	1	Failed	Fluvioglacial Deposits	2.50	3.00			
BH07	1	Failed	Fluvioglacial Deposits	3.50	4.00			

4.3.2 Hand Shear Vane Testing

Hand shear vane testing was conducted on any cohesive material encountered during excavation. Table 8 summaries averaged shear vane results.

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Position	Depth (m)	Strata	Shear Strength (kN/m ²)	Remoulded Shear Strength (kN/m ²)
WS01	1.2	MG	98.0	22.0
WS01	1.85	MG	18.0	8.0
WS01	3.4	ALUV	55.0	18.0
WS02	0.5	MG	54.0	12.0
WS02	1.0	MG	78.0	10.0
WS02	1.5	MG	78.0	20.0
WS02	2.0	MG	52.0	6.0
WS02	2.5	MG	68.0	10.0
WS03	1.4	MG	50.0	8.0
WS03	1.8	MG	57.0	21.0
WS03	2.2	MG	80.0	30.0
WS03	2.5	MG	55.0	20.0
WS04	0.3	ALUV	8.0	2.0
WS05	1.4	MG	18.0	6.0
WS05	1.9	MG	48.0	4.0
WS05	2.4	MG	14.0	2.0
WS07	2.2	MG	13.0	5.0
WS07	2.6	MG	19.0	8.0
WS07	2.9	ALUV	19.0	8.0
WS07	3.2	ALUV	12.0	2.0
WS08	1.5	ALUV	110.0	30.0
WS09	1.5	MG	110.0	30.0
WS10	0.9	MG	105.0	28.0
WS10	2.9	ALUV	8.0	2.0
WS11	1.5	MG	110.0	30.0
WS17	0.2	MG	98.0	20.0
WS17	0.8	MG	28.0	10.0
WS17	1.2	MG	45.0	-
WS17	1.6	MG	45.0	15.0
WS17	1.9	MG	68.0	22.0

Table 8: Average Hand Shear Vane Results

4.3.3 Standard Penetration Testing

Standard Penetration Tests (SPT) were undertaken within the boreholes, the results are summarised in, presented on the borehole logs in Appendix B and plotted in Figure 3.

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5.0 LABORATORY TESTING

5.1 Geotechnical Testing

A programme of laboratory testing was carried out on samples taken from the various strata encountered during the site investigation. Geotechnical testing was scheduled by Arup and by GSTL Ltd, an approved supplier in accordance with the requirements of WYG quality system and are UKAS accredited for a range of geotechnical tests. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 8. Laboratory geotechnical test results are given in Appendix D.

Table 9: Summary of Geotechnical Tests

Test	Standard (BS1377:1990)	No
Moisture Content	Part 2, Clause 3.2	18
4 Point Liquid and Plastic Limit	Part 2, Clause 4.3 & 5.3	17
Particle Density by Pykonometer	Part 2, Clause 8.3	6
PSD Wet Sieve Method	Part 2, Clause 9.2	17
PSD: Sedimentation by hydrometer	Part 2, Clause 9.4	10
Quick Undrained Triaxial Compression Test 3:100mm	Part 8, Clause 7.0	3
diameter samples		
рН	Part 3, Clause 9.0	7
Sulphate Content of Acid Extract	Part 3, Clause 5.0	7
Sulphate Content of Water Extract	Part 3, Clause 5.0	7
Sulphide Content	Part 3, Clause 5.0	3
Constant Head Permeability Test		2

5.2 Environmental Testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected soil samples carried out by Jones Environmental Forensics Ltd, which is an approved supplier in accordance with the requirements of WYG quality system and is UKAS accredited for a range of chemical analyses. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 11. Due to the final schedule being received late by the laboratory some of samples have deviated. The test result certificates and any deviations are included in Appendix E.



Table 10: Summary of Environmental Testing

Test	No
Metals	10
PAHs	7
TPH CWG	7
EPH	7
PCB	1
Phenol	7
Water Soluble Sulphate	1
Total Sulphate	1
рН	10

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NOTES

1. Standards

All boring operations, sampling of soils, *in situ* testing and geotechnical laboratory testing have been carried out in accordance with the recommendations of the British Standards BS 5930+A2 $(2010)^{(1)}$, BS 1377 $(1990)^{(2)}$ and BS10175 $(2001)^{(3)}$.

Soil and rock descriptions follow the recommendations of BS 5930+A2. Where descriptions or classifications are based on other documents (e.g. BS 8004 (1986) or CIRIA Project Report 11 (1993)), this is stated in the report text.

2. Site methods

Unless specifically stated otherwise, the following methods are used for exploratory holes.

- Holes described as cable percussive are bored using a light cable percussive rig. Standard penetration tests are carried out
 where appropriate, as shown in the logs. Disturbed and undisturbed samples are taken from the exploratory holes at the depths
 on the records.
- Window sampling generally uses the windowless sampling method, using a tracked Geotool.
- Dynamic probes are usually heavy dynamic probes, using the same tracked Geotool used for window sampling.

3. Definitions and abbreviations

The following terms are used in the exploratory hole logs **Samples**

U	Undisturbed 102mm dia. sample										
TW	Thin Walled undisturbed 102mm dia. sample										
В	ulk sample										
D	Small disturbed sample										
W	Water sample										
CBR	California Bearing Ratio test or CBR value										
	obtained from Mexiprobe test										
Core reco	overy and rock quality										
TCR	Total core recovery (%)										
SCR	Solid core recovery (%)										
00.0	Rock quality designation (%)										
RQD	Rock quality designation (%)										
RQD FI	Rock quality designation (%) Fracture index										
RQD FI NR	Rock quality designation (%) Fracture index No recovery										
RQD FI NR NI	Rock quality designation (%) Fracture index No recovery Not intact										
RQD FI NR NI Water sti	Rock quality designation (%) Fracture index No recovery Not intact rikes										
RQD FI NR NI Water stu	Rock quality designation (%) Fracture index No recovery Not intact r ikes Level of water strike										

Remarks at foot of log for details)

In situ	tests
S	Standard penetration test (SPT)
Ν	SPT N value (blows/300mm)
HP	Hand penetrometer – shear strength
SV	Hand shear vane – shear strength
VOC	Volatile organic compounds (ppm)
PID	Photo-ionisation detector - used to detect the presence of
	VOCs.

Rotary drilling sizes

	Nor	ninal diameter (mm)
Index letter	Borehole	Core
N	75	54
Н	99	76
Р	120	92
S	146	113

Depth means depth below existing ground level unless otherwise specified. Values specified in soil descriptions given in the exploratory

hole logs are depths unless otherwise specified.

St Asaph FRM



Figures

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Appendices

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Appendix A – Report Conditions

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APPENDIX A - REPORT CONDITIONS

GROUND INVESTIGATION

This report is produced solely for the benefit of Natural Resources Wales and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the site.

This report is based on a visual site inspection, reference to accessible referenced historical records, information supplied by those parties referenced in the text and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented as the best that can be obtained without further extensive research. Where ground contamination is suspected but no physical site test results are available to confirm this, the report must be regarded as initial advice only, and further assessment should be undertaken prior to activities related to the site. Where test results undertaken by others have been made available these can only be regarded as a limited sample. The possibility of the presence of contaminants, perhaps in higher concentrations, elsewhere on the site cannot be discounted.

Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categoric assurances that they will be accepted by Authorities or Funds etc. without question as such bodies often have unpublished, more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to WYGE. In time improved practices or amended legislation may necessitate a re-assessment.

The assessment of ground conditions within this report is based upon the findings of the study undertaken. We have interpreted the ground conditions in between locations on the assumption that conditions do not vary significantly. However, no investigation can inspect each and every part of the site and therefore changes or variances in the physical and chemical site conditions as described in this report cannot be discounted.

The report is limited to those aspects of land contamination specifically reported on and is necessarily restricted and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents. The opinions expressed cannot be absolute due to the limitations of time and resources imposed by the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contamination (past or present) exists further extensive research will be required before the effects can be better determined.

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December 2014



Appendix B – Exploratory Hole Logs, Sketches and Photographs

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WYG ENV Ground Engin	IRONMENT neering Services	Borehole Number BH1							ber	wg.	
5th Floor, Longcross Tel: 02920 2082 920	Court, 47 Newport Road, Cardiff, CF24 0AD. 0, Fax: 02920 2045 5321.						F	inal			00
Project	: St Asaph FRM		Но	ole In	format	ion		Sci	ale	1:50	Sheet 1 of 1
Project Number Client	: A089434 : Natural Resources Wales	From 0.00m	To 1.20m	Ha	Method and Tools	Dia	– Logged By : NEB Checked By : CBP			NEB CBP	
Method Co-ordinates	Cable Percussive Rig Ground Level 303170.14E - 375069.41N : 12.91m AOD	1.2011	10.0011	Cable	reicussive	кig	13011111	Star Finis	rt Date : 07/3 ish Date : 08/3		07/10/14 08/10/14
		Legend	Reduced Level	Depth (m)	Casing (m)	Wate Leve	r Installa Back	tion/ fill De	Sar	mpling 8	In Situ Testing
Red brown silty CL	AY with many roots and rootlets (TOPSOIL)		(IIIAOD) 12.71	0.20		(11)		0.00	-0.20 05	B D B	
Dry and friable bro fine to medium sul GROUND)	wn silty slightly gravelly CLAY. Gravel of p-rounded to rounded sandstone (BUND - MADE		12.41	- - 0.50 -				0.50 0.50 0.50	20 - -1.20 - -1.00 - 50 -	ES B D	
Brown silty slightly rounded sandstone GROUND)	gravelly CLAY. Gravel of fine angular to e, mudstone and brick (POSSIBLE BUND - MADE		11.71	 				1.20	- - - 1.65 -	- - - -	Bobbow& for 400mm
Red brown silty sat rounded sandstone	ndy very gravelly CLAY. Gravel of angular to e, mudstone and brick. (MADE GROUND)			-				1.70	-2.00 -	B D	
				-				2. 2.00	-2.50 -	S ES	N=13 (1,2,3,3,3,4)
			10.11	_ _ _ _ 2.80				2.	50 - - -	D	
Firm brown clayey	sandy SILT (ALLUVIUM)	× × × × × × × × × × × × × × × × × × ×	č	-				3. 3.00		S B	N=28 (3,3,6,6,6,10)
Dense brown silty	sandy rounded to angular fine to coarse	XXXX	9.41	3.50				з.	- 50 - -	- D	
mudstone and san	dstone GRAVEL (FLUVIO-GLACIAL DEPOSITS)							4. 4.00	- 00 -4.50 -	S B	N=49 (10,7,9,14,13,13)
Medium dense bro	wn sandy angular to rounded fine to coarse		8.41	- - 4.50 - -		[4 <u>.4</u> 4.5	ð	4. 4.	- 50 - 50 -	- W - D	
DEPOSITS)				-				5. 5.00	 00	S B	N=28 (13,12,8,8,6,6)
				-				5.	50 - - -	- D	
			6.61	- - 6.30				- 6. 6.00	-00	S B	N=17 (4,3,4,2,3,8)
Stiff red brown sar medium rounded t	dy very gravelly CLAY. Gravel of fine to o sub-rounded sandstone. (GLACIAL TILL)			- - - -				6.	50 - - - -	- D	
			F 41	- - -				7. 7.00	 00	S B	N=46 (6,7,9,10,13,14)
Very stiff red brow to medium rounde	n sandy very gravelly CLAY. Gravel of fine d to sub-rounded sandstone. (GLACIAL TILL)		5.41	 				7.	50 - - -	D	
				-				8.00	JO	B	50/295mm (8,9,10,11,14,15)
				-				8.	50 - - - -	D	
				- - -				9. 9.00	.00 -9.50 - -	B	N=46 (7,8,10,10,12,14)
			2.91	- - - - 10 00	10.00m			9.	50	- D	
	Borehole complete at 10.00 m bal.	دا شریب ا			150mm			10	.00	s	N=49 (3,7,10,11,14,14)
Observations / F	Remarks.	From	Chise	elling		\dashv	Struck	Gro Rising	ounc to T		Remarks
 Groundwater observing second day. Backfilled with bento gravel surround from surround from 4.00n Falling head test conditional second seco	ed at 4.5m bgl, rising to 4.4m bgl. At 4.3m bgl at start of nite from 10.0m bgl to 6.00m bgl, 50mm slotted pipe with 6.00m bgl to 4.00m bgl, 50mm plain pipe with bentonite h bgl to ground level. ducted within borehole.	4.30m 5.00m 7.00m	4.50m 5.40m 7.50m	30 min 60 min 60 m m	ns ns nins		4.50m	4.40m	1	<u>(mins)</u> 20	incention ins
				1							

Ground Engi	IRONMENT neering Services						Borehole Number BH2					wg.	
5th Floor, Longcross Tel: 02920 2082 920	Court, 47 Newport Road, Cardiff, CF24 0AD. 0, Fax: 02920 2045 5321.					ŀ		F	inal			00	
Project	: St Asaph FRM			Но	le Inf	ormat	ion		Sca	le 1:5) Shee	t 1 of 1	
Project Number Client	: A089434 : Natural Resources Wales		From 0.00m 1.20m	To 1.20m 8.00m	Ha Cable F	Method and Tools	Ria	Diameter - 150mm	Logge Check	dBy : edBy :	NEB CBP		
Method Co-ordinates	: Cable Percussive Rig Grou : 303240.96E - 375069.32N : 13.	und Level .17m AOD	1.2011	0.0011	Cubic 1	cicussive	rug	1501111	Start Finish	Date : Date :	09/10/14 09/10/14	L L	
			Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installat Backt	ion/ ill Dep	Sampling th Type Number	& In Situ Te	esting	
Brown clayey sand	ly gravelly SILT with many roots and rootlets	;	****	13.07	_ 0.10 _				0.00-0 0.05 0.10-1 0.10	10 B D 20 B D			
Soft to firm brown	silty sandy gravelly CLAY. Gravel of fine to		****	{					0.50-1				
medium sub-angul and brick (BUND -	ar to rounded sandstone, siltstone, mudston MADE GROUND).	ie		~	-								
				2	-				1.20-1		Blows=44		
				>	-					-			
				8	_				1.70-2 1.70-2 1.70				
				>	-				2.00-2	45	Blows=37		
				>	-				2.50-3	- - - в			
					-								
					-				3.00-3	45	Blows=45		
					-				3.50	- - - D			
Dense to medium	dense brown clayey silty sandy rounded to		<u> </u>	9.47	- - -				3.70-4	00 — В			
sub-rounded muds (FLUVIO-GLACIAL	stone and sandstone GRAVEL & COBBLES DEPOSITS)				-				4.00 4.00-4	50 _ S	N=31 (8,8,8,6,	9,8)	
					-		-		4.50	- - - D			
					-		4.60		4.80	- - w			
					-		4.00		5.00 5.00-5	50 _ B	N=13 (5,6,3,3,	4,3)	
					_				5.50				
					-					-			
					-			三旦	6.00 6.00-6	- S 50 - B	N=18 (4,4,6,4,	4,4)	
					-				6.50	- - - D			
					-					-			
Chiff and have a				6.07	- 7.10				7.00 7.00-7	- s 50 - B	N=28 (3,3,6,6,	3,8)	
rounded to sub-an	gular sandstone and mudstone. (GLACIAL TI	ILL)		c.	_				7.50				
				6	-					-			
				c c	- -	8.00m 150mm			8.00 8.00-8	45 _ D	N=18 (3,4,4,5,	4,5)	
	Boroholo complete at 9.45 m bol			4.72	- - 8.45 -					-			
	Borenoie complete at 6.45 m bgi.				-					-			
					-					-			
					-					-			
Observations ()	Pomorka			Chico					Gree		r		
Inspection Pit hand e Groundwater observer	excavated to 1.2m bgl prior to drilling. ed at 4.8m bgl rising to 4.6m bgl. At 4.5 at start of secon	nd	From	To	Time			Struck	Rising to	Time (mins)	Rer	narks	
 day. Backfilled with bento gravel surround 6 00 	nite from 8.00m bgl to 6.00m bgl, 50mm slotted pipe with	th round	4.50m 6.50m	5.00m 7.00m	60 mir 60 m m	ins		4.80M	4.60M	20	Se	shind	
from 4.00m bgl to g 4. Falling head test und	ound level. Jertaken within borehole.												
										1			

WYG ENVIRONMENT Ground Engineering Services					Bo	oreho E	nber	wyg.		
Sth Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD. Tel: 02920 2082 9200, Fax: 02920 2045 5321.						F	inal		00	
Project : St Asaph FRM		Ho	le In	format	ion		Scal	e 1:50	Sheet 1 of 1	
Project Number : A089434 Client : Natural Resources Wales	From 0.00m	To 1.20m	Ha	Method and Tools	Pig	Diameter -	Logge Check	Logged By : NEB Checked By : CBP		
Method : Cable Percussive Rig Ground Level Co-ordinates : 303452.00E - 374800.09N : 11.85m AOD	1.2011	5.0011		cicussive	Ng	13011111	Start I Finish	ate : Date :	13/10/14 13/10/14	
	Legend	Reduced Level	Depth (m)	Casing (m)	Water Level	Installat Back	tion/	Sampling &	In Situ Testing	
Grey sandy coarse angular limestone GRAVEL. (MADE GROUND)	****	(IIIAOD)	-		(11)		0.00-0.4	0 B D		
Grey clayey sandy SILT. (ALLUVIUM)		11.45	- 0.40				0.40-1.0	0 - B D		
olfactory hydrocarbon contamination		11.15	- 0.70				0.50	-		
sub rounded to rounded fine to coarse sandstone, mudstone,			-				1.00-1.2	- в - D		
SILSIONE. (FLUVIO-GLACIAL DEPUSITS)			_				1.20	0 _ B	N=22 (2,5,7,6,5,4)	
			E		[1]		1.70 1.70	w		
below 2.0m bal becoming very clavey with no			-		1.80		1.70 2.00 2.00-2.5	_ D _ S 0_ B	N=17 (4,10,5,5,3,4)	
cobbles.			-					-		
			-				2.50	- D -		
			-				3.00	s	50/179mm (6,12,33,15,2)	
		8.45	3.40				3.00-5.3			
Stiff to hard red brown slightly silty sandy very gravelly CLAY. Gravel fine to coarse rounded to sub-angular sandstone		e e	E				3.50	D		
and mudstone. (GLACIAL TILL)			E				4.00	_	50/283mm (4 10 12 15 14 9)	
			-				4.00-4.5	о В 	50/205mm (4,10,12,13,14,5)	
		1		4.50m 150mm			- 4.50	- D		
		6.85	-					-		
Borehole complete at 5.00 m bgl.	Charles 1	_	-				5.00 5.00-5.3	1 D -	50/164mm (3,11,17,27,6)	
			-					-		
			Ē							
								_		
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			Ē							
			-					-		
Observations / Remarks.		Chise	elling				Grou	ndwater		
 Inspection Pit hand excavated to 1.2m bgl prior to drilling. Groundwater observed at 1.8m Hole hackfilled with bantonite 	From 3.00m	To 3.50m	Time 60 mir	ıs		Struck 1.80m	Rising to 1.70m	(mins)	Remarks	

WYG ENVIRONMENT Ground Engineering Services					Borehole Number BH4					wyz.	
Sth Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD. Tel: 02920 2082 9200, Fax: 02920 2045 5321.						F	inal			00	
Project : St Asaph FRM	Erom	Ho	le Inf	format	ion	Diamotor	Sc	ale 1:5	50 SI	neet 1 of 1	
Project Number : A089434 Client : Natural Resources Wales	0.00m 1.20m	1.20m 5.00m	Ha Cable P	and Tools Percussive	Rig	- 150mm	- Log Che	iged By ecked By	: NEB : CBP	0/14	
Method : Cable Percussive Rig Ground Level Co-ordinates : 303529.73E - 374529.68N : 14.09m AOD							Fini	ish Date	: 16/:	10/14 10/14	
	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installa Back	tion/ fill D	Sampling Pepth Type Numbe	g & In S ≝_	itu Testing	
Dark brown clayey sandy SILT with many roots and rootlets (TOPSOIL)	****	13.99	0.10				0.0	00-0.20 B 0.05 D 0-1.00 B 0.10 D			
Brown cobbly angular to sub-angular sandstone and mudstone			-					-			
GRAVEL. (MADE GROUND)		13.09	-					-			
Very loose black clayey slightly sandy angular fine ash, brick,			-				1.0	00-1.20 B 1.00 D 1.20 S	N=2 (1	,0,0,1,0,1)	
			-				1.2	20-1.70 _ B			
			-					-			
							2.0	2.00 - S 00-2.50 B	N=7 (1	,1,1,1,3,2)	
Soft light brown slightly gravelly SILT. Gravel of fine angular		11.69	2.40					2.50 - D			
sandstone. (ALLUVIUM)	K-X,X-X X X X X X K-X,X-X		-					-			
	x x x x x x x x x x x x x x x x		-		-		3.0 3.0		810blev	NB - No Recovery	
	× × × × ×	10.69	- - 3.40		[3.20 ▽			-			
sub-rounded GRAVEL & COBBLES. (FLUVIO-GLACIAL DEPOSITS)	0.0.0		-		3.50			3.50 - W 3.50 _ D			
		9.99	4.10			W	4.0	4.00 - S 10-4.50 - B	50/177	'mm (6,13,6,6,38)	
Stiff red brown silty slightly sandy gravelly cobbly CLAY. Gravel and cobbles of rounded to sub-rounded sandstone.			-					-			
(GLACIAL TILL)			-					4.50 — D —			
			-					5.00 — s	50/231	mm (9,8,14,17,17,2)	
		8.64	- - -					-			
Borehole complete at 5.45 m bgl.			-					-			
			-					-			
			-					-			
			-								
			-					-			
			-					-			
			-					-			
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			-					-			
			-					-			
			-					-			
			-								
			-					-			
Observations / Remarks		Chice					6	roundwat	er		
Inspection Pit hand excavated to 1.2m bgl prior to drilling. Groundwater observed at 3.5m bgl.	From	To	Time	15		Struck	Rising	to (mins))	Remarks	
 Backfilled with bentonite from 5.0m bgl to 4.00m bgl, 50mm slotted pipe with gravel surround from 4.00m bgl to 3.50m bgl, 50mm plain pipe with bentonite surround from 3.50m bgl to ground level. 	1.5011	5.0011				5.5011	5.20	20		Seeping	
4. Falling head test conducted within borehole.											

WYG ENVIRONMENT Ground Engineering Services					Borehole Number BH5				wa.
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD. Tel: 02920 2082 9200, Fax: 02920 2045 5321.						F	inal		00
Project : St Asaph FRM		Нс	ole Inf	format	ion		Scal	e 1:50	Sheet 1 of 1
Project Number : A089434 Client : Natural Resources Wales Method : Cable Percussive Rig Ground Level	From 0.00m 1.20m	To 1.20m 6.00m	Ha Cable F	Method and Tools Percussive	Rig	Diameter - 150mm	– Logged Checke Start D Finish	By : dBy : ate : Date :	NEB CBP 15/10/14 16/10/14
CO-Ordinates . 303433.02L - 374333.00N . 13.22m AOD	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installat Backt	ion/ fill Dept	ampling 8	In Situ Testing
Dark brown slightly sandy SILT with many roots and rootlets.		13.02	0.20		()		0.00-0.2 0.10 0.20-1.0) _ B) _ D) _ B	
Brown and black slightly silty slightly sandy very cobbly fine to coarse, angular GRAVEL of brick and coal with tile, glass and metal fragments. (MADE GROUND)							1.00-1.2 1.00 1.20 1.20-1.7	D 	50/288mm (2,4,6,13,24,7)
Medium dense becoming dense brown slightly silty slightly sandy rounded to sub-rounded sandstone and mudstone GRAVEL with		11.72	- 1.50 - - -				1.70	- - - - D	
occasional cobbles. (FLUVIO GLACIAL DEPOSITS). gravel and cobbles layer at 2.0m bgl to 2.5m bgl.		1. N. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.			2.40		2.00 2.00-3.0	- S - B 	N=18 (11,6,5,4,4,5)
	가지 않는다. 가지 않는다. 가지 않는다.				2.80		3.00 3.00-4.0	- - - - - - - -	N=27 (5,7,6,5,7,9)
cobble layer 3.8m to 4.0m		1					4.00 4.00-4.4	- s - D - D 	50/253mm (5,12,13,17,14,6)
		8.02	- - - 5.20				5.00 5.00-5.4	- s 2 D	50/273mm (4,9,10,10,11,19)
Stiff red mottled grey brown silty gravelly CLAY with occasional sandstone cobbles. (GLACIAL TILL)		7.22	-	6.00m					
Borehole complete at 6.00 m bgl.			-	150mm			6.00-6.2	5 _ D -	50/135mm (12,13,26,24)
Observations / Remarks.		Chise					Grou		
 Inspection Pit hand excavated to 1.2m bgl prior to drilling. Groundwater observed at 2.80m bgl, rising to 3.2m bgl. At 3.2m bgl at start of 	From	To	Time	20		Struck	Rising to	Time (mins)	Remarks
 Backfilled with bentonite from 6.00m bgl to 4.00m bgl, 50mm slotted pipe with gravel surround from 4.00m bgl to 2.50m bgl, 50mm plain pipe with bentonite surround from 2.50m bgl to ground level. Falling head test conducted within borehole. 	2.50m 3.50m 5.50m	3.00m 4.00m 6.00m	60 mir 60 mir 60 m m	is ins		2.80m	2.40m	20	seeping

WYG ENVIRONMENT Ground Engineering Services					В	oreho E	le Num S H7	ber	wga.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.						F	inal		00
Project : St Asaph FRM	From	Ho	le Inf	format	ion	Diamatan	Scale	1:50	Sheet 1 of 1
Project Number : A089434 Client : Natural Resources Wales Method : Cable Percussive Rig Ground Level Co-ordinates : 303502.12E - 374218.29N : 15.27m AOD	0.00m 1.20m	1.20m 6.00m	Ha Cable P	Method and Tools Percussive	Rig	- 150mm	Logged I Checked Start Da Finish Da	By : M By : C te : 1 ate : 1	IEB 3BP 4/10/14 5/10/14
	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installat Back	ion/Sa ill Depth	Type Number	In Situ Testing
Red brown slightly sandy SILT with many roots and rootlets.	~~~~~	15.07	0.20				0.00-0.20 0.10 0.20-0.40 0.20	B D B D	
Brown orange clayey silty sandy angular brick, sandstone, ash GRAVEL & COBBLES (MADE GROUND)		14.07	_ 0.40 _ _ _				0.40-1.20	B D	
Firm to stiff red brown slightly sandy slightly gravelly CLAY. Gravel of fine to coarse angular to rounded brick, sandstone, coal and ash. (MADE GROUND)		13.27					1.20-1.65 1.70-2.00 1.70	- U 9	b eliswe , 300mm recovered
Dense brown clayey silty sandy GRAVEL of fine to coarse sub-rounded to rounded sandstone and mudstone. (FLUVIO GLACIAL DEPOSITS)		13.27	2.00 - - - - - -				2.00 — 2.00-2.50 — 2.50	S N	=38 (4,6,5,9,12,12)
			-		[3.30] \ 3.60		3.00 3.00-3.50 3.50	S N B D	=17 (4,5,7,3,3,4)
			-				4.00 - 4.00-4.50	B B	=50 (10,11,10,9,21,10)
Stiff red brown mottled grey silty sandy gravelly CLAY. Gravel of fine to coarse rounded to sub-rounded sandstone and mudstone. (GLACIAL TILL)		10.37	- - - - - - - - - - - - - - - - - - -				4.90 5.00 — 5.00-5.50 5.50		=28 (2,5,5,6,7,10)
Borehole complete at 6.00 m bgl.		5.21	6.00	6.00m 150mm			6.00-5.45 6.00-5.45		=20 (3,3,4,4,6,6)
Observations / Remarks.	F	Chise	elling			Church	Groun	dwater Time	Demonto
 Inspection Pit hand excavated to 1.2m bgl prior to drilling. Groundwater observed at 3.6m bgl, rising to 3.3m bgl. At 3.6m bgl at start of second day. Backfilled with bentonite from 6.00m bgl to 4.50m bgl, 50mm slotted pipe with gravel surround from 4.50m bgl to 3.00m bgl, 50mm plain pipe with bentonite surround from 4.00m bgl to ground level. Falling head test undertaken in borehole. 	From 2.50m 4.00m	To 3.00m 4.50m	Time 60 mir 60 mir	าร		Struck 3.60m	Rising to 3.30m	(mins) 20	Remarks



part of the WYG group

Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Window Sample / Probe Number WS01

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Sheet 1 of 1

Scale 1:50 Tel: 02920 829 200. Email: admin.cardiff@wyg.com Project: St Asaph FRM Client: Natural Resources Wales Easting: **303244.86** Northing: **375343.14** Ground Level: 12.174 Method: Windowless Sampler and Super Heavy Dynamic Probe Wate Strike Depth Readings Remarks Dept Depth mpl Description 10 15 20 25 30 35 40 Level (m) 5 45 (m) (m) (m) Blows / 100mm (m) (m) 3 Grass over brown silty CLAY with rootlets. 12.02 0.15 0.20-1.00 В 3 3 (TOPSOIL). Very stiff brown slightly sandy CLAY. (BUND -MADE GROUND). <u>4</u> <u>3</u> ES 0.50 3 1.0 SV s = 98kPa 1.50-1.95 В . . . at 1.5mbgl, becoming softer and drier/friable with depth. SV s = 18kPa10.22 1.95 2.00-3.00 В 2.0 Dark brown silty slightly gravelly fine to medium SAND. Gravel is fine to coarse, sub-rounded to rounded of sandstone. (MADE GROUND). 3 3 3 3.0 5 3 9.07 3.10 3.10-3.50 в Firm reddish brown silty CLAY. (ALLUVIUM). SV s = 55kPa 2 8.67 3.50 3.50-4.00 В Soft dark grey CLAY. (ALLUVIUM). 2 8.17 4.00 4.0 4.00-5.00 В 3 2 Brown grey sandy fine to coarse, sub-rounded to rounded GRAVEL of 2 3 sandstone. (FLUVIO-GLACIAL 5 4 DEPOSITS) 7 16 <u>6 10</u> 7.17 5.00 5.0 6.0 7.0 8.0 9.0

Remarks: mpling Ru PROJECT NO. A089434 Dyn Fall Height: 750mm From Diameter Recove Hand excavated pit to 1.20m bgl prior to drilling.
 No groundwater encountered.
 Backfilled with arisings. GC Logged by: 1.20m 2.00m 3.00m 4.00m 2.00m 3.00m 4.00m 5.00m 87mm 77mm 67mm 57mm 100% 100% 100% 100% Hammer Wt 63.50kg СВР Checked by: Probe Type DPSH Release Status: Final Cone Size: 50mm Excavation Date: 13/10/2014



part of the **WYG** group

Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Tel: 02920 829 200. Email: admin.cardiff@wyg.com Window Sample / Probe Number **WS02**

Sheet 1 of 1

Scale 1:50 Project: St Asaph FRM Client: Natural Resources Wales Easting: **303110.17** Northing: **375251.91** Ground Level: 12.200 Method: Windowless Sampler and Super Heavy Dynamic Probe Wate Strike Depth Readings Remarks Dept Inst Depth mpl Description Level (m) 10 15 20 25 30 5 35 40 45 (m) (m) (m) (m) Blows / 100mm (m) 3 Grass over brown silty CLAY with rotlets. 1.95 0.25 3 3 (TOPSOIL) 0.35 ES Stiff to firm brown mottled grey and orange CLAY with occasional gravel. (BUND - MADE GROUND) 3 SV s = 54kPa 0.50-1.00 В 1.0 SV s = 78kPa 1.20-2.90 В SV s = 78kPa SV s = 52kPa2.0 ... bund present until approximately 2.00m bgl. 2 6 10 SV s = 68 kPa<u>10</u> <u>10</u> <u>10</u> <u>10</u> . . . becoming dry and friable at 9.25 2.95 3.00-6.00 В 3.0 9 8 2.85mbgl 6 Brown sandy fine to coarse, sub-rounded to rounded GRAVEL of sandstone with pockets of coarse sand throughout. (FLUVIO-GLACIAL DEPOSITS) 6 4 5 3 3 3.85 4.0 4 3 _5 5 6 6 5 5.0 4 8 7 4 6.0 4 3 6 9 5.60 6.60 8 10 <u>10 9</u> 7.0 <u>11 11</u> <u>10</u> 10 10 11 99 10 12 8.0 <u>11 11</u> 10 13 10 10 <u>9 12</u> <u>15</u> 14 9.0 <u>11 16</u> <u>16</u> <u>16</u> 29 17 <u>50</u> Remarks: mpling Ru PROJECT NO. A089434 Dynami Fall Height: 750mm From Diameter Recove 1. Inspection Pit hand excavated to 1.20mbgl prior to GC 2.00m 3.00m 4.00m 5.00m 6.00m 6.60m Logged by: anglection in hand excerted to 1.20mg photo d drilling.
 Groundwater strike at 3.85 m bgl during sampling.
 Upon completion exploratory hole backfilled with Arisings and bentonite 1.20m 2.00m 3.00m 4.00m 5.00m 6.00m 100% 100% 100% 100% 100% 100% 87mm 77mm Hammer Wt 63.50kg СВР 67mm 57mm 57mm 57mm Checked by: robe Type DPSH Release Status: Final Cone Size: 50mm Excavation Date: 13/10/2014





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Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Tel: 02920 829 200. Email: admin.cardiff@wyg.com Window Sample / Probe Number **WS03**

Sheet 1 of 1

Scale 1:50

Project: St Asaph FRM Client: Natural Resources Wales Easting: **303139.76** Northing: **375194.35** Ground Level: 12.201 Method: Windowless Sampler and Super Heavy Dynamic Probe Wate Strike Depth Readings Remarks Dept Inst Depth mpl Description 10 15 20 25 30 35 40 Level (m) 5 45 (m) (m) (m) (m) Blows / 100mm (m) 0.10 2 12.10 Grass over brown silty CLAY with rootlets. 2 3 (TOPSOIL) 3 Firm to stiff reddish B ES 0.50-1.00 Firm to stiff reddish brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-rounded to rounded of sandstone. (BUND -MADE GROUND) 0.50 1.0 1.00-2.70 В 2 SV s = 50kPa SV s = 57kPa2.0 SV s = 80kPa 2 SV s = 55kPa9.50 2.70 9.40 2.80 6 Dark grey mottled brown clayey fine to medium SAND. (ALLUVIUM) 8 7 3.00-4.00 В 3.0 7 Brown grey sandy fine to coarse, sub-rounded to rounded GRAVEL of sandstone. (FLUVIO-GLACIAL DEPOSITS) 7 3 6 7 7 20 8.20 4.00 4.0 5.0 6.0 7.0 8.0 9.0 Remarks: npling Ru PROJECT NO. A089434 Fall Height: 750mm From Diameter Recove 1. Inspection pit hand excavated to 1.20mbgl prior to GC Logged by: Inspection pit hand excavated drilling.
 Backfilled with arisings.
 No groundwater encountered. 1.20m 2.00m 3.00m 2.00m 3.00m 4.00m 87mm 77mm 67mm 100% 100% 100% Hammer Wt 63.50kg СВР Checked by: Probe Type DPSH Release Status: Final Cone Size: 50mm Excavation Date: 13/10/2014



part of the WYG group

Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Window Sample / Probe Number **WS04**

Sheet 1 of 1

Scale 1:50 Tel: 02920 829 200. Email: admin.cardiff@wyg.com Project: St Asaph FRM Client: Natural Resources Wales Easting: **303124.68** Northing: **375101.10** Ground Level: 12.779 Method: Windowless Sampler and Super Heavy Dynamic Probe Wate Strike Depth Readings Remarks Dept Inst Dept mpl Description 10 15 20 25 30 Level (m) 5 35 40 45 ickt (m) (m) (m) Blows / 100mm (m) (m) 4 Grass over brown silty CLAY with rootlets. 12.58 0.20 4 6 .30-0.80 0.40 (TOPSOIL) B ES 6 6 Brown gravelly fine to coarse SAND. Gravel is 5 6 fine to coarse, angular to rounded of brick, limestone and sandstone. (BUND - MADE GROUND) <u>6 10</u> 1.0 1.00-2.80 В <u>13</u> 6 3 2.0 3 9.98 2.80 2.80-3.80 В Brown mottled orange very clayey fine to medium SAND. (MADE GROUND) 3.0 8.98 8.88 3.80 3.90 Grey brown coarse SAND. (MADE GROUND) 2 4.0 12 10 8.68 4.10 Brown black very sandy CLAY. (MADE GROUND) ... becoming sandy/gravelly with 8.53 4.25 9 SV s = 8kPa8.48 4.30 4.40 2 4.50-6.00 в depth Brick cobble. (MADE GROUND) 6 5.0 White/grey angular GRAVEL of quartz. (MADE 4 3 GROUND) 5 Very soft grey CLAY. (ALLUVIUM) Brown sandy fine to coarse, sub-rounded to rounded GRAVEL of 3 3 6.78 6.00 sandstone. (FLUVIO-GLACIAL DEPOSITS) 6.0 л 3 3 7.0 3 5 7 12 13 14 <u>13</u> <u>15</u> <u>13</u> <u>12</u> b 8.0 16 12 ቅ **-**<u>18</u> <u>13</u> <u>15</u> <u>14</u> <u>25 14</u> ٠ <u>16</u> <u>17</u> 9.0 <u>27 15</u> <u>13</u> <u>14</u> 15 14 <u>13</u> <u>13</u> 14 11 Remarks: mpling Ru PROJECT NO. A089434 Dyn Fall Height: 750mm From Diameter Recove 1. Inspection pit hand excavated to 1.20mbgl prior to GC Logged by: Inspection pit hand excavated to drilling.
 Backfilled with arisings.
 Groundwater struck at 4.5mbgl 1.20m 2.00m 3.00m 4.00m 5.00m 2.00m 3.00m 4.00m 5.00m 6.00m 100% 100% 100% 100% 100% 87mm 77mm Hammer Wt 63.50kg СВР Checked by: 67mm 57mm 57mm robe Type DPSH Release Status: Final

Cone Size:

50mm

Excavation Date: 13/10/2014





part of the WYG group

Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD

Window Sample / Probe Number WS05

Sheet 1 of 1

Scalo 1.50

Y	Tel: ()2920	829 20	0. Em	ail: ac	lmin	.card	liff@	wyg.co	m					SC	aie	1:50		
Project: St Asaph FRM											C	lient: I	Nat	ura	Re	sour	ces Wales		
Method: Windowless S	ample	er an	d Su	per l	Heav	/y C	Dyn	am	ic Pr	obe	G	round	Lev	el:	13.4	08	Northing: 30	3270.79 5050.87	
Depth Readings (m) Blows / 100mm	5	10 1	5 20	25	30 3	54	10 4	15	Depth (m)	Sample (m)	Water Strike (m)	Remar	ks	Reduced Level (m)	Depth (m)		Description		Inst. Backfi
Depth Readings (m) Blows / 100mm 3 3 3 2 2 1.0 2 3 3 3 2 2 1.0 2 3 3 3 3 3 2 2 1.0 2 3 3 3 3 3 3 2 3 2.0 3 3 6 4 7 3									Depth (m) 0.50 0.80-1.6 1.80-2.0 2.05-2.1 2.50-4.0	ample (m)	Waters (m)	Remark SV s = 1 SV s = 4 SV s = 1	88kPa 88kPa .4kPa	Reduced Level (m) 13.26 11.81 11.61 11.11 11.16 10.91 9.41	Depth (m) 0.15 0.80 1.60 1.80 2.05 2.15 2.50 4.00		Carass over brown sandy CLAY with (TOPSOIL) Brown slightly san gravelly CLAY. Gravel fine to coarse, sub-rounded to rn of sandstone. (BUM MADE GROUND) Brown sandy gravel sandstone. (BUM GROUND) Firm reddish brow (BUND - MADE G White sandstone. (BUND - MADE G White sandstone. (BUND - MADE G Brown and grev s sub-angular to sub-angular t	a silty rootlets.	
Remarks: 1. Inspection pit hand excavated to 1.20mt drilling. 2. Backfilled with arisings. 3. No groundwater encountered.	ngl prior to					Frc 1.20 2.00 3.00	om Om Om Om	Dynai 2.0 3.0 4.0	mic Samp To Di 00m 7 00m 7 00m 6	oling Ru ameter 37mm 77mm 57mm	in Reco 100 100 100	Very Fall % Han	Height nmer W	t: Vt:	750 63.5	mm PR _{Okg} Lo Ch	ROJECT NO. ogged by: necked by:	A0894 GC CBP	34
												Prot	ре Туре	e:	DI	^{rSH} Re	elease Status:	Final	



part of the **WYG** group

Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Tel: 02920 829 200, Email: admin.cardiff@wvg.com Window Sample / Probe Number **WS06**

Sheet 1 of 1

Scale 1:50

Project: St Asaph FRM	1												С	lien	t: Nat	ura	Re	sour	ces Wales		
Method: Windowless S	Samp	bler	and	d Su	ıpe	r H	eav	y C	Dyn	am	nic Pr	obe	G	rou	nd Lev	/el:	13.6	67	Easting: 303 Northing: 374	3311.58 1957.82	
Depth Readings (m) Blows / 100mm		51	.0 1!	5 20	25	53	03	54	10 4	15	Depth (m)	Sample (m)	Water Strike (m)	R	lemarks	Reduced Level (m)	Depth (m)		Description		Inst. Backf
	K										0.10-0.	50 B				13.62	0.05		White and grey ar GRAVEL path cove (MADE GROUND -	ngular ering. · PATH)	
		•	•													13.17	0.50		Brown mottled gro gravelly CLAY of f coarse, angular to sub-rounded of sandstone with we brick fragments.	ey very ine to ood and BUND -	
																12.47	1.20		Quartz and sands cobbles with some clay. (BUND - MAI GROUND)	tone e brown DE	
												70 B				11.47	2.20		Firm to stiff brown slightly sandy grav CLAY. (BUND - M/ GROUND)	n velly ADE	
	_																		gravely with d Brown gravely SA gravel is fine to co	epth. ND, barse,	
3.0 <u>-</u> <u>-</u> <u>-</u>	-															10.67	3.00		rounded. (FLUVIO-GLACIAL DEPOSITS)		
																		- - -			
4.0 — -											-							- - - -			
																		-			
5.0 -																		-			
- - - 6.0 -																		-			
																		• • •			
7.0																		-			
																		-			
8.0											-							-			
																		- - -			
9.0 																		- 			
																		- - -			
Remarks:								Fre) om	Dyna	mic Sam	pling Ru Diameter	n Reco	verv	Fall Heigh	nt:	750r	nm PF	OJECT NO.	A08943	34
 Inspection pit hand excavated to 1.20m drilling. Backfilled with arisings. 	bgl prior	to						1.20	0m 0m	2	.00m .00m	87mm 77mm	100	1% 1%	Hammer	Wt:	63.50	_{Okg} Lo	gged by:	GC	
3. No groundwater encountered.													1		Probe Ty	be:	DF	PSH Re	lecked by: lease Status:	свр Final	
													1	Ī	Cone Size	e:	50r	nm Ex	cavation Date:	14/10/2	014





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Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD

Window Sample / Probe Number WS07

Sheet 1 of 1

		Tel:	02920	829 2	200. E	Email	adm	in.car	diff@	wyg.co	m				Sca	ale 1:50	
Project: St As	aph FRM											С	lient: Na	tura	l Res	ources Wales	
Method: Wind	lowless Sa	ampl	er ar	nd Su	ipei	r He	avy	Dyr	nam	nic Pro	be	G	round Lev	vel:	13.5	73 Easting: 30 Northing: 37	3373.98 4966.14
Depth Re (m) Blows	eadings s / 100mm	5	10	15 20) 25	30	35	40	45	Depth (m)	Sample (m)	Water Strike (m)	Remarks	Reduce Level (m)	Depth (m)	Description	Ins Bac
	$\begin{array}{c} 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 3 \\ 3 \\ 4 \end{array}$	**************************************								0.40-0.80 0.50	D B ES			13.47	0.10	Grass over brown CLAY with rootlet (TOPSOIL) Brown gravelly sa with occasional b fragments. Grave to coarse, sub-an rounded of sands (BUND - MADE G	silty s. indy SILT rick jis fine gular to tone. ROUND)
2.0 2 2	<u>4</u> <u>3</u>									2.10-2.7	в		SV s = 13kPa	11.47	2.10		(BUND -
1	<u> </u>									2 60-2 8	в		SV c – 10kPa	10.97	2.60	becoming and gravelly w	firmer ith
3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0	<u>3</u> <u>2</u> <u>2</u>									2.80-3.50	D B		SV s = 19kPa	10.77	2.80	Brown and black SILT. Gravel is fir coarse, angular sandstone. (MAD	gravelly le to
	<u>1</u> 2 <u>5</u>									3.50-4.0	D		SV S = 12KPa	10.07	3.50	Soft brown silty C (ALLUVIUM) Brown sandy fine	to
4.0	<u>4</u> _ <u>6</u> _ <u>6</u>									-				9.57	4.00	coarse, sub-round rounded GRAVEL sandstone. (FLUVIO-GLACIAI DEPOSITS)	ded to of
5.0																· · · · · ·	
6.0 - - - - - - - - - - -										-						· 	
7.0																· 	
8.0										-							
- - - 9.0																- - - -	
Remarks:				1				From	Dyna	mic Samp	ling Ru	n Dec	Fall Heig	ht:	750m	m PROJECT NO.	A089434
 Inspection pit hand exe drilling. Backfilled with arisings No groundwater encourt 	cavated to 1.20mbg s. untered.	I prior to					1 2 3	.20m .00m .00m	2 3 4	.00m 8 .00m 7 .00m 6	7mm 7mm 7mm 7mm	100 100 100	% Hammer	Wt:	63.50	_{kg} Logged by: Checked by:	GC CBP
													Probe Ty Cone Size	pe: e:	DPS 50m	^{6H} Release Status: m Excavation Date:	Final 14/10/2014



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Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Tel: 02920 829 200. Email: admin.cardiff@wyg.com Window Sample / Probe Number **WS08**

Sheet 1 of 1

Scale 1:50

Project: St Asaph FRM Client: Natural Resources Wales Easting: **303524.28** Northing: **374717.66** Ground Level: 14.183 Method: Windowless Sampler and Super Heavy Dynamic Probe Wate Strik Depth Readings Remarks Inst Dept Depth mpl Description 10 15 20 25 30 35 40 Level (m) 5 45 (m) (m) Blows / 100mm (m) (m) (m) ² ² ² ¹ 1 Grass over silty CLAY. 14.03 0.15 (TOPSOIL) Dark brown sandy gravelly CLAY with roots rootlets and fragments of brick. Gravel is fine to coarse, 13.78 0.40 .40-0.50 В 13.68 0.50 ES 0.60 sub-rounded to rounded of sandstone. (BUND -MADE GROUND) 1.0 Reddish brown gravelly CLAY. Gravel is fine to 12.78 1.40 coarse, sub-rounded to 1.40-2.00 В SV s = 110kP ounded of sandston (BUND - MADE GROUND) Brown sandy gravelly SILT. Gravel is fine to SIL1. Gravel is fine to coarse, angular to rounded of sandstone, brick, limestone and ornamental slate with glass fragments. (BUND -MADE GROUND) bone at 12.18 2.00 2.0 . bone at 1.00mbgl. Very stiff reddish brown slightly sandy CLAY with occasional gravels of fine to medium, angular sandstone. (BUND - MADE 11.18 3.00 3.0 GROUND). Brown gravelly SAND, gravel is fine to coarse, sub- rounded to rounded. (FLUVIO-GLACIAL 4.0 DEPOSITS) 5.0 6.0 7.0 8.0 9.0 Remarks: pling Ru PROJECT NO. A089434 Fall Height: 750mm From Diameter Recove 1. Inspection pit hand excavated to 1.20mbgl prior to GC Logged by: drilling.
 Backfilled with arisings.
 No groundwater encountered. 1.20m 2.00m 2.00m 3.00m 87mm 77mm 100% 100% Hammer Wt 63.50kg СВР Checked by: robe Type DPSH Release Status: Final Excavation Date: 14/10/2014 Cone Size: 50mm





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Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD Window Sample / Probe Number **WS09**

Sheet 1 of 1

Scale 1:50 Tel: 02920 829 200. Email: admin.cardiff@wyg.com Project: St Asaph FRM Client: Natural Resources Wales Easting: **303479.13** Northing: **374624.67** Ground Level: 14.529 Method: Windowless Sampler and Super Heavy Dynamic Probe Wate Strike Depth Readings Remarks Inst Dept Depth mpl Description 10 15 20 25 30 35 40 Level (m) 45 5 (m) (m) Blows / 100mm (m) (m) (m) <u>4</u><u>5</u><u>4</u><u>6</u> 2 Grass over silty CLAY. 14.38 0.15 0.15-0.30 В (TOPSOIL) 14.23 0.30 0.30 0.30-1.00 ES B Brown mottled white clayey gravelly SILT. Gravel is fine-coarse, sub-angular to rounded of sandstone. (BUND -MADE GROUND) 13.53 1.00 1.0 1.00-2.00 В Light brown very dry gravely slightly sandy SILT. Gravel is fine to coarse, angular to sub-rounded of sandstone. (BUND - MADE \GROUND) SV s = 110kPa Stiff reddish brown slightly sandy CLAY with occasional gravels of fine to medium, angular sandstone. (BUND - MADE (GROUND) 12.53 2.00 2.0 Brown gravelly SAND, gravel is fine to coarse, sub- rounded to rounded. (FLUVIO-GLACIAL DEPOSITS) 11.53 3.00 3.0 4.0 5.0 6.0 7.0 8.0 9.0 Remarks: npling Ru PROJECT NO. A089434 Fall Height: 750mm From Diameter Recove 1. Inspection pit hand excavated to 1.20mbgl prior to GC Logged by: drilling.
 Backfilled with arisings.
 No groundwater encountered. 1.20m 2.00m 2.00m 3.00m 87mm 77mm 100% 100% Hammer Wt 63.50kg СВР Checked by: Probe Type DPSH Release Status: Final 50mm Excavation Date: 14/10/2014 Cone Size:



part of the **WYG** group

Ground Engineering Services 5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD

Window Sample / Probe Number WS10

Sheet 1 of 1

	Tel: 02920 82	29 200. Email: a	dmin.car	diff@wyg.co	m				SCa	ale 1:50	
oject: St Asaph FRM						Clien	t: Nat	ural	Res	ources Wales	
ethod: Windowless Sa	mpler and	Super Hea	vy Dyr	namic Pro	be	Grou	nd Lev	el: 1	15.09	94 Northing: 374501.3	4 4
nth Readings n) Blows / 100mm	5 10 15	20 25 30	35 40	Depth 45 (m)	Sample (m)	Water Strike (m)	Remarks	Reduced Level (m)	Depth (m)	Description	Ins Bac
<u>2</u> <u>9</u> 6	F							14.84 14.74	0.25 0.35	Grass over dark brown gravelly silty CLAY with rootlets. (TOPSOIL)	
$\begin{array}{c} 3 \\ 3 \\ 3 \\ 2 \\ 3 \\ 3 \\ 3 \\ 3 \\ 3 \\ 3 \\$				0.60-1.4 0.60	0 B ES	SV a	- 105kPa	14.49	0.60	Brown and grey silty sandy fine to coarse, angular GRAVEL of decorative slate. (BUND - MADE GROUND)	
$\begin{array}{c} \begin{array}{c} \begin{array}{c} 2 \\ 1 \\ \end{array} \\ \begin{array}{c} \end{array} \\ \begin{array}{c} 1 \\ \end{array} \\ \begin{array}{c} 4 \\ \end{array} \\ \begin{array}{c} 4 \\ \end{array} \\ \begin{array}{c} 4 \\ \end{array} \\ \begin{array}{c} 3 \end{array} \end{array}$				1 50 2 0		573	5 – 105Ki 6	13.64	1.45	Brown sandy gravelly SILT gravel is fine to coarse, angular to sub - rounded sandstone.	
$\begin{bmatrix} 2 & 2 \\ -1 & 2 \\ -1 & 2 \\ -1 & -1 \end{bmatrix}$				2.00	ЕS					Stiff brown mottled grey slightly gravelly CLAY. Gravel is fine, angular sandstone. (BUND - MADE	
				2.00						GROUND) Black mottled red, white and grey slightly clayey gravelly SAND with glass and brick fragments and ash and clinker. Gravel is	
	→			2.80-3.1	0 В	SV s	s = 8kPa	12.29 11.94	3.15	fine to coarse, angular sub - rounded brick, limestone and sandstone. (MADE GROUND) Very soft light brown	
15 17 12 12								11.39	3.70	CLAY. (ALLUVIUM). Grey brown gravelly sandy fine to coarse, sub - rounded to rounded GRAVEL of sandstone.	
0									-		/
- - - - - -										· · ·	
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				Dunamic Carro					- - - - -		
arks:	prior to		From 1.20m	Dynamic Samp	ling Run ameter	Recovery	Fall Heigh	t:	750m	PROJECT NO. A08	9434
arks: Inspection pit hand excavated to 1.20mbgl Irlling. Jackfilled with arisings. No groundwater encountered.	prior to		From 1.20m 2.00m 3.00m	Dynamic Samp To Di 2.00m 2 3.00m 2 3.70m 6	ling Run ameter 7mm 7mm 7mm	Recovery 100% 100%	Fall Heigh Hammer V	t: Vt:	750m	PROJECT NO. A08 kg Logged by: GC Checked by: CBP	9434

