SOAKAWAY TEST REPORT

SURFACE WATER

Fursdon House, Blunts Lane, Plymouth, Devon, PL6 8BE

Report Prepared for

Mr Angus Fraser

Report Prepared by

STG ENGINEERING LTD
GEOTECHNICAL SITE ENGINEERS

Report Status Sheet

Recipient:	Mr Angus Fraser
Project:	Fursdon House, Blunts Lane, Plymouth, Devon, PL6 8BE
Report Title:	Soakaway Test Report - Surface Water
Report Number:	STG1413 – STR – 01
Report Author:	Simon Tyrrell
Report Status:	FINAL
Date:	10th November 2023

CONTENTS

APPENDICES

LIMITATIONS AND EXCEPTIONS

THIS REPORT HAS BEEN PREPARED FOR THE SOLE INTERNAL USE AND RELIANCE OF MR ANGUS FRASER. THIS REPORT SHALL NOT BE RELIED UPON OR TRANSFERRED TO OTHER PARTIES WITHOUT THE EXPRESS WRITTEN AUTHORISATION OF STG ENGINEERING LTD. IF ANY UNAUTHORISED THIRD PARTY COMES INTO POSSESSION OF THIS REPORT THEY RELY ON IT AT THEIR OWN RISK AND THE AUTHORS OWE THEM NO DUTY OF CARE OR SKILL.

The findings and opinions conveyed via this Soakaway Test Report are based on information obtained from a variety of sources as detailed within this report, and which STG Engineering Ltd believes are reliable. Nevertheless, STG Engineering Ltd cannot and does not accept any liability for the detailed accuracy, errors or omissions in such information it has relied upon.

The report represents the findings and opinions of an experienced geotechnical consultant.
STG Engineering Ltd does not provide legal advice and the advice of lawyers may also be required.

It is possible that STG Engineering Ltd's inspections and assessments, while fully appropriate for the infiltration tests, may have failed to identify a variation of the strata (e.g further north or east of TP01). Assuming such variations exist, this information could not have been considered in the formulation of STG Engineering Ltd's findings and opinions.

In preparing this report, it has been assumed all relevant and other information has been provided. This report is not required to identify insufficiencies or mistakes in the information provided by the user/owner or from any other source but have sought to compensate for those where obvious in the light of other information.

The Findings (Soil Infiltration Rates) were specifically limited to the role STG Engineering Ltd was employed to undertake, as detailed and discussed within this report in accordance with the specified standards.

STG Engineering Ltd do not design or install SuDS (soakaway structures etc).

1 INTRODUCTION

1.1 Background

STG Engineering Ltd was commissioned by Mr Angus Fraser (hereby referred to as the client) via Wills Design Partnership Ltd to undertake soil infiltration tests in accordance with BRE Digest 365 for a surface water soakaway structure (hereby referred to as soakaway) for a proposed barn conversion at Fursdon House, Plymouth.

1.2 Site Location and Description

Fursdon House is located on Blunts Lane, Plymouth, Devon, PL6 8BE as a large rectangular parcel of land (hereby referred to as the site) within an urban area corresponding to the northern outskirts of Plymouth. The central region is occupied by the original residential dwelling, garage and driveway in the eastern region, barn in the SE corner whilst the remainder of the site is landscaped and terraced gardens with some established trees and shrubs.

The site gradient falls ~15° to the west corresponding to a N-S trending V-shaped valley. Consequently, to facilitate the original dwelling a prior cut and fill exercise has taken place; >2m cut in the east with material deposited in the western region creating a level lawned/garden area and a subsequent envelope of Made Ground which has steeper slope angle (~45°) as shown in additional photos in Appendix C.

The site is bounded by woodland to the north, west and south with commercial units further beyond to the north, N-S trending watercourse plus allotments further beyond to the west and managed grassland to the south whilst residential properties bound the site to the east.

1.3 Specification for the Works

Soakaway testing to determine the infiltration rate of the soil should be undertaken in accordance with BRE Digest 365 as follows:

- A trial pit with vertical sides trimmed square should be excavated, ideally in the proposed location of the soakaway, with a mechanical excavator to be 0.30-1.00m wide, 1.00-3.00m long and to a site-specific depth (suitable permeable geology). If necessary, for stability the hole should be filled with granular material and a full height perforated vertical pipe installed so that water levels can be monitored with a dip tape via the pipe.
- The trial pit should be filled to the design level of the drain (effective depth) and done so rapidly so that it is filled to its maximum effective depth in a short time replicating conditions when the soakaway will be at capacity, and for this a water bowser is required. Using a hose is not acceptable as water may infiltrate prior to the pit being full rendering inaccurate results.
- The filled hole with water should drain to near empty three time; each time record the water level and time from filling at intervals sufficiently close to clearly define water level versus time. The three fillings should be on the same or consecutive days. On sloping sites use a datum point on the lowest elevated face of the trial pit of the face thereby creating a constant when recording to the depth of the water.

2 SUMMARY OF THE WORKS

2.1 Overview

The area to the west of the barn conversion corresponding to garden was initially proposed but due to presence of nearby foul drainage, underground services, an old felled ash with substantial root network and inferred shallow bedrock based on topography/gradient this area of the site was avoided. Consequently, the area to the north of the terraced garden of Fursdon House was proposed corresponding to an area of scrub which would still promote a gravity flow system.

One trial pit (annotated TP01) was performed under the supervision of STG Engineering Ltd as shown in Appendix A1 noting Made Ground was expected.

The co-ordinates of the trial pit (displayed on the geological logs) were obtained with a hand-held Global Positioning System (GPS) with an accuracy of 3-5m.

The presence/absence of underground services was confirmed by the client and therefore a utility search was not undertaken by STG Engineering Ltd prior to sitework on this occasion. There were no underground services within the vicinity of TP01.

Risk Assessment and Methods Statements (RAMS) and Permit to Work were produced by STG Engineering Ltd prior to sitework and are kept on file and can be made available if required.

An excavator (Takeuchi TB230) with competent driver to undertake the excavation of the trial pit was supplied by the client whilst a tractor and water bowser supplied with clean water to undertake the infiltration tests were sourced locally by STG Engineering Ltd.

2.2 Duration of Works

TP01 and the three subsequent infiltration tests were performed on the 4th November 2023 and upon completion of sitework was reinstated that afternoon.

2.3 Weather Conditions

The weather during the sitework on the 4th November was cloudy and damp whilst a short shower (<5 mins) was experienced between Test 2 and Test 3.

Wet adverse weather was noted in the week prior corresponding to Storm Cairan and hence why the sitework was postponed for three days.

3 RESULTS

3.1 Geology

The geological records (British Geological Survey, GeoIndex, 2023) indicate no superficial geology and the bedrock geology to comprise Upper Devonian Slates – Slates.

3.2 Site Geology

3.2.1 TP01

This is a single large trial pit performed by a mechanical excavator 0.60m wide x 1.90m x long x 1.90m below existing ground level (begl) in the revised location of the proposed soakaway (Appendix A1).
The trial pit confirmed the findings of the geological records and identified a sequence of Topsoil over Made Ground (two stratum associated with a prior cut and fill exercise to facilitate Fursdon House and create a level garden area) over relic Topsoil over granular Residual Soil (weathered Upper Devonian Slate).
A summary of the ground conditions is presented in Table 1 below whilst a geological log is presented in Appendix B and the photographs are presented in Appendix C.
The strata within the trail pit were not level but followed the topography (~15°) to the west and thus the depths were recorded from the corner of Face A/B to reflect the maximum depths.
The presence of the Residual Soil was supported by an examination of the prior cut in the eastern region of the site by STG Engineering Ltd. Topsoil over orangish brown Residual Soil over weathered bedrock over bedrock was identified as shown in the additional photos in Appendix C.
It is worth noting that a dominant fabric (bedding) was evident within the bedrock which dipped steeply (80-90°) to the NE (annotated in Photo 14) which would promote downward movement of water.

Table 1: Summary of Ground Conditions (TP01)

Depth (m)	Geological Description (BS 5930:2015)
0 – 0.05	Dark brown slightly sandy CLAY with occasional rootlets (TOPSOIL)
0.05 – 0.45	Loose grey slightly silty sandy GRAVEL of angular to sub-angular various lithologies including concrete, slate and shale (MADE GROUND)
0.45 – 1.15	Loose yellowish brown silty GRAVEL with low cobble content. Gravel is angular to sub-angular fine to coarse shale (MADE GROUND – inferred cut material to the east)
1.15 – 1.30	Dark brown slightly sandy CLAY with occasional roots and rootlets (relic TOPSOIL)
1.30 – 1.90	Medium dense orangish brown silty GRAVEL with low cobble content. Gravel is angular to sub-angular fine to coarse elongate shale (RESIDUAL SOIL) (weathered Upper Devonian Slate)

3.2.2 Groundwater

TP01 was left open for >20 minutes standing time to determine any groundwater strikes to the base of the excavated trial pit. No groundwater was encountered from existing ground level to 1.90m begl, thereby allowing the process of performing the infiltration tests to be undertaken (in accordance with BRE Digest 365).

In accordance with The SuDS Manual C753 the maximum groundwater levels are to be >1m below the base of the soakaway structure and should always be adopted. Based on the sites setting and elevation due to overlying Made Ground acting as necessary cover, it is considered that the seasonal high groundwater table is likely to be below the base of any soakaway structure.

3.3 Geotechnical/Geological Implications

- Based on the density (medium dense) and composition of the granular Residual Soil (silty gravel with low cobble content) and confirmed permeability, the site or surrounding area is not susceptible to inundation settlement.
- Based on the geology, catchment gradient, and distance to existing structures/properties (>5m) there is no inferred concern from downhill waterlogging.
- The strength and natural composition of the underlying geology confirms the ground is not unstable and/or prone to differential settlement (loose/soft which could compact (removal of air between the soil particles), creation of voids via the washing of fines or be anthropogenic ground). Furthermore, the low cohesive content of the Residual Soil and interlocking granular nature with resultant density confirms a low risk from washing of fines and thus inferred low risk from subsidence.
- Based on the site topography there is consideration for critical cross-section beyond the site boundaries corresponding to both the Made Ground envelope and the natural slope beyond where infiltrated soakaway water issues from a (steep) ground surface which can cause erosion, instability and flooding. However, due to the soakaway being positioned within natural ground below the Made Ground, downward preferred movement of water, the favourable infiltration rates (See Section 3.5) and that there was no impermeable soil or rock layer(s) to promote horizontal movement of water (to an identified depth of 1.90m begl) it is considered that the majority of the infiltrated water will move downwards within the ground profile especially when considering the steeply dipping dominant fabric within the bedrock and so the risk of erosion, instability and flooding is considered low noting that this is not a direct concentrated surface discharge with high flow capable of surface washout and rilling. Furthermore, both the Made Ground slope and the natural slope are heavily vegetated, so any infiltrated water is likely to be absorbed by the vegetation before breaking the surface. It is also worth noting the natural slope corresponds to a N-S trending valley with a watercourse with seasonal waterlogging based on the hydrophilic vegetation observed.
- There are no underlying clay strata of medium to high plasticity which is prone to shrinking (contracting) and expanding (heave/swell) depending on the water content based on the

seasons and abstraction by any nearby vegetation which could lead to differential movement of the soakaway structure.

- The site is not within a mining area (except local quarries/pits) and thus there are not considered any underground shafts or features which may be affected by the infiltrating water from the proposed soakaway which could lead to future subsidence at the surface.
- There are no underlying calcareous rock formations (e.g. chalk) which can slowly dissolve over time leading to instability via sinkholes.

Overall, it is inferred that the proposed use of soakaway drainage, when constructed to be within the underlying Residual Soil would not result in demonstrable harm to the proposed site or existing adjacent areas.

3.4 Geo-Environmental Implications

Despite overlying Made Ground (reworked natural ground from prior cut and fill exercise to accommodate the original dwelling of Fursdon House), the potential for the soakaway to cause or accelerate the leaching of contamination to the groundwater and/or underlying soils is considered low as the soakaway would be positioned in natural ground from a start depth/top invert of 1.30m begl.

There was no evidence (visual or olfactory) of any contamination within TP01, no evidence of potential contamination sources upslope (residential properties) and groundwater >1.90m begl. Thus, contaminated land and any protection measures to prevent water from infiltrating contaminated layers, does not need to be considered further (based on the findings of the sitework/testing).

3.5 Soil Infiltration Rates

Three infiltration tests were undertaken within a trial pit of dimensions 1.90m long, 0.60m wide and 1.90m deep with an effective storage depth of 0.60m from a start depth of 1.30m begl. Please note the start depth was specified by the ground conditions encountered (avoid overlying Made Ground and relic Topsoil) plus maximum achievable depth of 1.90m begl due to collapse of the overlying Made Ground.

Photographs are presented in Appendix C noting Test 1 in-progress was not obtained based on short time recording intervals required, whilst the Test Sheets are presented in Appendix D.

The tests drained from 75% -25% effective depth in 3 minutes, 4.10 minutes and 4.88 minutes respectively as shown in Appendix E.

Using equation $f = V_{p75\text{-}25} \div a_{p50} \times t_{p75\text{-}25}$

$V_{p75\text{-}25}$: 1.90 x 0.60 x (1.75 – 1.45) = 0.342m³

a_{p50}: (1.90 x 0.30 x 2) + (0.60 x 0.30 x 2) + (1.90 x 0.60) = 2.64m²

$t_{p75\text{-}25}$: 180, 246 and 292.8 secs respectively

Therefore, $=0.342 \div (2.64 \times 180) = 0.000719697 = 7.20 \times 10^{-4}$

$=0.342 \div (2.64 \times 246) = 0.000526608 = 5.27 \times 10^{-4}$

$=0.342 \div (2.64 \times 292.8) = 0.000442437 = 4.42 \times 10^{-4}$

Lowest soil infiltration rate to be used for design is: **4.42×10^{-4} m/s** and corresponds to Test 3.

3.6 Summary

Infiltration test results confirm that the ground conditions at Fursdon House, Plymouth are suitable for infiltration and thus a soakaway structure is a viable option for the disposal of surface water within underlying orangish brown Residual Soil noting geotechnical and geo-environmental implications have been considered.

It is assumed that a geo-cellular crate type soakaway will be utilised in a rectangular format.

The overlying Made Ground to the east would be thinner whilst to the west would be thicker corresponding to the engineered terrace. However, it is assumed that a nominal 5m separation from the crest will be maintained to avoid unnecessary collapse within deeper Made Ground for the excavation of the soakaway structure but also instability to the actual Made Ground envelope.

REFERENCES

BRE Digest 365 – Soakaway Design. Revised 2016;

British Geological Survey (GeoIndex). 2023;

Building Regulations. 2015. Drainage and waste disposal – Approved Document H;

British Standards Institution. 2015. Code of Practice for ground investigations. BS 5930:2015. BSI, London;

British Standards Institution. 2020. Code of Practice for ground investigations. BS 5930:2015+A1:2020. BSI, London;

British Standards Institution. 2007. Eurocode 7 – Geotechnical Design, Part 1 General Rules, BS EN 1997-1. BSI, London;

British Standards Institution. 2007. Eurocode 7 – Geotechnical Design, Part 2 Ground Investigation and Testing, BS EN 1997-2. BSI, London;

CIRIA C753. The SuDS Manual. 2015. London;

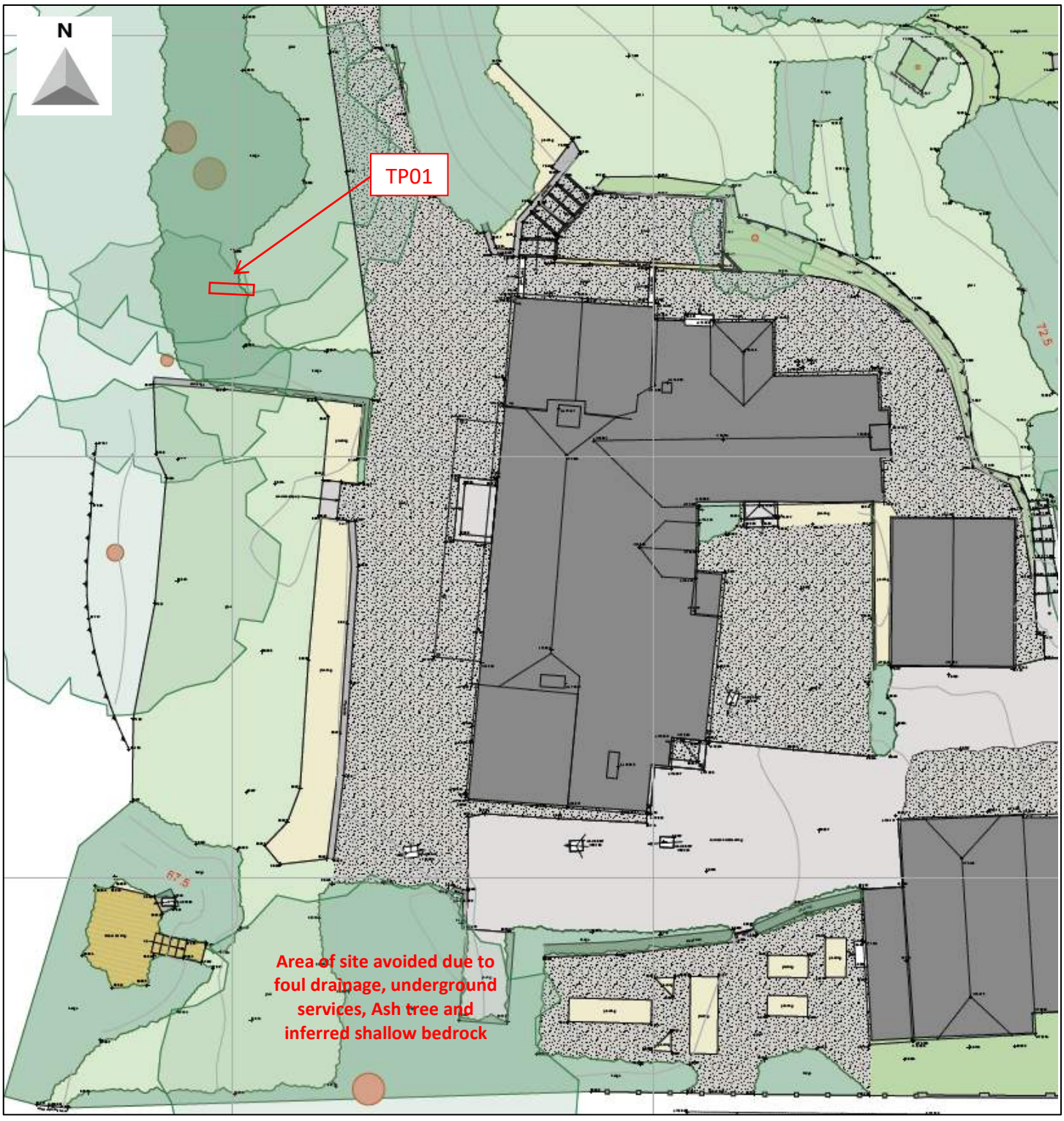
Drawing: Prism Measured Surveys - 2022.227 Site Plan, as existing

Appendix A: Figures

A1: Annotated Site Plan

STG ENGINEERING LTD
GEOTECHNICAL SITE ENGINEERS

ANNOTATED SITE PLAN
Fursdon House, Plymouth



Reproduced with permission from Prism Measured Surveys (Drawing No. 2022.227 Site Plan, as existing)

Appendix B: Logs

B1: TP01

STG ENGINEERING LTD GEOTECHNICAL SITE ENGINEERS	**Project Name:** Fursdon House	**Project Number:** STG1413	**Plant Used:** Takeuchi TB230	**TP01**
	Stability: Some collapse in MG	**Support:** None	**Weather:** Cloudy/damp	
Trial Pit Log	**E:** 50463 **N:** 59217	**Date:** 04/11/2023	**Logged By:** ST	**Page Number:** Sheet 1 of 1

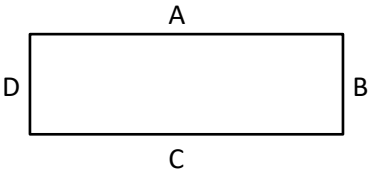
Sample and In Situ Testing			Stratum Details	
Depth (m)	Type	Test Results	Depth (m)	Stratum Description
			0.05	Dark brown slightly sandy CLAY with occasional rootlets (TOPSOIL)
				Loose grey slightly silty sandy GRAVEL of angular to sub-angular various lithologies including concrete, slate and shale (MADE GROUND)
			0.45	
				Loose yellowish brown silty GRAVEL with low cobble content. Gravel is angular to sub-angular fine to coarse shale (MADE GROUND – inferred cut material to the east)
			1.15	Dark brown slightly sandy CLAY with occasional roots and rootlets (relic TOPSOIL)
			1.30	
				Medium dense orangish brown silty GRAVEL with low cobble content. Gravel is angular to sub-angular fine to coarse elongate shale (RESIDUAL SOIL) (weathered Upper Devonian Slate)
			1.90	
				Trial Pit terminated at 1.90m (achievable depth due to collapse of overlying Made Ground)

1
2
3

Sample and Test Types:

D	Small disturbed sample (500ml)	SV	Shear Vane (SL810)
BB	Large disturbed sample (>5kg)	PP	Pocket Penetrometer
AJ	Amber jar (250ml)	SH	Schmidt Hammmer
V	Vial (60ml)	GP	Geological Pick

Strike of Face A	095 degrees
Length of Face A	1.90m
Width of Face B	0.60m



Groundwater Observations (level and rate of inflow):
None

Remarks:
Strata are not horizontal but follow the natural topography (15 degrees to the west) thus recorded depths were taken from the corner of Face A & Face B.
Infiltration Test Hole with 0.60m effective storage depth beneath relic Topsoil.
Trial Pit terminated at a maximum achievable depth of 1.90m begl due to collapse of overlying Made Ground
Density based upon difficulty of excavating and observations in trial pit only and no field tests or in-situ tests performed.

Appendix C: Photographs

C1: 4th November 2023

Photo 1: Completed TP01 from Face B looking 095 E

Photo 2: Completed TP01 from Face A looking 005 N

Photo 3: Completed TP01 from Face C looking 185 S

Photo 4: Spoil of TP01 (0 – 0.45m) looking 090 E

Photo 5: Spoil of TP01 (0.45 – 1.30m) looking 090 E

Photo 6: Spoil of TP01 (1.30 – 1.90m) looking 200 S

Photo 7: TP01 Test 1 in-progress (3 mins) from Face B looking 095 E

NOT OBTAINED

Photo 8: TP01 Test 1 competed (8 mins 15 secs) from Face B looking 095 E

Photo 9: TP01 Test 2 in-progress (4 mins 30 secs) from Face B looking 095 E

Photo 10: TP01 Test 2 competed (9 mins 42 secs) from Face B looking 250 W

Photo 10: TP01 Test 3 in-progress (3 mins) from Face B looking 095 E

Photo 11: TP01 Test 3 completed (12 mins) from Face B looking 095 E

Photo 12: Vegetated Made Ground envelope deposited upon natural ground looking N

Photo 14: Natural vegetated slope/ground beyond Made Ground looking N

Photo 13: Prior cut to the east showing Topsoil over Residual Soil looking E

Photo 14: Prior cut to the east showing underlying weathered Bedrock over Bedrock

Appendix D: Field Test Sheets

D1: TP01 – Test 1, Test 2 & Test 3

STG ENGINEERING LTD
GEOTECHNICAL SITE ENGINEERS

FIELD TEST SHEET

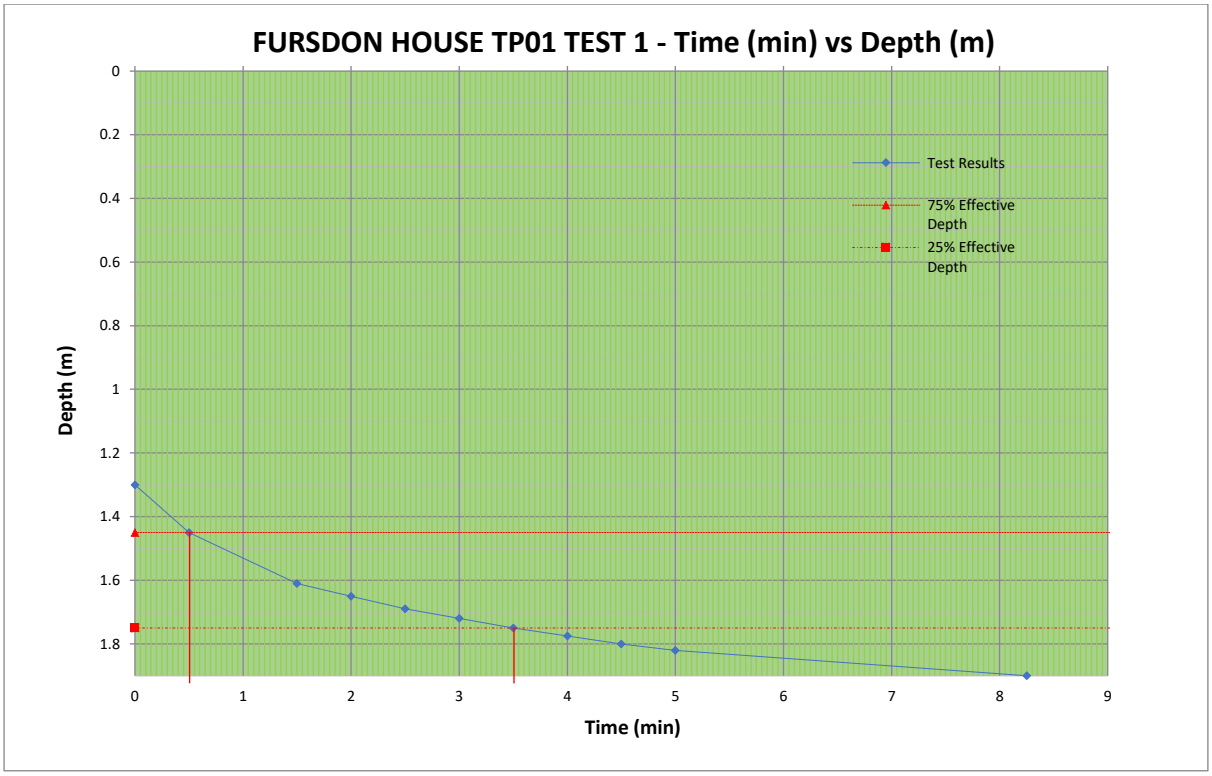
SURFACE WATER

Site: Fursdon House, Plymouth	Soakaway Number: **TP01**
Method of Excavation: Machine	Engineer: ST
Trial Pit Dimensions:	1.90m long x 0.60m wide x 1.90m deep
Co-ordinates:	E: 50463 N: 59217 (SX)

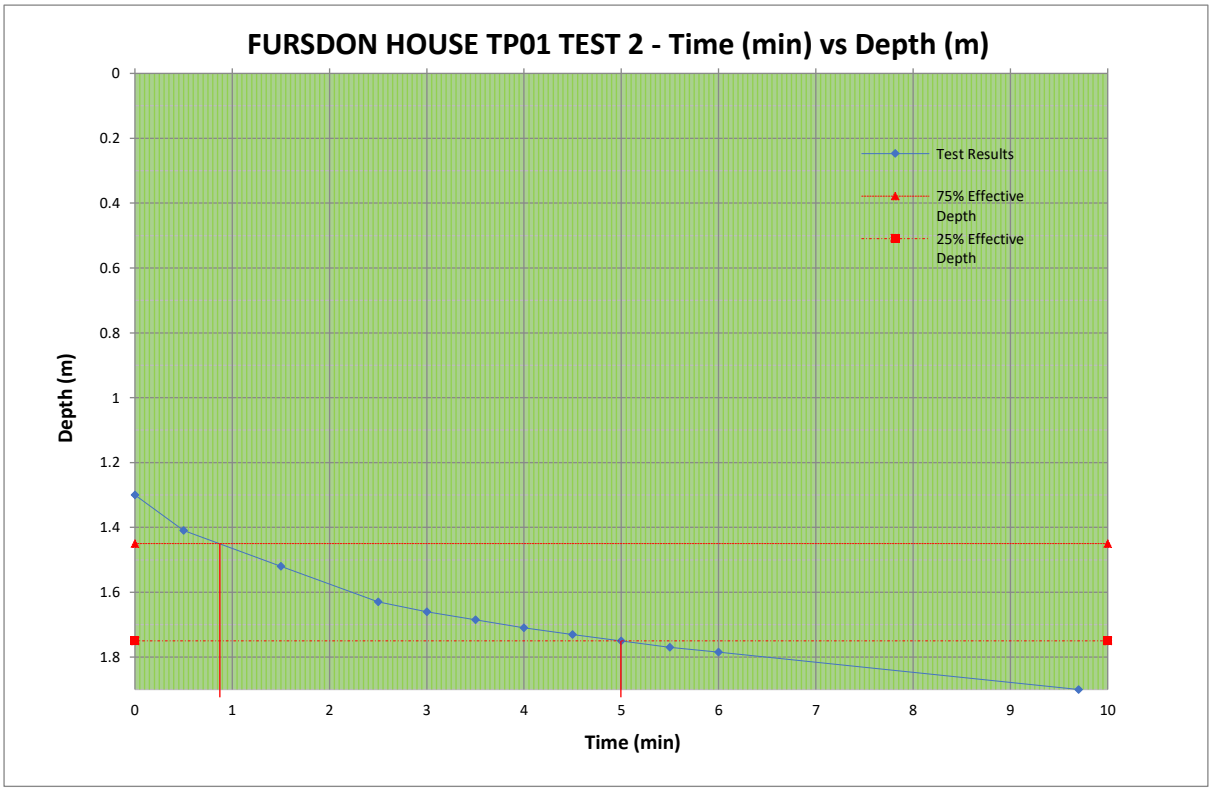
Test 1 Date: 04/11/23 Time: 10:10 Cloudy/damp		**Test 2** Date: 04/11/23 Time: 10:25 Cloudy/damp		**Test 3** Date: 03/07/23 Time: 10:40 Cloudy/shower	
Time	Depth (m)	Time	Depth	Time	Depth
0	1.30	0	1.30	0	1.30
30 secs	1.45	30 secs	1.41	30 secs	1.40
1 min 30 secs	1.61	1 min 30 secs	1.52	1 min 30 secs	1.51
2 mins	1.65	2min 30 secs	1.63	2 mins	1.56
2 mins 30 secs	1.69	3 mins	1.66	2 mins 30 secs	1.59
3 mins	1.72	3 mins 30 secs	1.685	3 mins	1.62
3 mins 30 secs	1.75	4 mins	1.71	3 mins 30 secs	1.65
4 mins	1.775	4 mins 30 secs	1.73	4 mins	1.675
4 mins 30 secs	1.80	5 mins	1.75	4 mins 30 secs	1.70
5 mins	1.82	5 mins 30 secs	1.75	5 mins	1.72
8 mins 15 secs	EMPTY	6 mins	1.785	5 mins 30 secs	1.74
		9 mins 42 secs	EMPTY	6 mins	1.755
				6 mins 30 secs	1.77
				7 mins 30 secs	1.795
				12 mins	EMPTY

Appendix E: Time Vs Depth Curves

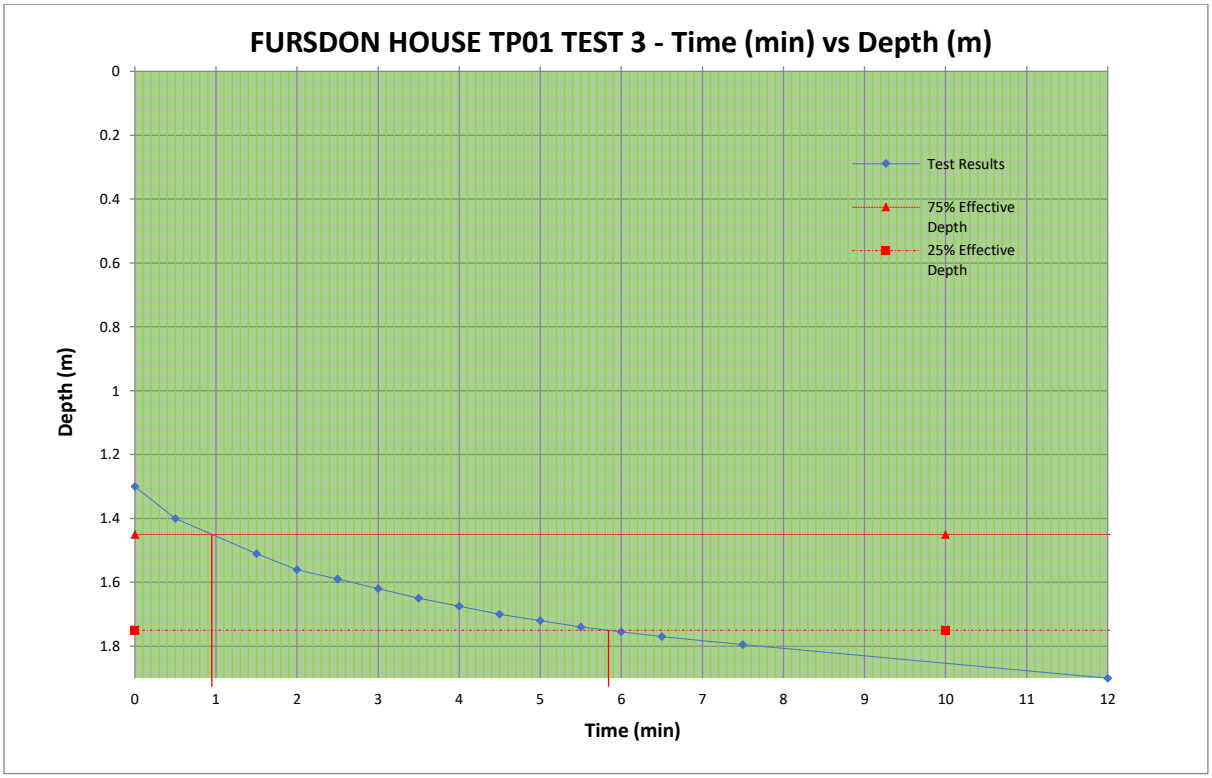
E1: TP01 - Test 1, Test 2 & Test 3



TEST 1: 75% Effective Depth Time = 0.50 mins, 25% Effective Depth Time = 3.50 mins. $T_{p75\text{-}25}$: 3.50 – 0.50 = 3.00 mins



TEST 2: 75% Effective Depth Time = 0.875 mins, 25% Effective Depth Time = 5.00 mins. $T_{p75\text{-}25}$: 5.00 – 0.875 = 4.125 mins



TEST 3: 75% Effective Depth Time = 0.95 mins, 25% Effective Depth Time = 5.83 mins. $T_{p75\text{-}25}$: 5.83 – 0.95 = 4.88 mins