

Our ref: 6872FCA_RevD

Flood Consequences Assessment
and Drainage Strategy

for

Land off Vicarage Lane

at

Gresford, Wrexham

For : Gower Homes
8 Temple Row
Wrexham
LL13 8LY

25 April 2019

Flood Consequences Assessment and Drainage Strategy
for Land off Vicarage Lane at Gresford, Wrexham

Document Verification

Project Title	Land off Vicarage Lane at Gresford, Wrexham
Project Number	6872
Document Title	Flood Consequences Assessment and Drainage Strategy
Document Number	6872FCA_RevD
This document is not to be used for contractual or engineering purposes unless the document verification sheet is signed where indicated by the approver of the document.	

Prepared by

Checked and Approved




A Jones

P R Sykes

*Senior Infrastructure Engineer**BSc (Hons), MSc (Eng), CGeol, FGS***Document Revision**

Report Reference	Date	Description	Prepared	Checked and Approved
6872FCA_Rev D	25/04/2019	Flood Consequences Assessment	A Jones	P R Sykes

This report has been prepared for and on behalf of our client, in accordance with the terms and conditions of the appointment agreement with Coopers. Other than where specifically allowed for in the said appointment agreement, any other party using this report for any purpose whatsoever does so at their own risk and any duty of care to that party is specifically excluded.

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

Contents

<u>Section</u>	<u>Page No.</u>
1.0 Introduction	3
2.0 Site Characteristics.....	4
3.0 Sources of Flood Risk Information	5
4.0 Sources of Flood Risk.....	7
5.0 Surface Water Drainage.....	8
6.0 Conclusions and Recommendations	10

Figures

Figure 1	- Site Location	4
Figure 2	- Natural Resources Wales Flood Map (River and Sea)	5
Figure 3	- Natural Resources Wales Surface Water Flooding Map	6

List of Appendices

Appendix 1	- Reference Drawing
Appendix 2	- Infiltration SUDS GeoReport
Appendix 3	- Dwr Cymru Welsh Water Pre-Planning Sewerage Enquiry
Appendix 4	- Greenfield Run-off Calculation
Appendix 5	- Infiltration Tests (GroundSolve Ltd)

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

1.0 Introduction

Coopers (Chester) Ltd, (Coopers) have been appointed by Gower Homes to assess the risk of flooding and to provide a Drainage Strategy for a site off Vicarage Lane, Gresford, Wrexham. Gower Homes are proposing a new housing development, comprising of approximately 41 No. dwellings.

Gower Homes are planning the construction of a mixture of semi-detached and detached residential properties with associated access road, parking, vehicular access and landscaping subject to conditions. It is understood the site does not currently benefit from any planning decision.

This flood consequences assessment (FCA) evaluates the proposals with regard to flood risk, identifying and appraising potential flood risk both to and from the whole site. Coopers have carried out the following:

- i. Assessment of the development potential of the site in line with the Welsh Government's Technical Advice Note 15: Development and Flood Risk (TAN15) and;
- ii. An assessment of surface water runoff and drainage strategy

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

2.0 Site Characteristics

2.1 Site Location

The site is a parcel of agricultural land in Gresford to the north of Wexham. The site is situated off Vicarage Lane at approximate grid reference SJ351544

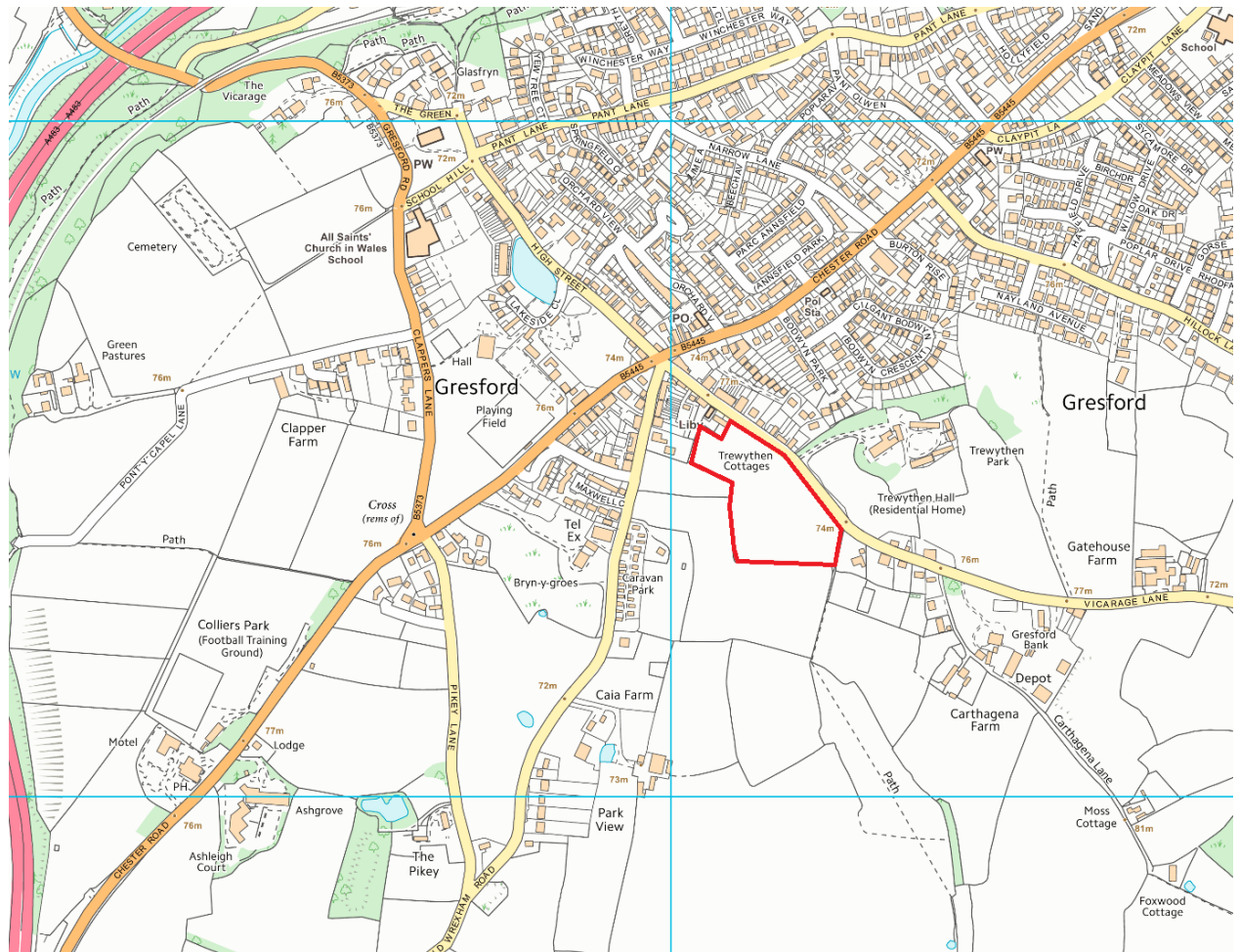


Figure 1 – Site Location

2.2 Site Description

The site covers an area of 2.75 Hectares and consists of one large grassed open agricultural field that was generally surrounded by trees, hedgerows and also Vicarage Lane to the northeast.

The topography of site varies from 76.8 AOD at the north, 75.5m AOD at the south and a low point in the center of the site at 69.7m AOD. Refer to topographical survey in Appendix 1.

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

3.0 Sources of Flood Risk Information

3.1 The Welsh Government Development Advice Map

The Welsh Government Development Advice Map shows the site is located within Flood Zone A – an area considered to be at little or no risk of fluvial or tidal flooding, with a less than 1 in 1000 (0.1%) annual probability of flooding in any given year

The proposed residential development is considered to be ‘highly vulnerable’ development in accordance with Figure 2 of the Welsh Governments Technical Advice Note 15. Highly vulnerable development is considered to be appropriate within Flood Zone A.

3.2 Natural Resources Wales

The NRW Flood Map shows the site is located within Flood Zone 1 – an area considered to have the lowest probability of fluvial flooding. It is assessed as having a less than 0.1% annual probability of flooding in any given year.

It should be noted that the Flood Map only covers flooding from rivers and the sea. Flooding can occur at any time and in any place from sources such as rising groundwater levels, burst water mains, blocked road drains, run-off from hillsides, sewer overflows, etc.



Figure 2 – Natural Resources Wales Flood Map for Planning (River and Sea)

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

The Natural Resources Wales long term flood risk maps indicate the site has a low risk of flooding from Surface Water. The areas shown to be at low risk are localised depressions in the topography and will be associated with general overland flow routes where water will collect for small duration prior to infiltrating into the natural ground. The trial pits encountered a siltier strata and infiltration test were observed as slower in this location, so any overland flows will pond in this area and slowly infiltrate into the surrounding ground. The larger area of surface water flooding on the western boundary will also take overland flows from the adjacent land as topography falls towards the site. Refer to Coopers Drawing No. 6872 / SK03 for overland flow routes and extent of flood area.

This area of flooding will need to be maintained or mitigated to ensure there is no additional flood risk post development. We have estimated approximately 630cu.m. of storage for surface water flooding is provided at the depression on the western boundary with a top water level of 70.75m AOD. Approximately half of this catchment is from within the site boundary and will be managed by the development site and re-grading therefore the storage requirement will be reduced.

Refer to Coopers Drawing No. 6872 / SK04 for surface water flood mitigation proposals. We are proposing to create a depression in an area of POS with similar base and top water level to the existing situation. The overall storage volume being provided is 320cu.m. and the lowest FFL on adjacent properties is set to a level of 71.05m AOD providing a 300mm freeboard.



Figure 2 – Natural Resources Wales Surface Water Flooding Map

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

3.3 British Geological Survey

The Infiltration SUDS report presented in Appendix 2 has identified the site groundwater as being likely to be more than 5m below the ground surface throughout the year and has not identified any likelihood of flooding within the vicinity of the site.

3.4 Wrexham LLFA

The Wrexham County Borough Council Local Flood Risk Management Strategy (April 2013) contains no records of any flooding at or near to the site.

4.0 Sources of Flood Risk

4.1 Fluvial

Extreme fluvial flood events have the potential to cause rapid inundation of the site whilst posing a threat to welfare and users. As outlined in Section 3.1; the site is within Flood Zone 1 and is therefore not at risk from extreme fluvial or tidal flooding. Therefore, the risk from extreme fluvial flooding to the site is considered to be low.

4.2 Infrastructure Failure (Existing and Proposed)

The failure of infrastructure such as culverts or bridges could increase the risk of flooding at the site. The following infrastructure includes:

- A proposed Foul Pumping Station is required to be constructed as part of the development, which if it failed due to flooding may cause the foul sewer to backup and flood the housing estate or other parts of the site.

The proposed Foul Pumping Station is to be constructed at 0.3m above the surrounding area to reduce the risks to it posed by flooding. Therefore; the risk of the pumping station failing due to flooding or the foul backing up within the housing estate is considered as very low.

4.3 Overland Flow

Overland flow occurs when the infiltration capacity of the ground is exceeded in a storm event. This can result in water travelling as a sheet flow overland or excess water being conveyed from location to another via local road networks. Due to the topography of the site sloping down towards the middle of the site and the road layout / proposed public open space, overland flow is not considered a significant risk.

4.4 Sewer Flooding

If the capacity of the sewers is exceeded in an extreme event, or a blockage occurs, surcharging of the network can result in surface flooding. Welsh Water sewer plans which are included in Appendix 3, indicate that there are currently no existing adopted sewers located within the site boundary.

Welsh Water have confirmed that foul flows will be allowed to drain to the public foul sewer network to a 150mm diameter combined sewer to the north of the site at an unrestricted rate.

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

The overall risk from sewer flooding is considered as low.

4.5 Groundwater Flooding

Groundwater flooding occurs as a result of water rising up from the underlying superficial deposits, bedrock or from springs.

The Infiltration SUDS report presented in Appendix 2 has not identified any risk of flooding due to groundwater and is therefore not at risk from groundwater.

4.5 Coastal Flooding

The site is not located in proximity of any tidal waterway or within close proximity to the Sea and is therefore not at risk from tidal inundation.

4.6 Reservoirs

The site is not located in proximity of any reservoirs. Additionally, the NRW maps indicate the site is not at risk of flooding from reservoirs.

5.0 Surface Water Drainage

5.1 General

The design for a surface water drainage system for the proposed development will be guided by the principles set out in the Welsh Government's 'Recommended non-statutory standards for sustainable drainage (SuDS) in Wales – designing, constructing, operating and maintaining surface water drainage systems' (2017)

The SuDS Standards Wales sets out the following hierarchy for surface water runoff destination:

Priority Level 1: Surface water runoff is collected for use;

Priority Level 2: Surface water runoff is infiltrated to ground;

Priority Level 3: Surface water runoff is discharged to a surface water body;

Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system;

Priority Level 5: Surface water runoff is discharged to a combined sewer.

Note that Priority Level 1 is the preferred (highest priority) and that 4 and 5 should only be used in exceptional circumstances.

5.2 Existing Surface Water Drainage

There is no existing surface water drainage within the proposed development site boundary.

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

5.3 Existing Site Runoff

The catchment surface area for the site and the proposed development is <50ha, therefore Micro Drainage software has been used to calculate the greenfield runoff for the site using the Interim Code of Practice (ICP) SUDS method. The outputs are provided in Appendix 4.

The greenfield runoff rate has been calculated as QBAR 2.1 l/s per hectare.

Therefore, with the area of the whole site being 2.65 Ha, the whole site has a QBAR of 5.56 l/s.

5.4 Proposed Surface Water Drainage and Runoff Rates

Priority Level 1

Whilst rainwater harvesting has been considered for the proposed development it should be noted that any device enabling water re-use cannot be taken into account when sizing attenuation as the storage facility may be full when a storm event occurs. Therefore, an over flow to an infiltration device (where ground conditions allow) or to a watercourse / sewer will be required.

Gower Homes are not proposing to incorporate rainwater harvesting within the development; however, they are proposing to install a water butt to each dwelling which will allow for water collection for garden re-use.

Priority Level 2

GroundSolve Ltd have undertaken infiltration testing on site during April 2018. The rates of infiltration varied and are generally very good. The only location where tests recorded slow rates was in the depressions at the lower elevation of the site. This is probably due to accumulations of silts being washed down from higher ground and collecting in the low points. However, any deeper soakaways can be located away from this area which may be more suited to shallow permeable paving which has a greater surface area.

It is therefore proposed that surface water run off from roofs and private drives will discharge into individual private soakaways installed within their gardens and all adoptable highways will discharge to a network of highway soakaways. The soakaways will be designed to accommodate a 100-year storm event and have an allowance for climate change.

Soakaways should be located at least 5m away from foundations. This is to prevent water that soaks into the surrounding ground from adversely affecting soil properties and causing excessive movement.

The locations of the tests along with trial pit information and infiltration rate calculations can be found in Appendix 5.

5.5 Foul Drainage

Welsh Water have responded to a pre-planning enquiry and have stated that foul flows can be accommodated within the public sewerage system and should be communicated with the foul sewer at or beyond manhole SJ35540501 located just off the site, to the north within Vicarage Lane.

Flood Consequences Assessment and Drainage Strategy for Land off Vicarage Lane at Gresford, Wrexham

Topography of the site is lower than the existing sewers and will therefore require a pump station to be incorporated into the new development to enable foul flows to be pumped back up to Vicarage Lane via a rising main. A breakout chamber will be required approximately 10m upstream of the point of connection into the public sewer.

6.0 Conclusions and Recommendations

The site is located in Flood Zone 1 and has been shown to be at low risk of flooding from rivers, groundwater, sewers and climate change. Therefore, mitigation measures are not considered necessary for any future development at the site.

There is a low risk of surface water flooding within the site. The overland flows within the development site will be mitigated by the development and incorporation of drainage networks. The overland flows from adjacent land off-site will still drain into the site so an area of POS providing temporary flood storage has been provided to mitigate any additional flood risk.

The BGS SUDS Infiltration Report indicates that the underlying soils have potential infiltration characteristics for soakaways across the site. Therefore, surface water run-off from highways, roof and private drives will discharge into the ground via infiltration techniques.

The 6 No. infiltration tests undertaken across the site by GroundSolve Ltd have confirmed the ground conditions are suitable to drain the site via infiltration techniques. The final design may incorporate a combination of devices at various depths to suit the site conditions.

A foul pumping station will be required to pump flows back to the public sewers in Vicarage Lane. This should be set approximately 300mm above the surrounding ground and will be subject to Welsh Water approval.

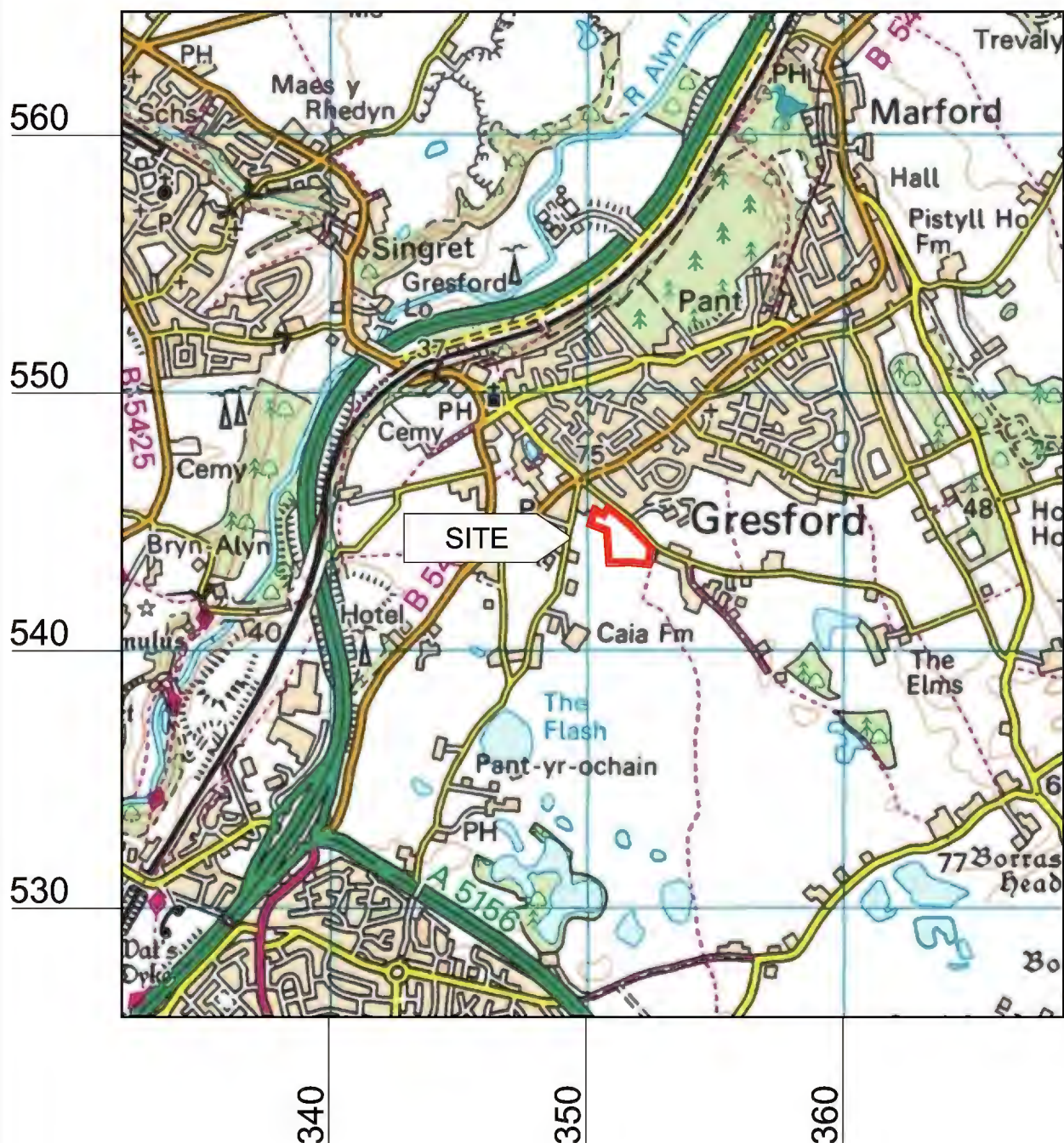
Flood Consequences Assessment and Drainage Strategy
for land off Vicarage Lane at Gresford, Wrexham

Appendix 1

Reference Drawings

<u>Drawing No.</u>	<u>Revision</u>	<u>Title</u>
6872 / L1	-	Site Location Plan
6871 / AP		Aerial Photograph
M1432	A	Topographical Survey
6872 / SK01	B	Preliminary Site Levels
6872 / SK02	B	Preliminary Drainage Strategy
6872 / SK03	-	1000-year Surface Water Flooding
6872 / SK04	-	1000-year Surface Water Flooding - Mitigation


 National Grid reference
 of the proposed site.

SJ 351544


0 200 400 600 800 1000 1500 2000

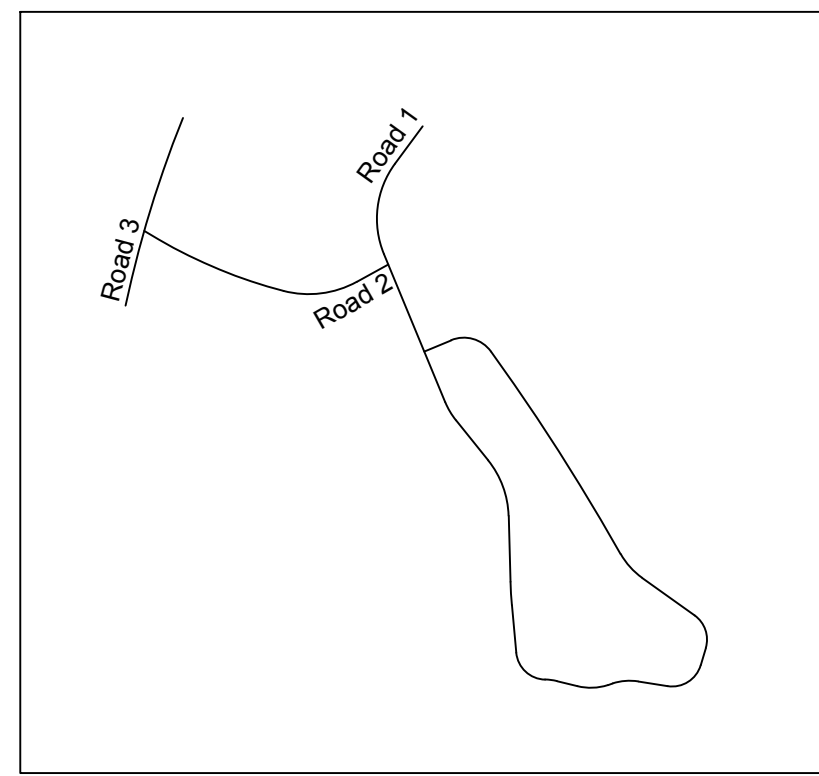
SCALE BAR (m)


KEY
 Site boundary

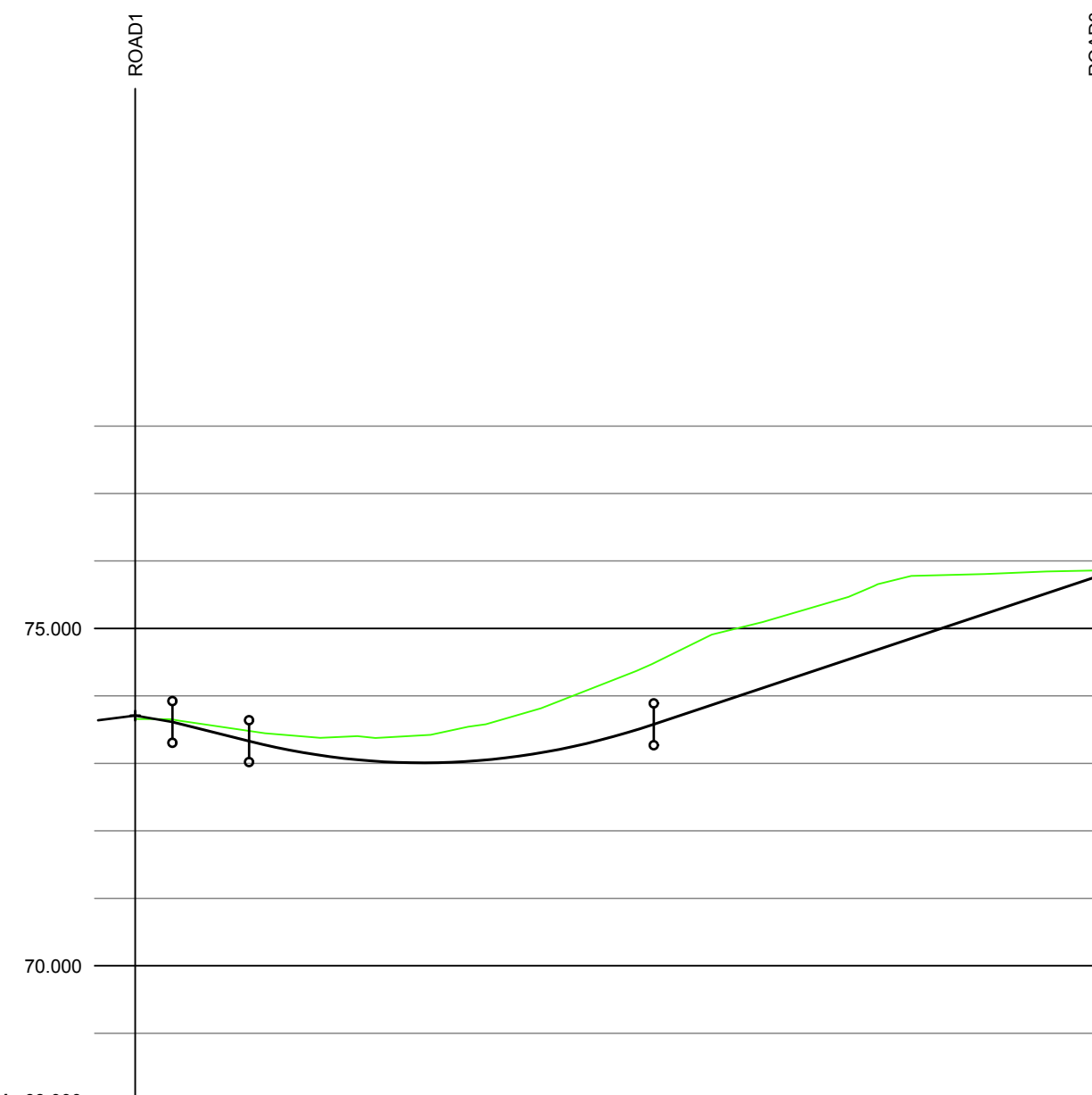
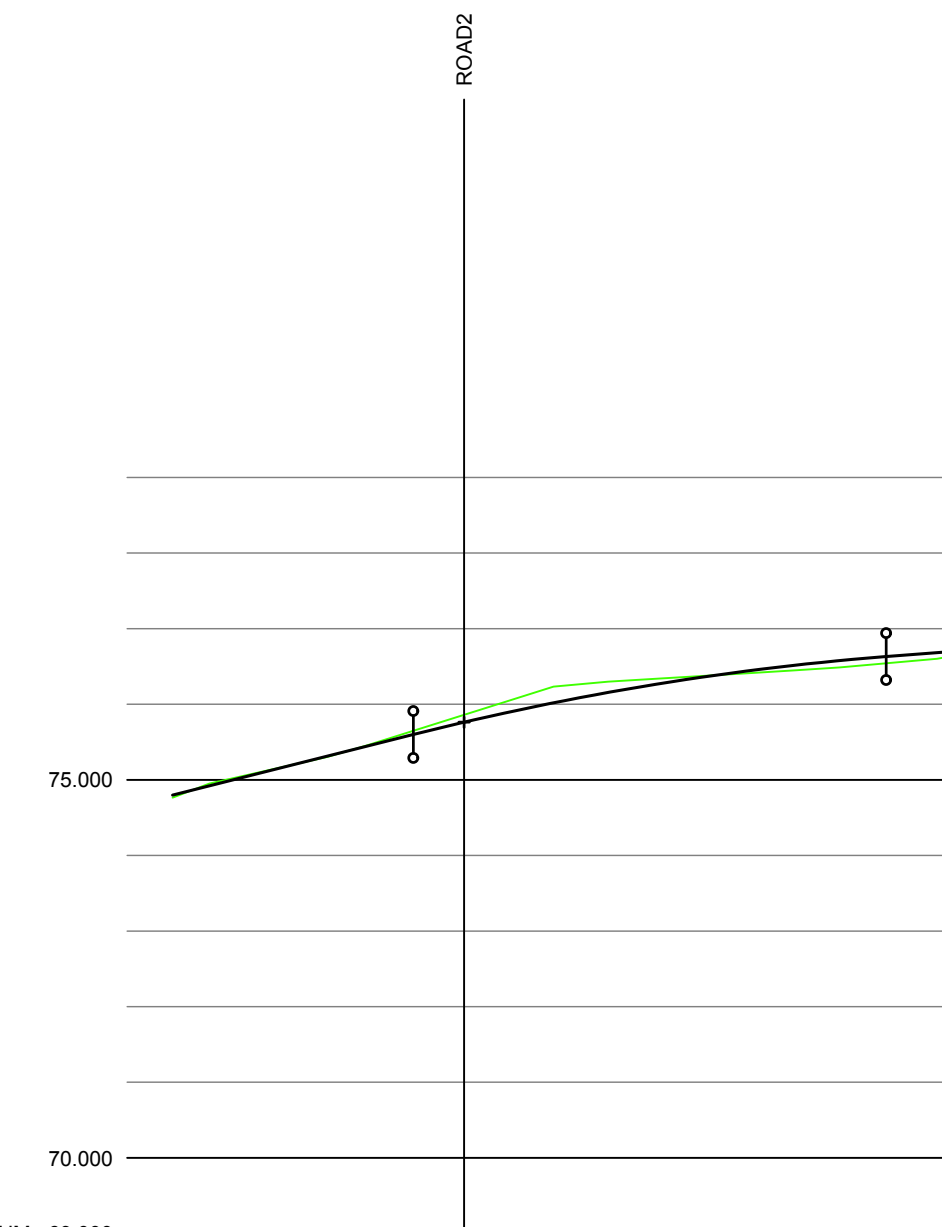
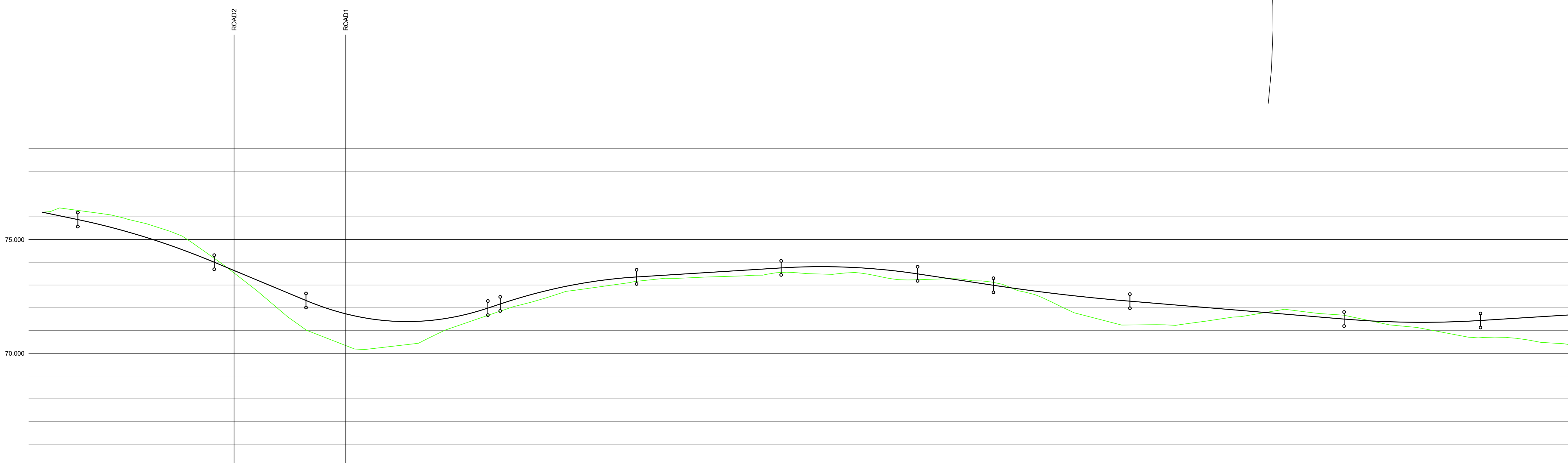
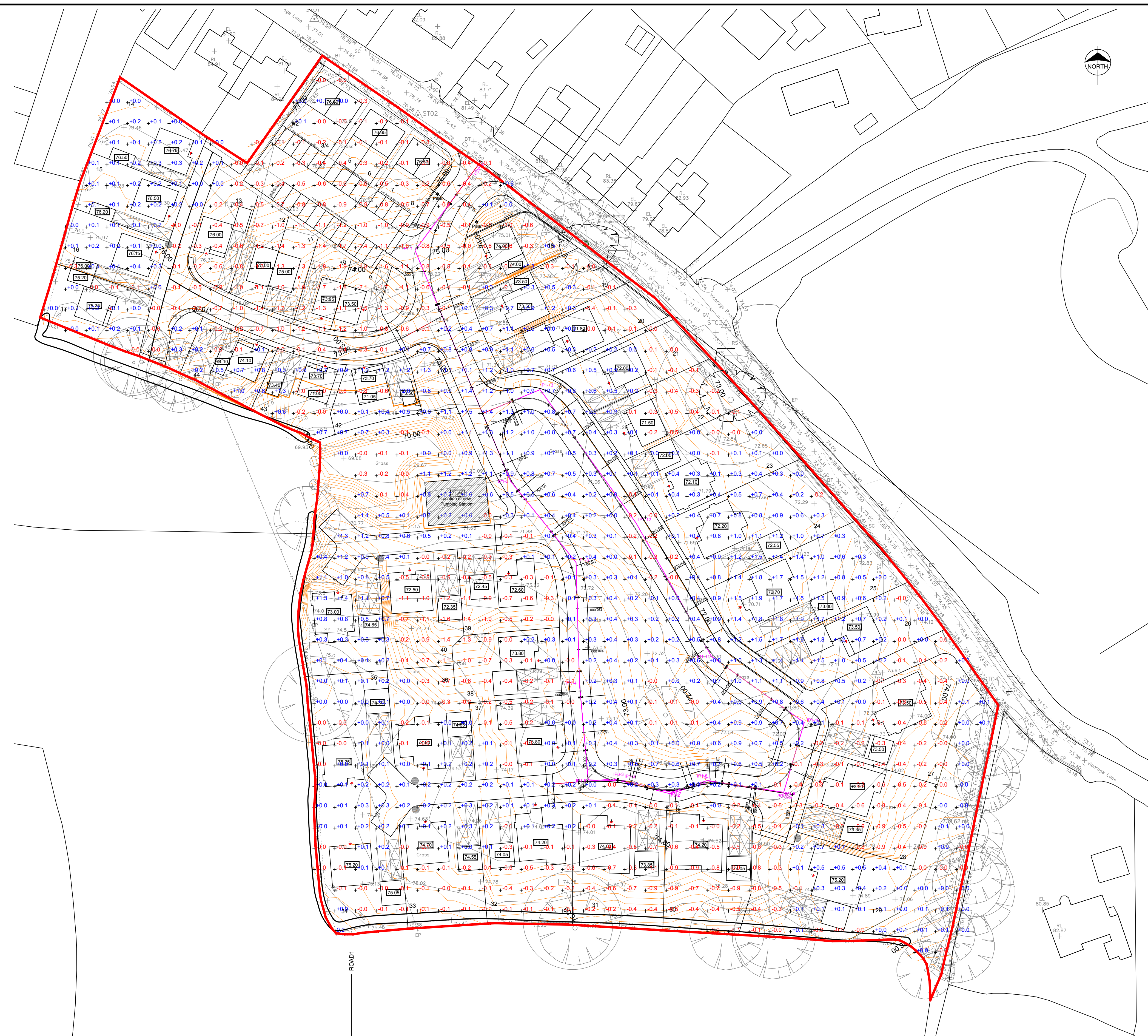

0 200 400 600 800 1000 1500 2000

SCALE BAR (m)

DO NOT SCALE



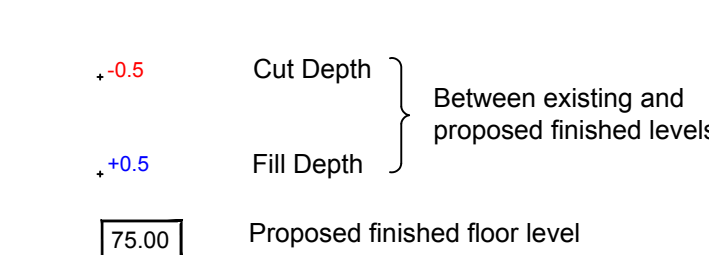
Key Plan

[illegible][illegible][illegible]

Notes

1. Contours shown are proposed finished levels at 200mm intervals.
2. Existing EARTHWORKS as shown is to be excavated and all unsuitable material, including soft spots/vegetation must be removed prior to construction of the hard areas commencing.
3. Any running or standing water, pipes or structures are to be reported to the engineer immediately where the relevant advice will be provided.
4. All excavations are to be back-filled in accordance with the specification (BY OTHERS)

Legend



PRELIMINARY

B	10.04.19	Updated to suit revised planning layout	WC	AJ
A	26.03.18	Updated to suit revised planning layout	AJ	AJ
Rev.	Date	Revision	By	Appd.



Chartered consulting engineers

Tel: 01244 684910
Fax: 01244 684911
Email: admin@coopers.co.uk
Web: <http://coopers.co.uk>

Park House
Sandpiper Court
Chester Business Park
Chester
CH4 9QU

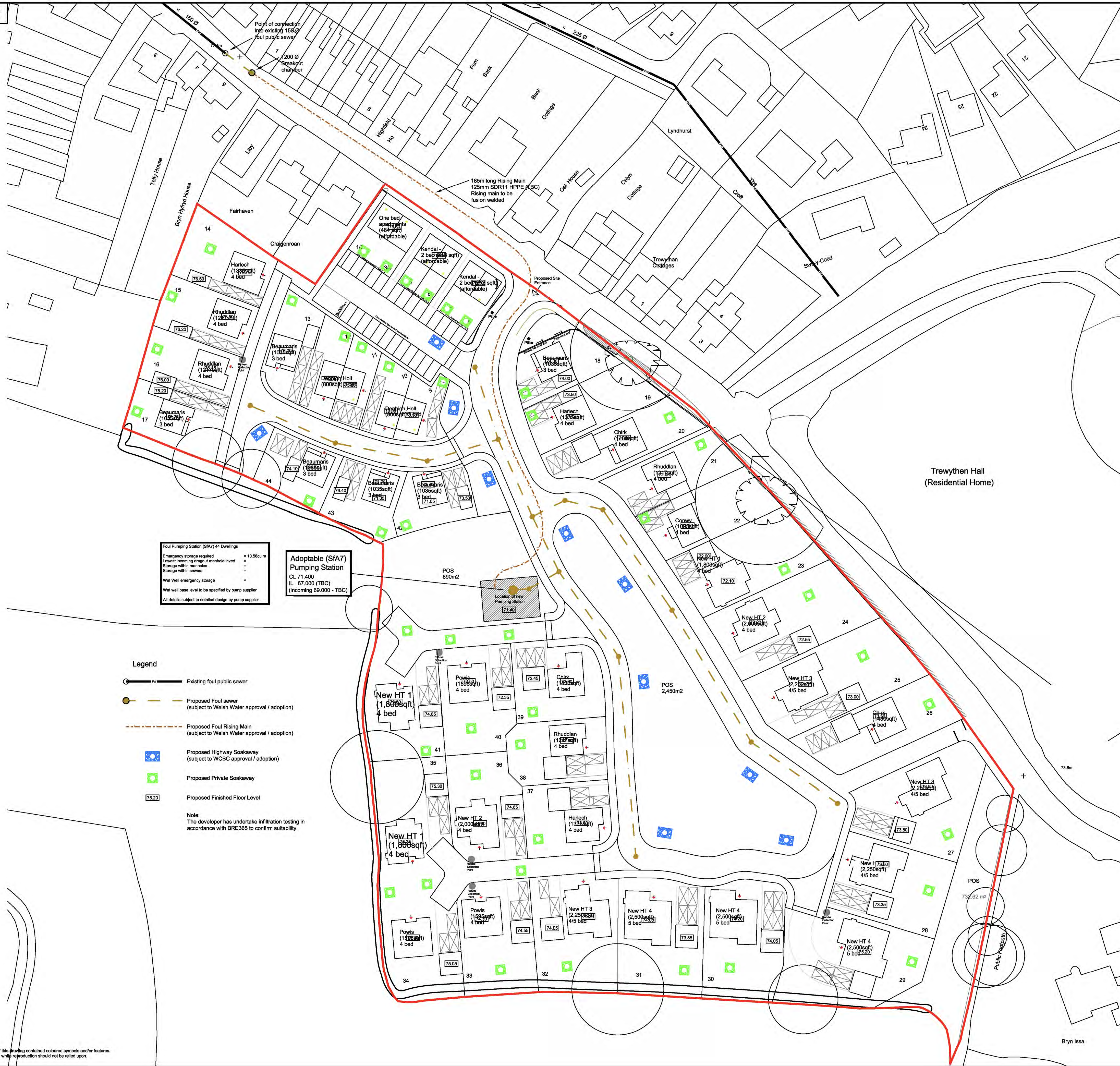
Client **GOWER HOMES**

Project **LAND AT VICARAGE LANE
GRESFORD, WREXHAM**

Preliminary Site Levels

DRAWING NUMBER 6872 / SK01	SCALE at A0 1:500		REVISION B
	DATE	Oct 2017	
	DRAWN	AJ	
	CHECKED	AJ	

DO NOT SCALE



Notes

- All dimensions are in millimetres unless otherwise shown.
- All adoptable drainage shall be constructed in accordance with 'Sewers for Adoption' 7th Edition, Welsh Ministers Standards and Welsh Water Details and Guidelines.
- All private drainage works are to comply fully with Part H of the Building Regulations.
- All existing invert levels to be checked by the contractor at the start of works and any other discrepancies notified to the Engineer prior to commencing works. All levels are based on topographical survey information provided by others.
- It is the responsibility of the Contractor to verify all information given with regards to existing services and drainage connections etc. prior to commencing the works.
- The Contractor shall adhere to the CDM Regulations at all times.
- Only trained personnel shall be permitted to enter confined spaces.
- All materials to bear the relevant B.S. Kitemark and comply fully with the Sewers for Adoption 7th Specification. All concrete & concrete products must use Sulphate resistant cement (unless the site investigation report proves that sulphate attack from soils and groundwater will not occur to withstand a class 3 condition).
- All opening notices etc. as required under Highways Acts etc. are to be obtained prior to commencement of works. All works are to be inspected by L.A., NHBC or Welsh Water as applicable.
- Trench backfill in highways to within 1m of highway shall, as directed by the Highway Authority be a suitable granular material all in accordance with Sewers for Adoption.
- Cover loadings shall be as detailed on the Manhole Schedule.
- Drain trenches should not be excavated lower than the foundations of any building nearby unless either:
a) The trench is within 1m of the foundation, the trench is filled with concrete up to the lowest level of the foundation, or
b) Where the trench is further than 1m from the building, the trench is filled with concrete to a level below the lowest level for the building equal to the distance from the build, less 150mm.
- Soakaways to be constructed a minimum of 5.0m from any proposed buildings or existing structures.
- All SVP and RWP connections are indicative and shall be confirmed by the client.
- Pipe gradients out of the building to connecting manhole to be laid at 1:40 in accordance with Building Regulations, Part H, Table 6.
- Where pipe sizes are not indicated:
1000 to be used for foul
1000 to be used for surface water unless stated otherwise.
- Minimum surface water gradients shall be:
100 laid at 1:100 with the exception of the first connection which shall be minimum 1:50
1500 laid at 1:150
- Minimum 1000 foul drainage gradient to be 1:80 with the exception of the first connection which shall be minimum 1:40.
- Manhole covers to be marked FWS or SW as appropriate.
- All manhole covers and frames shall comply with BS EN124. All adoptable manholes and chambers shall comply with Sewers for Adoption 7th Edition. Covers on roads to be grade D400 and be 150mm deep. Manhole covers in car parking areas and drives to be grade B125 and covers in landscaping areas to be grade A15. All to be sized in accordance with Building Regulations Part H, Tables 11 & 12.
- Precast concrete rings to be reinforced.
- Backdrops in private manholes / inspection chambers to be internal
- Private drains laid under adopted / private roads to be Class S granular bed and surround with a minimum of 1.2m cover, where this cannot be achieved a Class Z concrete bed and surround shall be provided.
- Private drains located under landscape areas or driveways / car parking bays to be Class B granular bed and surround with a minimum 0.6m cover, where this cannot be achieved a Class Z concrete bed and surround shall be provided.

PRELIMINARY

B	17.04.19	Updated to suit revised planning layout	PJN	AJ
A	26.03.18	Updated to suit revised planning layout	AJ	AJ
Rev.	Date	Revision	By	Appd.



chartered consulting engineers

Tel: 01244 684910
Fax: 01244 684911
Email: admin@coopers.co.uk
Web: http://coopers.co.uk

Park House
Sandpiper Court
Chester Business Park
Chester
CH4 9QU

Client

GOWER HOMES

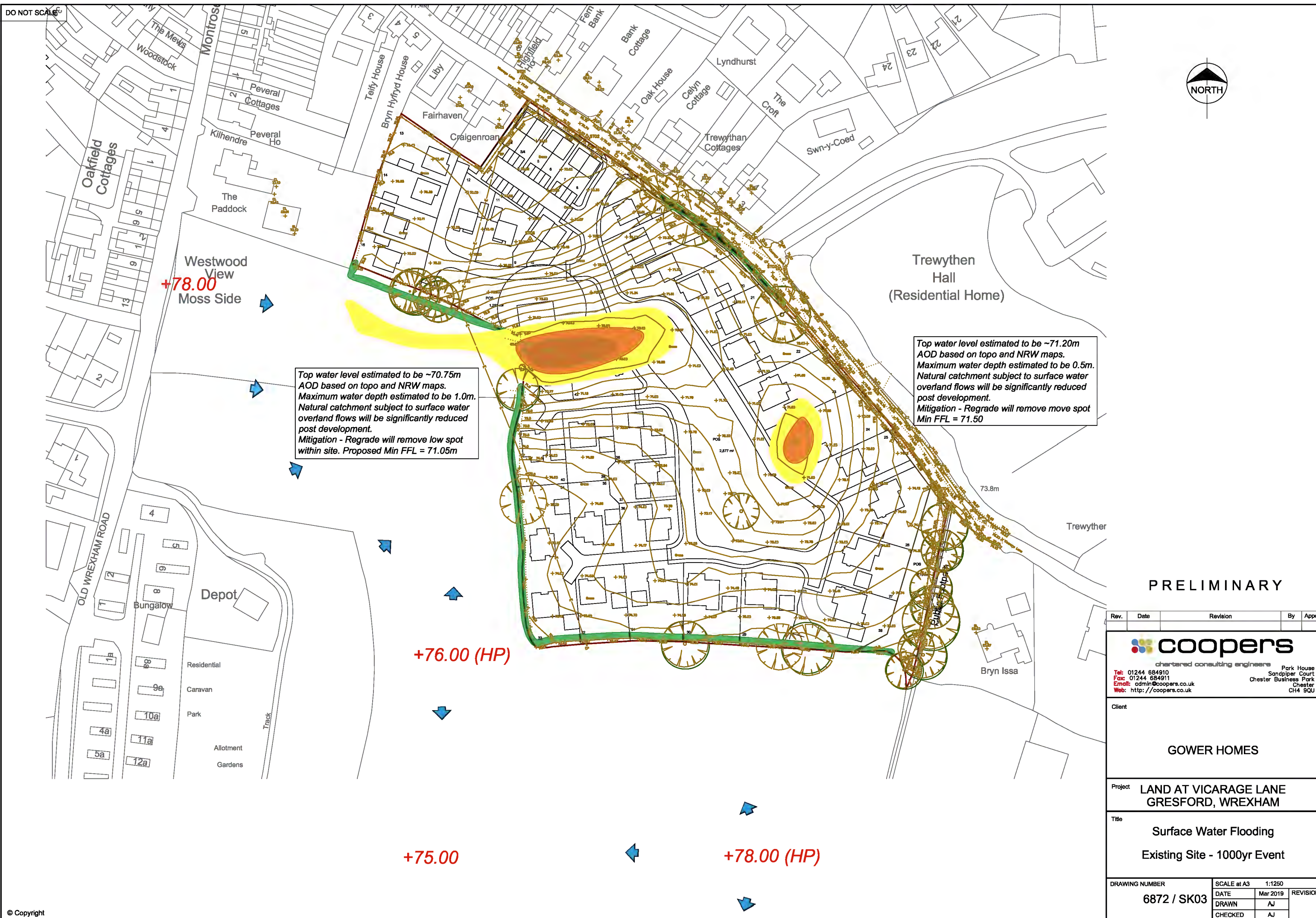
Project

LAND AT VICARAGE LANE
GRESFORD, WREXHAM

Title

Preliminary Drainage Layout

DRAWING NUMBER	SCALE at A1	1:500
6872 / SK02	DATE	Oct 2017
	DRAWN	AJ
	CHECKED	AJ
	REVISION	B



PRELIMINARY

Rev.	Date	Revision	By	Appd.
------	------	----------	----	-------

coopers

chartered consulting engineers

Tel: 01244 684910
Fax: 01244 684911
Email: admin@coopers.co.uk
Web: http://coopers.co.uk

Park House
Sandpiper Court
Chester Business Park
Chester
CH4 9QU

Client

GOWER HOMES

Project LAND AT VICARAGE LANE
GRESFORD, WREXHAMTitle Surface Water Flooding
Existing Site - 1000yr Event

DRAWING NUMBER	SCALE at A3	1:1250
6872 / SK03	DATE	Mar 2019
	DRAWN	AJ
	CHECKED	AJ

DO NOT SCALE



Mitigation
Regrade Base level = 69.700
Top WL = 70.75 (Max 1.05m depth)
Available volume = 320cu.m.
(temporary storage)

PRELIMINARY

Rev.	Date	Revision	By	Appd.
------	------	----------	----	-------

 **coopers**

Chartered consulting engineers
Tel: 01244 684910
Fax: 01244 684911
Email: admin@coopers.co.uk
Web: http://coopers.co.uk

Park House
Sandpiper Court
Chester Business Park
Chester
CH4 9QU

Client

GOWER HOMES

Project **LAND AT VICARAGE LANE
GRESFORD, WREXHAM**

Title
**Surface Water Flooding
Proposed Mitigation**

DRAWING NUMBER	SCALE at A3	1:1250
6872 / SK04	DATE	Mar 2019
	DRAWN	AJ
	CHECKED	AJ

Flood Consequences Assessment and Drainage Strategy
for land off Vicarage Lane at Gresford, Wrexham

Appendix 2

Infiltration SUDS GeoReport

Report ID: GR_217176 / 1



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoReports

**Neil Cooper
Coopers
21 Holbein Close
Chester
Cheshire
CH4 8EU**

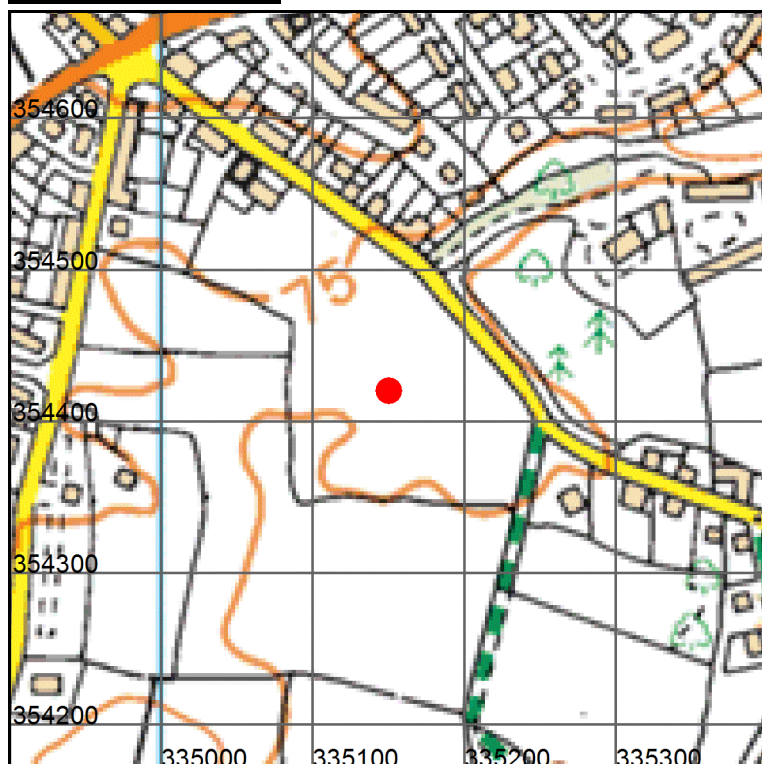
Infiltration SuDS GeoReport:

This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

Report Id: GR_217176/1

Client reference: 6872

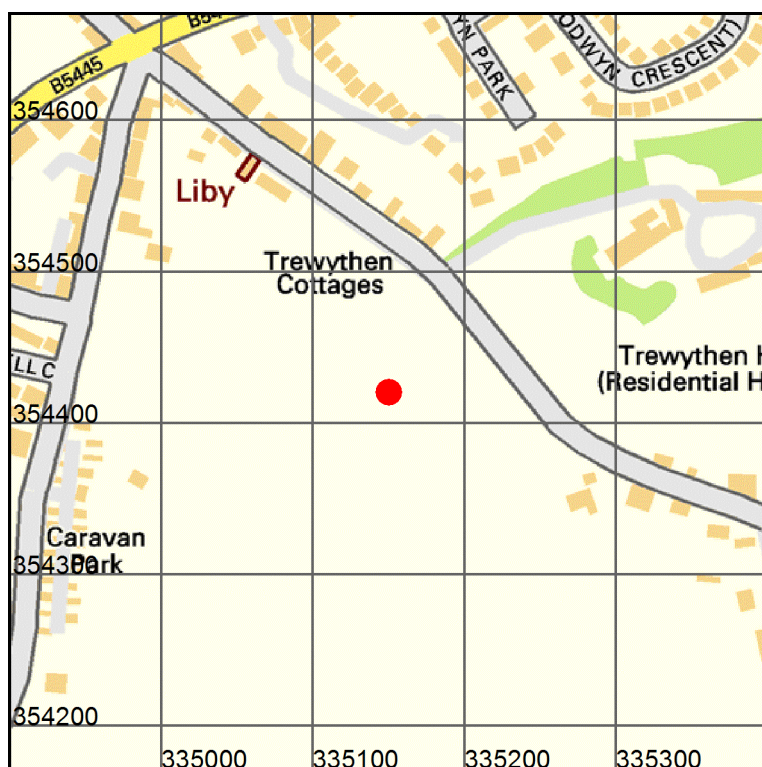
Search location



Point centred at:
335150,354420

Search location indicated in
red

This product includes mapping data licensed from Ordnance Survey.
© Crown Copyright and/or database right 2017. Licence number 100021290 EUL
Scale: 1:5 000 (1cm = 50 m)



Contains Ordnance Survey data © Crown Copyright and database right 2017
OS Street View: Scale: 1:5 000 (1cm = 50 m)

Assessment for an infiltration sustainable drainage system

Introduction

Sustainable drainage systems (SuDS) are drainage solutions that manage the volume and quality of surface water close to where it falls as rain. They aim to reduce flow rates to rivers, increase local water storage capacity and reduce the transport of pollutants to the water environment. There are four main types of SuDS, which are often designed to be used in sequence. They comprise:

- **source control:** systems that control the rate of runoff
- **pre-treatment:** systems that remove sediments and pollutants
- **retention:** systems that delay the discharge of water by providing surface storage
- **infiltration:** systems that mimic natural recharge to the ground.

This report focuses on infiltration SuDS. It provides subsurface information on the properties of the ground with respect to drainage, ground stability and groundwater quality protection. It is intended principally for those involved in the preliminary assessment of the suitability of the ground for infiltration SuDS, and those involved in assessing proposals from others for sustainable drainage, but it may also be useful to help house-holders judge whether or not further professional advice should be sought. If in doubt, users should consult a suitably-qualified professional about the results in this report before making any decisions based upon it.

This GeoReport is structured in two parts:

- **Part 1. Summary data.**

Comprises three maps that summarise the data contained within Part 2.

- **Part 2. Detailed data.**

Comprises a further 24 maps in four thematic sections:

- **Very significant constraints.** Maps highlight areas where infiltration may result in adverse impacts due to factors including: ground instability (soluble rocks, non-coal shallow mining and landslide hazards); persistent shallow groundwater, or the presence of made ground, which may represent a ground stability or contamination hazard.
- **Drainage potential.** Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits.
- **Ground stability.** Maps indicate the presence of hazards that have the potential to cause ground instability resulting in damage to some buildings and structures, if water is infiltrated to the ground.
- **Groundwater protection.** Maps provide key indicators to help determine whether the groundwater may be susceptible to deterioration in quality as a result of infiltration.

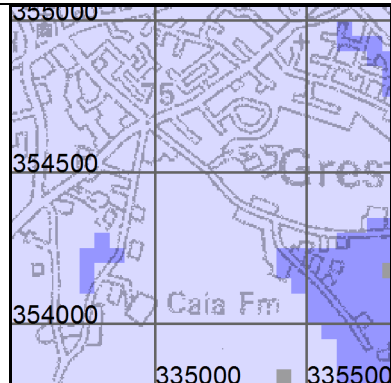
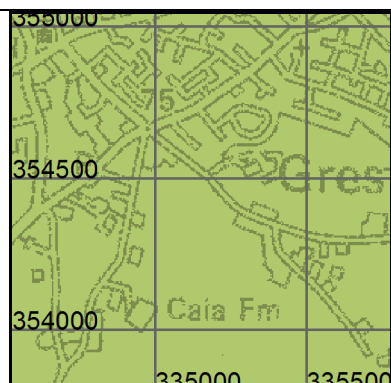
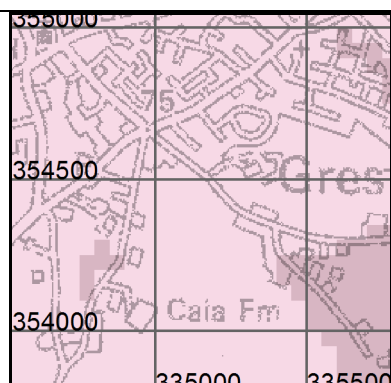


This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration SuDS are, or are not, appropriate as this is highly dependent on the design of the individual system. This report therefore describes the subsurface conditions at the site, allowing the reader to determine the suitability of the site for infiltration SuDS.

The map and text data in this report is similar to that provided in the '*Infiltration SuDS Map: Detailed*' national map product. For further information about the data, consult the '*User Guide for the Infiltration SuDS Map: Detailed*', available from <http://nora.nerc.ac.uk/16618/>.

PART 1: SUMMARY DATA

This section provides a summary of the data on the following pages.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.
	 Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.
	 Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.
	 Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.
Is ground instability likely to be a problem?	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is very unlikely to result in ground instability.
	 Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability
	 Ground instability problems are probably present. Increased infiltration may result in ground instability.
	 There is a very significant potential for one or more geohazards associated with infiltration.
Is the groundwater susceptible to deterioration in quality?	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 The groundwater is not expected to be especially vulnerable to contamination.
	 The groundwater may be vulnerable to contamination.
	 The groundwater is likely to be vulnerable to contaminants.
	 Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

PART 2: DETAILED DATA

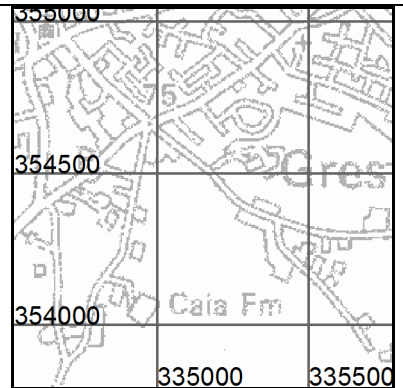
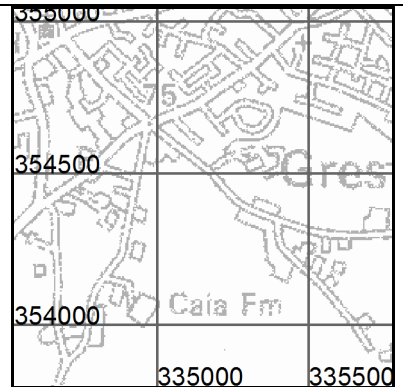
This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.

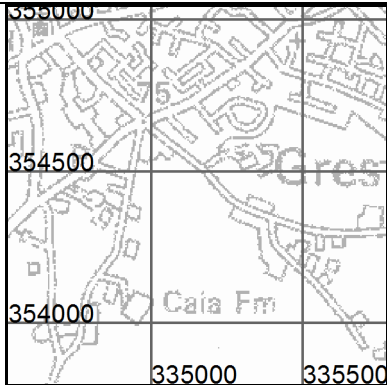
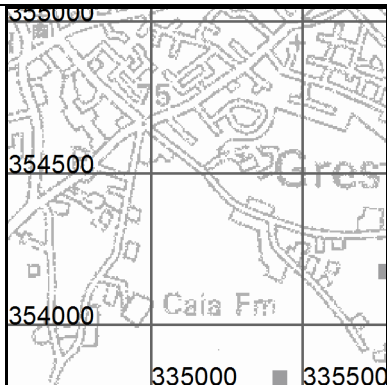
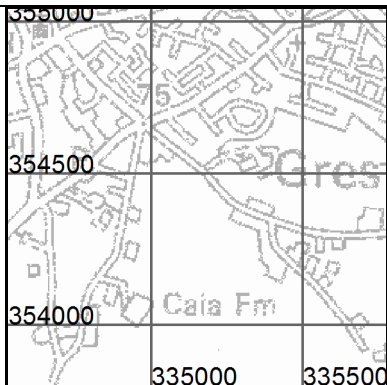
Section 1. Very significant constraints

Where maps are overlain by grey polygons, geological or hydrogeological hazards may exist that could be made worse by infiltration. The following hazards are considered:

- soluble rocks
- landslides
- shallow mining
- shallow groundwater
- made ground

For more information read 'Explanation of terms' at the end of this report.

Soluble rock hazard	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Very significant soluble rock hazard. Soluble rocks are present with a very significant possibility of localised subsidence that could be initiated or made worse by infiltration. The site investigation should consider whether the potential for or the consequences of subsidence as a result of infiltration are significant. ☐ Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.
Landslide hazard	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Very significant landslide hazard. Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail. The site investigation should consider whether the potential for or the consequences of landslide as a result of infiltration are significant. ☐ Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.

Shallow mining hazard	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Very significant mining hazard. Shallow mining is likely to be present with a very significant possibility of localised subsidence that could be initiated or made worse by increased infiltration. Also, infiltration may increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of subsidence and/or remobilisation of pollutants as a result of infiltration are significant. ☐ Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.
Persistent shallow groundwater	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Very high likelihood of persistent or seasonally shallow groundwater. Persistent or seasonally shallow groundwater is likely to be present. Infiltration may increase the likelihood of soakaway inundation, or groundwater emergence at the surface. The site investigation should consider whether the potential for or the consequences of groundwater level rise as a result of infiltration are significant. ☐ See Part 2 for the likely depth to water table.
Made ground	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	☒ Made ground present. Made ground is present at the surface. Infiltration may affect ground stability or increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of ground instability and/or pollutant leaching as a result of infiltration are significant. ☐ None recorded

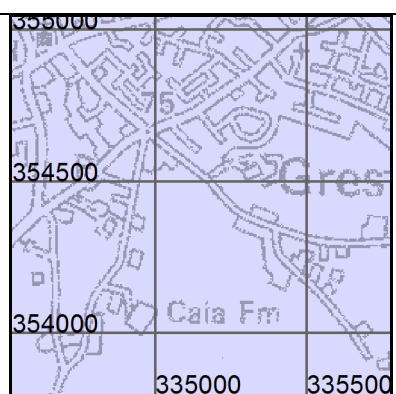
Section 2. Drainage potential

The following pages contain maps that will help you assess the drainage potential of the ground by considering the:

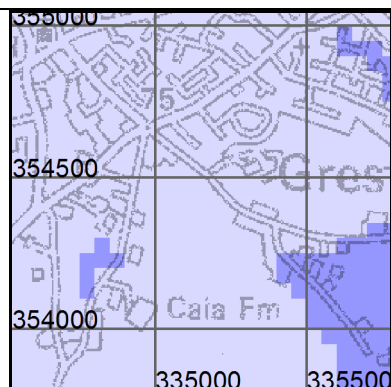
- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

Superficial deposits are not present everywhere and therefore some areas of the *superficial deposit permeability* map may not be coloured. Where this is the case, the *bedrock permeability* map shows the likely permeability of the ground. Superficial deposits in some places are very thin and hence in these places you may wish to consider both the permeability of the superficial deposits and the permeability of the bedrock. The *superficial thickness* map will tell you whether the superficial deposits are thin (< 3 m thick) or thick (>3 m). Where they are over 3 m thick, the permeability of the bedrock may not be relevant.

For more information read 'Explanation of terms' at the end of this report.

Depth to groundwater table	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Groundwater is likely to be more than 5 m below the ground surface throughout the year.
	 Groundwater is likely to be between 3 and 5 m below the ground surface for at least part of the year.
	 Groundwater is likely to be less than 3 m below the ground surface for at least part of the year.

Superficial deposit permeability



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



Superficial deposits are likely to be **free-draining**.



The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

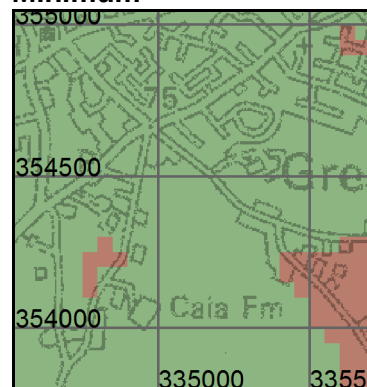


Superficial deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

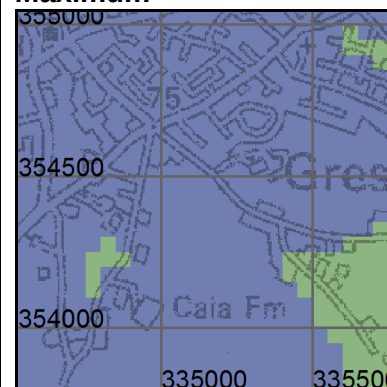
-  Very Low
-  Low
-  Moderate
-  High
-  Very High

Minimum



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Maximum



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Superficial deposit thickness



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

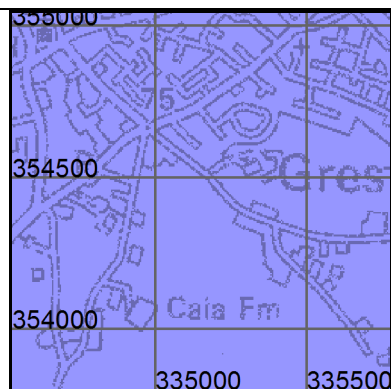


The thickness of superficial deposits is **< 3 m** and hence the permeability of the ground may be dependent on both the superficial deposits (where present) and underlying bedrock (see below).



The thickness of superficial deposits is **> 3 m** and hence the permeability of the superficial deposits is likely to determine the permeability of the ground.

Bedrock permeability



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



Bedrock deposits are likely to be **free-draining**.



The bedrock permeability is **spatially variable**, but likely to permit moderate infiltration.



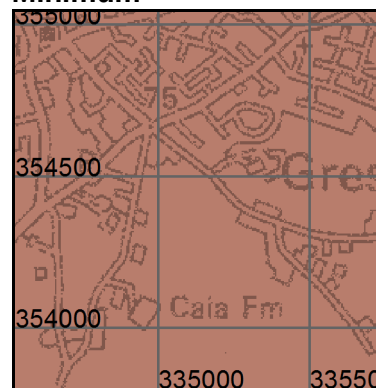
Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

Key

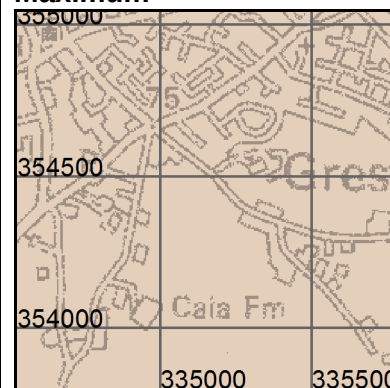
-  Very Low
-  Low
-  Moderate
-  High
-  Very High

Minimum



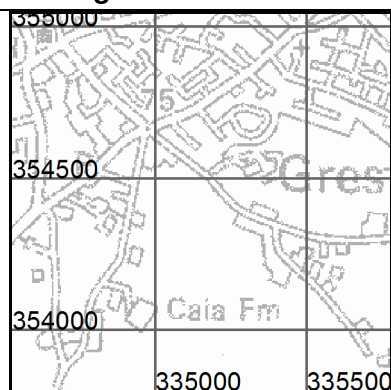
© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Maximum



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Geological indicators of flooding



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



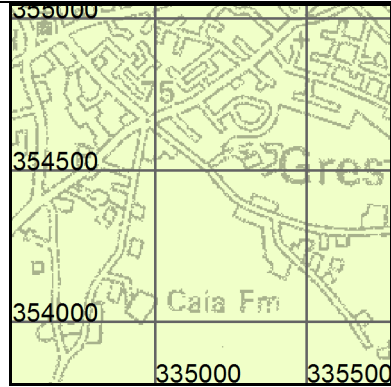
Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.

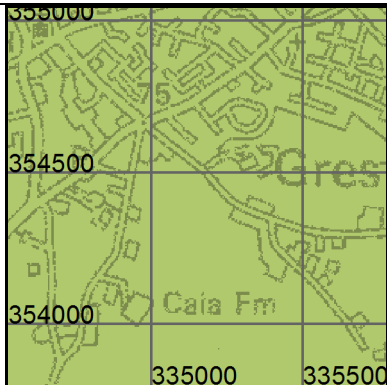
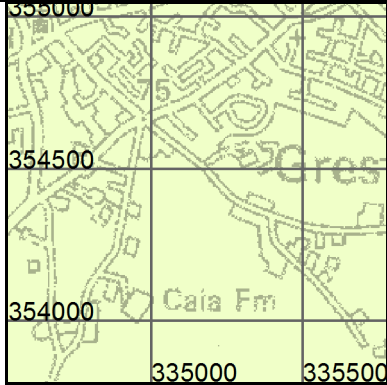
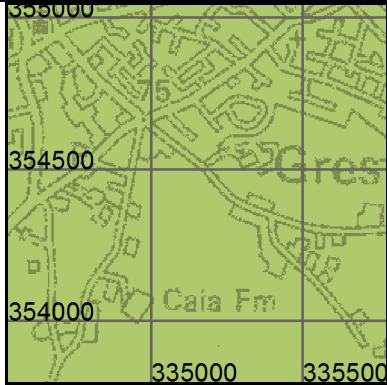
Section 3. Ground stability

The following pages contain maps that will help you assess whether infiltration may impact the stability of the ground. They consider hazards associated with:

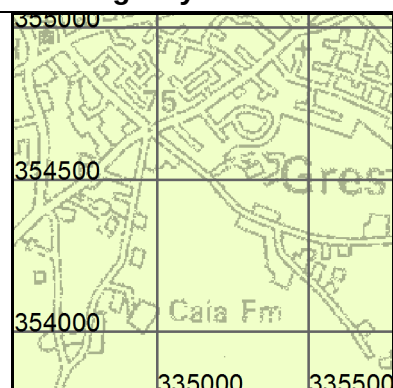
- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground

In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to result in subsidence.
	 Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
	 Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
	 Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

Landslides	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to lead to slope instability.
	 Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
	 Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability.
	 Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail.
Shallow mining	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to lead to subsidence.
	 Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	 Shallow mining could be present with a significant possibility that localised subsidence could be initiated or made worse by increased infiltration.
	 Shallow mining is likely to be present, with a very significant possibility that localised subsidence may be initiated or made worse by increased infiltration.
Running sand	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to cause ground collapse associated with running sands.
	 Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	 Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

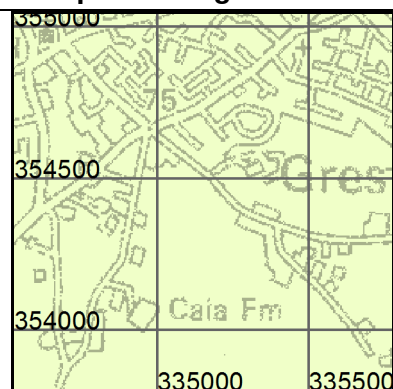
Swelling clays



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

-  Increased infiltration is unlikely to cause shrink-swell ground movement.
-  Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Ground is susceptible to shrink-swell ground movement. Increased infiltration may result in a geohazard.

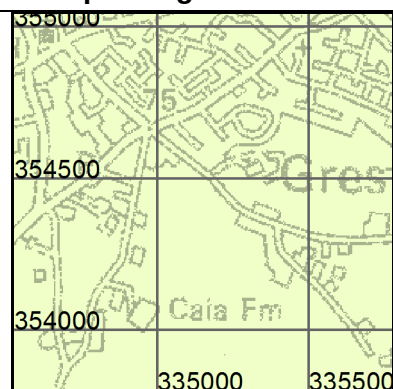
Compressible ground



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

-  Increased infiltration is unlikely to lead to ground compression.
-  Compressibility and uneven settlement hazards are probably present. Increased infiltration may result in a geohazard.

Collapsible ground



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

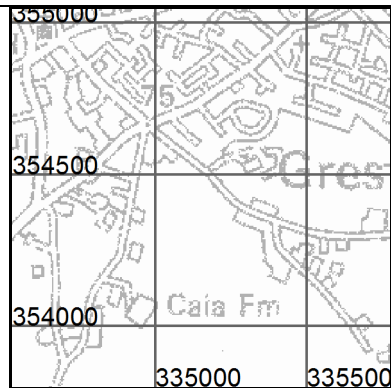
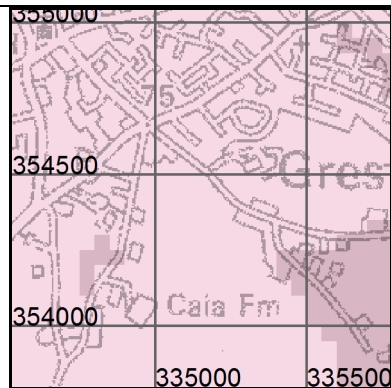
-  Increased infiltration is unlikely to result in subsidence.
-  Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
-  Deposits with potential to collapse when loaded and saturated are probably present in places. Increased infiltration may result in a geohazard.

Section 4. Groundwater quality protection

The following pages contain maps showing some of the information required to ensure the protection of groundwater quality. Data presented includes:

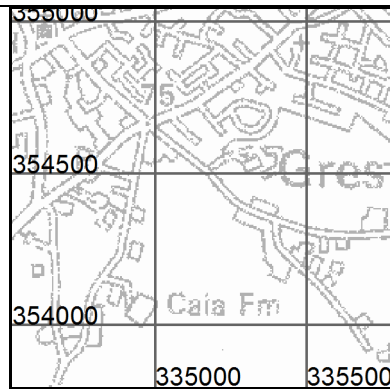
- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

For more information read 'Explanation of terms' at the end of this report.

Groundwater source protection zones	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2017.	 Groundwater is not within a source protection zone.
	 Source protection zone IV
	 Source protection zone III
	 Source protection zone II
	 Source protection zone I.
Predominant flow mechanism	
 © Crown Copyright and/or database right 2017. All rights reserved. Licence number 100021290 EUL	 Water is likely to percolate through the unsaturated zone to the groundwater through either the pore space in granular media or through porespace and fractures; these processes have some potential for contaminant removal and breakdown.
	 Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.



Made ground



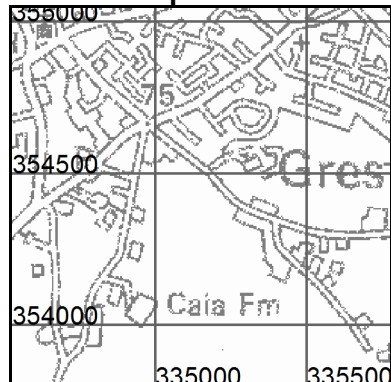
Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

© Crown Copyright and/or database
right 2017. All rights reserved.
Licence number 100021290 EUL

Section 5. Geological Maps

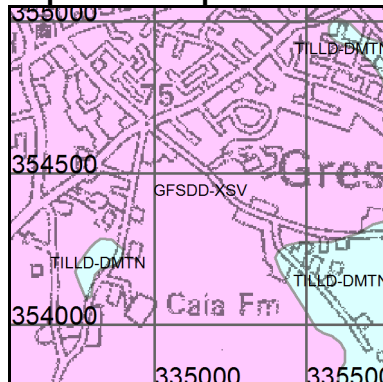
The following maps show the artificial, superficial and bedrock geology within the area of interest.

Artificial deposits



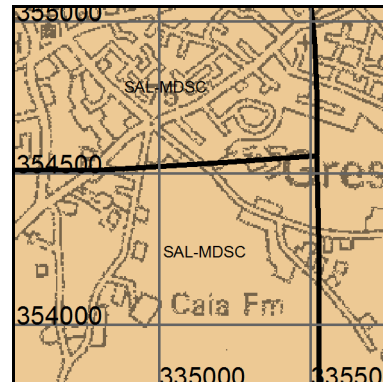
© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Superficial deposits



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL

Bedrock



© Crown Copyright and/or database right 2017. All rights reserved.
Licence number 100021290 EUL



Fault

Coal, ironstone or mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Artificial deposits:

No deposits recorded by BGS in the search area

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	GFSD-XSV	GLACIOFLUVIAL SHEET DEPOSITS, DEVENSAN	SAND AND GRAVEL
	TILLD-DMTN	TILL, DEVENSAN	DIAMICTON

Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	KNSF-SDST	KINNERTON SANDSTONE FORMATION	SANDSTONE
	SAL-MDSC	SALOP FORMATION	MUDSTONE, SANDSTONE AND CONGLOMERATE



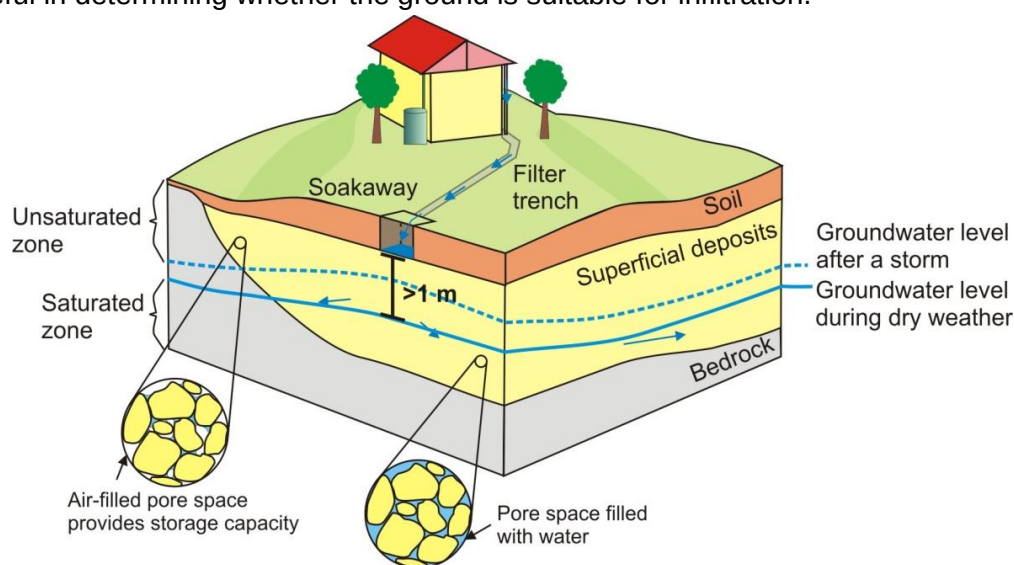
Limitations of this report:

- This report is concerned with the potential for infiltration-to-the-ground to be used as a SuDS technique at the site described. It only considers the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- This report is NOT an alternative for an on-site investigation or soakaway test, which might reach a different conclusion.
- This report must NOT be used to justify disposal of foul waste or grey water.
- This report is based on and limited to an interpretation of the records held by the British Geological Survey (BGS) at the time the search is performed. The datasets used (with the exception of that showing depth to water table) are based on 1:50 000 digital geological maps and not site-specific data.
- Other more specific and detailed ground instability information for the site may be held by BGS, and an assessment of this could result in a modified assessment.
- To interpret the maps correctly, the report must be viewed and printed in colour.
- The search does NOT consider the suitability of sites with regard to:
 - previous land use,
 - potential for, or presence of contaminated land
 - presence of perched water tables
 - shallow mining hazards relating to coal mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: www.coalminingreports.co.uk.
 - made ground, where not recorded
 - proximity to landfill sites (searches for landfill sites or contaminated land should be carried out through consultation with local authorities/Environment Agency)
 - zones around private water supply boreholes that are susceptible to groundwater contamination.
- This report is supplied in accordance with the GeoReports Terms & Conditions available separately, and the copyright restrictions described at the end of this report

Explanation of terms

Depth to groundwater

In the shallow subsurface, the ground is commonly unsaturated with respect to water. Air fills the spaces within the soil and the underlying superficial deposits and bedrock. At some depth below the ground surface, there is a level below which these spaces are full of water. This level is known as the groundwater level, and the water below it is termed the groundwater. When water is infiltrated, the groundwater level may rise temporarily. To ensure that there is space in the unsaturated zone to accommodate this, there should be a minimum thickness of 1 m between the base of the infiltration system and the water table. An estimate of the *depth to groundwater* is therefore useful in determining whether the ground is suitable for infiltration.



Groundwater flooding

Groundwater flooding occurs when a rise in groundwater level results in very shallow groundwater or the emergence of groundwater at the surface. If infiltration systems are installed in areas that are susceptible to groundwater flooding, it is possible that the system could become inundated. The susceptibility map seeks to identify areas where the geological conditions and water tables indicate that groundwater level rise could occur under certain circumstances. A high susceptibility to groundwater flooding classification does not mean that groundwater flooding has ever occurred in the past, or will do so in the future as the susceptibility maps do not contain information on how often flooding may occur. The susceptibility maps are designed for planning; identifying areas where groundwater flooding might be an issue that needs to be taken into account.

Geological indicators of flooding

In floodplain deposits, groundwater level can be influenced by the water level in the adjacent river. Groundwater level may increase during periods of fluvial flood and therefore this should be taken into account when designing infiltration systems on such deposits. The *geological indicators of flooding* dataset shows where there is geological evidence (floodplain deposits) that flooding has occurred in the past.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at www.environment-agency.gov.uk/ or the Scottish Environment Protection Agency (Scotland) at www.sepa.org.uk.

Artificial ground

Artificial ground comprises deposits and excavations that have been created or modified by human activity. It includes ground that is worked (quarries and road cuttings), infilled (back-filled quarries), landscaped (surface re-shaping), disturbed (near surface mineral workings) or classified as made ground (embankments and spoil heaps). The composition and properties of artificial ground are often unknown. In particular, the permeability and chemical composition of the artificial ground should be determined to ensure that the ground will drain and that any contaminants present will not be remobilised.

Superficial permeability

Superficial deposits are those geological deposits that were formed during the most recent period of geological time (as old as 2.6 million years before present). They generally comprise relatively thin deposits of gravel, sand, silt and clay and are present beneath the pedological soil in patches or larger spreads over much of Britain. The ease with which water can percolate through these deposits is controlled by their permeability and varies widely depending on their composition. Those deposits comprising clays and silts are less permeable and thus infiltration is likely to be slow, such that water may pool on the surface. In comparison, deposits comprising sands and gravels are more permeable allowing water to percolate freely.

Bedrock permeability

Bedrock forms the main mass of rock forming the Earth. It is present everywhere, commonly beneath superficial deposits. Where the superficial deposits are thin or absent, the ease with which water will percolate into the ground depends on the permeability of the bedrock.

Natural ground instability

Natural ground instability refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards (e.g. ground dissolution/compressible ground). Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale. Significant natural ground instability has the potential to cause damage to buildings and structures, especially when the drainage characteristics of a site are altered. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.

Shrink-swell

A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out the ground or changes to local drainage patterns, such as the creation of soakaways. Shrinkage may remove support from the foundations of buildings and structures, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

Landslides (slope stability)

A landslide is a relatively rapid outward and downward movement of a mass of ground on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, by placing material on the slope, especially at the top, or by increasing the water content of the materials forming the slope. Increase in subsurface water content beneath a soakaway could increase susceptibility to landslide hazards. The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

Soluble rocks (dissolution)

Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The release of water into the subsurface from infiltration systems may increase the dissolution of rock or destabilise material above or within a cavity. Dissolution cavities may create a pathway for rapid transport of contaminated water to an aquifer or water course.

Compressible ground

Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The compressibility of the ground may alter as a result of changes in subsurface water content caused by the release of water from soakaways.

Collapsible deposits

Collapsible ground comprises certain fine-grained materials with large pore spaces (the spaces between solid particles). It can collapse when it becomes saturated by water and/or a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The subsurface underlying a soakaway will experience an increase in water content that may affect the stability of the ground. This hazard is most likely to be encountered only in parts of southern England.

Running sand

Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the drainage system installation. During installation, excavation of the ground may create a space into which sand can flow, potentially causing subsidence of surrounding ground.

Shallow mining hazards (non coal)

Current or past underground mining for coal or for other commodities can give rise to cavities at shallow or intermediate depths, which may cause fracturing, general settlement, or the formation of crown-holes in the ground above. Spoil from mineral workings may also present a pollution hazard. The release of water into the subsurface from soakaways may destabilise material above or within a cavity. Cavities arising as a consequence of mining may also create a pathway for rapid transport of contaminated water to an aquifer or watercourse. The mining hazards map is derived from the geological map and considers the potential for subsidence associated with mining on the basis of geology type. Therefore if mining is known to occur within a certain rock, the map will highlight the potential for a hazard within the area covered by that geology.



For more information regarding underground and opencast **coal mining**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by **coal mining** please contact the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG; telephone 0845 762 6848 or at www.coal.gov.uk. For more information regarding other types of mining (i.e. non-coal), please contact the British Geological Survey.

Groundwater source protection zones

In England and Wales, the Environment Agency has defined areas around wells, boreholes and springs that are used for the abstraction of public drinking water as source protection zones. In conjunction with Groundwater Protection Policy the zones are used to restrict activities that may impact groundwater quality, thereby preventing pollution of underlying aquifers, such that drinking water quality is upheld. The Environment Agency can provide advice on the location and implications of source protection zones in your area (www.environment-agency.gov.uk/)



Contact Details

Keyworth Office

British Geological Survey
Environmental Science Centre
Nicker Hill
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363143
Fax: 0115 9363276
Email: enquiries@bgs.ac.uk

Wallingford Office

British Geological Survey
Maclean Building
Wallingford
Oxford
OX10 8BB
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Edinburgh Office

British Geological Survey
Lyell Centre
Research Avenue South
Edinburgh
EH14 4AP
Tel: 0131 6671000
Email: enquiry@bgs.ac.uk



Terms and Conditions

General Terms & Conditions

This Report is supplied in accordance with the GeoReports Terms & Conditions available on the BGS website at <https://shop.bgs.ac.uk/georeports> and also available from the BGS Central Enquiries Desk at the above address.

Important notes about this Report

- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

Copyright:

Copyright in materials derived from the British Geological Survey's work, is owned by the Natural Environment Research Council (NERC) and/ or the authority that commissioned the work. You may not copy or adapt this publication, or provide it to a third party, without first obtaining NERC's permission, but if you are a consultant purchasing this report solely for the purpose of providing advice to your own individual client you may incorporate it unaltered into your report to that client without further permission, provided you give a full acknowledgement of the source. Please contact the BGS Copyright Manager, British Geological Survey, Environmental Science Centre, Nicker Hill, Keyworth, Nottingham NG12 5GG. Telephone: 0115 936 3100.

© NERC 2017 All rights reserved.

This product includes mapping data licensed from the Ordnance Survey® with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright 2017. All rights reserved. Licence number 100021290 EUL



**Report issued by
BGS Enquiry Service**

Flood Consequences Assessment and Drainage Strategy
for land off Vicarage Lane at Gresford, Wrexham

Appendix 3

Dwr Cymru Welsh Water

Pre Development Sewerage Enquiry



Dŵr Cymru
Welsh Water

Developer Services
PO Box 3146
Cardiff
CF30 0EH

Tel: +44 (0)800 917 2652
Fax: +44 (0)2920 740472
E.mail: developer.services@dwrcymru.com

Gwasanaethau Datblygu
Blwch Post 3146
Caerdydd
CF30 0EH

Ffôn: +44 (0)800 917 2652
Ffacs: +44 (0)2920 740472
E.bost: developer.services@dwrcymru.com

RECEIVED
27 OCT 2017

Mr Michael Forgrave
Gower Homes
8 Temple Row
Wrexham
LL13 8LY

Date: 23/10/2017
Our Ref: PPA0002475

Dear Mr Forgrave,

Grid Ref: 335141 354444

Site Address: Vicarage Lane, Gresford, Wrexham, LL12 8UR

Development: Residential development of 40 dwellings

I refer to your pre-planning enquiry received relating to the above site, seeking our views on the capacity of our network of assets and infrastructure to accommodate your proposed housing development. Having reviewed the details submitted on 06/10/2017 I can provide the following comments which should be taken into account within any future planning application for the development.

SEWERAGE

The foul flows only from the proposed development can be accommodated within the public sewerage system. We advise that the flows should be communicated with to the foul sewer at or beyond manhole SJ35540501. This manhole chamber is positioned just off the site, to the North within Vicarage Lane.

Should a planning application be submitted for this development we will seek to control these points of communication via appropriate planning conditions and therefore recommend that any drainage layout or strategy submitted as part of your application takes this into account.

However, should you wish for an alternative connection point to be considered please provide further information to us in the form of a drainage strategy, preferably in advance of a planning application being submitted.



Welsh Water is owned by Glas Cymru – a 'not-for-profit' company.
Mae Dŵr Cymru yn eiddo i Glas Cymru – cwmni 'nid-er-elw'.

We welcome correspondence in
Welsh and English

Dŵr Cymru Cyf, a limited company registered in
Wales no 2366777. Registered office: Pentwyn Road,
Nelson, Treharris, Mid Glamorgan CF46 6LY

Rydym yn croesawu gohebiaeth yn y
Gymraeg neu yn Saesneg

Dŵr Cymru Cyf, cwmni cyfyngedig wedi'i gofrestru yng
Nghymru rhif 2366777. Swyddfa gofrestredig: Heol Pentwyn
Nelson, Treharris, Morgannwg Ganol CF46 6LY.

With reference to the surface water flows from the proposed development, you are required to fully exhaust all technical options outlined under Sections 3.2 and 3.4 of Part H of the publication 'Building Regulations 2000; Disposal should be made through the hierarchical approach, preferring infiltration and, where infiltration is not possible, disposal to watercourses in liaison with the Land Drainage Authority and/or Natural Resources Wales. Discharge of surface water to the public sewer is only to be made as a last resort. Please refer to further detailed advice relating to surface water management included in our attached Advice & Guidance note.

In addition, please note that no highway or land drainage run-off will be permitted to discharge directly or indirectly into the public sewerage system.

Advisory

You may need to apply to Dwr Cymru Welsh Water for any connection to the public sewer under Section 106 of the Water Industry Act 1991. However, if the connection to the public sewer network is either via a lateral drain (i.e. a drain which extends beyond the connecting property boundary) or via a new sewer (i.e. serves more than one property), it is now a mandatory requirement to first enter into a Section 104 Adoption Agreement (Water Industry Act 1991). The design of the sewers and lateral drains must also conform to the Welsh Ministers Standards for Foul Sewers and Lateral Drains, and conform with the publication "Sewers for Adoption"- 7th Edition. Further information can be obtained via the Developer Services pages of www.dwrcymru.com

You are also advised that some public sewers and lateral drains may not be recorded on our maps of public sewers because they were originally privately owned and were transferred into public ownership by nature of the Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011. The presence of such assets may affect the proposal. In order to assist you may contact Dwr Cymru Welsh Water on 0800 085 3968 to establish the location and status of the apparatus in and around your site.

SEWAGE TREATMENT

No problems are envisaged with the Waste Water Treatment Works for the treatment of domestic discharges from this site.

WATER SUPPLY

This Development is outside Dwr Cymru Welsh Water water supply area. Water will therefore be sourced from Dee Valley Water Company.

I trust the above information is helpful and will assist you in forming water and drainage strategies that should accompany any future planning application. I also attach copies of our water and sewer extract plans for the area, and a copy of our Planning Guidance Note which provides further information on our approach to the planning process, making connections to our systems and ensuring any existing public assets or infrastructure located within new development sites are protected.



Welsh Water is owned by Glas Cymru – a 'not-for-profit' company.
Mae Dwr Cymru yn eiddo i Glas Cymru – cwmni 'nid-er-elw'.

We welcome correspondence in
Welsh and English

Dwr Cymru Cyf, a limited company registered in
Wales no 2366777. Registered office: Pentwyn Road,
Nelson, Treharris, Mid Glamorgan CF46 6LY

Rydym yn croesawu gohebiaeth yn y
Gymraeg neu yn Saesneg

Dwr Cymru Cyf, cwmni cyfyngedig wedi'i gofrestru yng
Nghymru rhif 2366777. Swyddfa gofrestredig: Heol Pentwyn
Nelson, Treharris, Morgannwg Ganol CF46 6LY.

Please note that our response is based on the information provided in your enquiry and should the information change we reserve the right to make a new representation. Should you have any queries or wish to discuss any aspect of our response please do not hesitate to contact our dedicated team of planning officers, either on 0800 917 2652 or via email at developer.services@dwrcymru.com

Please quote our reference number in all communications and correspondence.

Yours faithfully,



Owain George
Planning Liaison Manager
Developer Services

Please Note that demands upon the water and sewerage systems change continually; consequently the information given above should be regarded as reliable for a maximum period of 12 months from the date of this letter.

PPA0002475



LEGEND (Representative of most common features)

	Sluice Valve		Gravity Sewer
	Air Valve SINGLE		Rising Main
	Tap		Outfall
	Pressure Reducing Valve		Pumping Station
	Meter		Lampole
	Bulk Meter		Combined Sewer Overflow
	Fire Hydrant		Special Purpose Chamber
	Cap		Treatment Works
	Non Dwr Cymru Main		Private Sewer Transfer
	Existing Distribution Main		Lateral Drain
			Inspection Chamber

NB: Sewer symbol colour indicates the sewer type.
RED - Combined
GREEN - Surface Water
BROWN - Foul

Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF). It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation.

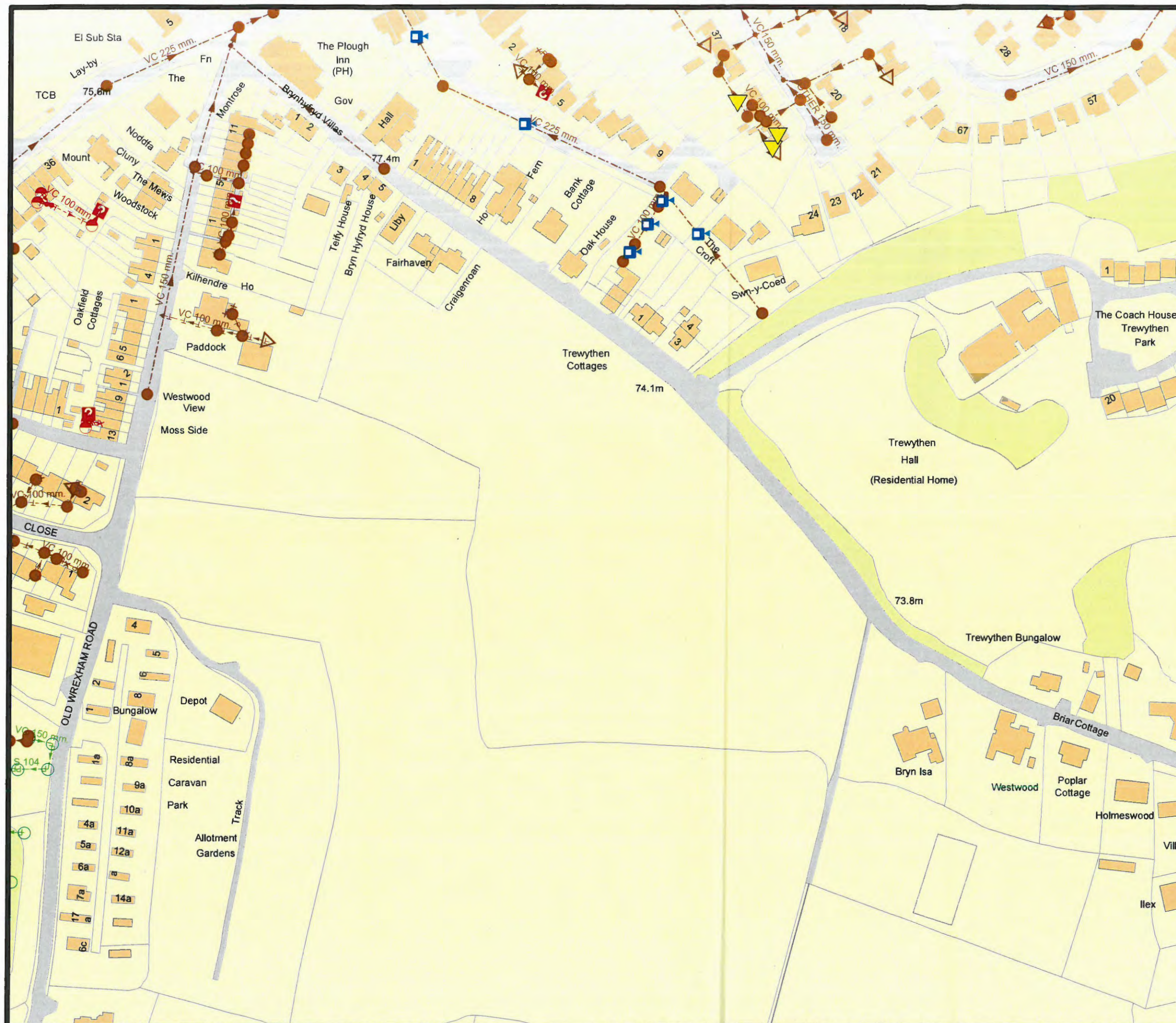
Dwr Cymru Cyl gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the Company's apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. It must be understood that the furnishing of the information is entirely without prejudice to the provision of the New Roads and Streetworks Act 1991 and of the Company's right to be compensated for any damage to its apparatus.

Service pipes are not generally shown but their presence should be anticipated.

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2008. All rights reserved.
Ordnance Survey License number 100019534.

Map Ref: 335142,354444
Map scale: 1:1500
Printed by: Little Phillip
Printed on: 25/10/2017



Flood Consequences Assessment and Drainage Strategy
for land off Vicarage Lane at Gresford, Wrexham

Appendix 4

Greenfield Run-off Calculation

MicroDrainage Source Control

6872

Land off Vicarage Lane
at Gresford, Wrexham

Greenfield Run-off Rates

Rural Runoff Calculator

Micro Drainage

ICP SUDS

ICP SUDS Input (FSR Method)

Return Period (Years)

Area (ha)

SAAR (mm)

Soil

Growth Curve

Partly Urbanised Catchment (QBAR)

Urban

Region

Results

QBAR rural (l/s)

QBAR urban (l/s)

Return Period Flood

Region	QBAR (l/s)	Q (1yrs) (l/s)	Q (1 yrs) (l/s)	Q (30 yrs) (l/s)	Q (100 yrs) (l/s)
Region 1	2.1	1.8	1.8	4.0	5.2
Region 2	2.1	1.8	1.8	4.0	5.5
Region 3	2.1	1.8	1.8	3.7	4.4
Region 4	2.1	1.7	1.7	4.1	5.4
Region 5	2.1	1.8	1.8	5.1	7.5
Region 6/Region 7	2.1	1.8	1.8	4.8	6.7
Region 8	2.1	1.6	1.6	4.0	5.1
Region 9	2.1	1.9	1.9	3.7	4.6
Region 10	2.1	1.8	1.8	3.6	4.4
Ireland National	2.1	1.8	1.8	3.3	3.9

OK Cancel Help

Enter Return Period between 1 and 1000

Flood Consequences Assessment and Drainage Strategy
for land off Vicarage Lane at Gresford, Wrexham

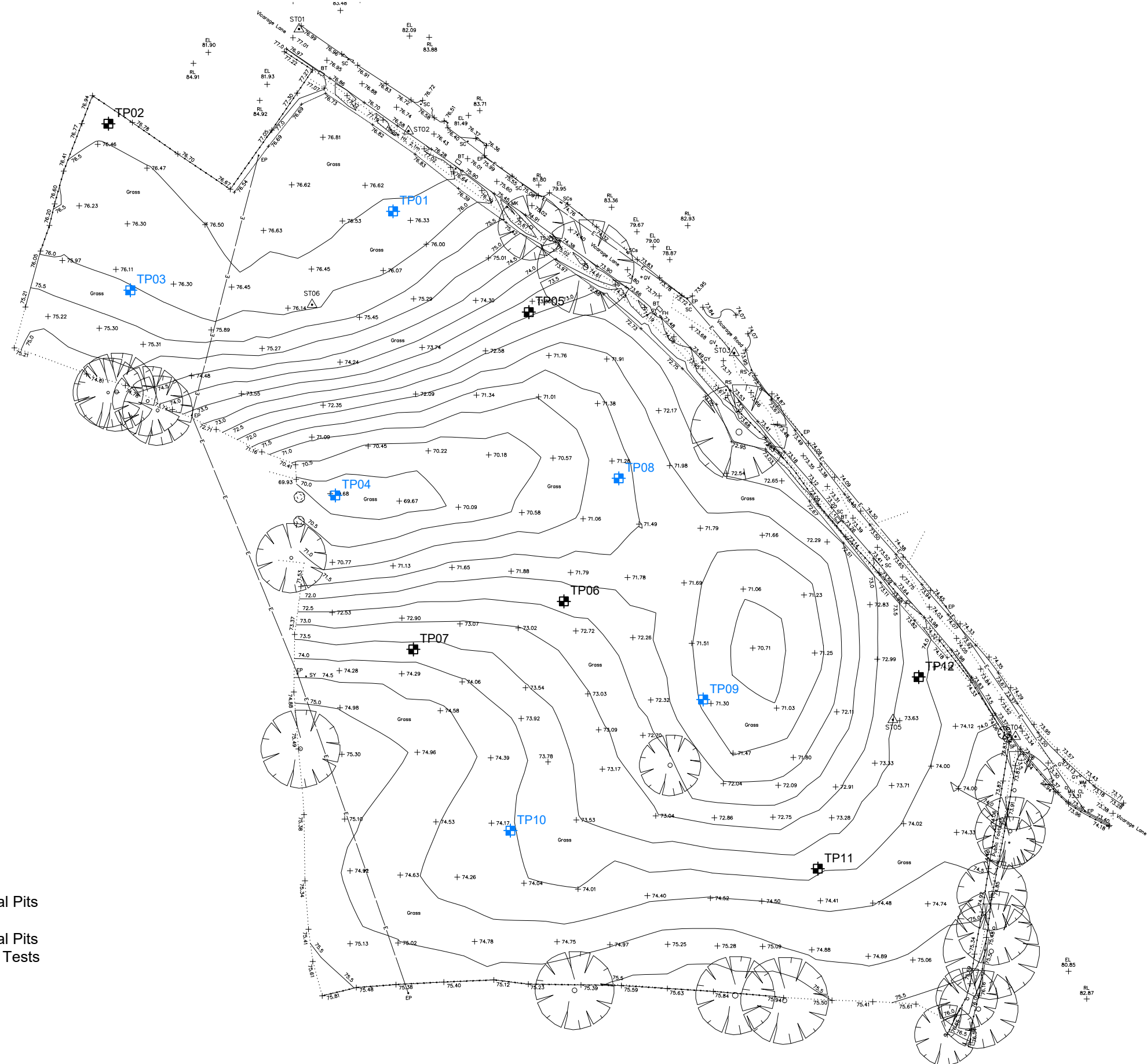
Appendix 5

Infiltration Testing

Information supplied by GroundSolve Ltd



RL
79.19
+
EL
78.16
+
RL
80.91
+
EL
78.18
+



Key

- TP02 Location of Trial Pits
- TP01 Location of Trial Pits with Infiltration Tests

SCALE 1:1000 @ A3

Figure Title
SITE LAYOUT & LOCATION
OF TRIAL PITS

FIGURE 2

TRIAL PIT 01 – SJ 35113 54526

Depth (m)	Strata
0.00 – 0.25	Grass over loose brown sandy slightly gravelly SILT (TOPSOIL)
0.25 – 0.75	Loose to medium dense red brown silty SAND & GRAVEL with occasional cobble and small boulder. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.75 – 1.50	Loose to medium dense orange brown slightly silty SAND & GRAVEL. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions – 1.80 x 0.60 x 1.50m depth.
2. Pit sides were unstable below 0.75m.
3. No groundwater encountered.
4. Infiltration test carried out in trial pit, see results output.



Trial Pit 01



Trial Pit 01 – Pit Walls



Trial Pit 01 - Arisings

TRIAL PIT 02 – SJ 35049 54539

Depth (m)	Strata
0.00 – 0.30	Grass over loose brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 0.80	Loose to medium dense red brown silty SAND & GRAVEL with occasional cobble and small boulder. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.80 – 1.80	Loose to medium dense brown slightly silty SAND & GRAVEL. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions – 1.80 x 0.60 x 1.80m depth.
2. Pit sides were unstable below 0.80m.
3. No groundwater encountered, however material was wet.
4. Bulk sample taken for PSD tests at 0.80 – 1.00m depth.



Trial Pit 02



Trial Pit 02 – Pit Walls



Trial Pit 02 - Arisings

TRIAL PIT 03 – SJ 35054 54501

Depth (m)	Strata
0.00 – 0.30	Grass over loose brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 0.60	Loose to medium dense orange brown silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.60 – 1.50	Loose to medium dense brown slightly silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions – 1.80 x 0.60 x 1.50m depth.
2. Pit sides were unstable below 0.60m.
3. No groundwater encountered.
4. Infiltration test carried out in trial pit, see results output.



Trial Pit 03



Trial Pit 03 – Pit Walls



Trial Pit 03 - Arisings

TRIAL PIT 04 – SJ 35099 54461

Depth (m)	Strata
0.00 – 0.40	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.40 – 2.70	Loose to medium dense orange brown very sandy gravelly SILT with occasional cobble. Gravel is medium to coarse rounded to sub-rounded (GLACIOFLUVIAL DEPOSIT)
2.70 – 2.85	Medium dense to dense light brown silty SAND & GRAVEL. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL DEPOSIT)

Notes

1. Pit dimensions – 1.80 x 0.60 x 2.85m depth.
2. Pit sides were generally stable.
3. No groundwater encountered.
4. Infiltration test carried out in trial pit, see results output.



Trial Pit 04



Trial Pit 04 – Pit Walls



Trial Pit 04 – Arisings

TRIAL PIT 05 – SJ 35144 54503

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 0.80	Loose to medium dense brown silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.80 – 1.10	Loose to medium dense brown silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.10 – 2.00	Medium dense brown SAND & GRAVEL with occasional cobble and small boulder (200mm). Sand is medium to coarse rounded, and gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions – 1.80 x 0.60 x 2.00m depth.
2. Pit sides were generally stable.
3. No groundwater encountered.
4. Bulk sample taken for PSD tests at 1.60 – 1.80m depth.



Trial Pit 05



Trial Pit 05 – Pit Walls



Trial Pit 05 – Arisings

TRIAL PIT 06 – SJ 35152 54437

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 1.80	Loose to medium dense brown SAND & GRAVEL with occasional cobble. Sand is medium to coarse rounded, and gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions (at base) – 1.80 x 0.60 x 1.80m depth.
2. Pit sides were unstable.
3. No groundwater encountered.
4. Bulk sample taken for PSD test at 1.20 – 1.5m depth.



Trial Pit 06



Trial Pit 06 – Pit Walls



Trial Pit 06 – Arisings

TRIAL PIT 07 – SJ 35117 54426

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 0.60	Loose to medium dense brown silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.60 – 1.80	Loose to medium dense brown slightly silty SAND & GRAVEL with occasional cobble and small boulder (200mm). Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions –1.80 x 0.60 x 1.80m depth.
2. Pit sides were unstable.
3. No groundwater encountered.



Trial Pit 07



Trial Pit 07 – Pit Walls



Trial Pit 07 – Arisings

TRIAL PIT 08 – SJ 35164 54465

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 1.20	Loose to medium dense red brown sandy gravelly SILT with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.20 – 1.80	Medium dense light brown slightly silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions –1.80 x 0.60 x 1.80m depth.
2. Pit sides were unstable below 1.20m.
3. No groundwater encountered.
4. Infiltration test carried out in trial pit, see results output.



Trial Pit 08



Trial Pit 08 – Pit Walls



Trial Pit 08 – Arisings

TRIAL PIT 09 – SJ 35183 54414

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 0.80	Loose to medium dense red brown sandy gravelly SILT with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.80 – 1.50	Medium dense brown silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.50 – 1.70	Medium dense brown medium to coarse SAND with gravel. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.70 – 2.30	Medium dense brown slightly silty SAND & GRAVEL. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions –1.80 x 0.60 x 2.30m depth.
2. Pit sides were unstable below 1.50m.
3. No groundwater encountered.
4. Infiltration test carried out in trial pit, see results output.



Trial Pit 09

GroundSolve Ltd
Unit 7 Well House Barns
Chester Road
Bretton
Flintshire CH4 0DJ

Job Number: 2026
Trial Pit Logs
Issue April 2018



Trial Pit 09 – Pit Walls



Trial Pit 09 – Arisings

TRIAL PIT 10 – SJ 35139 54384

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 1.00	Loose to medium dense brown sandy gravelly SILT. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.00 – 1.20	Loose to medium dense brown silty SAND & GRAVEL. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.20 – 1.60	Medium dense light brown silty fine to medium SAND (GLACIOFLUVIAL SHEET DEPOSIT)
1.60 – 1.75	Loose brown and grey medium to coarse rounded GRAVEL (GLACIOFLUVIAL SHEET DEPOSIT)
1.75 – 2.10	Medium dense brown slightly silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded. (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions –1.80 x 0.60 x 2.10m depth.
2. Pit sides were unstable below 1.60m.
3. No groundwater encountered.
4. Infiltration test carried out in trial pit, see results output.



Trial Pit 10



Trial Pit 10 – Pit Walls



Trial Pit 10 – Arisings

TRIAL PIT 11 – SJ 35210 54376

Depth (m)	Strata
0.00 – 0.30	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.30 – 0.60	Loose to medium dense light red brown sandy gravelly SILT. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.60 – 1.40	Loose to medium dense brown slightly silty SAND & GRAVEL with occasional cobble and small boulder (200mm). Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.40 – 1.90	Medium dense very silty SAND & GRAVEL with occasional cobble and small boulder. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
1.90 – 2.10	Medium dense brown medium to coarse SAND with fine to corae rounded to sub-rounded gravel (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions –1.80 x 0.60 x 2.10m depth.
2. Pit sides were unstable.
3. No groundwater encountered.
4. Bulk sample taken for PSD test at 1.10 – 1.3m depth.



Trial Pit 11

GroundSolve Ltd
Unit 7 Well House Barns
Chester Road
Bretton
Flintshire CH4 0DJ

Job Number: 2026
Trial Pit Logs
Issue April 2018



Trial Pit 11 – Pit Walls



Trial Pit 11 – Arisings

TRIAL PIT 12 – SJ 35233 54419

Depth (m)	Strata
0.00 – 0.25	Grass over loose dark brown sandy slightly gravelly SILT (TOPSOIL)
0.25 – 0.50	Loose to medium dense brown silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.50 – 0.90	Loose to medium dense brown slightly silty SAND & GRAVEL with occasional cobble. Gravel is fine to coarse rounded to sub-rounded (GLACIOFLUVIAL SHEET DEPOSIT)
0.90 – 1.80	Medium dense brown medium to coarse SAND with fine to corae rounded to sub-rounded gravel (GLACIOFLUVIAL SHEET DEPOSIT)

Notes

1. Pit dimensions –1.80 x 0.60 x 1.80m depth.
2. Pit sides were unstable from 0.50m.
3. No groundwater encountered.



Trial Pit 12



Trial Pit 12 – Pit Walls

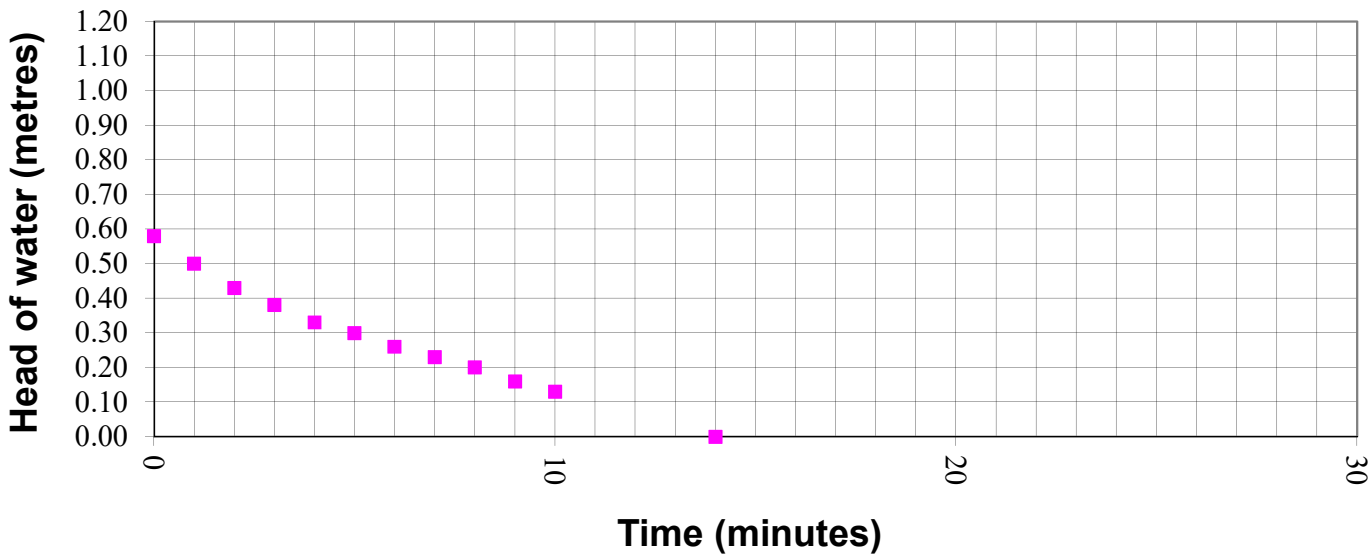


Trial Pit 12 – Arisings

[illegible]

GroundSolve Ltd

2026 Vicarage lane, Gresford
TP1 Test 1
 05/04/18



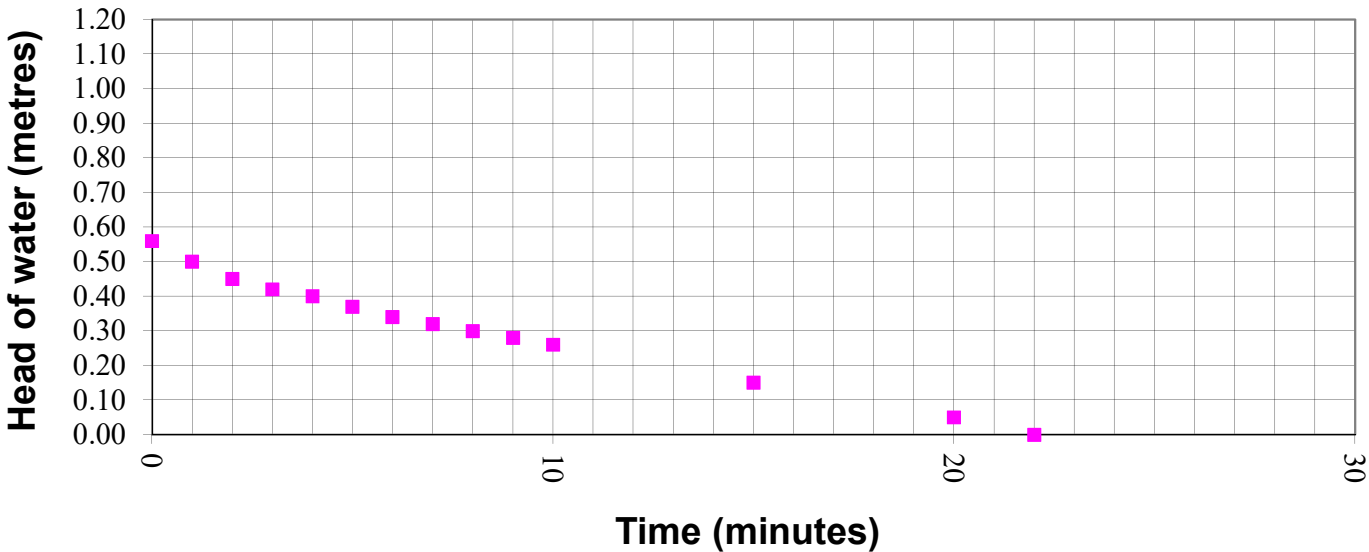
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.40	2.00	1.30	0.435	0.15	0.58	4.514	0.754	1.00	2	10	3.480E-04

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage lane, Gresford
TP1 Test 2
 05/04/18



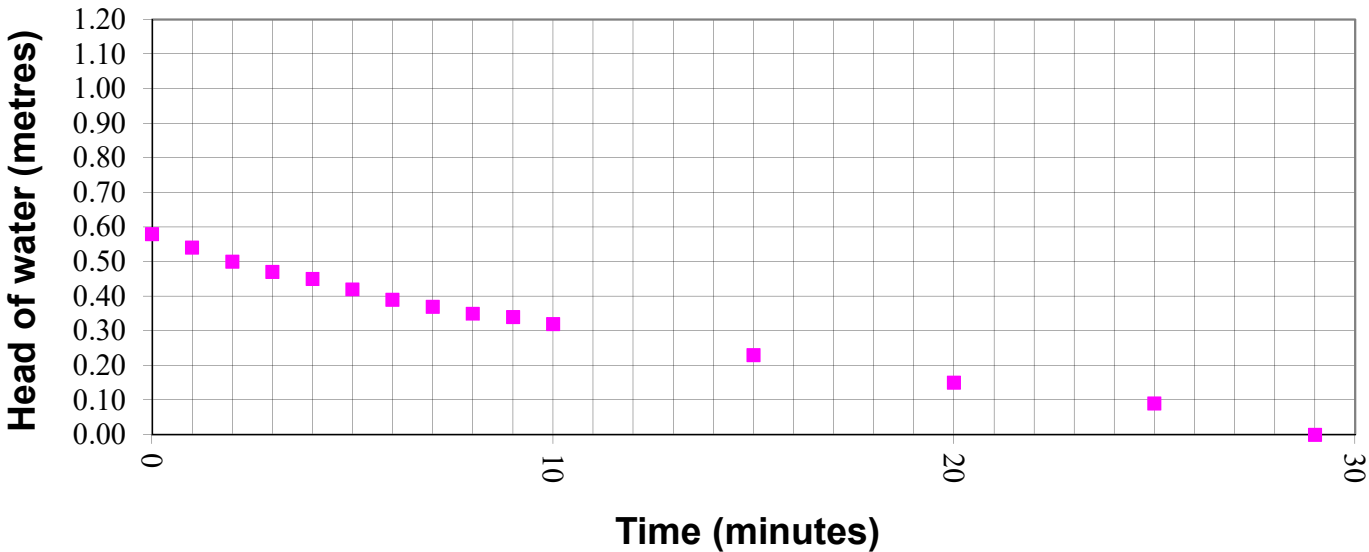
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.40	2.00	1.30	0.420	0.14	0.56	4.448	0.728	1.00	3	16	2.098E-04

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage lane, Gresford
TP1 Test 3
 05/04/18



Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.40	2.00	1.30	0.435	0.15	0.58	4.514	0.754	1.00	4.5	20	1.796E-04

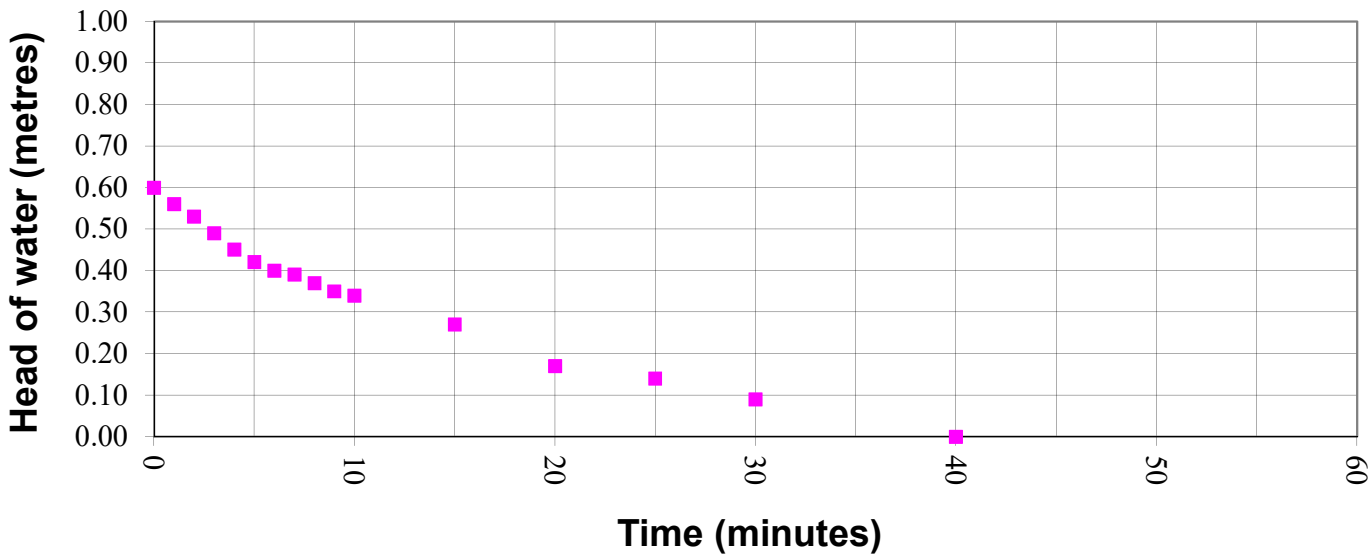
* with gravel filter adjustment factor = 0.30, with no filter = 1.0

Partial pit wall collapse at 9 minutes

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP3 Test 1
 05/04/18



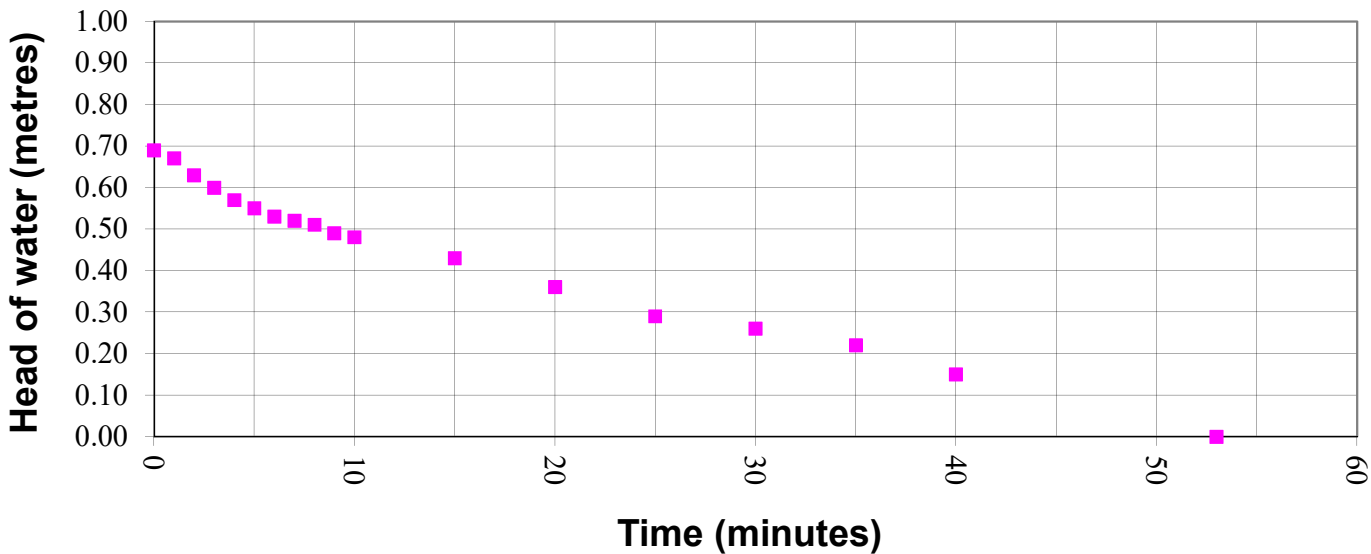
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjusment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.40	2.00	0.90	0.450	0.15	0.60	3.540	0.540	1.00	4	24	1.271E-04

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP3 Test 2
 05/04/18



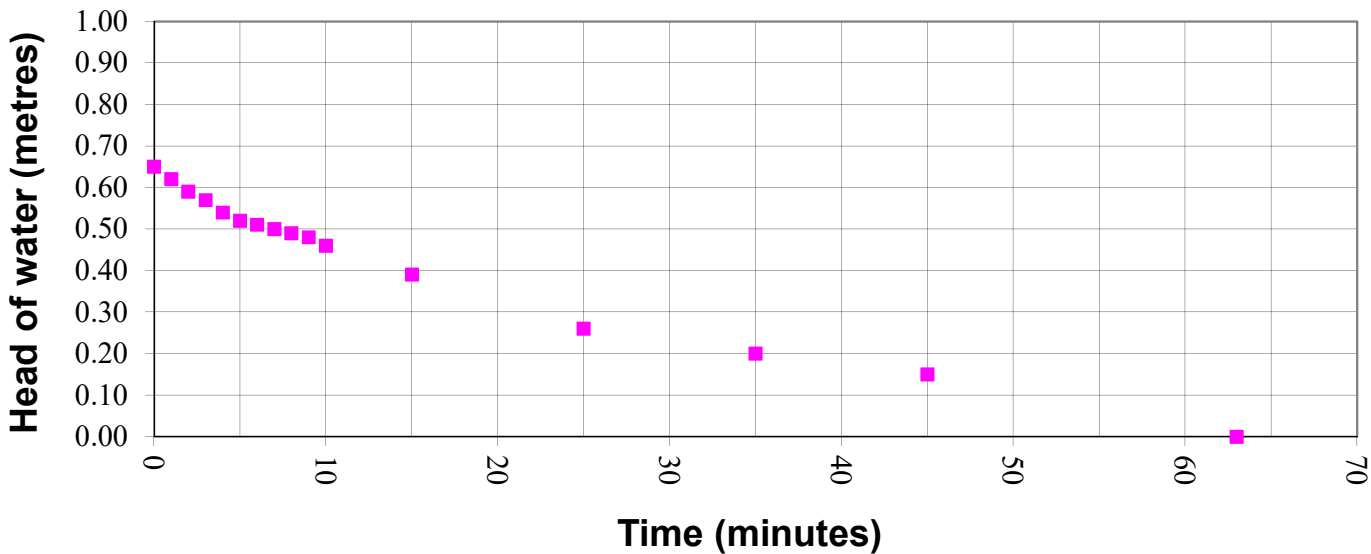
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.40	2.00	0.90	0.518	0.17	0.69	3.801	0.621	1.00	8	38	9.077E-05

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP3 Test 3
 05/04/18



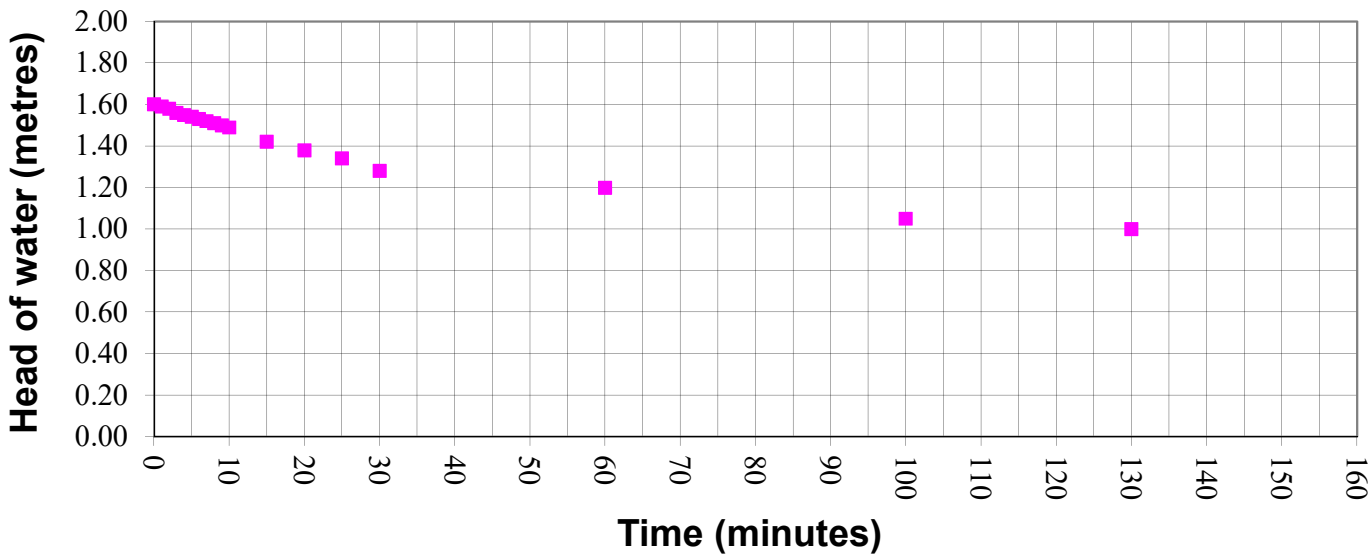
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.40	2.00	0.90	0.488	0.16	0.65	3.685	0.585	1.00	9	43	7.782E-05

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP4 Test 1
 05/04/18



Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
2.85	1.80	0.60	1.200	0.40	1.60	4.920	0.864	1.00			#DIV/0!

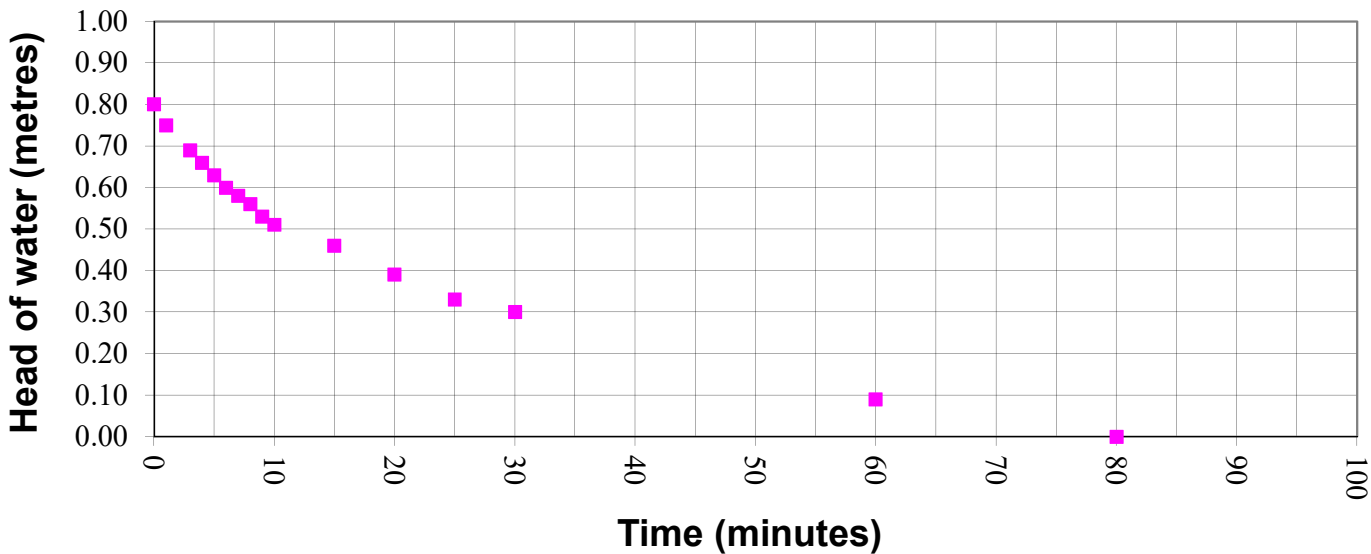
* with gravel filter adjustment factor = 0.30, with no filter = 1.0

Unable to leave trial pit open over night therefore infiltration rate can not be calculated, slow infiltration due to high silt content in the material

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP8 Test 1
 06/04/18



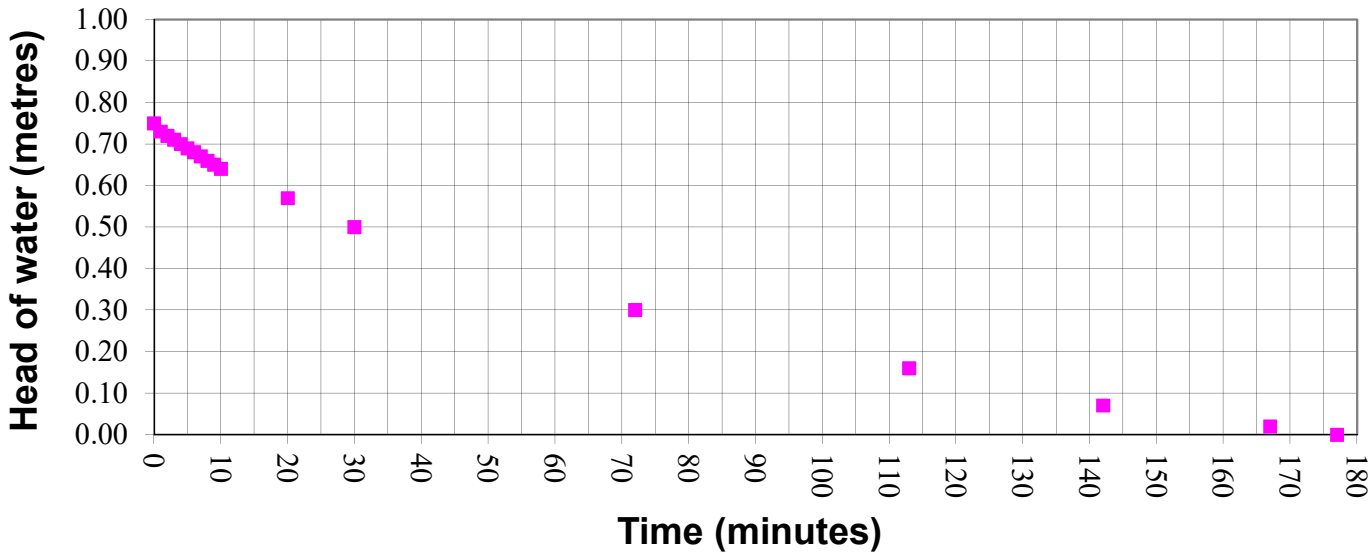
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.70	1.80	0.80	0.600	0.20	0.80	3.520	0.576	1.00	6	45	6.993E-05

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP8 Test 2
 06/04/18



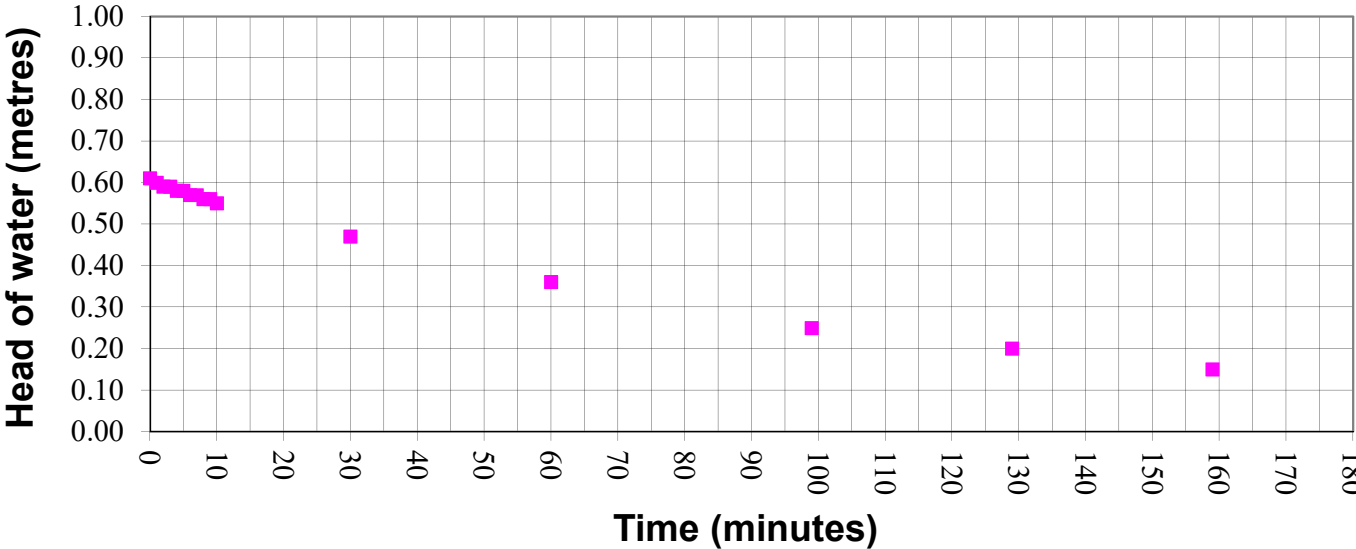
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.70	1.80	0.80	0.563	0.19	0.75	3.390	0.540	1.00	21	100	3.361E-05

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP8 Test 3
 06/04/18



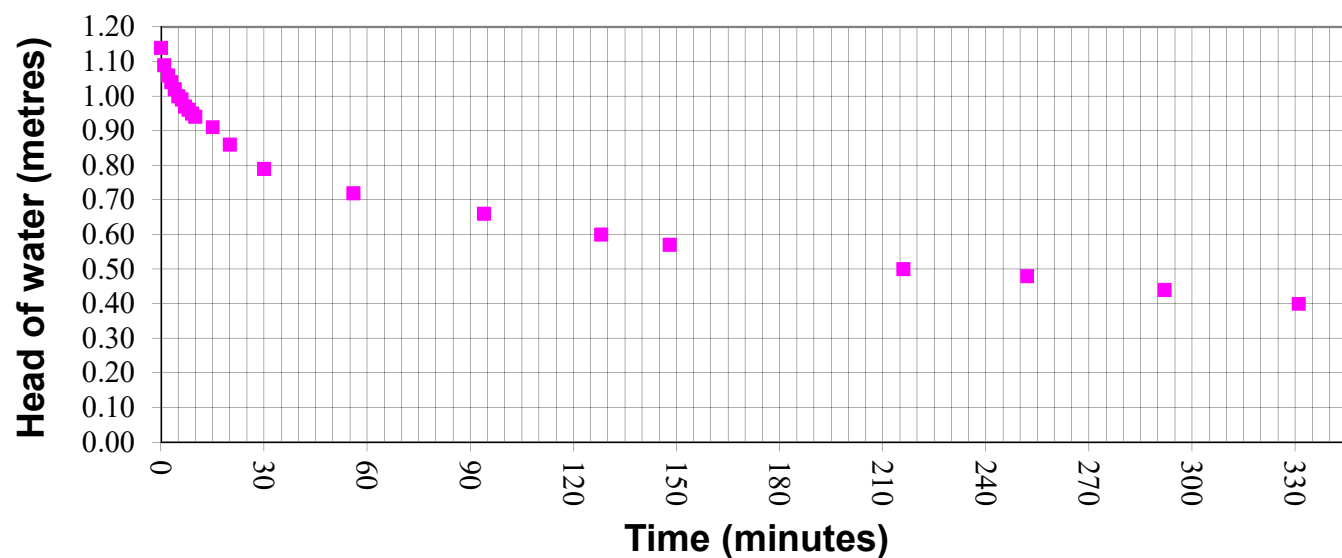
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.70	1.80	0.80	0.458	0.15	0.61	3.026	0.439	1.00	35	159	1.951E-05

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

Time (Mins)	Depth of Water	Head of Water
0	1.06	1.14
1	1.11	1.09
2	1.14	1.06
3	1.16	1.04
4	1.18	1.02
5	1.20	1.00
6	1.21	0.99
7	1.23	0.97
8	1.24	0.96
9	1.25	0.95
10	1.26	0.94
15	1.29	0.91
20	1.34	0.86
30	1.41	0.79
56	1.48	0.72
94	1.54	0.66
128	1.60	0.60
148	1.63	0.57
216	1.70	0.50
252	1.72	0.48
292	1.76	0.44
331	1.80	0.40

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP9 Test 1
06/04/18



Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjustment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
2.20	1.80	1.00	0.855	0.29	1.14	4.992	1.026	1.00	22	420	8.607E-06

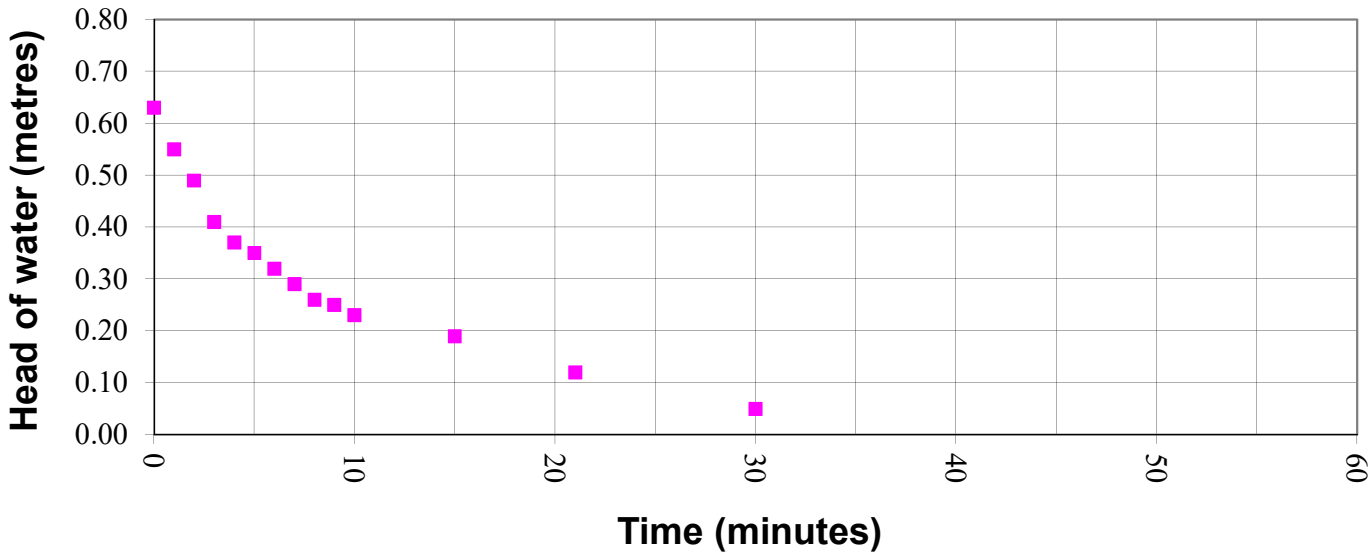
* with gravel filter adjustment factor = 0.30, with no filter = 1.0

25% volume not reached after 5hrs 30minutes of monitoring - t25 value extrapolated from best fit line

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP10 Test 1
 06/04/18



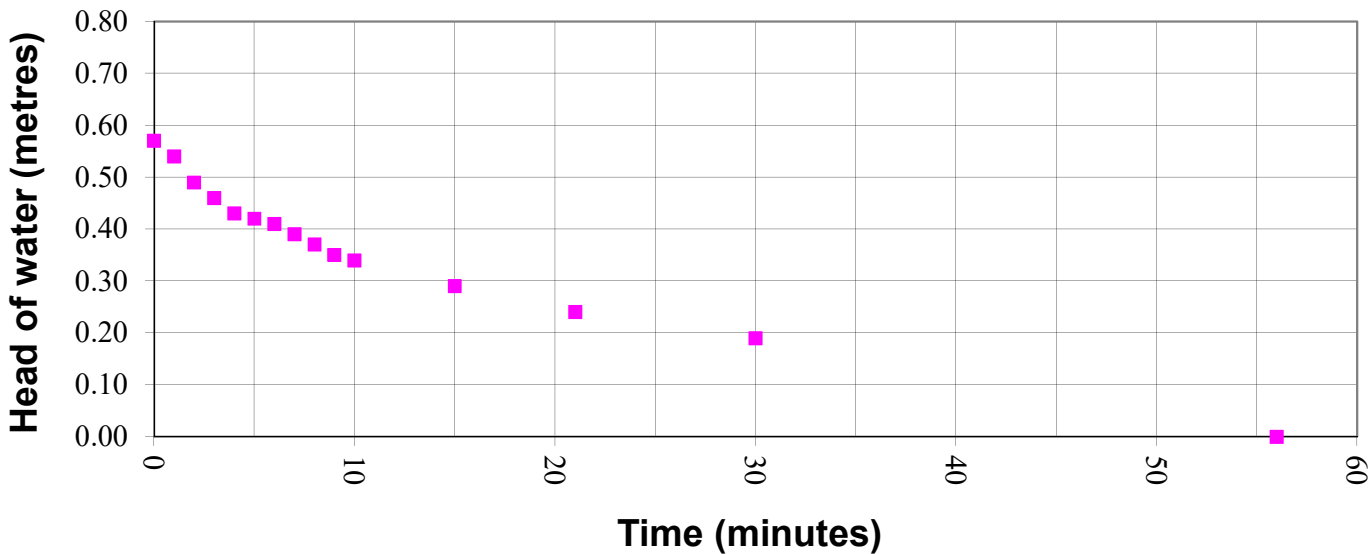
Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.75	1.80	1.10	0.473	0.16	0.63	3.807	0.624	1.00	2.5	20	1.560E-04

* with gravel filter adjustment factor = 0.30, with no filter = 1.0

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP10 Test 2
 06/04/18



Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.75	1.80	1.10	0.428	0.14	0.57	3.633	0.564	1.00	5	40	7.396E-05

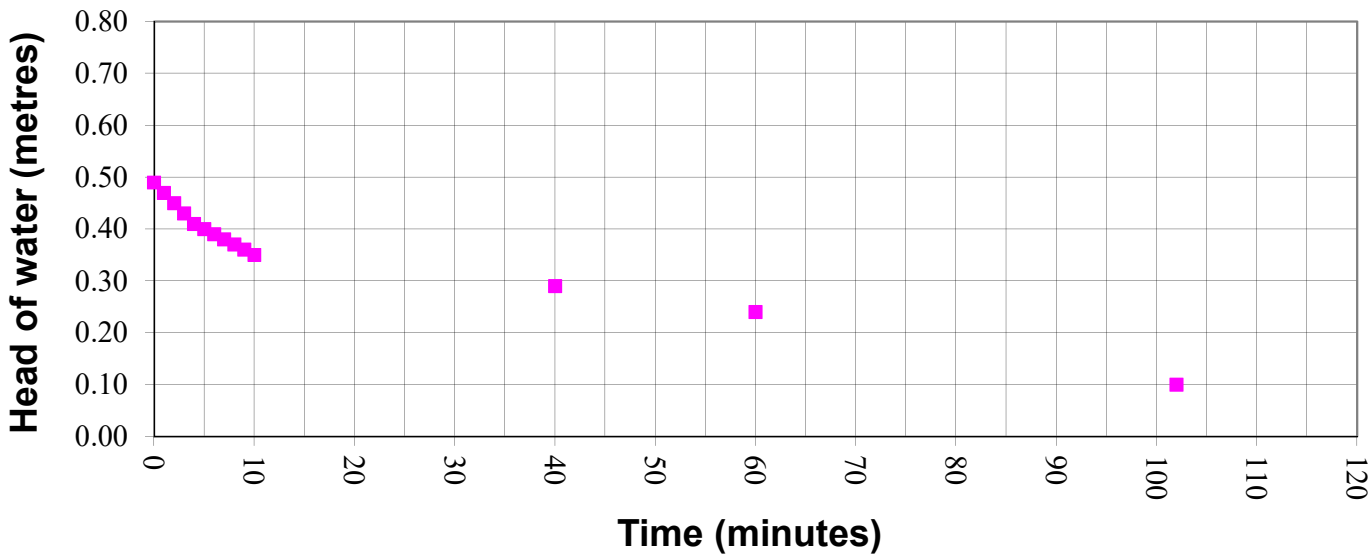
* with gravel filter adjustment factor = 0.30, with no filter = 1.0

Bottom of trial pit cleared of silt sediment build up before comencing test 2

[illegible]

GroundSolve Ltd

2026 Vicarage Lane, Gresford
TP10 Test 2
 06/04/18



Depth	Length	Width	Head at 75% Vol	Head at 25% Vol	Water depth(t=0)	Effective Area	Vp75-Vp25	Adjsutment Factor *	t75	t25	Infiltration
(m)	(m)	(m)	(m)	(m)	(m)	Ap50 m2	Volume of water m3		(mins)	(mins)	rate m/s
1.75	1.80	1.10	0.368	0.12	0.49	3.401	0.485	1.00	9	100	2.612E-05

* with gravel filter adjustment factor = 0.30, with no filter = 1.0