WYG Environment
part of the WYG group

Natural Resources Wales

St Asaph FRMS (PAR) – Ground Investigation 2014

Factual Report

January 2015

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

Tel: 029 2082 9200

Email: enviro.cardiff@wyg.com

Document Control

Project:	St Asaph Flood Risk Management Scheme
Client:	Natural Resources Wales
Job Number:	A089434
File Origin:	\\CARDIFF31\dataold\Environmental\projects\A089434 - St Asaph FRM\Report

Document Checking:

Prepared by:	Nicholas Bool Geo-environmental Engineer Gemma Cauchi Graduate Geo-environmental Engineer	Signed:

Reviewed by:	Chris Pugh Associate Director	Signed:

Issue	Date	Status
1	December 2014	Draft
2	January 2015	Final

Contents Page

FIGURES

APPENDICES

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.

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 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.

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

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*

**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.

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.

Table 5: Summarised Water Strike Data

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

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 installed		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 (m/s)	Stratum	Depth of Casing (m)	Depth of Borehole (m)
BH01	1	4.8×10^{-5}	Fluvioglacial Deposits	4.00	4.50
BH02	1	2.2×10^{-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.

Table 8: Average Hand Shear Vane Results

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

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.

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 diameter samples	Part 8, Clause 7.0	3
pH	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
pH	10

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
B	Bulk sample
D	Small disturbed sample
W	Water sample
CBR	California Bearing Ratio test or CBR value obtained from Mexiprobe test

In situ tests

S	Standard penetration test (SPT)
N	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.

Core recovery and rock quality

TCR	Total core recovery (%)
SCR	Solid core recovery (%)
RQD	Rock quality designation (%)
FI	Fracture index
NR	No recovery
NI	Not intact

Rotary drilling sizes

	Nominal diameter (mm)	
Index letter	**Borehole**	**Core**
N	75	54
H	99	76
P	120	92
S	146	113

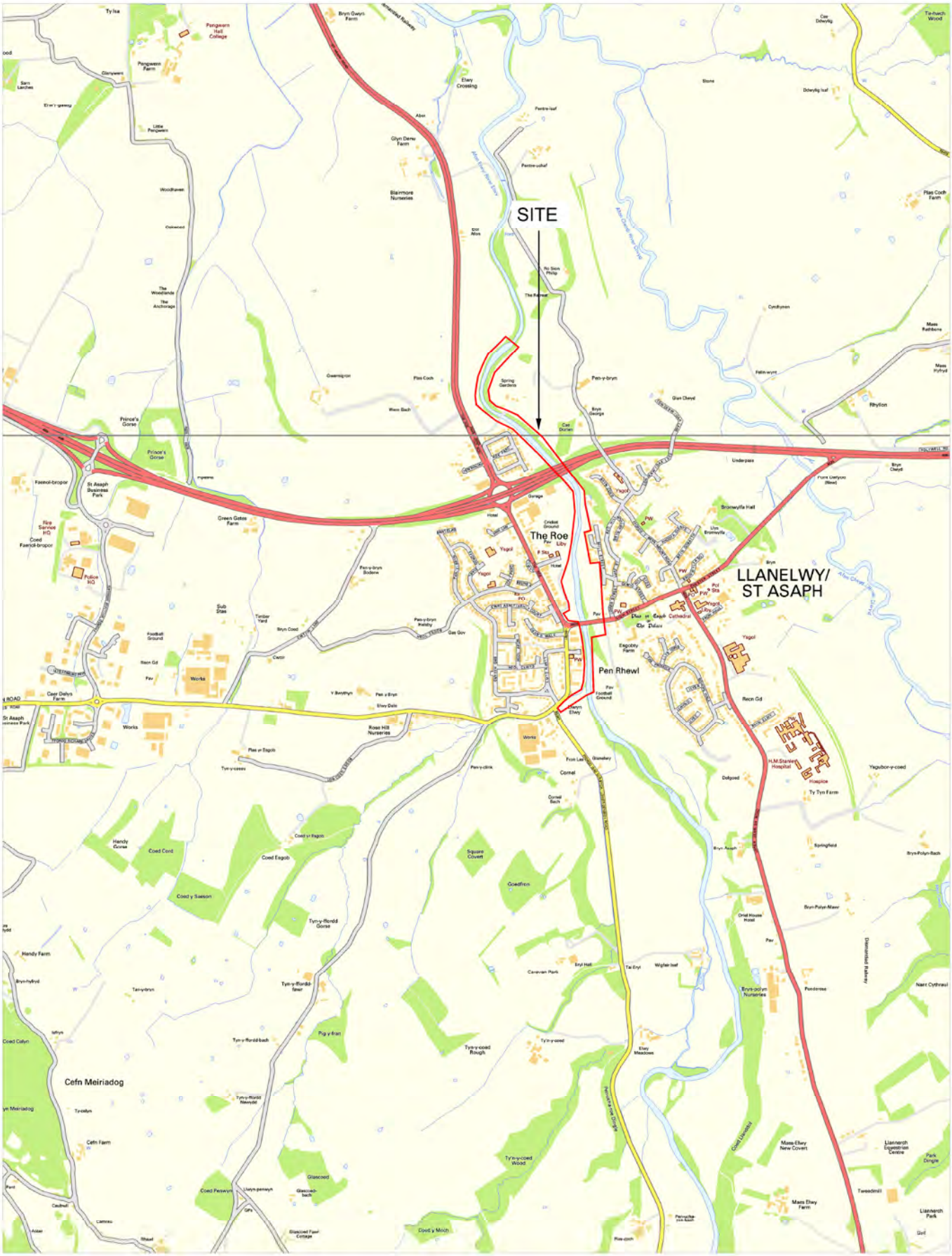
Water strikes

▽	Level of water strike
▼	Water level rose to this level (see Remarks at foot of log for details)

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.

Figures

DO NOT SCALE: CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT ANY OMISSIONS OR ERRORS



REV	DESCRIPTION	BY	CHK	APP	DATE

5th FLOOR, LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD

TEL: +44 (0)29 2032 0769
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com

Client: NATURAL ENGLAND WALES

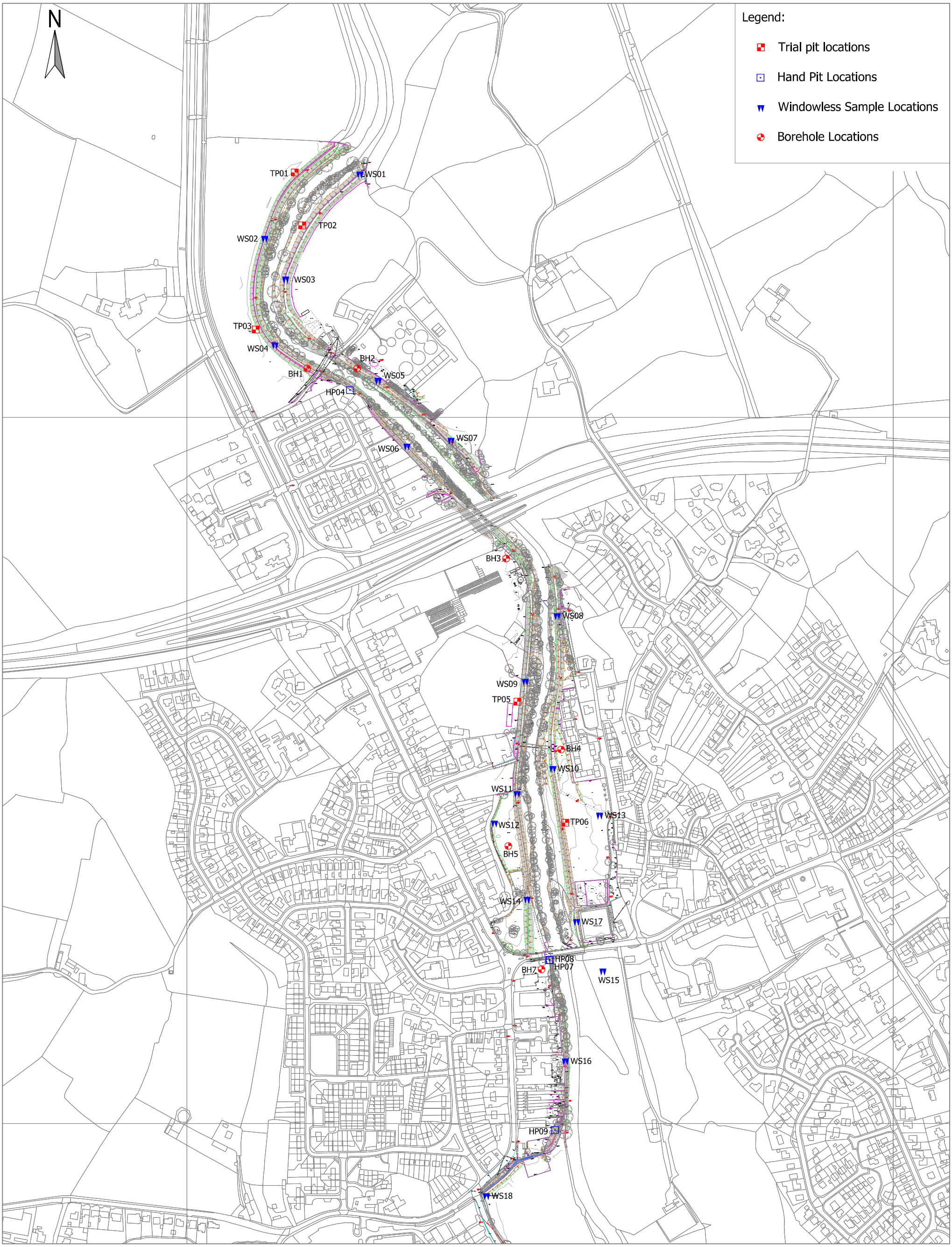
Project: ST ASAPH FRM

Drawing Title: SITE LOCATION PLAN

Scale @ A4	Drawn	Date	Checked	Date	Approved	Date
NTS	PP	08.12.14	GC	08.12.14	CBP	08.12.14

Project No.	Office	Type	Drawing No.	Revision
A089434	CDF	GEO	1	00

DO NOT SCALE: CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT ANY OMISSIONS OR ERRORS



REV	DESCRIPTION	BY	CHK	APP	DATE

5th FLOOR, LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD

TEL: +44 (0)29 2032 0769
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com

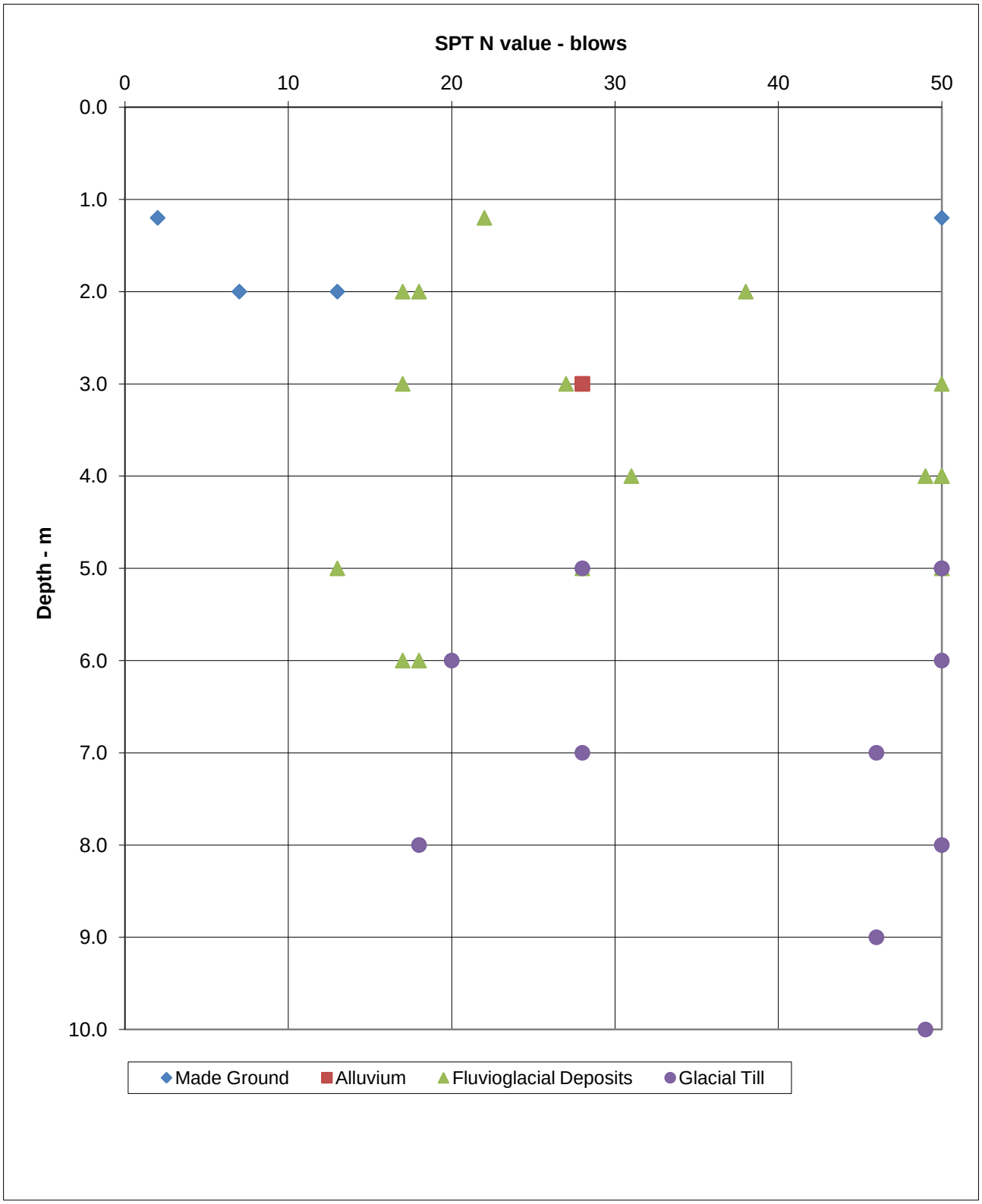
Client: NATURAL ENGLAND WALES

Project: ST ASAPH FRMS

Drawing Title: SITE INVESTIGATION LAYOUT PLAN

Scale @ A3	Drawn	Date	Checked	Date	Approved	Date
1:5000	PP	30.10.14	GC	08.12.14	CBP	08.12.14

Project No.	Office	Type	Drawing No.	Revision
A089434_2	CDF	GEO	2	00



WYG Environment Ltd
Longcross Court, Newport Rd, Cardiff, CF24 0AD
Tel: 02920 892200
Fax: 02920 455321

Environmental Consultancy

	Project: **St Asaph**	Drawing Title: **SPT vs Depth Plot**
	Client: **NRW**	Drawing No.: **FIGURE 3**

Appendices

Appendix A – Report Conditions

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.

Appendix B – Exploratory Hole Logs, Sketches and Photographs

WYG ENVIRONMENT
Ground Engineering Services
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.

Borehole Number
BH1
Final

Project : **St Asaph FRM**
Project Number : **A089434**
Client : **Natural Resources Wales**
Method : **Cable Percussive Rig**
Co-ordinates : **303170.14E - 375069.41N**
Ground Level : **12.91m AOD**

Hole Information

From	To	Method	Diameter
0.00m	1.20m	Hand Tools	-
1.20m	10.00m	Cable Percussive Rig	150mm

Scale 1:50 Sheet 1 of 1
Logged By : **NEB**
Checked By : **CBP**
Start Date : **07/10/14**
Finish Date : **08/10/14**

Strata	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installation/ Backfill	Sampling & In Situ Testing: Depth	Type	Number
Red brown silty CLAY with many roots and rootlets (TOPSOIL)		12.71	0.20				0.00-0.20	B	D
							0.05		
Dry and friable brown silty slightly gravelly CLAY. Gravel of fine to medium sub-rounded to rounded sandstone (BUND - MADE GROUND)		12.41	0.50				0.20-0.50	B	D
							0.20		
Brown silty slightly gravelly CLAY. Gravel of fine angular to rounded sandstone, mudstone and brick (POSSIBLE BUND - MADE GROUND)		11.71	1.20				0.50-1.20	ES	
							0.50-1.00	B	D
							0.50		
Red brown silty sandy very gravelly CLAY. Gravel of angular to rounded sandstone, mudstone and brick. (MADE GROUND)							1.20-1.65	U	Refusal for 400mm
							1.70-2.00	B	D
							1.70		
							2.00	S	N=13 (1,2,3,3,3,4)
							2.00-2.50	ES	
		10.11	2.80				2.50	D	
Firm brown clayey sandy SILT (ALLUVIUM)							3.00	S	N=28 (3,3,6,6,6,10)
							3.00-3.50	B	
		9.41	3.50				3.50	D	
Dense brown silty sandy rounded to angular fine to coarse mudstone and sandstone GRAVEL (FLUVIO-GLACIAL DEPOSITS)							4.00	S	N=49 (10,7,9,14,13,13)
							4.00-4.50	B	
		8.41	4.50		4.50		4.50	W	
Medium dense brown sandy angular to rounded fine to coarse sandstone, mudstone and quartz GRAVEL. (FLUVIO-GLACIAL DEPOSITS)							4.50	D	
							5.00	S	N=28 (13,12,8,8,6,6)
							5.00-5.50	B	
							5.50	D	
		6.61	6.30				6.00	S	N=17 (4,3,4,2,3,8)
							6.00-6.50	B	
Stiff red brown sandy very gravelly CLAY. Gravel of fine to medium rounded to sub-rounded sandstone. (GLACIAL TILL)							6.50	D	
							7.00	S	N=46 (6,7,9,10,13,14)
							7.00-7.50	B	
		5.41	7.50				7.50	D	
Very stiff red brown sandy very gravelly CLAY. Gravel of fine to medium rounded to sub-rounded sandstone. (GLACIAL TILL)							8.00	S	50/295mm (8,9,10,11,14,15)
							8.00-8.50	B	
							8.50	D	
							9.00	S	N=46 (7,8,10,10,12,14)
							9.00-9.50	B	
							9.50	D	
		2.91	10.00	10.00m			10.00	S	N=49 (3,7,10,11,14,14)
				150mm					
Borehole complete at 10.00 m bgl.									

Observations / Remarks.

1. Inspection pit hand excavated to 1.2m bgl prior to drilling.
2. Groundwater observed at 4.5m bgl, rising to 4.4m bgl. At 4.3m bgl at start of second day.
3. Backfilled with bentonite from 10.0m bgl to 6.00m bgl, 50mm slotted pipe with gravel surround from 6.00m bgl to 4.00m bgl, 50mm plain pipe with bentonite surround from 4.00m bgl to ground level.
4. Falling head test conducted within borehole.

Chiselling

From	To	Time
4.30m	4.50m	30 mins
5.00m	5.40m	60 mins
7.00m	7.50m	60 m mins

Groundwater

Struck	Rising to	Time (mins)	Remarks
4.50m	4.40m	20	

WYG ENVIRONMENT
Ground Engineering Services
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.

Borehole Number
BH2
Final

Project : **St Asaph FRM**
Project Number : **A089434**
Client : **Natural Resources Wales**
Method : **Cable Percussive Rig**
Co-ordinates : **303240.96E - 375069.32N**
Ground Level : **13.17m AOD**

Hole Information

From	To	Method	Diameter
0.00m	1.20m	Hand Tools	-
1.20m	8.00m	Cable Percussive Rig	150mm

Scale 1:50 Sheet 1 of 1
Logged By : **NEB**
Checked By : **CBP**
Start Date : **09/10/14**
Finish Date : **09/10/14**

Description	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installation/ Backfill	Sampling & In Situ Testing: Depth	Type Number	
Brown clayey sandy gravelly SILT with many roots and rootlets (TOPSOIL)		13.07	**0.10**				0.00-0.10	B	
							0.05	D	
							0.10-1.20	B	
							0.10	D	
Soft to firm brown silty sandy gravelly CLAY. Gravel of fine to medium sub-angular to rounded sandstone, siltstone, mudstone and brick (BUND - MADE GROUND).							0.50-1.00	ES	
							1.20-1.65	U	Blows=44
							1.70-2.00	ES	
							1.70-2.00	B	
							1.70	D	
							2.00-2.45	U	Blows=37
							2.50-3.00	B	
							2.50	D	
							3.00-3.45	U	Blows=45
							3.50	D	
		9.47	**3.70**				3.70-4.00	B	
Dense to medium dense brown clayey silty sandy rounded to sub-rounded mudstone and sandstone GRAVEL & COBBLES (FLUVIO-GLACIAL DEPOSITS)							4.00	S	N=31 (8,8,8,6,9,8)
							4.00-4.50	B	
					4.60		4.50	D	
					4.80		4.80	W	
							5.00	S	N=13 (5,6,3,3,4,3)
							5.00-5.50	B	
							5.50	D	
							6.00	S	N=18 (4,4,6,4,4,4)
							6.00-6.50	B	
							6.50	D	
		6.07	**7.10**				7.00	S	N=28 (3,3,6,6,8,8)
							7.00-7.50	B	
Stiff red brown very gravelly CLAY. Gravel fine to coarse rounded to sub-angular sandstone and mudstone. (GLACIAL TILL)							7.50	D	
				8.00m			8.00	S	N=18 (3,4,4,5,4,5)
				150mm			8.00-8.45	D	
		4.72	**8.45**						
Borehole complete at 8.45 m bgl.									

Observations / Remarks.

1. Inspection Pit hand excavated to 1.2m bgl prior to drilling.
2. Groundwater observed at 4.8m bgl rising to 4.6m bgl. At 4.5 at start of second day.
3. Backfilled with bentonite from 8.00m bgl to 6.00m bgl, 50mm slotted pipe with gravel surround 6.00m bgl to 4.00m bgl, 50mm plain pipe with bentonite surround from 4.00m bgl to ground level.
4. Falling head test undertaken within borehole.

Chiselling

From	To	Time
4.50m	5.00m	60 mins
6.50m	7.00m	60 m mins

Groundwater

Struck	Rising to	Time (mins)	Remarks
4.80m	4.60m	20	Seeping

WYG ENVIRONMENT
Ground Engineering Services
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.

Borehole Number
BH3
Final

Project : **St Asaph FRM**
Project Number : **A089434**
Client : **Natural Resources Wales**
Method : **Cable Percussive Rig**
Co-ordinates : **303452.00E - 374800.09N**
Ground Level : **11.85m AOD**

Hole Information

From	To	Method	Diameter
0.00m	1.20m	Hand Tools	-
1.20m	5.00m	Cable Percussive Rig	150mm

Scale 1:50 Sheet 1 of 1
Logged By : **NEB**
Checked By : **CBP**
Start Date : **13/10/14**
Finish Date : **13/10/14**

Description	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installation/ Backfill	Sampling & In Situ Testing: Depth	Type Number	
Grey sandy coarse angular limestone GRAVEL. (MADE GROUND)							0.00-0.40	B	
. . . . 0.10m clear DPM							0.10	D	
		11.45	**0.40**						
Grey clayey sandy SILT. (ALLUVIUM)							0.40-1.00	B	
. . . . olfactory hydrocarbon contamination							0.40	D	
		11.15	**0.70**				0.50		
Medium dense brown sandy cobbly GRAVEL. Gravel and cobbles are sub rounded to rounded fine to coarse sandstone, mudstone, siltstone. (FLUVIO-GLACIAL DEPOSITS)							1.00-1.20	B	
							1.00	D	
							1.20	S	N=22 (2,5,7,6,5,4)
							1.20-1.70	B	
					[1.80]		1.70	W	
					1.80		1.70		
							1.70	D	
							2.00	S	N=17 (4,10,5,5,3,4)
. . . below 2.0m bgl becoming very clayey with no cobbles.							2.00-2.50	B	
							2.50	D	
							3.00	S	50/179mm (6,12,33,15,2)
							3.00-3.50	B	
		8.45	**3.40**						
Stiff to hard red brown slightly silty sandy very gravelly CLAY. Gravel fine to coarse rounded to sub-angular sandstone and mudstone. (GLACIAL TILL)							3.50	D	
							4.00		50/283mm (4,10,12,15,14,9)
							4.00-4.50	B	
				4.50m					
				150mm			4.50	D	
		6.85	**5.00**						
							5.00	S	50/164mm (3,11,17,27,6)
							5.00-5.31	D	
Borehole complete at 5.00 m bgl.									

Observations / Remarks.

1. Inspection Pit hand excavated to 1.2m bgl prior to drilling.
2. Groundwater observed at 1.8m
3. Hole backfilled with bentonite

Chiselling

From	To	Time
3.00m	3.50m	60 mins

Groundwater

Struck	Rising to	Time (mins)	Remarks
1.80m	1.70m	20	

WYG ENVIRONMENT
Ground Engineering Services
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.

Borehole Number
BH4
Final

Project : **St Asaph FRM**
Project Number : **A089434**
Client : **Natural Resources Wales**
Method : **Cable Percussive Rig**
Co-ordinates : **303529.73E - 374529.68N**
Ground Level : **14.09m AOD**

Hole Information

From	To	Method	Diameter
0.00m	1.20m	Hand Tools	-
1.20m	5.00m	Cable Percussive Rig	150mm

Scale 1:50 Sheet 1 of 1
Logged By : **NEB**
Checked By : **CBP**
Start Date : **15/10/14**
Finish Date : **16/10/14**

Description	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installation/ Backfill	Sampling & In Situ Testing: Depth	Type Number	
Dark brown clayey sandy SILT with many roots and rootlets (TOPSOIL)		13.99	**0.10**				0.00-0.20	B	
							0.05	D	
							0.10-1.00	B	
							0.10	D	
Brown cobbly angular to sub-angular sandstone and mudstone GRAVEL. (MADE GROUND)		13.09	**1.00**						
							1.00-1.20	B	
							1.00	D	
Very loose black clayey slightly sandy angular fine ash, brick, glass and metal GRAVEL (MADE GROUND)							1.20	S	N=2 (1,0,0,1,0,1)
							1.20-1.70	B	
							2.00	S	N=7 (1,1,1,1,3,2)
							2.00-2.50	B	
		11.69	**2.40**						
Soft light brown slightly gravelly SILT. Gravel of fine angular sandstone. (ALLUVIUM)							2.50	D	
							3.00-3.45	U	87 blows - No Recovery
							3.00-3.50	B	
		10.69	**3.40**		3.20				
Brown slightly clayey slightly silty sandy rounded to sub-rounded GRAVEL & COBBLES. (FLUVIO-GLACIAL DEPOSITS)					3.50		3.50	W	
							3.50	D	
		9.99	**4.10**				4.00	S	50/177mm (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)							4.00-4.50	B	
							4.50	D	
							5.00	S	50/231mm (9,8,14,17,17,2)
		8.64	**5.45**						
Borehole complete at 5.45 m bgl.									

Observations / Remarks.

1. Inspection Pit hand excavated to 1.2m bgl prior to drilling.
2. Groundwater observed at 3.5m bgl.
3. 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.
4. Falling head test conducted within borehole.

Chiselling

From	To	Time
4.50m	5.00m	60 mins

Groundwater

Struck	Rising to	Time (mins)	Remarks
3.50m	3.20m	20	Seeping

WYG ENVIRONMENT
Ground Engineering Services
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.

Borehole Number
BH5
Final

Project : **St Asaph FRM**
Project Number : **A089434**
Client : **Natural Resources Wales**
Method : **Cable Percussive Rig**
Co-ordinates : **303455.02E - 374393.00N**
Ground Level : **13.22m AOD**

Hole Information

From	To	Method	Diameter
0.00m	1.20m	Hand Tools	-
1.20m	6.00m	Cable Percussive Rig	150mm

Scale 1:50 Sheet 1 of 1
Logged By : **NEB**
Checked By : **CBP**
Start Date : **15/10/14**
Finish Date : **16/10/14**

Strata Description	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installation/ Backfill	Sampling & In Situ Testing: Depth	Type Number	
Dark brown slightly sandy SILT with many roots and rootlets. (TOPSOIL)		13.02	**0.20**				0.00-0.20	B D	
							0.10		
							0.20-1.00	B D	
							0.20		
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)									
							1.00-1.20	B	
							1.00	D	
							1.20	S	50/288mm (2,4,6,13,24,7)
		11.72	**1.50**				1.20-1.70	B	
Medium dense becoming dense brown slightly silty slightly sandy rounded to sub-rounded sandstone and mudstone GRAVEL with occasional cobbles. (FLUVIO GLACIAL DEPOSITS).									
							1.70	D	
							2.00	S	N=18 (11,6,5,4,4,5)
							2.00-3.00	B	
. . . gravel and cobbles layer at 2.0m bgl to 2.5m bgl.					2.40				
					2.80				
							3.00	S	N=27 (5,7,6,5,7,9)
							3.00-4.00	B	
. . . . cobble layer 3.8m to 4.0m									
							4.00	S	50/253mm (5,12,13,17,14,6)
							4.00-4.40	D	
		8.02	**5.20**				5.00	S	50/273mm (4,9,10,10,11,19)
							5.00-5.42	D	
Stiff red mottled grey brown silty gravelly CLAY with occasional sandstone cobbles. (GLACIAL TILL)									
		7.22	**6.00**	6.00m 150mm			6.00	S	~~50/135mm (12,13,26,24)~~
							6.00-6.26	D	
Borehole complete at 6.00 m bgl.									

Observations / Remarks.

1. Inspection Pit hand excavated to 1.2m bgl prior to drilling.
2. Groundwater observed at 2.80m bgl, rising to 3.2m bgl. At 3.2m bgl at start of second day.
3. 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.
4. Falling head test conducted within borehole.

Chiselling

From	To	Time
2.50m	3.00m	60 mins
3.50m	4.00m	60 mins
5.50m	6.00m	60 m mins

Groundwater

Struck	Rising to	Time (mins)	Remarks
2.80m	2.40m	20	Seeping

WYG ENVIRONMENT
Ground Engineering Services
5th Floor, Longcross Court, 47 Newport Road, Cardiff, CF24 0AD.
Tel: 02920 2082 9200, Fax: 02920 2045 5321.

Borehole Number
BH7
Final

Project : **St Asaph FRM**
Project Number : **A089434**
Client : **Natural Resources Wales**
Method : **Cable Percussive Rig** **Ground Level**
Co-ordinates : **303502.12E - 374218.29N** : **15.27m AOD**

Hole Information

From	To	Method	Diameter
0.00m	1.20m	Hand Tools	-
1.20m	6.00m	Cable Percussive Rig	150mm

Scale 1:50 Sheet 1 of 1
Logged By : **NEB**
Checked By : **CBP**
Start Date : **14/10/14**
Finish Date : **15/10/14**

Description	Legend	Reduced Level (mAOD)	Depth (m)	Casing (m)	Water Level (m)	Installation/ Backfill	Sampling & In Situ Testing: Depth	Type Number	
Red brown slightly sandy SILT with many roots and rootlets. (TOPSOIL)		15.07	0.20				0.00-0.20 0.10	B D	
Brown orange clayey silty sandy angular brick, sandstone, ash GRAVEL & COBBLES (MADE GROUND)		14.87	0.40				0.20-0.40 0.20	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)							0.40-1.20 0.40	B D	
							1.20-1.65	U	81 Blows, 300mm recovered
							1.70-2.00 1.70	B D	
		13.27	2.00				2.00	S	N=38 (4,6,5,9,12,12)
Dense brown clayey silty sandy GRAVEL of fine to coarse sub-rounded to rounded sandstone and mudstone. (FLUVIO GLACIAL DEPOSITS)							2.00-2.50	B	
							2.50	D	
					3.30		3.00	S	N=17 (4,5,7,3,3,4)
							3.00-3.50	B	
					3.60		3.50	D	
							4.00	S	N=50 (10,11,10,9,21,10)
							4.00-4.50	B	
		10.37	4.90				4.90	D	
Stiff red brown mottled grey silty sandy gravelly CLAY. Gravel of fine to coarse rounded to sub-rounded sandstone and mudstone. (GLACIAL TILL)							5.00	S	N=28 (2,5,5,6,7,10)
							5.00-5.50	B	
							5.50	D	
		9.27	6.00	6.00m 150mm			6.00	S	N=20 (3,3,4,4,6,6)
Borehole complete at 6.00 m bgl.							6.00-6.45	D	

Observations / Remarks.

1. Inspection Pit hand excavated to 1.2m bgl prior to drilling.
2. Groundwater observed at 3.6m bgl, rising to 3.3m bgl. At 3.6m bgl at start of second day.
3. 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 3.00m bgl to ground level.
4. Falling head test undertaken in borehole.

Chiselling

From	To	Time
2.50m	3.00m	60 mins
4.00m	4.50m	60 mins

Groundwater

Struck	Rising to	Time (mins)	Remarks
3.60m	3.30m	20	

WYG ENVIRONMENT
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 **WS01**

Sheet 1 of 1

Scale 1:50

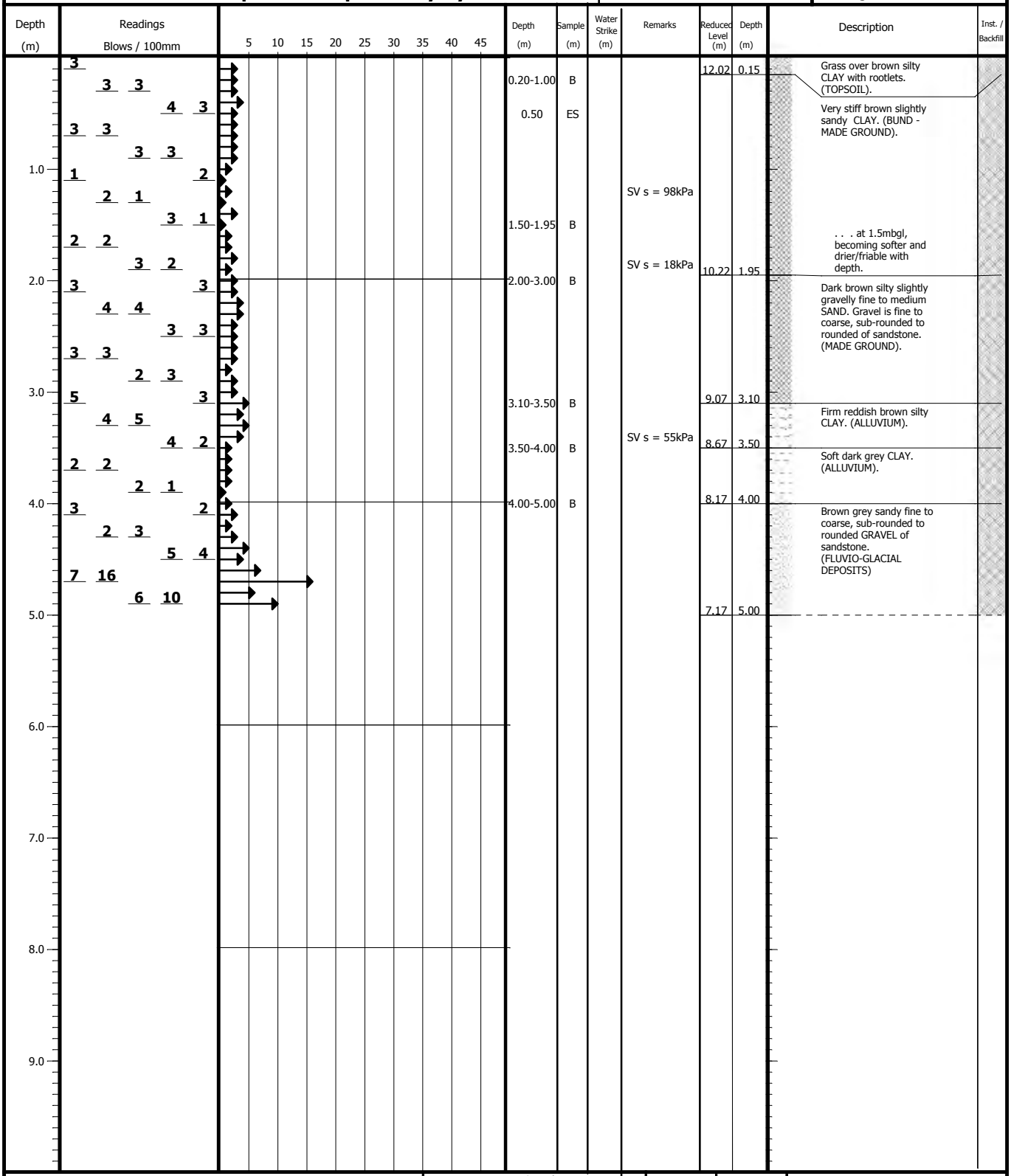
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **12.174**

Easting: **303244.86**
Northing: **375343.14**



Remarks:

1. Hand excavated pit to 1.20m bgl prior to drilling.
2. No groundwater encountered.
3. Backfilled with arisings.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	4.00m	67mm	100%
4.00m	5.00m	57mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **13/10/2014**

WYG ENVIRONMENT
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

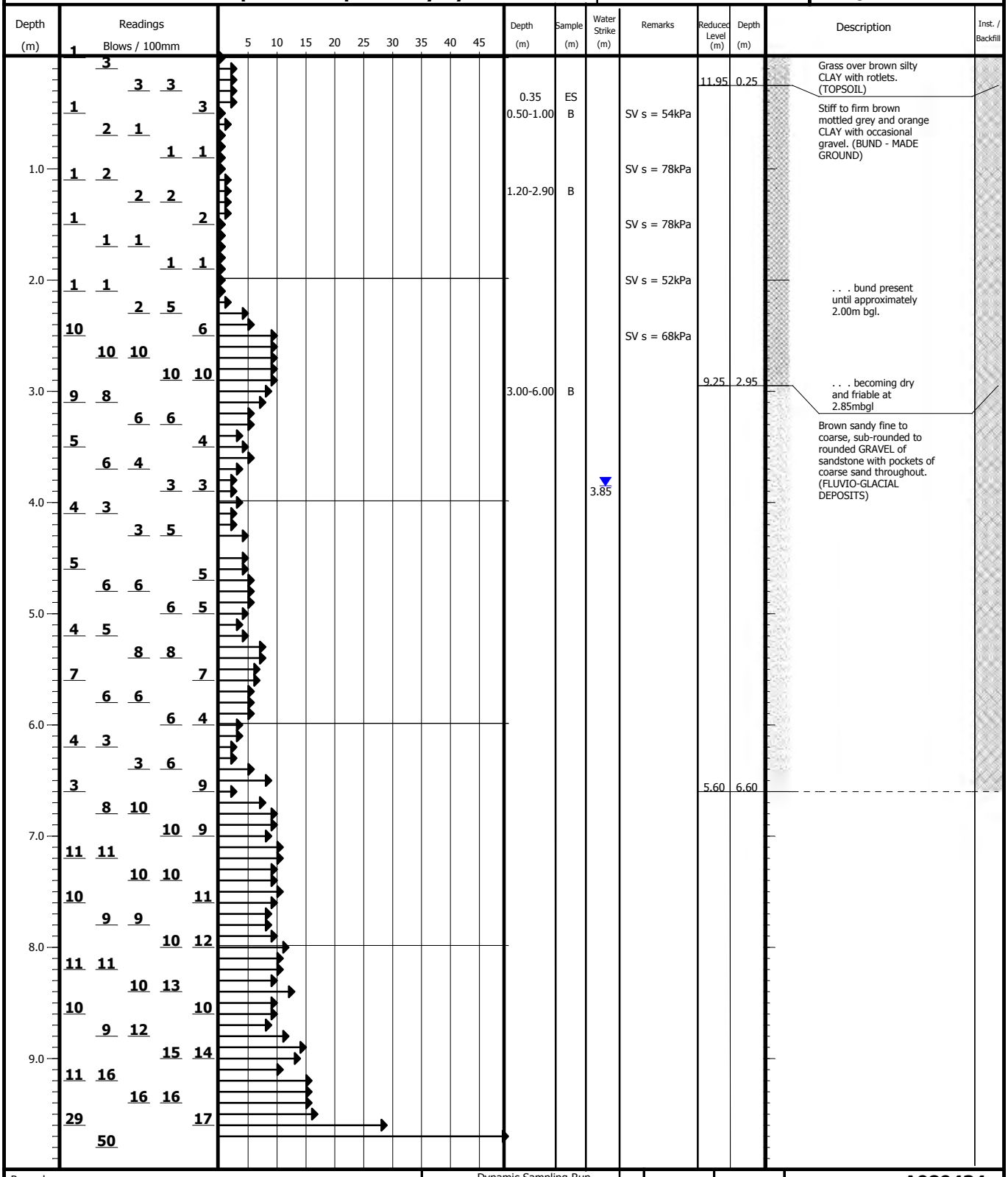
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **12.200**

Easting: **303110.17**
Northing: **375251.91**



Remarks:

1. Inspection Pit hand excavated to 1.20mbgl prior to drilling.
2. Groundwater strike at 3.85 m bgl during sampling.
3. Upon completion exploratory hole backfilled with Arisings and bentonite

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	4.00m	67mm	100%
4.00m	5.00m	57mm	100%
5.00m	6.00m	57mm	100%
6.00m	6.60m	57mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **13/10/2014**

Plate Title	Plate No
WINDOW SAMPLE 01	1

WYG Environment
5th Floor, Longcross Court, 47 Newport Road, Cardiff
Tel: 02920 829200
Fax: 02920 455321
Environmental Consultancy
Ground Engineering Services

Project	Plate Title	
ST ASAPH FRM	WINDOW SAMPLE 02	
Client: NRW	Checked by: CBP	Plate No.: 2

WYG ENVIRONMENT
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 **WS03**

Sheet 1 of 1

Scale 1:50

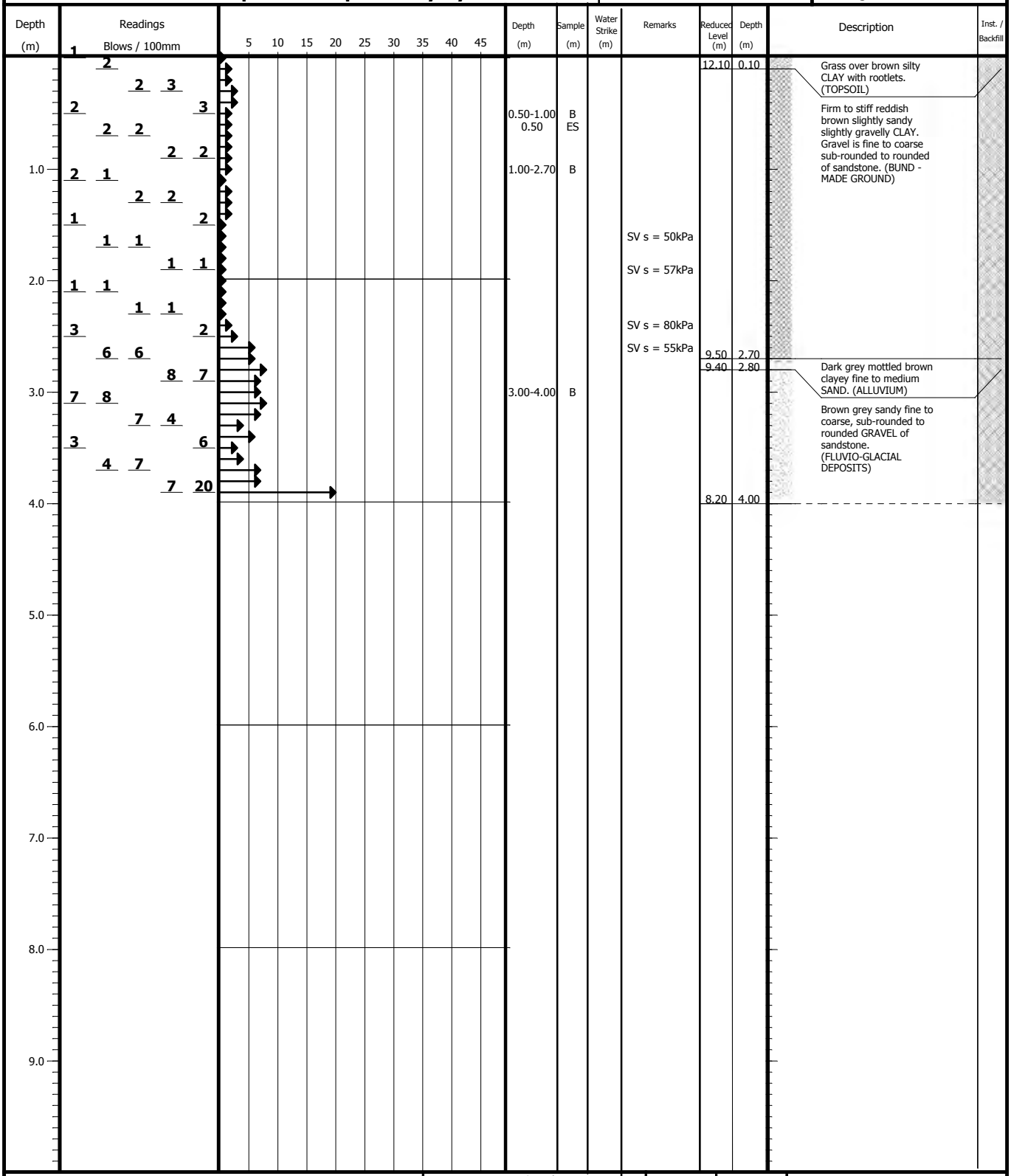
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **12.201**

Easting: **303139.76**
Northing: **375194.35**



Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	4.00m	67mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **13/10/2014**

WYG ENVIRONMENT
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 **WS04**

Sheet 1 of 1

Scale 1:50

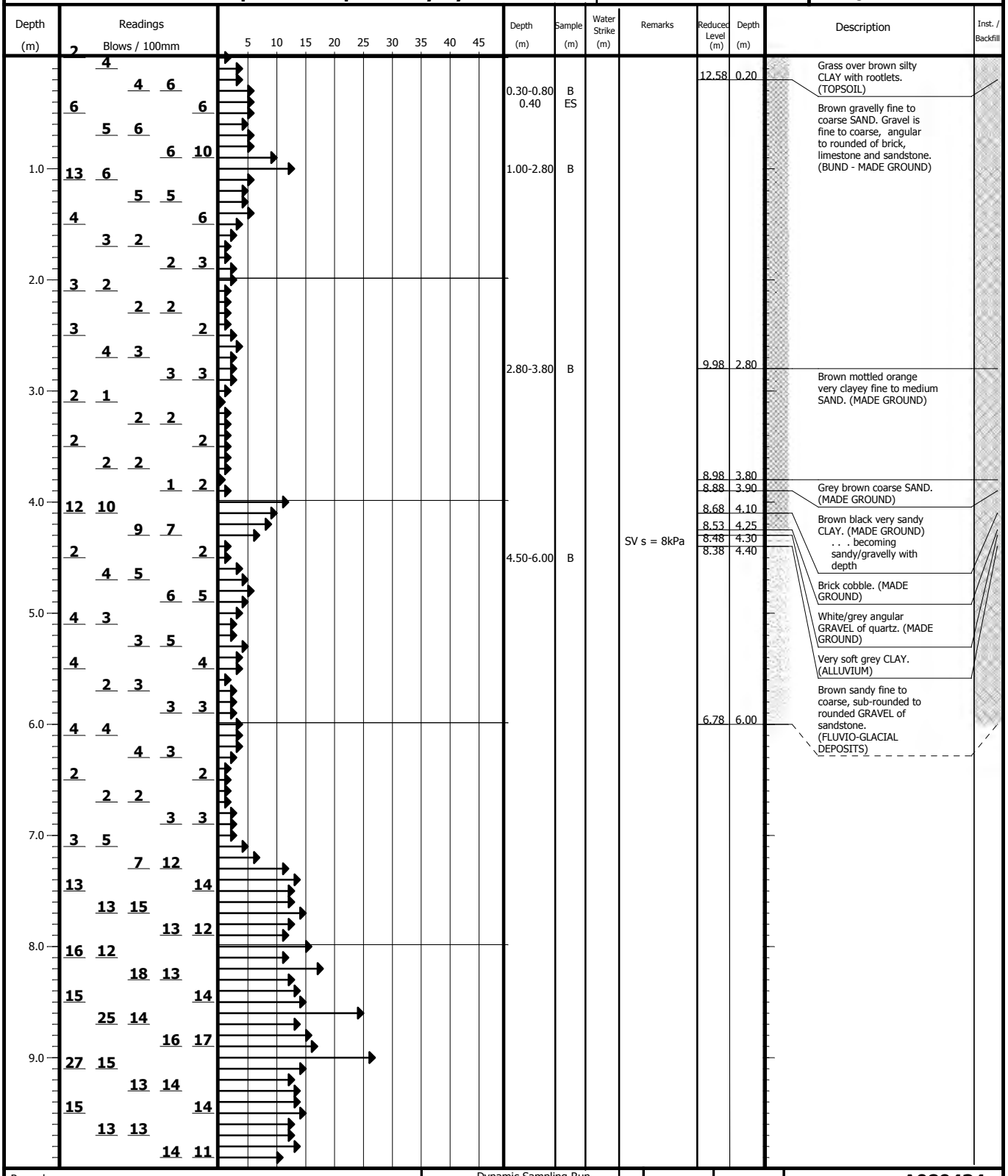
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **12.779**

Easting: **303124.68**
Northing: **375101.10**



Depth (m)	Sample (m)	Water Strike (m)	Remarks
0.30-0.80	B		
0.40	ES		
1.00-2.80	B		
2.80-3.80	B		
4.50-6.00	B		SV s = 8kPa

Reduced Level (m)	Depth (m)	Description	Inst. / Backfill
12.58	0.20	Grass over brown silty CLAY with rootlets. (TOPSOIL)	
		Brown gravelly fine to coarse SAND. Gravel is fine to coarse, angular to rounded of brick, limestone and sandstone. (BUND - MADE GROUND)	
9.98	2.80	Brown mottled orange very clayey fine to medium SAND. (MADE GROUND)	
8.98	3.80		
8.88	3.90	Grey brown coarse SAND. (MADE GROUND)	
8.68	4.10	Brown black very sandy CLAY. (MADE GROUND)	
8.53	4.25	. . . becoming sandy/gravelly with depth	
8.48	4.30	Brick cobble. (MADE GROUND)	
8.38	4.40	White/grey angular GRAVEL of quartz. (MADE GROUND)	
		Very soft grey CLAY. (ALLUVIUM)	
6.78	6.00	Brown sandy fine to coarse, sub-rounded to rounded GRAVEL of sandstone. (FLUVIO-GLACIAL DEPOSITS)	

Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. Groundwater struck at 4.5mbgl

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	4.00m	67mm	100%
4.00m	5.00m	57mm	100%
5.00m	6.00m	57mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO.	**A089434**
Logged by:	**GC**
Checked by:	**CBP**
Release Status:	**Final**
Excavation Date:	**13/10/2014**

Plate Title	Plate No
WINDOW SAMPLE 03	3

WYG Environment
5th Floor, Longcross Court, 47 Newport Road, Cardiff
Tel: 02920 829200
Fax: 02920 455321
Environmental Consultancy
Ground Engineering Services

Project	Plate Title	
ST ASAPH FRM	WINDOW SAMPLE 04	
Client: NRW	Checked by: CBP	Plate No.: 4

WYG ENVIRONMENT
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 **WS05**

Sheet 1 of 1

Scale 1:50

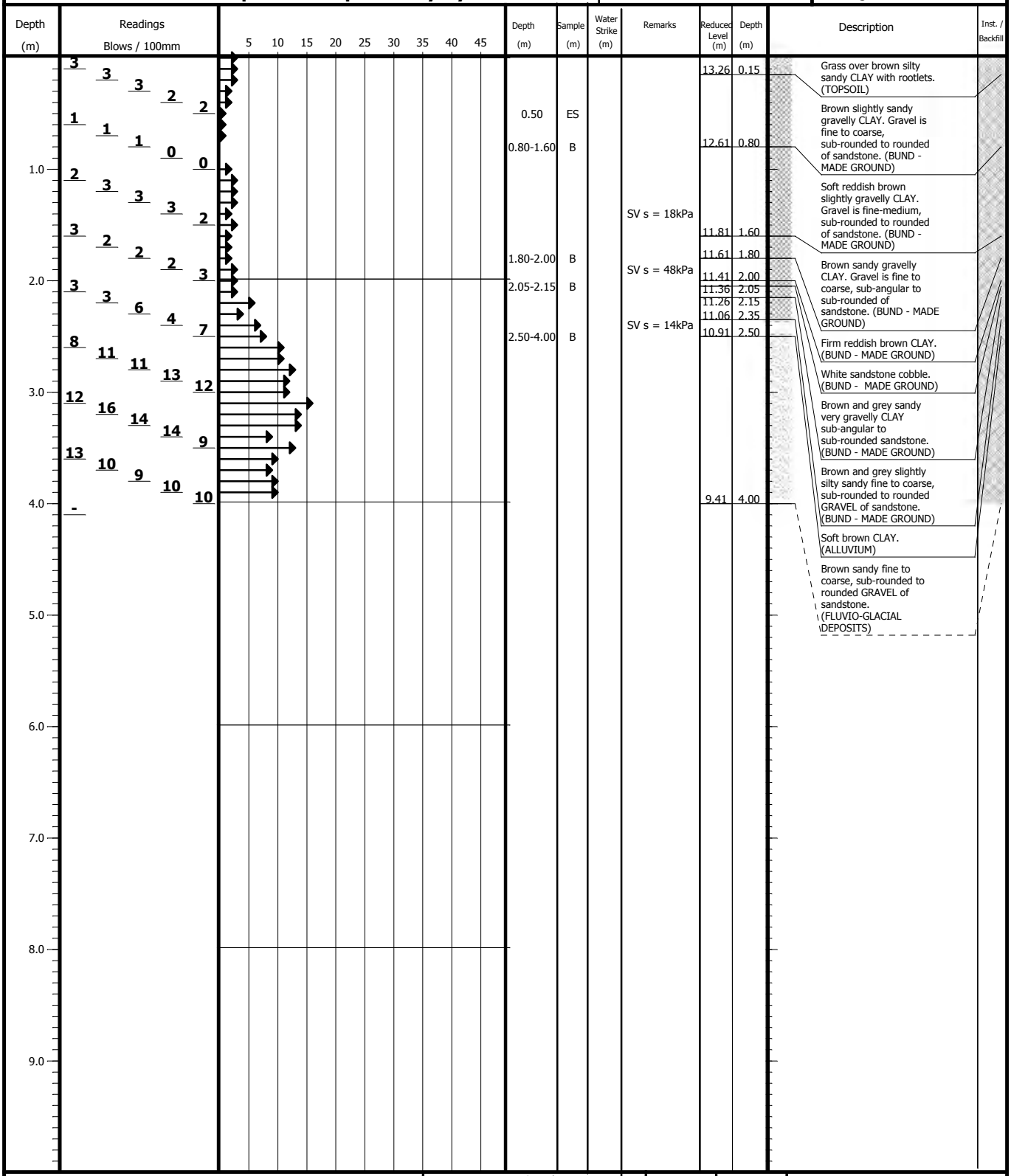
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **13.408**

Easting: **303270.79**
Northing: **375050.87**



Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	4.00m	67mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO.	**A089434**
Logged by:	**GC**
Checked by:	**CBP**
Release Status:	**Final**
Excavation Date:	**14/10/2014**

WYG ENVIRONMENT
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 **WS06**

Sheet 1 of 1

Scale 1:50

Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **13.667**

Easting: **303311.58**
Northing: **374957.82**

Depth (m)	Readings Blows / 100mm	Depth (m)	Sample (m)	Water Strike (m)	Remarks	Reduced Level (m)	Depth (m)	Description	Inst. / Backfill
0.0	2 2 1 2 2	0.10-0.50	B			13.62	0.05	White and grey angular GRAVEL path covering. (MADE GROUND - PATH)	
	5 4 7 11 4					13.17	0.50	Brown mottled grey very gravelly CLAY of fine to coarse, angular to sub-rounded of sandstone with wood and brick fragments. (BUND - MADE GROUND)	
1.0	3 3 2 2 3					12.47	1.20	Quartz and sandstone cobbles with some brown clay. (BUND - MADE GROUND)	
	3 3 3 3 3							Firm to stiff brown slightly sandy gravelly CLAY. (BUND - MADE GROUND)	
2.0	- - - - -	2.10-2.70	B			11.47	2.20	. . . becoming gravelly with depth.	
	- - - - -							Brown gravelly SAND, gravel is fine to coarse, sub- rounded to rounded. (FLUVIO-GLACIAL DEPOSITS)	
3.0	-					10.67	3.00		
4.0									
5.0									
6.0									
7.0									
8.0									
9.0									

Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO.	**A089434**
Logged by:	**GC**
Checked by:	**CBP**
Release Status:	**Final**
Excavation Date:	**14/10/2014**

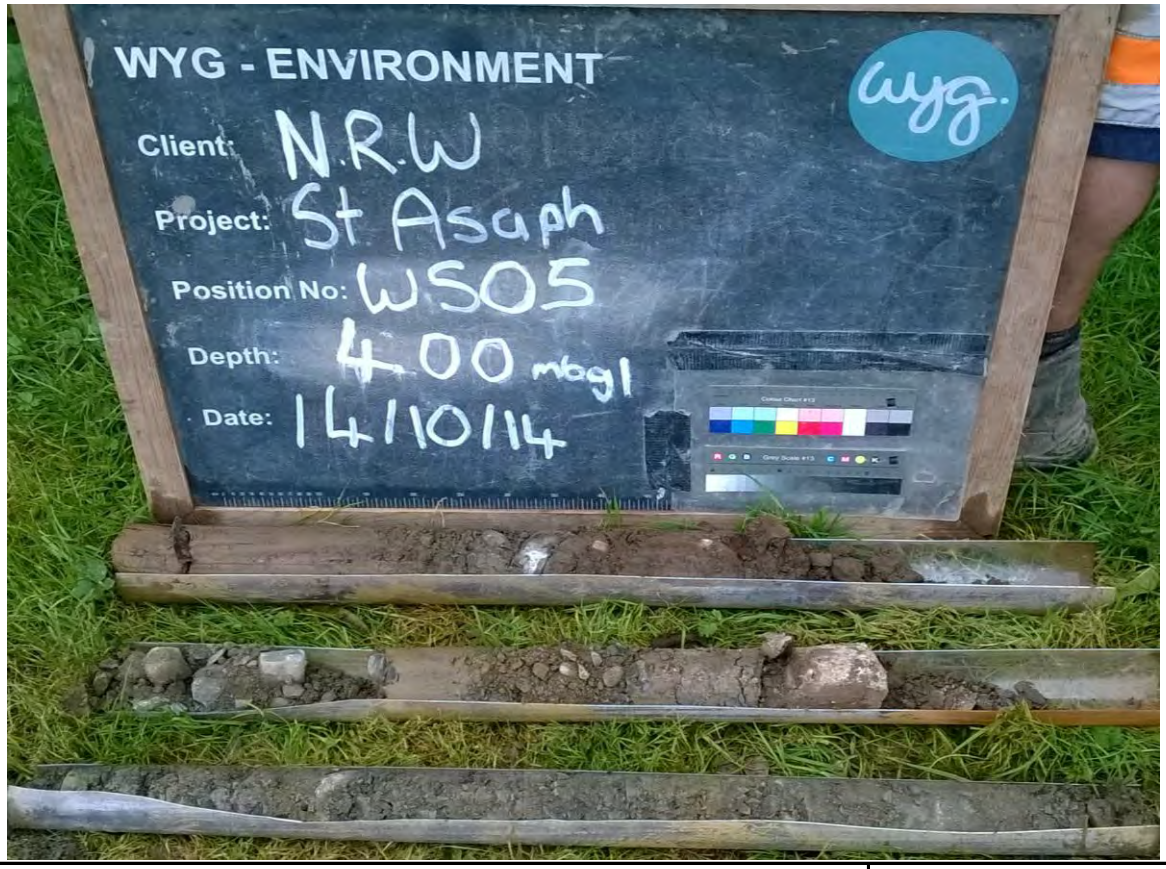


Plate Title	Plate No
WINDOW SAMPLE 05	5

WYG Environment
5th Floor, Longcross Court, 47 Newport Road, Cardiff
Tel: 02920 829200
Fax: 02920 455321
Environmental Consultancy
Ground Engineering Services

Project	Plate Title	
ST ASAPH FRM	WINDOW SAMPLE 06	
Client: NRW	Checked by: CBP	Plate No.: 6

WYG ENVIRONMENT
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 **WS07**

Sheet 1 of 1

Scale 1:50

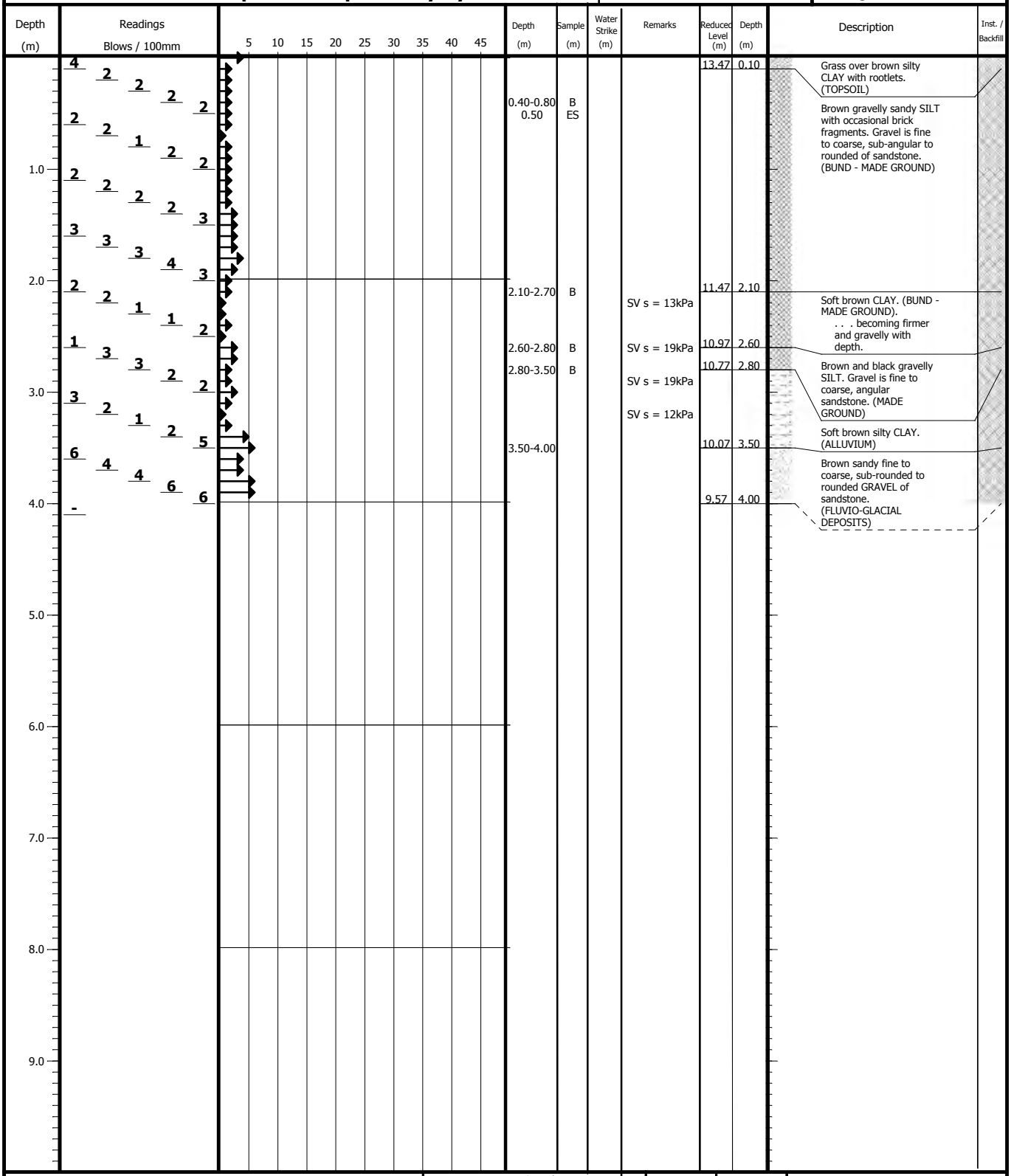
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **13.573**

Easting: **303373.98**
Northing: **374966.14**



Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	4.00m	67mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **14/10/2014**

WYG ENVIRONMENT
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 **WS08**

Sheet 1 of 1

Scale 1:50

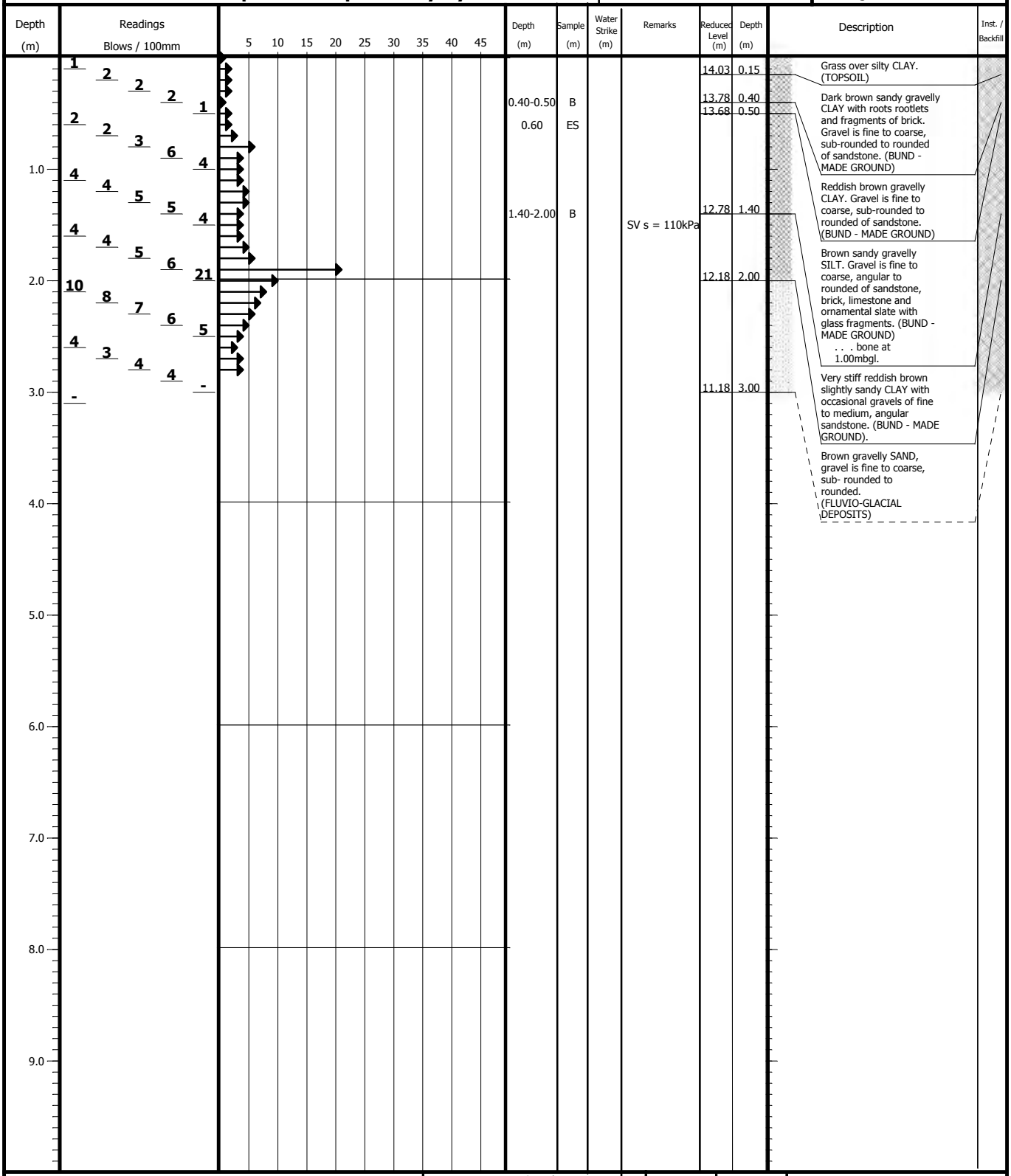
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **14.183**

Easting: **303524.28**
Northing: **374717.66**



Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **14/10/2014**

Plate Title	Plate No
WINDOW SAMPLE 07	7

WYG Environment
5th Floor, Longcross Court, 47 Newport Road, Cardiff
Tel: 02920 829200
Fax: 02920 455321
Environmental Consultancy
Ground Engineering Services

Project	Plate Title	
ST ASAPH FRM	WINDOW SAMPLE 08	
Client: NRW	Checked by: CBP	Plate No.: 8

WYG ENVIRONMENT
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 **WS09**

Sheet 1 of 1

Scale 1:50

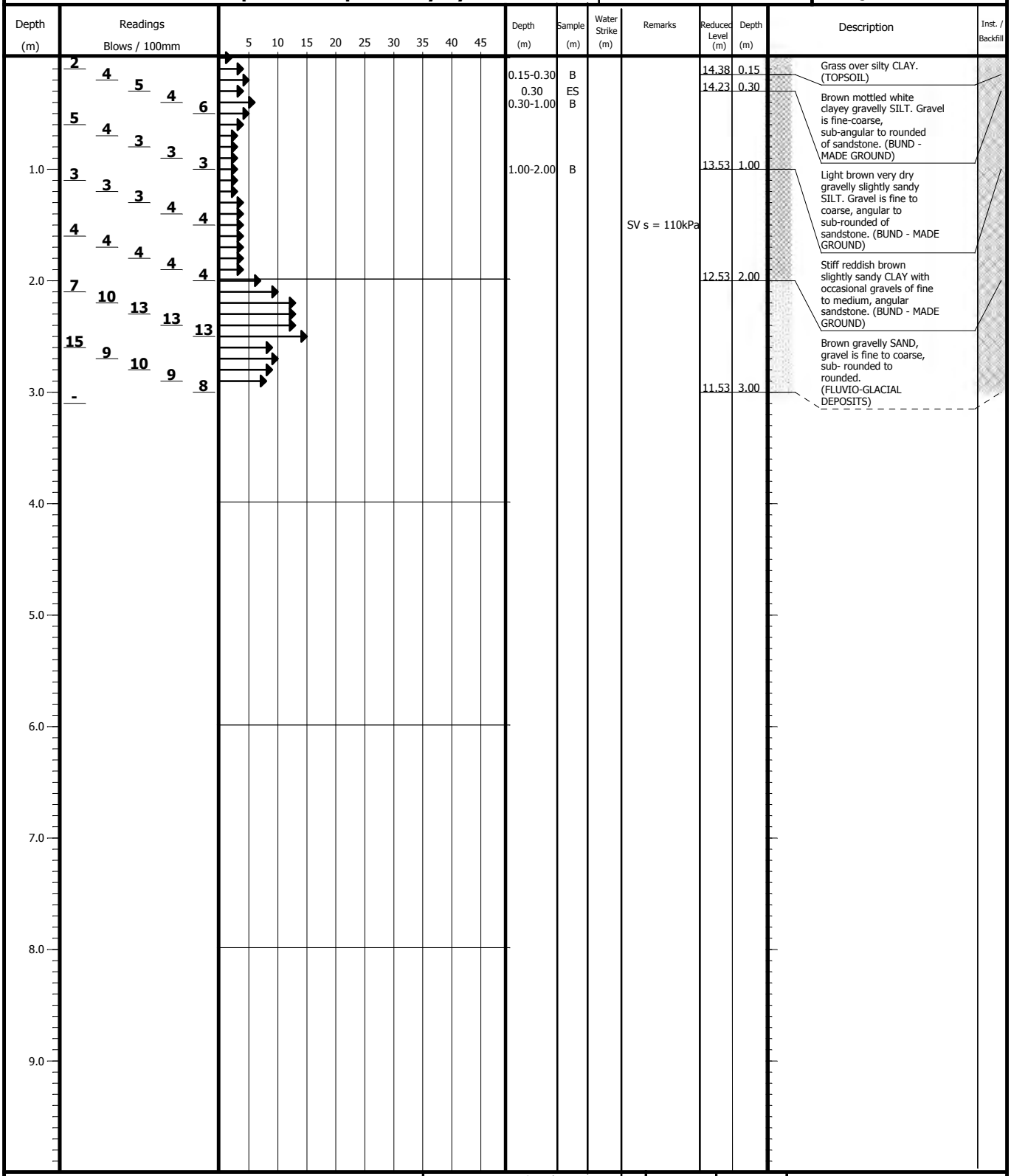
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **14.529**

Easting: **303479.13**
Northing: **374624.67**



Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **14/10/2014**

WYG ENVIRONMENT
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 **WS10**

Sheet 1 of 1

Scale 1:50

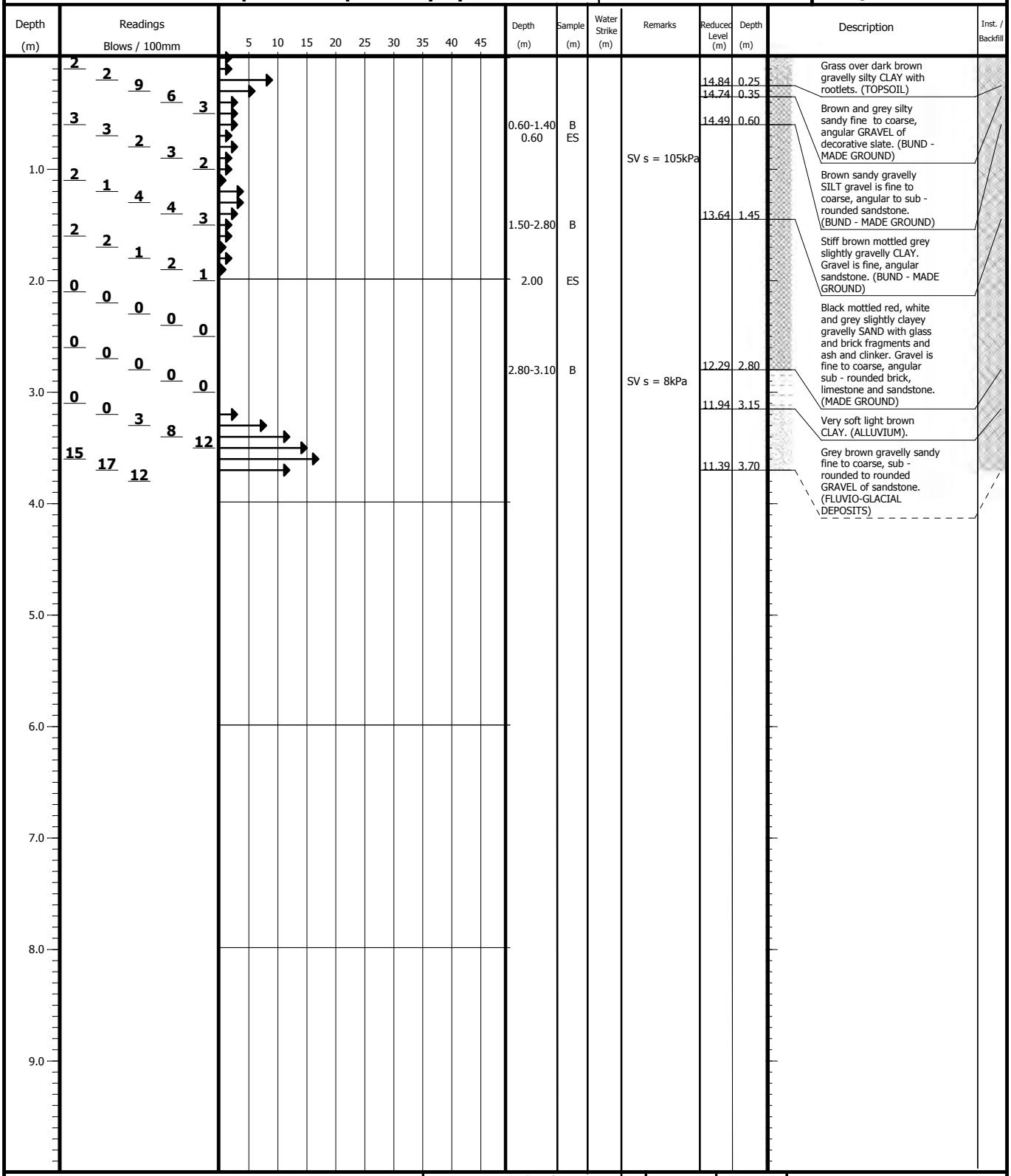
Project: **St Asaph FRM**

Client: **Natural Resources Wales**

Method: **Windowless Sampler and Super Heavy Dynamic Probe**

Ground Level: **15.094**

Easting: **303518.04**
Northing: **374501.34**



Remarks:

1. Inspection pit hand excavated to 1.20mbgl prior to drilling.
2. Backfilled with arisings.
3. No groundwater encountered.

Dynamic Sampling Run

From	To	Diameter	Recovery
1.20m	2.00m	87mm	100%
2.00m	3.00m	77mm	100%
3.00m	3.70m	67mm	100%

Fall Height:	750mm
Hammer Wt:	63.50kg
Probe Type:	DPSH
Cone Size:	50mm

PROJECT NO. **A089434**
Logged by: **GC**
Checked by: **CBP**
Release Status: **Final**
Excavation Date: **15/10/2014**

Plate Title	
WINDOW SAMPLE 09	9

WYG Environment
5th Floor, Longcross Court, 47 Newport Road, Cardiff
Tel: 02920 829200
Fax: 02920 455321
Environmental Consultancy
Ground Engineering Services

Project	Plate Title	
ST ASAPH FRM	WINDOW SAMPLE 10	
Client: NRW	Checked by: CBP	Plate No.: 10