



Monmouthshire County Council

**Land at Chepstow Road,
Raglan**

**Flood Consequence Assessment and
Drainage Strategy**

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REPORT CONTROL

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Contents

1	INTRODUCTION.....	1
	Authorisation.....	1
	Background.....	1
	Aims and Objectives.....	1
	Limitations.....	2
2	SITE DESCRIPTION	3
	Site Location	3
	Proposed Development.....	3
	Site Topography	3
	Geology and Hydrogeology.....	3
	Catchment Hydrology.....	3
	Drainage Infrastructure	4
3	ASSESSMENT OF FLOOD RISK.....	5
	Planning Policy Wales – TAN 15	5
	Development Advice Maps.....	5
	Regional and Local Policy.....	7
4	ASSESSMENT OF FLOOD RISK.....	9
	Fluvial and Tidal Flood Risk.....	9
	Risk from Surface Water Flooding	12
	Groundwater Flooding	13
	Drainage and Infrastructure Flooding.....	13
	Other Sources of Flooding	13
	Flood Mitigation	13
	Soil Infiltration	14
5	SURFACE WATER DRAINAGE STRATEGY	15
	Overview	15
	Methodology	15
	Proposed Receptor of Site Runoff	16
	Existing Greenfield Runoff Rates.....	17
	Proposed Surface Water Drainage Strategy.....	17
6	CONCLUSIONS AND RECOMMENDATIONS	20

Appendices

- Appendix A - Site Location
- Appendix B - Topographic Survey
- Appendix C - Natural Resource Wales Information

Appendix D	- DCWW Email and Plan
Appendix E	- Surface Water Calculations
Appendix F	Development Proposal
Appendix G	Soil Infiltration Testing

1 INTRODUCTION

Authorisation

- 1.1 Vectos has been appointed on behalf of Monmouthshire County Council to provide a Flood Consequence Assessment (FCA) and surface water drainage strategy to support the proposed residential development on land west of Chepstow Road, Raglan, Monmouthshire.

Background

- 1.2 The site is currently greenfield agricultural land covering an area of approximately 2.2 hectares to the south of the town of Raglan, Monmouthshire (see **Appendix A**). The site is partly located in Development Advice Map (DAM) Zone B and DAM Zone C2. Therefore, and in accordance with the guidelines on Development and Flood Risk, as set out in Planning Policy Wales Technical Advice Note 15 (TAN15), this FCA has been prepared to assess the consequences of flooding at the site and identify flood mitigation, where required.
- 1.3 In accordance with TAN15, the proposed development must also result in no detrimental impact off site in terms of surface water runoff. Evidence of the proposed surface water management strategy is therefore also an essential element of this FCA.
- 1.4 This FCA has identified the key flooding and surface water drainage constraints and opportunities which have been used to inform the masterplan for the site (see **Appendix F**). This includes surface water drainage calculations completed in Microdrainage (see **Appendix E**) and infiltration rates from a Soakaway Ground Investigation Report (see **Appendix G**).

Aims and Objectives

- 1.5 The aim of this FCA is to understand the consequence of flooding to the proposed development and show that the site can be developed safely, without adversely affecting the risk of flooding at the site but also to surrounding areas.
- 1.6 The objectives of this FRA are to:
- Confirm the local sources of flooding present;
 - Undertake an appraisal of the flood consequences to the proposed use of the site and potential impact of the development on flood risk elsewhere; and

- Provide a conceptual strategy for mitigating flood risks to or resulting from the proposed development of the site with respect to surface water runoff. This will be based on the principles of Sustainable Drainage Systems (SuDS).

Limitations

1.7 The general limitations of this assessment are that:

- A number of sources have been used to compile this document, whilst Vectos believe them to be trustworthy; Vectos is unable to guarantee the accuracy of the information that has been provided by others.
- This report is based on information available at the time of preparing the FCA. Consequently, there is potential for further information to become available or variations to the development proposals to be made. These changes may lead to future alteration to the conclusions or calculations in this report.

2 SITE DESCRIPTION

Site Location

- 2.1 The site consists of approximately 2.2 hectares of greenfield agricultural land located to the south of Raglan. The grid reference for the site is SO 413 073. The site location and red line boundary is provided in **Appendix A**.
- 2.2 Residential housing is located immediately to the north and west of the site. Chepstow Road and an industrial unit borders the east and the Nant y Wilcae watercourse is located to the south of the site.

Proposed Development

- 2.3 A layout of the proposed development is provided in **Appendix F**, with this showing the layout of residential units across the site.

Site Topography

- 2.4 The site slope follows a gradual gradient in a southerly direction towards the Nany y Wilcae watercourse. Ground levels in the northern part of the site are approximately 38 m AOD, whilst in the south, adjacent to the watercourse, ground levels are around 36 m AOD. A topographical survey of the site is provided in **Appendix B**.

Geology and Hydrogeology

- 2.5 The 1 in 50,000 scale British Geological Survey (BGS) online mapping indicates that the bedrock underlying the site is Raglan Mudstone Formation. There are superficial deposits of Alluvium (Clay, Silt, Sand and Gravel) that overlay the bedrock across the entire site.
- 2.6 The Cranfield University Soilscales website classifies the soils in this area as loamy and clayey floodplain soils with naturally high groundwater.

Catchment Hydrology

- 2.7 The Nany y Wilcae watercourse is located along the southern boundary of the site, flowing in an easterly direction towards the Nant Olway Brook, approximately 4 km south of the site.

Drainage Infrastructure

- 2.8 The topographic survey included in **Appendix B** shows there to be a 225 mm surface water sewer that passes through the northern part of the site, draining in an easterly direction.
- 2.9 However, DCWW provided a sewer asset map for the area, which is included in **Appendix D**. This classifies the northern sewer not as a surface water sewer but as a foul sewer.
- 2.10 In addition, there is a foul rising main that passes through the southern part of the site. This drains across the site in an easterly direction towards a pumping station adjacent the eastern site boundary. The foul sewer then joins with the foul sewer that crosses the northern part of the site at a manhole located in Chepstow Road. Foul drainage is then discharged from this manhole into a combined sewer then drains south towards a treatment works.
- 2.11 The sewers that cross the site represent a development constraint, and consideration has therefore been given to the route and associated easements of these with the development block layout, as shown in **Appendix F**.

3 ASSESSMENT OF FLOOD RISK

Planning Policy Wales – TAN 15

- 3.1 Technical Advice Note (TAN15) on Development and Flood Risk provides technical guidance in relation to development and flood risk, to supplement the requirements as set out in Planning Policy Wales (PPW). It provides a framework within which risks arising from both river and coastal flooding, and from additional surface water run-off associated with development, can be assessed and the consequences then considered. Section 8 of TAN15 addresses requirements for the management of surface water from development.
- 3.2 Managing flooding is an important part of contributing towards achieving a sustainable development. Paragraph 2.11 of TAN15 advises that the relevant sustainable development considerations must be considered with regards to flood risk:
- Guiding development to locations that are at little or no risk from river, tidal or coastal flooding or from run off arising from development in any location;
 - Managing the consequences of flooding where development can be justified and the consequences are considered acceptable;
 - Making provision for future changes in flood risk, for example taking account of climate change where they can be anticipated.

Development Advice Maps

- 3.3 Under the guidance in TAN15, Development Advice Maps (DAMs) are used to determine whether the consequences of a particular frequency of flood event are acceptable for the location of a specific type of development or land use.
- 3.4 There are three DAM Flood Zones (A, B and C) to which are attributed different planning actions, as summarised in the extract of Figure 1 from TAN15 on the following page.

Figure 1 TAN15 – composition and use of different zones

Description of Zone		Use within the precautionary framework
Considered to be at little or no risk of fluvial or tidal/coastal flooding.	A	Used to indicate that justification test is not applicable and no need to consider flood risk further.
Areas known to have been flooded in the past evidenced by sedimentary deposits.	B	Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further.
Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal)	C	Used to indicate that flooding issues should be considered as an integral part of decision making by the application of the justification test including assessment of consequences.
Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.	C1	Used to indicate that development can take place subject to application of justification test, including acceptability of consequences.
Areas of the floodplain without significant flood defence infrastructure.	C2	Used to indicate that only less vulnerable development should be considered subject to application of justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

- 3.5 The site is partly located in DAM Zone C2 (adjacent to the river); Zone B (across the centre of the site); and Zone A (furthest from the river), which are discussed in Section 4 of this FCA.

Non-Statutory Standards for Sustainable Drainage (SuDS) in Wales (2015)

- 3.6 The Water Strategy for Wales 2015 places an emphasis on the use of Sustainable Drainage Systems (SuDS) to manage surface water; it sets out the Welsh Governments intentions to embed SuDS principles in all new developments.
- 3.7 To supplement the strategy, the Welsh Government has published Recommended Non-Statutory Standards for Sustainable Drainage (SuDS) in Wales (2015). This standard is to be used by developers and local authorities to demonstrate that they have taken account of the Welsh Government’s planning advice on sustainable drainage. For major developments where a surface water drainage strategy document is required, it must demonstrate how these standards have been met in the site design.

- 3.8 One of the core principles of the non-statutory standard for SuDS is the ‘drainage hierarchy’, which aims to ensure that runoff is treated as a resource and managed in a way that minimises negative impacts of the development on flood risk, together with the morphology and water quality of receiving waters and the associated ecology.
- 3.9 This principle requires rainwater to be discharged to a receptor in order of the priority detailed in Standard S1 – Surface Water Runoff Destination (see extract below). The highest priority discharge receptor should be met by the surface water drainage strategy to the maximum extent possible; exception criteria must be applied where this cannot be achieved.

S1 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.

Regional and Local Policy

- 3.10 The Monmouthshire County Council Adopted Local Development Plan outlines two key policies that are pertinent to the proposed development in context of this report and are outlined below.

Policy SD3 - Flood Risk
<p>Proposals for highly vulnerable development or emergency services will not be permitted in areas which may be liable to flooding, unless the residential development is for the conversion of upper floors within defined settlement boundaries or the proposal is to extend an established tourism, leisure or educational establishment. Less vulnerable built development will be permitted within defined settlements or on sites allocated for uses such as employment. Development proposals within a flood plain will be required to demonstrate that:</p> <ul style="list-style-type: none">a) the development is or can be protected by approved engineering works and / or other flood protection measures;b) such remedial measures would not cause flooding or significantly increase the risk of flooding elsewhere;c) the development, including any remedial measures, can be sympathetically assimilated into the environment in terms of its siting, scale, design and landscaping;d) the development does not interfere with the ability of the Environment Agency or other bodies to carry out flood control works or maintenance; ande) the nature conservation interest of the water source corridor is protected and, where practicable, enhanced. <p>Development resulting in additional surface water run-off and leading to an increased risk of flooding will only be permitted where adequate protection and mitigation measures are included as part of the proposal.</p>

3.11 Development will be located outside of areas susceptible to flooding and therefore this Policy SD3 is not relevant. This is discussed in Section 4.

Policy SD4 – Sustainable Drainage

Development proposals will be expected to incorporate water management measures, including Sustainable Urban Drainage Systems (SUDS), to reduce surface water run-off and minimise its contribution to flood risk elsewhere.

3.12 Policy SD4 refers to the sustainable drainage requirements of new development sites. Section 5 outlines how SuDS will be incorporated into the proposed development.

3.13 Monmouthshire County Council are the Lead Local Flood Authority (LLFA) for the site, who have not developed specific guidance on SuDS design. However, they refer to the general principles set out in the Welsh Government’s publication ‘Recommended non-statutory standards for sustainable drainage (SuDS) in Wales – designing, constructing, operating and maintaining surface water drainage systems’. This guidance document has informed the work undertaken as part of this FCA, as outlined in Section 5.

4 ASSESSMENT OF FLOOD RISK

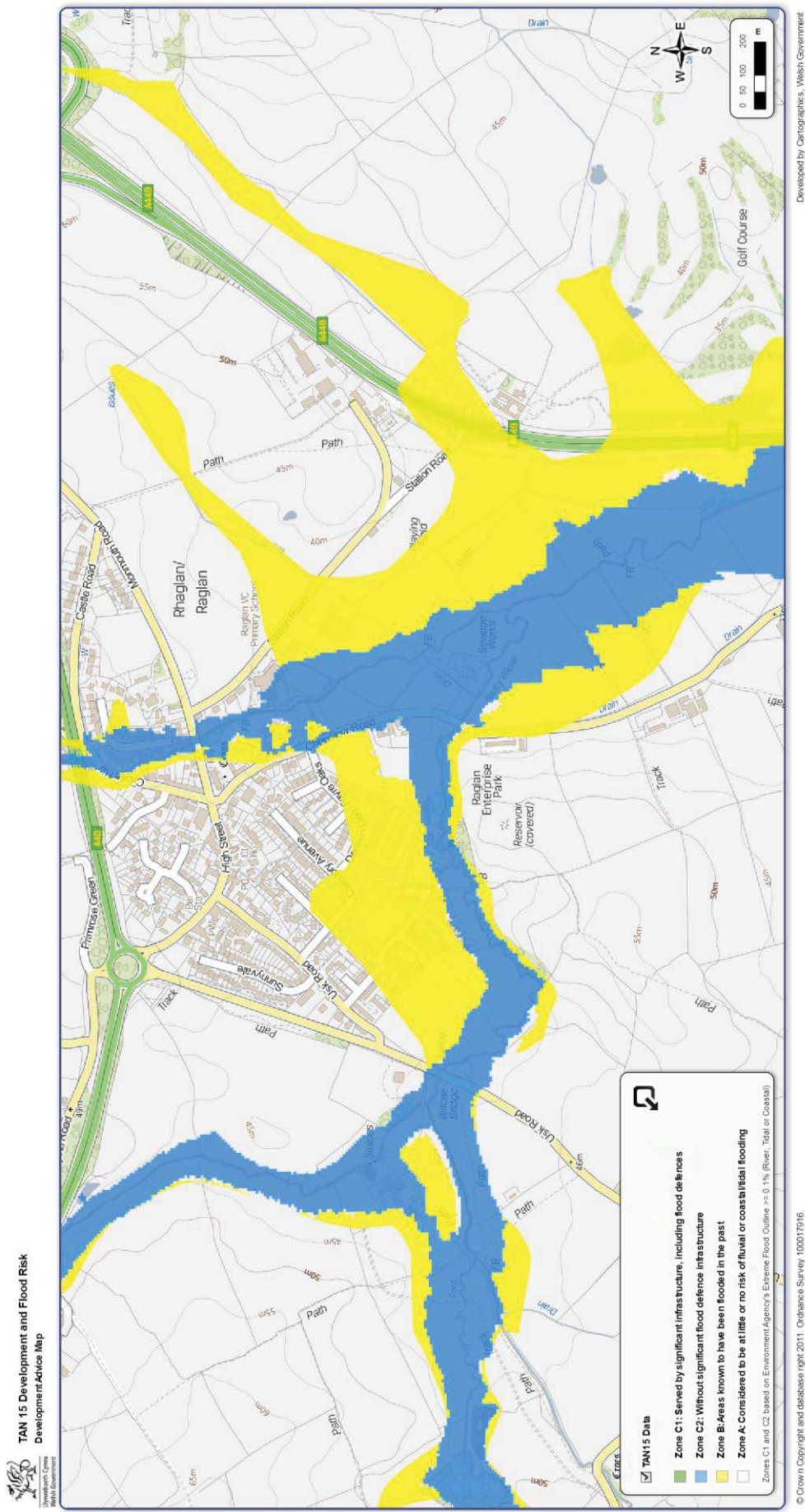
Fluvial and Tidal Flood Risk

- 4.1 An extract from the DAM is provided in Figure 3. It shows that the south part of the site is located in Zone C2, which is associated with the floodplain of the Nany y Wilcae watercourse. Zone C2 is based on the Environment Agency's Extreme flood outline (i.e. Land having a less than 1 in 1,000 annual probability of river or sea flooding). The DAM also shows that the site does not benefit from flood defence infrastructure.
- 4.2 Natural Resource Wales have confirmed that the DAM at this location is derived using the JFLOW national flood mapping programme, rather than a site specific flood modelling study. Therefore, no flood levels are available to inform this FCA.
- 4.3 Considering that land levels over the site are elevated over 36 m AOD, the flooding identified on the DAM is not from a tidal source and is therefore a result of river / fluvial flooding.
- 4.4 All development will be steered outside of Zone C2. Natural Resource Wales have confirmed that they would also encourage this consideration in the development layout (see **Appendix C**). On this basis, the development would be regarded as being safe from fluvial flooding.
- 4.5 Some development will be located in Zone B, but this is considered to be acceptable. Zone B is derived based on the position of the superficial deposits (i.e. alluvium) observed across the site. These were deposited in the geological past and are now located in parts of the site that are elevated up to 2 m above the floodplain and are no longer susceptible to flooding.
- 4.6 Given the above, the location of built development in DAM Zone B and Zone A, is considered compliant with the requirements of TAN15.
- 4.7 The proposed site vehicular access will be provided off Chepstow Road and is located at the edge of Zone C2. This may impair access and egress. However, given that new development will be steered into areas outside of the floodplain, there will be no need to evacuate during a flood. There could conceivably be a need for emergency services to access the site when there is a flood event, which could be impaired if the vehicular access was inundated. However, the access is only located on the edge of Zone C2, therefore this will flood in only

the most extreme events and is anticipated to be shallow. Given that it is on the edge of the floodplain, waters should also recede more quickly.

- 4.8 It should be noted that a pedestrian footpath is available from the site to the west onto Fayre Oaks, which would provide a dry means of access and egress on foot. Therefore, whilst vehicular access and egress may be impaired, this is not considered a significant constraint given the possibility of pedestrian access and egress.

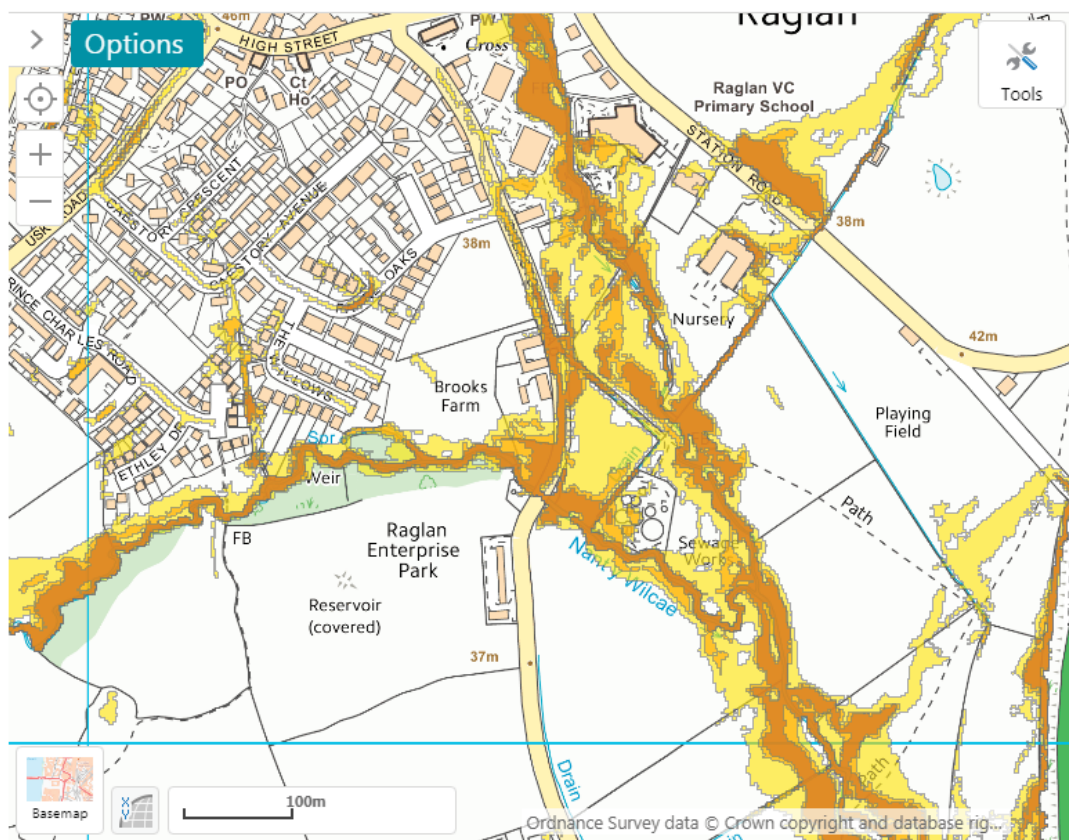
Figure 2 Development Advice Map



Risk from Surface Water Flooding

- 4.9 Surface water flooding is a result of overland flow that can follow a rainfall event, before the runoff enters a watercourse or sewer. This form of flooding is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has a low permeability.
- 4.10 The Risk of Flooding from Surface Water map has been obtained for the site from the NRW website, as shown in Figure 3.

Figure 3 Map of Surface Water Flood Risk



- 4.11 The Surface Water Flood Map shows that the site is predominantly located in an area where there is no surface water flood risk. However, the area alongside the Nany y Wilcae watercourse is shown to be susceptible to surface water flooding. Surface water flooding is less extensive compared to the fluvial flood extents (i.e. Zone C2, see Figure 2). All built development will be steered outside of Zone C2 and therefore surface water flooding will result in no additional flood risk to the development.

Groundwater Flooding

- 4.12 The Monmouthshire County Council Preliminary Flood Risk Assessment states that there is no local information on future groundwater flooding for Monmouthshire. It also states that the risk of groundwater flooding is considered to be low, and it is not considered to be a significant issue within the catchment.

Drainage and Infrastructure Flooding

- 4.13 Drainage and infrastructure flooding occurs when sewerage systems are overwhelmed and result in flooding, which may occur alone or be combined with other flood sources (e.g. fluvial or surface water).
- 4.14 DCWW were contacted and confirmed that they hold no records of sewer flooding within the vicinity of the site (see **Appendix D**).

Other Sources of Flooding

- 4.15 Non-natural or artificial sources of flooding can include reservoirs, lakes, canals etc.
- 4.16 A review of online mapping sources was undertaken to check for other possible sources of flood risk. The review did not show there to be any other significant sources of artificial flooding near to or on the site with a greater elevation.

Flood Mitigation

- 4.17 All sources of flood risk for the area proposed for built development have been identified to be low and flood risk mitigation measures are not required.
- 4.18 However, for units located adjacent to the floodplain, minimum finished floor levels (FFL) should be elevated 300 mm above the 1% AEP plus climate change event flood level. In the absence of flood level data from Natural Resource Wales, the required uplift to the FFL can be estimated based on ground levels at the edge of Zone C2.
- 4.19 FFL across the remainder of the wider site should be elevated above surrounding ground levels by at least 150 mm in accordance with building regulations, which will provide protection against shallow ponding of water, which is inevitable following very heavy rainfall.

Soil Infiltration

- 4.20 In accordance with the sustainable drainage hierarchy, a drainage strategy that discharges to the ground should be considered where appropriate and achievable. A soakaway ground investigation report was completed by Terra Firma, primarily to determine soil infiltration rates across the site but also to give information on groundwater levels (see **Appendix G**).
- 4.21 Testing was completed in trial pits excavated at five locations across the site, TP01 and TP02 located to the south-west and south-east respectively, TP03 and TP04 located to the east and west of the central part of the site respectively and TP05 located to the north. Testing was completed in accordance with BRE Digest 365, with each trial pit also logged in accordance with Eurocode 7 in order to assess the underlying shallow ground conditions.
- 4.22 The infiltration testing has concluded that soakaways are unlikely to discharge as required for locations TP01 to TP04. Also as groundwater was encountered (between depths of 1.60 and 1.70m bgl), then this would restrict the viability of shallow soakaways in these areas.
- 4.23 The infiltration testing indicted some potential for shallow infiltration features at location TP05 (northern part of the site). However, given the location of this trial pit in the part of the site where land levels are greatest, this wouldn't be a site wide solution. Whilst there may be some local benefit from infiltration into the ground (e.g. gardens, public open space), the surface water drainage strategy should be based on calculations that assume no infiltration.

5 SURFACE WATER DRAINAGE STRATEGY

Overview

- 5.1 Guidance on surface water runoff from development is given in TAN15. This advises that all types of land use change will impact on the hydrological cycle in one way or another and flooding is not confined to floodplains, as heavy rain falling on waterlogged ground can cause localised flooding almost anywhere.
- 5.2 In all flood zones, development should not increase the risk of flooding elsewhere. Surface water runoff from developments in these areas can, if not properly controlled, result in flooding at other locations and significantly alter the frequency and extent of floods further down the catchment.
- 5.3 Built development, such as roads, pavements, and roofing, tends to increase the surface area of impermeable ground, thus reducing percolation and increasing rapid surface run-off. This has the effect of reducing the time it takes for precipitation to enter the watercourse and consequently increasing the peak discharge.
- 5.4 Sustainable Drainage Systems (SuDS) can perform an important role in managing run-off from a site and should be implemented, wherever they will be effective, in all new development proposals, irrespective of the flood zone in which they are located.
- 5.5 Development may increase run-off and hence flood risk in other areas, therefore, the aim should be for new development not to create additional run-off when compared with the undeveloped situation, and for re-development to reduce run-off where possible. Whilst TAN15 advises that it is accepted that there may be practical difficulties in achieving this, the aim of this surface water drainage strategy is to achieve this.

Methodology

- 5.6 The objective of the surface water drainage strategy is to ensure that there are no residual adverse impacts on flood risk over the site and elsewhere in the catchment as a consequence of the proposed development through provision of a sustainable approach to the management of surface water runoff. This assessment will:

- Analyse the changes in land use as a consequence of the development;

- Determine the existing runoff rates;
- Estimate the required measures to mitigate / manage the increase in runoff; and
- Outline a conceptual surface water drainage strategy.

Proposed Receptor of Site Runoff

- 5.7 Standard S1 (Surface water runoff destination) of the Sustainable Drainage Systems Standards for Wales, identifies a drainage hierarchy, which aims is to ensure that surface water runoff is treated as a resource and managed in a way that minimises negative impacts of the development on flood risk, the morphology and water quality of receiving waters and the associated ecology. Standard S1 has been presented below.

S1 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.

- 5.8 The Sustainable Drainage Systems Standards for Wales states that 4 and 5 should only be used in exceptional circumstances.
- 5.9 It is recommended that some water is collected by water butts for the watering of garden plants etc (i.e. Priority Level 1). However, this is not sufficient for the management of surface water runoff for extreme rainfall events.
- 5.10 Infiltration testing was completed by Terra Firma across the site to determine the potential for infiltration to ground in the surface water drainage strategy (see **Appendix G**).
- 5.11 This testing determined there to be limited infiltration across the majority of the site, although with some potential for shallow infiltration features in the northern part. However, the benefit from infiltration features in the drainage strategy at this location is limited, in part because this is where land levels are greatest. Whilst there may be some local benefit from infiltration into the ground (e.g. gardens, public open space), the surface water drainage strategy should be based on calculations that assume there to be no infiltration.

5.12 Therefore, in accordance with the drainage hierarchy, runoff will be discharged to a surface water body (i.e. Priority Level 3). Surface water will be discharged to the Nany y Wilcae watercourse on the southern site boundary. Surface water runoff from the site currently drains to this watercourse, so this proposed connectivity will retain the existing conditions.

5.13 In order to meet with the requirements of TAN15, surface water that is discharged from a site into the watercourse must be restricted to greenfield runoff rates and volumes.

Existing Greenfield Runoff Rates

5.14 The ICP SuDS Method has been used within MicroDrainage to calculate the existing greenfield runoff rates. The parameters utilised are detailed in **Table 1** below. The calculated rates are presented in **Table 2**. The summary sheet is provided in **Appendix E**.

5.15 The greenfield runoff rates for the proposed development were calculated based on the amount of developable area within the site instead of the gross area. This has excluded the part of the site in the floodplain (i.e. Zone C2), which will not be developed.

Table 1 ICP SuDS parameters

Parameter	Value	Unit
Developable Area	1.5	Ha
SAAR	1000	mm
Soil class	0.30	-
Region	9	-
Urban	0	%

Table 2 ICP SuDS results

Return Period	Peak Greenfield Discharge (l/s)
QBAR	4.1
Q30	7.3
Q100	9.0

Proposed Surface Water Drainage Strategy

5.16 SuDS will be utilised to manage surface water runoff from the entire site. This will be in the form of an attenuation storage feature(s). The SuDS Manual (CIRIA, 2015) and the Sustainable Drainage Systems Standards for Wales have been considered during the preparation of this outline surface water drainage strategy for development site.

- 5.17 Based on the topographical survey (**Appendix B**), the proposed development comprises a single catchment draining to the watercourse. It is therefore proposed to discharge surface water runoff from the proposed development at controlled rate to this watercourse.
- 5.18 To deliver an integrated approach to SuDS at the site, a hierarchy of surface water run-off control measures has been considered. This hierarchy requires source control measures connected to site control and in some cases regional control.
- 5.19 Source control involves the management of runoff close to where the rain falls on the ground or roof surfaces. Methods appropriate for the proposed development include:
- Pervious and Permeable Surfaces
 - Filter Drains and Strips
 - Swales
 - Bioretention areas
- 5.20 Where possible, the source control measures proposed will consist of permeable paving and swale. A swale could be used to convey surface water to an attenuation feature within the site area. An attenuation pond is proposed to provide the required attenuation volume. The attenuation pond will be located towards the south-east corner of the site, and outside of the floodplain (i.e. outside of Zone C2). Surface water would be conveyed from this feature towards the watercourse adjacent the southern site boundary as a discharge receptor.
- 5.21 A MicroDrainage quick storage estimate was undertaken to determine the amount of attenuation storage that would be required to accommodate surface water runoff from the developed part of the site for all events up to and including a 1 in 100 year plus climate change event. A 60% impermeable ratio of the proposed developable area has been assumed (i.e. $1.5 \times 0.6 = 0.9$ ha). These calculations are also enclosed in **Appendix E**. The variables included in the MicroDrainage quick storage estimate are given in **Table 3**.

Table 3 Quick Storage Parameters

Variable	Value	Unit
Return period	100	
Impermeable area	0.9	ha
Max allowable discharge	3.2	l/s
Infiltration	0	m/hr
Climate change	25	%

- 5.22 The drainage strategy has been based on providing sufficient attenuation of up to and including the 1 in 100 year plus climate change event and to achieve the Q_{BAR} greenfield runoff rate. This can be achieved using a hydroslide (or similar) at the outfall.
- 5.23 This runoff rate has been adopted to ensure the long term storage volume has been accommodated so that the volume of water discharged from the site will not be increased. The total volume of storage required for this purpose equates to approximately 690 m³. The Micro Drainage quick storage estimate provides an attenuation range, and this volume is the mid-value in the storage range that has been computed.
- 5.24 The drainage strategy has been prepared to demonstrate the proposed development can meet national and local requirements. Further development of the drainage strategy will be required to inform the evolving masterplan.
- 5.25 It is recommended that a site investigation is undertaken to confirm the likely groundwater level within the site. This will inform the requirement (or not) of clay lining etc for the proposed wetland or pond.

6 CONCLUSIONS AND RECOMMENDATIONS

- 6.1 This Flood Consequence Assessment (FCA) has been undertaken to support the proposed residential development of land west of Chepstow Road, Raglan, Monmouthshire.
- 6.2 This FCA has been prepared by Vectos on behalf of Monmouthshire County Council (MCC) in accordance with the guidelines set out in Technical Advice Note 15 (TAN15) on Development and Flood Risk. The following conclusions are made:
- The site is partially located in DAM Zone C2, which is a result of fluvial flooding, with the remainder of the site located in DAM Zones B and A;
 - Surface water flooding was also identified on site, but this impacts the same location as fluvial flooding and does not introduce any further risk to the development;
 - There are no other sources of flooding that are considered to represent a constraint at the site;
 - All built development will be steered into Zone A and Zone B, which as a result will ensure it is safe from fluvial flood risk;
 - There are sewers that cross the site in an easterly direction, a foul sewer in the northern part of the site and a foul rising main in the southern part of the site;
 - The sewers that cross the site represent a development constraint, and consideration has therefore been given to the route and associated easements of these with the development block layout.
 - It is also recommended that Finished Floor Levels (FFL) of dwellings adjacent to the floodplain are set at least 300 mm above the peak flood level with FFL across the remainder of the development set 150mm above ground levels;
 - The main access and egress point to the site is towards the edge of Zone C2, and there is the potential for flooding, although this would only be in the most extreme events and levels are anticipated to be shallow. A dry pedestrian access and egress point leading to an area outside of the floodplain is available;


- 6.3 A surface water drainage strategy has been developed which will retain the existing connectivity of surface water runoff from the site into the watercourse. In order to meet with the requirements of TAN15, surface water discharged off site must be restricted to greenfield runoff rates.
- 6.4 The surface water drainage strategy has been designed to accommodate the 1 in 100-year plus climate change event. It has adhered to the sustainable drainage hierarchy and has been based on the principles of Sustainable Drainage Systems (SuDS).
- 6.5 Soil infiltration testing was completed by Terra Firma at five locations across the site, which determined the limited potential for infiltration for the management of surface water runoff.
- 6.6 An attenuation led surface water drainage strategy would therefore be required, with an attenuation pond having been proposed to provide the required attenuation volume.
- 6.7 This feature would manage the surface water runoff rate. The attenuation pond will be located towards the south-east corner of the site. Surface water would be conveyed from this towards the watercourse adjacent the southern site boundary as a discharge receptor.

APPENDIX A

Site Location

Land at Chepstow Road, Raglan



	Details			Rev No.		© Hawlfraint y Goron a hawliau cronfa ddata 2011 Arolwg Ordnans 100023415 © Crown copyright and database rights 2011 Ordnance Survey 100023415	
	Details of the plan						
	Drawn by	Scale	Date			Monmouthshire County Council County Hall Cwmbrau NP44 2XH www.monmouthshire.gov.uk/maps	
Griffiths.RO	1:2000	6/17/2013					
File Pathname / Project / Drawing No.							

APPENDIX B

Topographic Survey

APPENDIX C

Natural Resource Wales Information

Nick Bosanko

From: South East Planning <southeastplanning@cyfoethnaturiolcymru.gov.uk>
Sent: 16 August 2017 09:21
To: Nick Bosanko
Subject: Pre-app Free - Land at Chepstow Road, Raglan (Pre-app Free) - NRW Response NRW:01191175

Good morning Nick.

Where all development is sited outside of DAM Zone C2 and is clearly shown on the site masterplan, NRW would not object to these proposals. However, we would request that a minimal Flood consequences Assessment (FCA) is undertaken to confirm the predicted flood depths and velocities on the site access (assumed to be on Chepstow Road) in accordance with the requirements of Section A1.15 of TAN15.

An FCA was undertaken by Atkins in May 2016 on behalf of Monmouthshire County Council for the school on Station Road which models flood risk from the Barton Brook (and limited data for the Nant-y-Wilcae) and may be available on request from the Local Authority. This FCA would provide the best available information on risk to the site access/egress routes.

Should development be proposed within the DAM Zone C2 areas at risk from the Nant-y-Wilcae or Barton Brook, a new or updated hydraulic model and FCA will be required to ensure the risk to the site can be managed for the lifetime of the development. Any changes in ground levels which could impact on the flood storage or flood flow routes in the south of the site will need to be quantified as part of the FCA.

If this is the case please contact us again and we can provide a FCA checklist to assist with the production of the FCA.

Kind Regards
Stewart Rowden

Tîm Cynllunio Datblygu / Development Planning Team
Cyfoeth Naturiol Cymru / Natural Resources Wales
03000 653355
www.cyfoethnaturiol.cymru / www.naturalresources.wales

Yn falch o arwain y ffordd at ddyfodol gwell i Gymru trwy reoli'r amgylchedd ac adnoddau naturiol yn gynaliadwy.

Proud to be leading the way to a better future for Wales by managing the environment and natural resources sustainably.



APPENDIX D

DCWW Email and Plan

Nick Bosanko

From: Sewerage Services <Sewerage.Services@dwrwymru.com>
Sent: 20 July 2017 08:40
To: Eleanor Maxfield
Subject: Asset/Flooding Risk Enquiry

Our Reference 8000095618

Good Morning Eleanor

Thank you for your email of 18 July 2017, requesting information on the below:

"I have an enquiry with regards to DCWW infrastructure flood risk in the vicinity of a potential development site at land on Chepstow Road, Raglan Monmouthshire nearest postcode is NP15 2HB, grid reference is SO413073. The red line boundary and site location is provided below. Do you have any DG5 records and flood history in the vicinity of this site that we should be aware of?"

Having checked our records and I can confirm that we have no records of sewer flooding or identified flooding risks in the vicinity of this site.

I hope that my response was helpful. Should you have any further questions, please don't hesitate to contact me on 02920 740266 (Monday to Friday 9:00am to 4:00pm)

Kind Regards



Jessica Harris
Customer Care Team
Dwr Cymru Customer Services




If we've gone the extra mile to provide you with excellent service,
let us know. You can nominate an individual or team for a Diolch award through our [website](#)

'''

APPENDIX E

Surface Water Drainage Calculations

Vectos (South) Limited		Page 1
Unit 704 The Paintworks Bristol BS4 3EH	Raglan FCA Greenfield Runoff	
Date 29/08/2017 File	Designed by GT Checked by NB	
XP Solutions	Source Control 2015.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	1.500	Urban	0.000
SAAR (mm)	1000	Region Number	Region 9

Results 1/s

QBAR Rural 4.1
QBAR Urban 4.1

Q100 years 9.0

Q1 year 3.7
Q30 years 7.3
Q100 years 9.0

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall	Cv (Summer)	0.750
Return Period	Cv (Winter)	0.840
Regi	Impermeable Area	0.900
Ma	Maximum Allowable Discharge (l/s)	4.1
M5-60	Infiltration Coefficient	0.00000
Ratio R	Safety Factor	2.0
	Climate Change (%)	25

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 556 m³ and 825 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

APPENDIX F

Development Proposals



NOTES
 © Keep 2018
 This drawing has been produced for Mornmouthshire County Council for the proposed development at 2.6 Temple Studios Bristol, BS1 6CA for use by any other person or for any other purposes. Responsibility is not accepted for errors made by others in scaling from this drawing. All construction information should be taken from figured dimensions only. All omissions and discrepancies to be reported to Keep immediately.

Key

- Site boundary
- Residential development
- Land within utility easements can be used for roads and parking
- Main frontages
- Pedestrian links
- Proposed green infrastructure
- Existing trees and hedges
- Proposed trees
- Surface water sewer with 6m total easement (approximate location)
- Line of existing overhead cables (assumed to be grounded)
- Foul sewer with 6m total easement (approximate location)
- Flood Zone C2
- Main vehicular access

Notes	DR	CH	Date	Rev
Layout amended to take into sewer	NS	SC	28/02/2018	B
Layout amended	NS	SC	12/02/2018	A
First issue	NS	SC	23/07/2017	-



Keep Architecture Limited t: 0117 325 0359
 2.6 Temple Studios
 Bristol, BS1 6CA
 e: info@keeparchitecture.co.uk
 w: keeparchitecture.co.uk

Project
 ReQJan
Drawing
 Block Plan
Drawing number
 1391 - F - 002
Scale
 1:1000 @ A3
Revision number
 B



APPENDIX G

Soil Infiltration Testing

**SOAKAWAY GROUND
INVESTIGATION REPORT**
CHEPSTOW ROAD
RAGLAN
USK
MONMOUTHSHIRE

**Prepared for:
Monmouthshire County Council**

November 2017

Report No: 6036



Consulting Geo-Technical &
Geo-Environmental Engineers
Site Investigation Contractors

The Pump House, 44 Marlborough Road,
Exeter, Devon, EX2 4LL
Tel: 01392 438982
Email: info@terrafirmasouth.co.uk
Web: www.terrafirmasouth.co.uk

SOAKAWAY GROUND INVESTIGATION REPORT
CHEPSTOW ROAD
RAGLAN
USK
MONMOUTHSHIRE

Prepared for:
Monmouthshire County Council

November 2017

TERRA FIRMA (SOUTH)

The Pump House
44 Marlborough Road
Exeter
EX2 4LL

Tel: 01392 438982
E-mail: info@terrafirmasouth.co.uk
Website: www.terrafirmasouth.co.uk

Report No. 6036

REPORT TITLE : **Soakaway Ground Investigation**
Chepstow Road, Raglan, Usk,
Monmouthshire

REPORT STATUS : **Final**

REVISION :

JOB NUMBER : **6036**

DATE : **November 2017**

PREPARED BY :



Mr S. Reed B.Sc. (Hons), M.Sc., MCSM, FGS

APPROVED BY :



Mr S. Hill B.Sc. (Hons), M.Sc., CGeol, FGS

TABLE OF CONTENTS

Section 1 Introduction and Proposed Development

- 1.1 Limitations and Exceptions of Investigation

Section 2 Review of Existing Data

- 2.1 Physical Setting
- 2.2 Current Use and Site Conditions
- 2.3 Geology
- 2.4 Hydrology

Section 3 Field Investigation

- 3.1 Site Works
- 3.2 Ground Conditions
- 3.3 Water Strikes
- 3.4 In-situ Permeability Testing
 - 3.4.1 Soakaway Testing

Section 4 Engineering Recommendations

- 4.1 General
- 4.2 Storm Drainage

Tables

- Table 3.1 Summary of Soakaway Depths
- Table 3.2 Summary of Ground Conditions
- Table 4.1 Soakaway Test Results

Annexes

- Annex A Trial Pit Logs
- Annex B In-situ Soakaway Calculation Sheets

Drawings

- Drawing 01 Site Location
- Drawing 02 Exploratory Hole Location Plan

SECTION 1 Introduction and Proposed Development

Monmouthshire County Council are proposing to redevelop land off Chepstow Road, Raglan, Usk for residential usage. This development will be restricted to the existing site boundaries.

Vectos (South) Ltd are the consulting drainage engineers for the proposed development.

Terra Firma (South) have been commissioned to carry out a soakaway ground investigation at the above site.

The main objectives of the soakaway ground investigation were to:

- Log exploratory holes in accordance with Eurocode 7 in order to assess the underlying shallow ground conditions.
- Provide an assessment of soil permeability in accordance with BRE Digest 365 including appropriate calculations of infiltration rates in order to enable drainage design for the proposed new soakaways.

In order to achieve the above objectives, Terra Firma (South) carried out an assessment programme comprising a field investigation to determine the prevailing ground conditions and undertake in-situ permeability tests.

1.1 Limitations and Exceptions of Investigation

Vectos (South) Ltd, on behalf of Monmouthshire County Council, has requested that a Soakaway Ground Investigation (GI) be performed in order to determine the underlying ground conditions and associated soil permeability rates.

The GI was conducted and this report has been prepared for the sole internal reliance of Monmouthshire County Council and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (South). If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (South) does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths tested.

The site investigation was limited by the following site constraints:

- Underground services and utilities, and
- Existing structures, fences and heavily vegetated areas.

SECTION 2 Review of Existing Data

2.1 Physical Setting

The proposed development is located within land to the west of Chepstow Road, Raglan, Usk, Monmouthshire, NP15 2HA.

The site is approximately centred on National Grid Reference 341356, 207383 as presented in **Drawing 01**.

The site is irregular in shape and covers an area of some 2.16 hectares. Ground levels within the site range between 38m and 40m AOD.

The topography of the site and surrounding area falls to the south towards the Nant y Wilcae, which is located approximately 10m to the south of the site.

2.2 Current Use and Site Conditions

At the time of the fieldworks the site comprised open fields with a fence running through the centre in an E-W direction. The site was bounded to the west and north by residential dwellings, with the east also bounded in places by residential dwellings. To the south, trees and the Nant y Wilcae bound the site, with Chepstow Road and Fayre Oaks Road to the east and north respectively.

2.3 Geology

The British Geological Survey's (BGS) 1:50, 000 scale geological map of the area shows that the site is underlain by the Raglan Mudstone Formation of Silurian Age. The Raglan Mudstone Formation is indicated to be covered by superficial deposits in the form of Alluvium.

The BGS describe the Raglan Mudstone Formation as siltstone and mudstone. The Alluvium Deposits are described as clay, silt, sand and gravel.

2.4 Hydrology

The nearest surface water feature is the Nant y Wilcae, located approximately 10m to the south of the site.

SECTION 3 Field Investigation

3.1 Site Works

A ground investigation scoped by Vectos (South) Ltd and comprising five trial pits with in-situ soakaway tests was carried out at the site on the 1st of November 2017.

The trial pits were excavated using a JCB 3CX wheeled excavator.

In-situ permeability tests were undertaken within the excavated trial pits in order to provide conventional soakaway design detail. Table 3.1 below summarises the depths of the soakaway tests undertaken:

Table 3.1 Summary of Soakaway Depths		
Soak away Test	Type	Depth (m)
TP01	Conventional	1.80
TP02	Conventional	1.80
TP03	Conventional	2.00
TP04	Conventional	1.70
TP05	Conventional	2.10

A 1500 gallon tanker was used to rapidly fill the excavations with water.

Once the soakaway tests were completed, the trial pits were backfilled with arisings. The backfilled arisings were compacted in 300mm thick layers using the backhoe of the excavator.

Before any excavation, all exploratory trial pit locations were scanned using a Cable Avoidance Tool (CAT).

The fieldworks were supervised by Terra Firma (South), who also logged the trial pits to the requirements of BS5930:2015.

The trial pit logs are presented in **Annex A** and the locations of the trial pits are shown on **Drawing 02**.

3.2 Ground Conditions

The ground conditions encountered by the trial pits can in general be summarised as shown in Table 3.2 on the following page:

3.2 Ground Conditions (Continued)

Table 3.2 Summary of Ground Conditions				
Depth (m)		Thickness (m)	Stratum	
GL	- 0.15/0.40	0.15/0.40	Grass over soft, reddish-brown/dark brown, silty sandy CLAY .	<i>Topsoil</i>
0.15/0.40 - 0.80/1.00		0.60/0.65	Soft to firm/stiff, reddish-brown, sandy gravelly CLAY .	<i>Alluvium</i>
0.80/1.00 - >2.10		>1.30	Dense to very dense, reddish-brown, slightly clayey/clayey sandy GRAVEL . <u>OR</u> Firm to stiff, reddish brown, sandy gravelly CLAY with cobbles and boulders of sandstone.	<i>Glacial Till</i>

The Raglan Mudstone Formation was not encountered in any of the trial pits. Instead, Glacial Till was recovered, as described in the table above.

It should be noted that made ground deposits were recovered in TP02, comprising sandy gravelly clay including brick to a depth of 0.30mbgl.

Most of the trial pits were stable with the exception of TP05 where some slight spalling was recorded. In addition, alluvium was not encountered in TP05.

3.3 Water Strikes

A groundwater strike was encountered within TP01, TP02 and TP04 at depths of between 1.60 – 1.70mbgl. The strikes were recorded as a seepage to moderate flow.

3.4 In-situ Permeability Testing

3.4.1 Soakaway Testing

During the site investigation, a single in-situ permeability test was carried out within each of the five trial pits to the requirements of BRE Digest 365 where possible.

The appropriate calculation sheets are presented in **Annex B** and the results are discussed in Section 4.1.

SECTION 4 Engineering Recommendations

4.1 General

The shallow ground conditions encountered within all trial pits typically comprised sandy gravelly clays and clayey sandy gravels.

Therefore, during drainage design, consideration should be given to the variability encountered across the site both vertically and horizontally.

It should also be noted that soakaways would only be effective above the depth of the groundwater table, encountered between 1.60 and 1.70m bgl.

4.2 Storm Drainage

The in-situ soakaway tests were undertaken in general accordance with the requirements of BRE Digest 365. The infiltration rates are as follows:

Table 4.1 Soakaway Test Results			
Borehole No.	Depth (m)	Typical Soil Type	Soil Permeability (m/s)
TP01 – First Fill	1.80	Sandy gravelly CLAY	-
TP02 – First Fill	1.80	Slightly clayey gravelly SAND	-
TP03 – First Fill	2.00	Sandy gravelly CLAY	-
TP04 – First Fill	1.70	Slightly clayey gravelly SAND	-
TP05 – First Fill	2.10	Slightly clayey gravelly SAND	2.73×10^{-5}

TP01, TP02, TP03 and TP04 did not sufficiently drain to enable calculation of infiltration rates in accordance with BRE 365. It is considered that soakaways are unlikely to discharge from full to half-volume within 24 hours in readiness for subsequent storm inflows and therefore shallow soakaways are unlikely to be suitable at these locations.

The infiltration rate for TP05 has been determined as per BRE 365 guidelines, although only the first fill was possible within the time constraints.

Based upon the above it is considered that there is some potential for shallow soakaways within the northern part of the site where TP05 was located.

In the other areas of the site, low infiltration rates were encountered indicating that the potential for soakaways for discharge of surface water is limited. In addition, groundwater was encountered across the central and southern portion of the site at between 1.60m and 1.70mbgl. The presence of shallow groundwater may restrict the viability of shallow soakaways in these areas.

ANNEX A
Trial Pit Logs

Exploratory Hole Key Sheet

Samples

ES	Environmental Chemistry Soil Sample (Multiple containers where appropriate)
EW	Environmental Chemistry Water Sample (Multiple containers where appropriate)
B	Bulk Disturbed Sample
D	Small Disturbed Sample
U	Driven Tube Sample
UT	Driven Thin Wall Tube Sample
P	Pushed Piston Sample
C	Core Sample (from rotary core)
G	Gas Sample

In-situ Tests

SPT(S) or (C)	Standard Penetration Test, Split Spoon (S) or Solid Cone (C)
HV	Hand Vane Shear Strength
PP	Pocket Penetrometer Test

Ground Water



Groundwater Strike



Groundwater Level after standing period

Drilling Records

TCR	Total Core Recovery (given as % of core run)
SCR	Solid Core Recovery (given as % of core run)
RQD	Rock Quality Designation (given as % of core run)
FI	Fracture Indices
NI	Non Intact core run

Installations



Plain Standpipe



Slotted Standpipe

Backfill Legends

Arisings



Concrete



Gravel



Sand



Bentonite/Grout



Notes


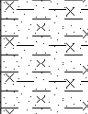
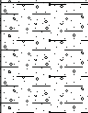
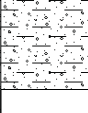





Soils and rocks are described in accordance with BS 5930:2015.

The assessment of TCR, SCR, RQD and FI excludes artificial fractures caused by drilling

Strata Legends in accordance with BS5930:2015.

Exploratory logs present the results of the Standard Penetration Test recorded in the field.

Project Name Raglan		Project No. 6036	Date 01/11/2017 to 01/11/2017	Hole Type TP	
Client Monmouthshire County Council		Co-ords E: N: L:	Water Strike Details		Logged By SR
Contractor ALD Plant Hire			Plant Used JCB 3CX	Depth Strike 1.60	Remarks
					Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.20) 0.20		TOPSPOIL Grass over soft, reddish-brown, silty sandy CLAY. Frequent rootlets present. Soft, reddish-brown, silty sandy CLAY.	
			(0.60)			
			0.80			
			1		Soft to firm, reddish-brown, sandy gravelly CLAY. Gravels are subangular to subrounded, fine to coarse of flint pebbles and cobbles.	
			(1.00)			
			1.80		End of Trial Pit at 1.80m	
			2			
			3			
			4			

Trial Pit Photographs



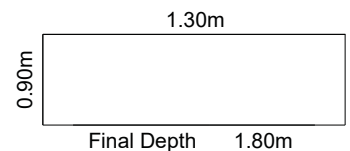
Remarks

Moderate to fast inflow.

Pit Stability

Relatively stable

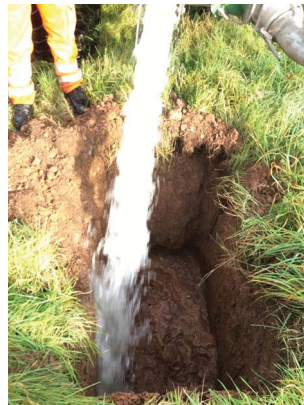
Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.



Project Name Raglan		Project No. 6036	Date 01/11/2017 to 01/11/2017	Hole Type TP	
Client Monmouthshire County Council		Co-ords E: N: L:	Water Strike Details		Logged By SR
Contractor ALD Plant Hire			Plant Used JCB 3CX	Depth Strike 1.70	Remarks
					Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.15)		TOPSOIL	
			0.15		Grass over soft, dark-brown, sandy silty CLAY.	
			(0.15)		MADE GROUND	
			0.30		Firm, reddish-brown, sandy gravelly CLAY. Gravels are subangular to subrounded, fine to coarse of brick and sandstone.	
			(0.70)		Firm to stiff, reddish-brown, sandy gravelly CLAY. Gravels are subrounded to rounded, fine to coarse of sandstone.	
			1.00	1	Medium dense, reddish-brown, slightly clayey gravelly SAND. Gravels are subrounded to rounded, fine to coarse of sandstone. Frequent cobbles and boulders present.	
			(0.80)			
			1.80		End of Trial Pit at 1.80m	
				2		
				3		
				4		

Trial Pit Photographs

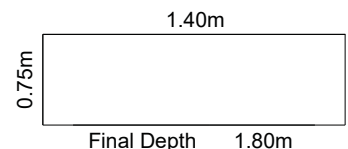


Remarks

Pit Stability

Relatively stable.

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.



Project Name Raglan		Project No. 6036	Date 01/11/2017 to 01/11/2017		Hole Type TP
Client Monmouthshire County Council		Co-ords E: N: L:	Water Strike Details		Logged By SR
Contractor ALD Plant Hire Ltd			Plant Used JCB 3CX	Depth Strike 1.60	Remarks
Scale 1:50					

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.40)		TOPSOIL Grass over soft, reddish-brown, silty sandy CLAY.	
			0.40 (0.40)		Firm, reddish-brown, slightly gravelly sandy CLAY. Gravels are subangular to subrounded, fine to coarse of sandstone.	
			0.80 1 (0.90)		Medium dense to dense, reddish-brown, slightly clayey gravelly SAND. Gravels are subrounded to rounded, fine to coarse of sandstone.	
			1.70		End of Trial Pit at 1.70m	
			2			
			3			
			4			

Trial Pit Photographs

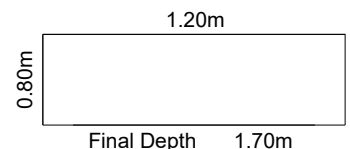


Remarks

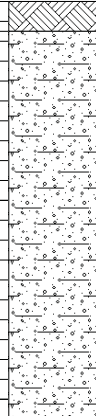
Pit Stability

Relatively stable.

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.



Project Name Raglan		Project No. 6036	Date 01/11/2017 to 01/11/2017	Hole Type TP	
Client Monmouthshire County Council		Co-ords E: N: L:	Water Strike Details		Logged By SR
Contractor ALD Plant Hire			Plant Used JCB 3CX	Depth Strike	Remarks
					Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
			(0.15) 0.15		<p>TOPSOIL Grass over soft, dark-brown, slightly gravelly silty CLAY. Gravels are subangular to subrounded, fine to coarse of sandstone.</p> <p>Dense to very dense, reddish-brown, clayey sandy GRAVEL. Gravels are rounded to subrounded, coarse of sandstone with frequent cobbles and boulders at depth.</p>	
			1 (1.95)			
			2 2.10		End of Trial Pit at 2.10m	
			3			
			4			

Trial Pit Photographs

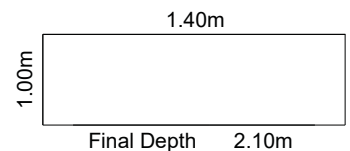


Remarks

Pit Stability

Relatively unstable.

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.



ANNEX B
In-situ Soakaway Calculation Sheets

Site Name: Raglan, Usk TP01	Job No.: 6036 Test No.: 1	Date Undertaken: 01/11/2017
--	--	------------------------------------

(Top of test / effective depth - 100%)

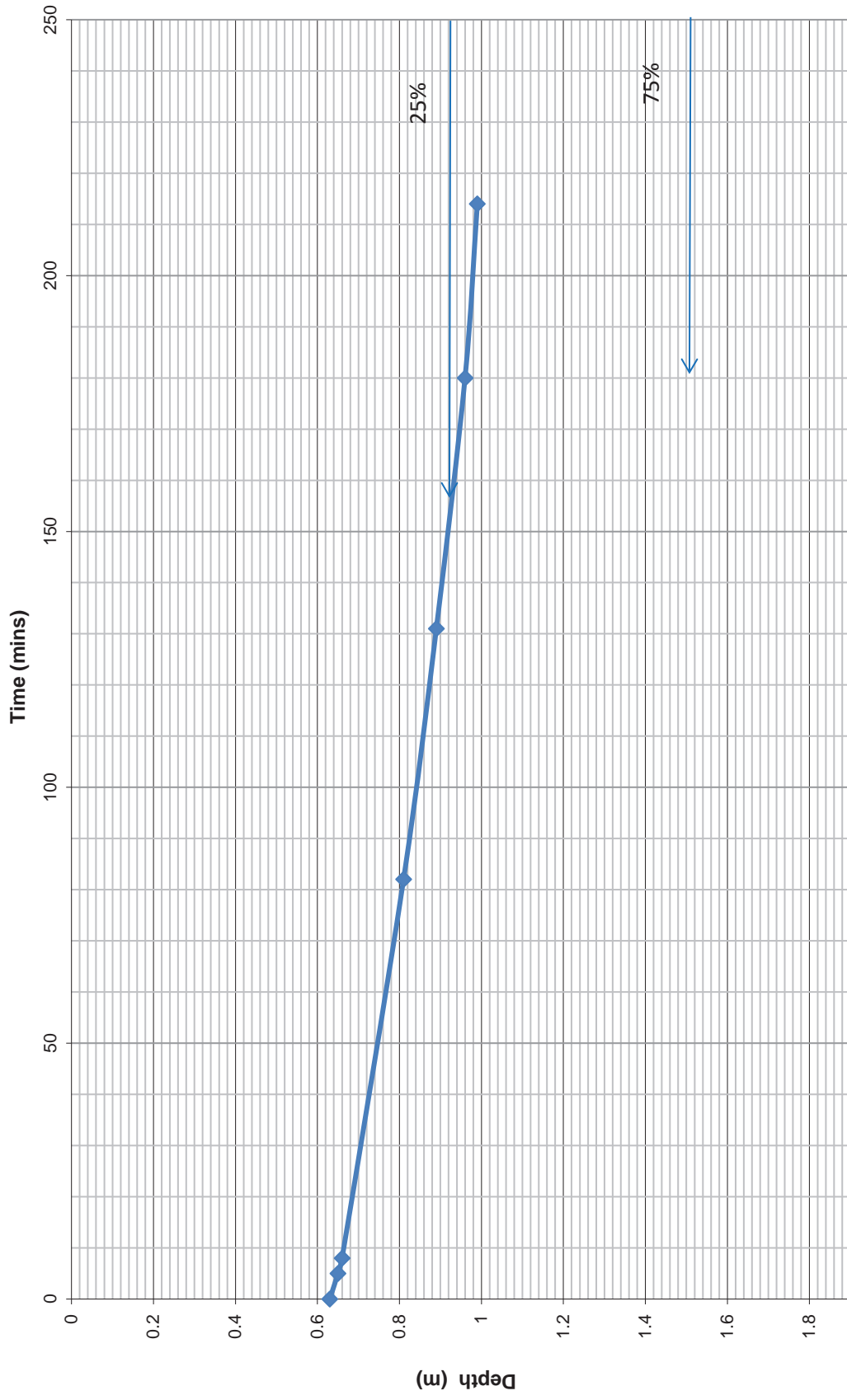
Depth to Water (m)	Time (Mins)
0.63	0
0.65	5
0.66	8
0.81	82
0.89	131
0.96	180
0.99	214
1.800	

(Base of pit / effective depth - 0%)

Length of Trial Pit (m)	1.3
Width of Trial Pit (m)	0.9
Depth of Trial Pit (m)	1.8
Effective Storage Depth (m)	1.170
Vp25	0.9225
Vp75	1.5075
Vp75-25	0.684
50% effective depth (m)	0.585
Mean Surface area ap50 (m2)	3.744
Time for 25% Outflow (tp25)	157
Time for 75% Outflow (tp75)	/
tp75 - 25	#VALUE!
Soil Infiltration Rate (m/s)	#VALUE!

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP01, Test 1



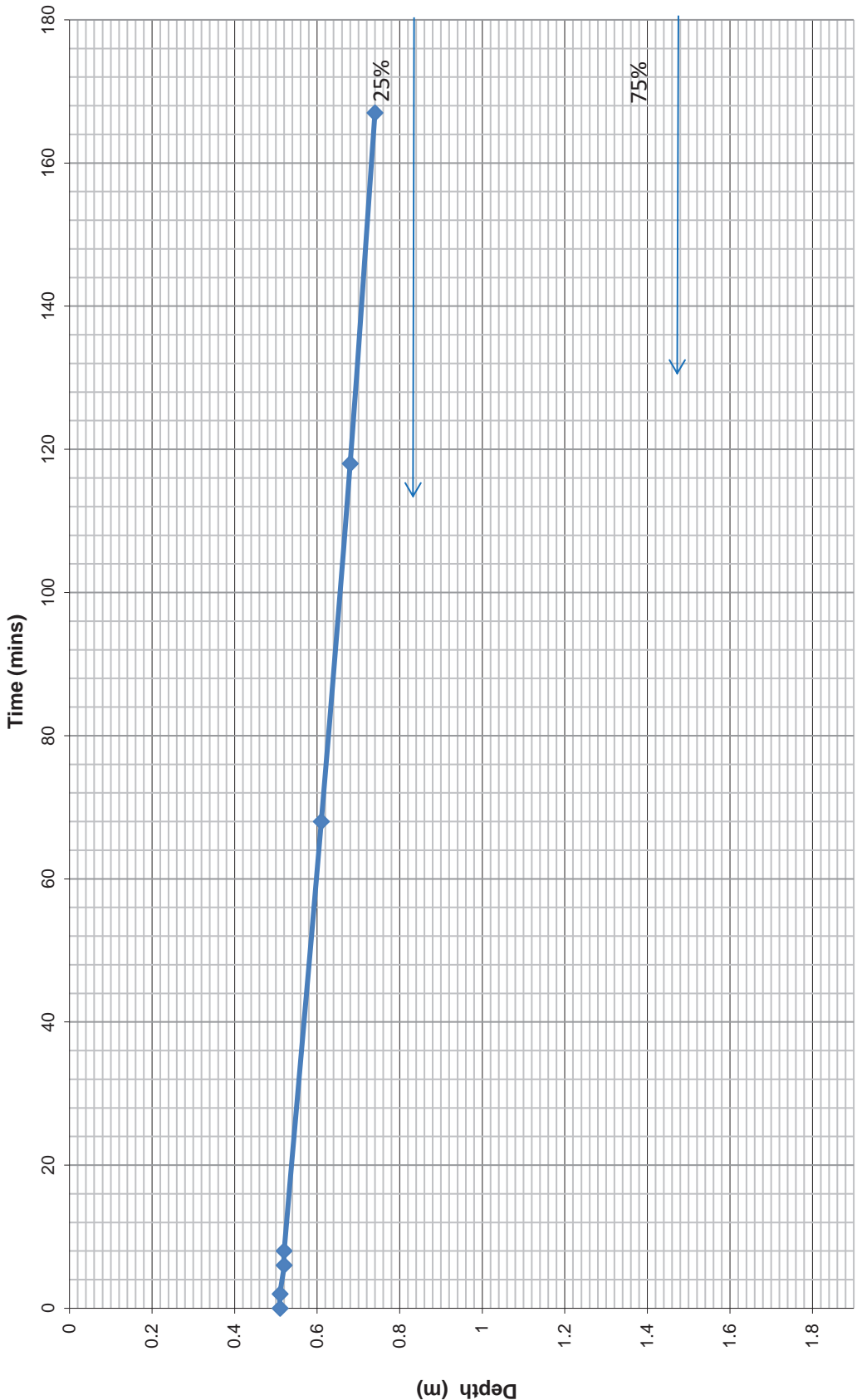
Site Name: Raglan, Usk TP02	Job No.: 6036 Test No.: 1	Date Undertaken: 01/11/2017
--	--	------------------------------------

	Depth to Water (m)	Time (Mins)
(Top of test / effective depth - 100%)	0.51	0
	0.51	2
	0.52	6
	0.52	8
	0.61	68
	0.68	118
	0.74	167
(Base of pit / effective depth - 0%)	1.800	

Length of Trial Pit (m)	1.4
Width of Trial Pit (m)	0.75
Depth of Trial Pit (m)	1.8
Effective Storage Depth (m)	1.290
Vp25	0.8325
Vp75	1.4775
Vp75-25	0.677
50% effective depth (m)	0.645
Mean Surface area ap50 (m2)	3.824
Time for 25% Outflow (tp25)	/
Time for 75% Outflow (tp75)	/
tp75 - 25	#VALUE!
Soil Infiltration Rate (m/s)	#VALUE!

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP02, Test 1



Site Name: Raglan, Usk TP03	Job No.: 6036 Test No.: 1	Date Undertaken: 01/11/2017
--	--	------------------------------------

Depth to Water (m)	Time (Mins)
0.4	0
0.45	4
0.47	8
0.65	53
0.77	102
0.84	147
2.000	

(Top of test / effective depth - 100%)

(Base of pit / effective depth - 0%)

1.5
0.75
2

Length of Trial Pit (m)

Width of Trial Pit (m)

Depth of Trial Pit (m)

Effective Storage Depth (m)

Vp25

Vp75

Vp75-25

50% effective depth (m)

Mean Surface area ap50 (m2)

Time for 25% **Outflow** (tp25)

Time for 75% **Outflow** (tp75)

tp75 - 25

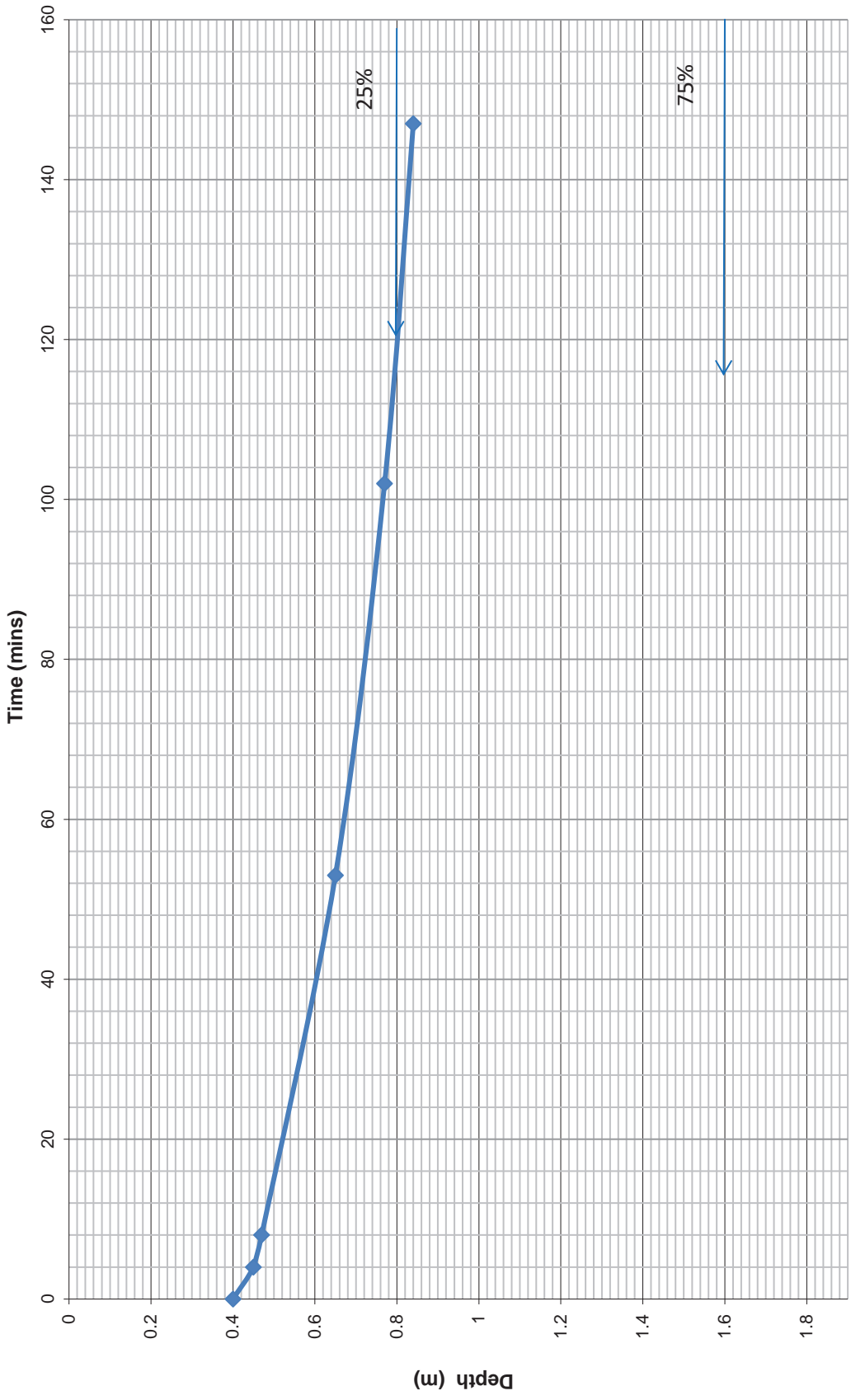
#VALUE!

#VALUE!

Soil Infiltration Rate (m/s)

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP03, Test 1



Site Name: Raglan, Usk TP04	Job No.: 6036 Test No.: 1	Date Undertaken: 01/11/2017
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Depth to Water (m)	Time (Mins)
0.46	0
0.46	2
0.46	4
0.47	39
0.48	78
0.49	126
1.700	

(Top of test / effective depth - 100%)

(Base of pit / effective depth - 0%)

1.2
0.8
1.7

Length of Trial Pit (m)

Width of Trial Pit (m)

Depth of Trial Pit (m)

Effective Storage Depth (m)

Vp25

Vp75

Vp75-25

50% effective depth (m)

Mean Surface area ap50 (m2)

Time for 25% **Outflow** (tp25)

Time for 75% **Outflow** (tp75)

tp75 - 25

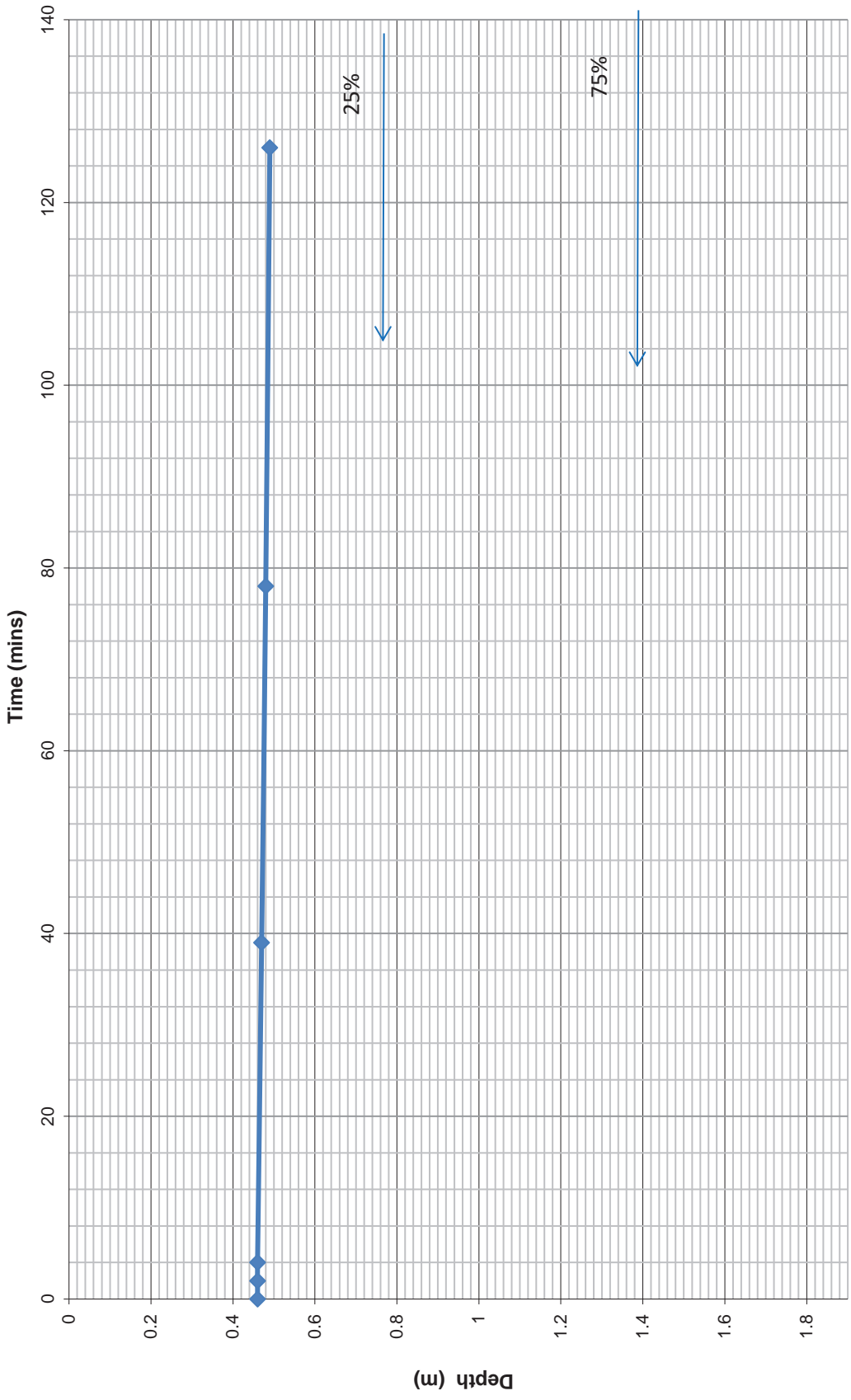
Soil Infiltration Rate (m/s)

#VALUE!

#VALUE!

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP04, Test 1



Site Name: Raglan, Usk	Job No.: 6036	Date Undertaken: 01/11/2017
Trial Pit No.: TP05	Test No.: 1	

(Top of test / effective depth - 100%)

Depth to Water (m)	Time (Mins)
0.57	0
0.61	2
0.66	3
0.76	9
0.95	22
1.14	37
1.28	55
1.36	67
1.39	74
1.48	100
1.55	117
1.65	129
1.69	141
1.72	152
2.100	

(Base of pit / effective depth - 0%)

1.4
1
2.1

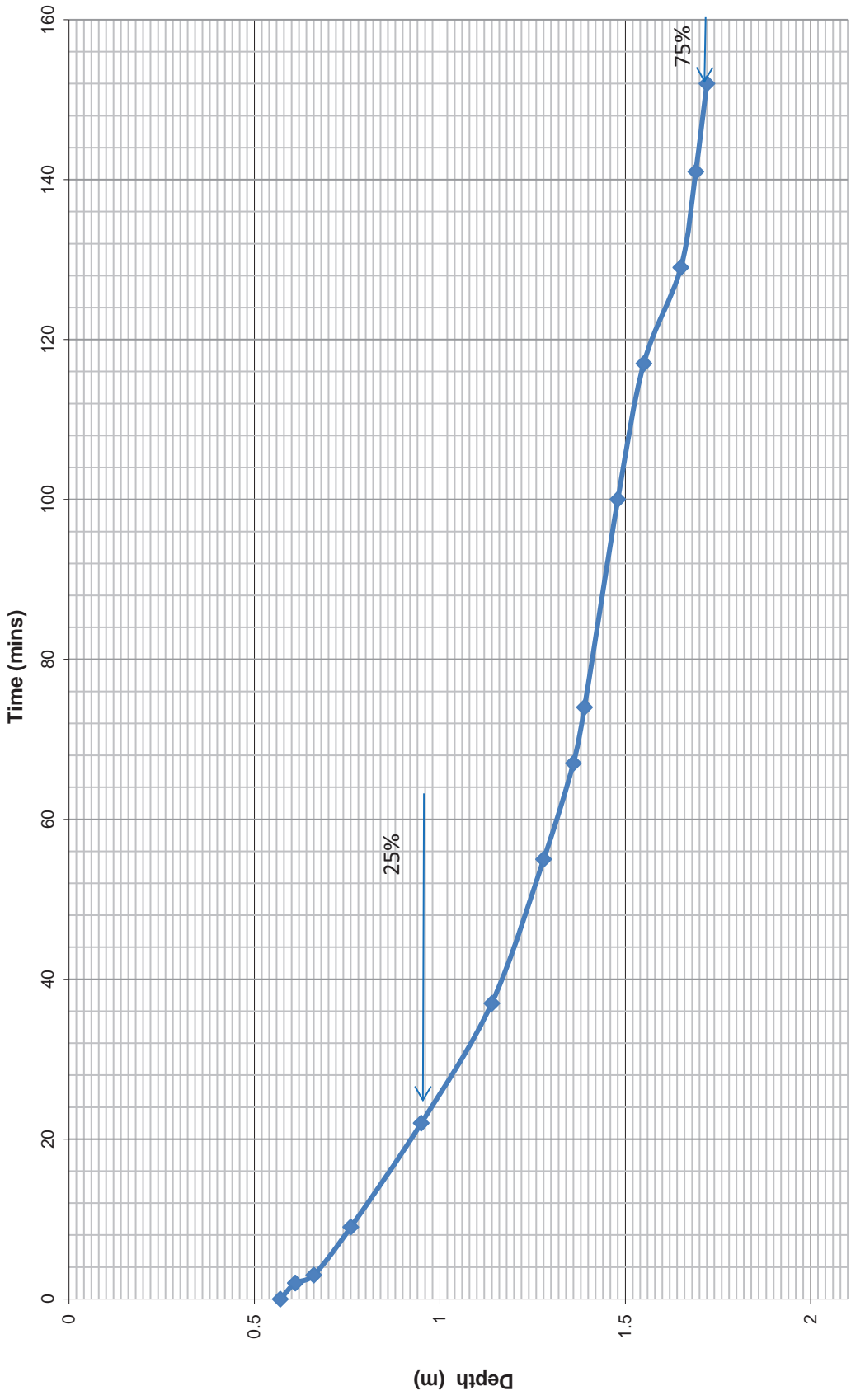
Length of Trial Pit (m)
Width of Trial Pit (m)
Depth of Trial Pit (m)
Effective Storage Depth (m)
Vp25
Vp75
Vp75-25
50% effective depth (m)
Mean Surface area ap50 (m2)
Time for 25% **Outflow** (tp25)
Time for 75% **Outflow** (tp75)
tp75 - 25

22
151
129

Soil Infiltration Rate (m/s) **2.72816E-05**

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP05, Test 1





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<p>Project: Chepstow Road, Raglan, Usk</p>
<p>Drawing 01 – Site Location NTS</p>