



**TOP ROAD
SUMMERHILL, WREXHAM**

**FLOOD CONSEQUENCE ASSESSMENT &
DRAINAGE MANAGEMENT STRATEGY**



For

Macbryde Homes Ltd
Macbryde House
28 St Asaph Business Park
St Asaph
Denbigshire
LL17 0LJ



JULY 2017

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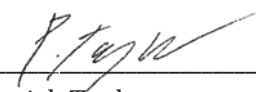
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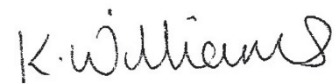
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Document Tracking Sheet

Document Reference: **HYD229_TOP.ROAD_FCA&DMS**

Revision: **2.0**
Date of Issue: **27th July 2017**
Report Status: **Final**

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Revision History:

Rev.:	Date:	Status:	Prepared by:	Checked by:	Issued by:
2.0	27 th July 2017	Final	PT	RA	PT
1.0	10 th May 2017	Final	PT	DK/RDN	PT
0	8 th May 2017	Draft	PT	DK/RDN	PT

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EXECUTIVE SUMMARY

This Flood Consequence Assessment and Drainage Management Strategy (FCA&DMS) was commissioned by Macbryde Homes referred to hereafter as 'the client'. This report has been prepared to support a full planning application for a residential development on land to the east of Top Road in Summerhill (Wrexham).

Flood Risk

The development is located within Flood Zone A on the Development Advice Map and the nature of the proposals are considered as 'Highly Vulnerable'; this is considered 'acceptable' within Flood Zone A.

The FCA has reviewed all sources of flood risk to both the proposed development and to the existing adjacent development as a result of the proposals, including; fluvial, tidal, pluvial, groundwater, sewers and flooding from artificial sources. The development site is located within Flood Zone A and therefore at low flood risk.

The nearest Main River to the site is the River Alyn due to the proximity from site (approximately 1.5km) fluvial flood risk from this source is considered low. The nearest Ordinary Watercourse is located 100m to the west of the site, due to local topography the risk from this source is minimal and is considered accessible for emergency access and egress as the site is not located within the extents of the floodplain.

An Internet based search for flooding events did not recall identify historical flooding to the site. Initial consultation with Natural Resources Wales, Wrexham County Borough Council and Welsh Water has not identified any onsite historical flooding.

The proposed development has been justified in accordance with TAN15 and suitable mitigation measures have been proposed to ensure that the development is safe for its lifetime. This assessment illustrates that there is: minimal risk to life, minimal disruption to people, minimal potential damage to property and that proposals will have minimal impacts on flood risk generally.

Drainage Strategy

In accordance with the drainage hierarchy there are three methods that have been reviewed for the appropriate management and discharge of surface water, these have been applied in the order of priority; discharge via infiltration, to a watercourse and finally to public sewerage system. Based on the ground conditions identified online, it can be considered that infiltration could likely provide a viable full (if not part) surface water drainage solution for the site. In accordance with LPA's and WW typical requirements, Soakaway Testing to BRE365 has been undertaken and confirms infiltration will be feasible at the site.

Although testing confirms infiltration is feasible at the site, due to engineering constraints (gradient of the site) it may offer only a part surface water management solution (to be confirmed at detailed design stage). The next method in the hierarchical approach should be to discharge to watercourse. Review of the mapping indicates an Ordinary watercourse located 100m to the west of the site. Anecdotal evidence suggests there is a possible culverted watercourse to the east of

site as there is an identified surface water sewer outfall, however more information into the watercourse is unknown. Further investigation into this system is currently being undertaken including discussion with WCBC. Following further investigation this would be the preferred alternative point of outfall.

Alternatively should discharge to a watercourse not be feasible then the WW sewer records identify a public surface water sewer (150mm), approximately 50 metres to the east of site. Discussion with WW will be required for any works to the public sewer network and this should be agreed as part of detailed design stage.

It is proposed that SuDS systems are considered within the scheme to in part manage the surface water run-off generated. The development and its drainage systems should be designed to cope with intense storm events up to and including the 100 year return period rainfall event with an allowance for Climate Change (CC); based on the design life of the proposal this allowance will be in the form of 30%.

The nature of the proposals would suggest an opportunity to reduce the potential flood risk; opportunities should be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off. Based on the nature and scale of the development there will likely be the opportunity to implement various SUDS options in private (non-adopted) areas such as permeable paving, bio-filtration units and rainwater harvesting, along with pond/basin(s) within POS areas. Consideration into management and future adoption of any proposed SuDS will be required and detailed design should confirm feasibility following more detailed levels, capacity and attenuation review.

This Flood Consequence Assessment and Drainage Management Strategy is considered to be commensurate with the development proposals and in summary, the development can be considered appropriate in accordance with TAN15, providing the mitigation measures proposed are conformed to.

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Specialist Software

-  MicroDrainage WinDES (v.14.1) – Calculation of Greenfield run-off rates IH124/ICP-SUDS, Greenfield run-off volumes, rates of rainfall and stormwater storage estimates.

Abbreviations & Acronyms

AEP	Annual Exceedance Probability
BGL	Below Ground Level
BGS	British Geological Survey
CC	Climate Change
CFMP	Catchment Flood Management Plan
DAM	Development Advice Map
EA	Environment Agency
FCA	Flood Consequence Assessment
FEH	Flood Estimation Handbook
FZ	Flood Zone
Ha	Hectare
IDB	Internal Drainage Board
LDP	Local Development Plan
LFRDP	Local Flood Risk Development Plan
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	Metres Above Ordnance Datum
NGR	National Grid Reference
NRW	National Resources Wales
NSRI	National Soil Resource Institute
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPW	Planning Policy Wales
QSE	Quick Storage Estimate
SFCA	Strategic Flood Consequence Assessment
SuDS	Sustainable Urban Drainage Systems
SMP	Shoreline Management Plan
SWMP	Surface Water Management Plan
TAN15	Technical Advice Note 15
TWL	Top Water Level
UKCIP	United Kingdom Climate Impacts Programme
WW	Welsh Water
WCBC	Wrexham County Borough Council

1.0 INTRODUCTION

1.1 Planning Policy Context

- 1.1.1 All forms of flooding and their impact on the natural and built environment are material planning considerations. Planning Policy Wales (PPW) sets out the Government's objectives for the planning system, and how planning should facilitate and promote sustainable patterns of development, avoiding flood risk and accommodating the impacts of climate change. Government policy with respect to development in flood risk areas is contained within the PPW, Technical Advice Note 15, (TAN15) 'Development and Flood Risk' issued in July 2004.

Technical Advice Note 15 (TAN15)

- 1.1.2 TAN15 provides technical guidance to supplement the policy's set out in PPW with regards to 'development and flood risk', a framework is provided to enable new development to be considered appropriately with regards to arising risks of fluvial and tidal flooding along with risks associated with additional run-off from development in all locations (see **Appendix D**).

1.2 Site Context

- 1.2.1 This Flood Consequence Assessment and Drainage Management Strategy (FCA&DMS) has been prepared to support a full planning application for a residential development on land in Summerhill (Wrexham). The proposals will be complete with access, car parking, external works and lighting, landscaping, boundary walls and fencing, external services and drainage. The proposals are considered to be highly vulnerable in accordance with TAN15 guidance, given the residential nature.
- 1.2.2 The site is shown to be wholly located within Flood Zone A on the Development Advice Map (DAM) with the nearest watercourse being located 100m to the west of the site (at a naturally lower elevation).
- 1.2.3 A FCA is required to justify that the proposed development is appropriate with reference to TAN15, this FCA will provide justification that;
-  The consequences of flooding to that development and elsewhere have been fully considered and implemented against for the lifetime of the development;
 -  No increase in flooding will occur to the development site or surrounding area due to the proposals including flooding from surface water and sewers;

1.3 Consultation

- 1.3.1 The preparation of this report has been undertaken in consultation with the following interested parties; Natural Resources Wales (NRW), Welsh Water (WW) and Wrexham County Borough Council (WCBC), responses can be seen in **Appendix D, H and I**. The Local Planning Authority (LPA), WCBC (also acts as the Lead Local Flood Authority), will make the final decision with regard to any planning permission. The LPA should consult with NRW who will provide advice and guidance on flood issues at a strategic level and in relation to planning applications.

2.0 EXISTING SITE BACKGROUND

2.1 Location

- 2.1.1 The Ordnance Survey National Grid Reference (OS NGR) for the site is 331162 (Easting), 353357 (Northing) and the postcode for the area is LL11 4QB. The site is edged in red in Figure 1; a location plan is included in **Appendix A**.
- 2.1.2 The site is located to the west of Summerhill Road/Top Road in Wrexham. To the west of the site is a wooded area with Moss Road and an Ordinary Watercourse beyond. To the east of site is Top Road/Summerhill Road with residential development beyond. To the north and south lies further wooded undeveloped areas with residential development beyond (see **Figure 1**).



Figure 1: Aerial Photograph of site (Bing Maps 2017)
Aerial view of the proposed development area

2.2 Existing and Historical Land Use

- 2.2.1 At present the majority of site is undeveloped however there is an existing farm, access road and associated outbuildings in the centre of the site. No other historical land use of the site has been identified during the preparation of this report.
- 2.2.2 The site is currently classified as 'less vulnerable' given its nature of use, however, the nature of use will change to 'highly vulnerable' due to the residential nature of the proposals in accordance with TAN15.

2.3 Topography

- 2.3.1 TAN15 requires all sources of flood risk to be considered and analysed with reference to the current levels of the site, a topographical survey has been reviewed as part of this FCA; such is included in **Appendix B**.
- 2.3.2 The existing ground levels fall towards from the north-west to the south-eastern boundary (with Summerhill Road). Levels range from 161.99mAOD in the north-western corner to 133.41mAOD in the south-eastern corner. To the west of site the topography falls steeply west towards Moss Valley. A topographical survey is included in **Appendix B**.

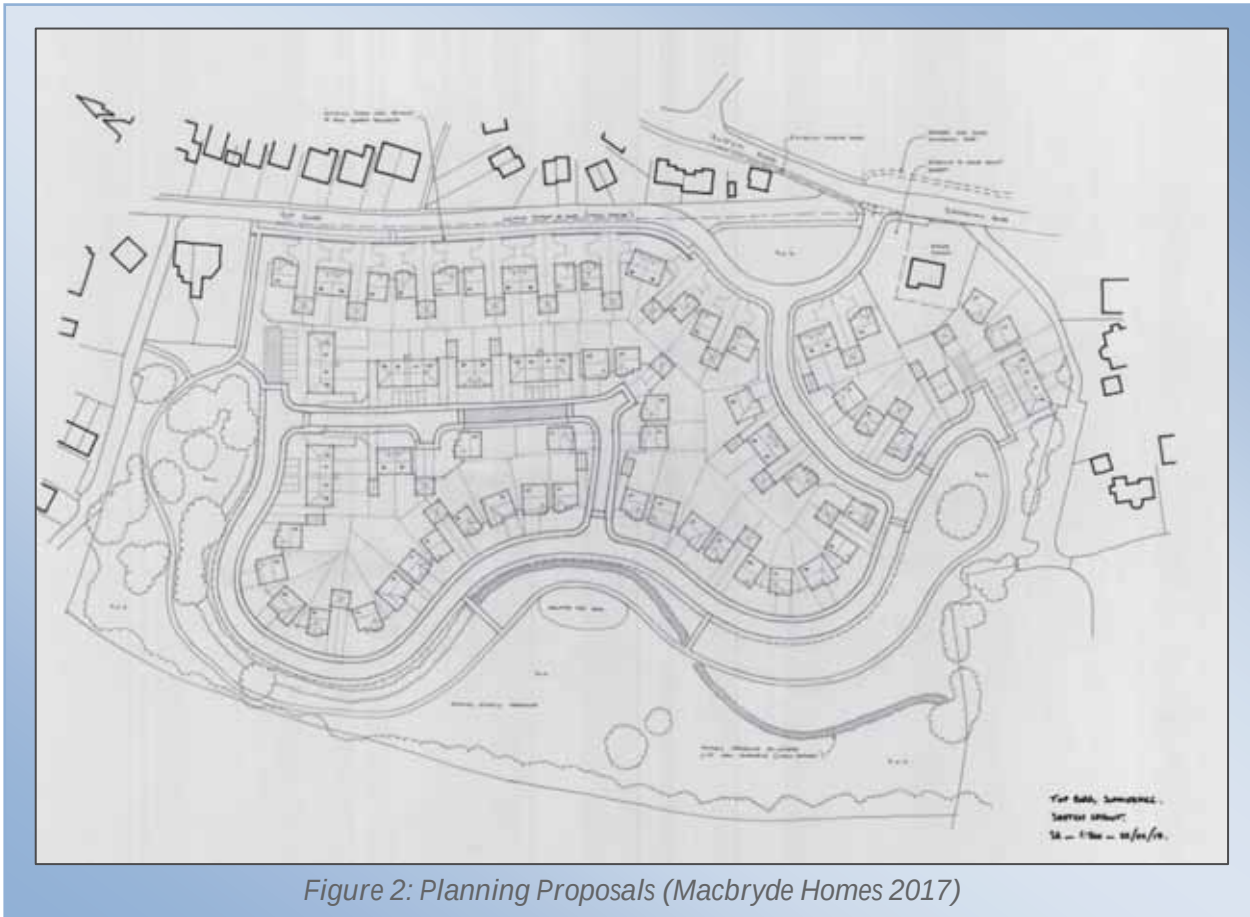
2.4 Justification for Development

- 2.4.1 Planning Policy Wales (5th Ed. – November 2012) states that the Welsh Government is committed to promoting ‘sustainable development’ by providing for homes, infrastructure, investment and jobs in a way which is consistent with sustainable development principles PPW Sec. 2.2). The FCA will be considerate to the nature and scale of the proposals and will review flood risk to and from the development along with considering any appropriate mitigation measures based on the identified sources of risk.
- 2.5.2 The development proposals are of a highly vulnerable nature and will be located solely within Flood Zone A, which is considered to be justified in accordance with TAN15 providing surface water is managed appropriately and no increased flood risk results from the development.

3.0 DEVELOPMENT PROPOSALS

3.1 Nature of the development

- 3.1.1 This FCA has been prepared to support a full planning application for a residential development on land off Top Road in Summerhill (Wrexham), the proposals will be complete with, access, footpaths, car parking, external works, landscaping, boundary fencing, external services and drainage as indicated in **Figure 2**.



- 3.1.2 The site area (red edge) covers approximately 5.49ha and is predominantly undeveloped at present although there are some existing hardstanding areas associated with the existing farm (covering 3% of site). The proposed development area will cover a smaller portion of the wider site (3.331ha) which excludes those areas where development will not take place. In light of the nature and scale of the proposals, the post-development impermeable areas will increase, to approximately 50% of the development area based on indicative planning proposals.

4.0 TECHNICAL ADVICE NOTE 15 (TAN15)

4.1 Flood Zone Classification

- 4.1.1 The Welsh Government Development Advice Map (DAM) is to be utilised when considering and determining flood risk associated with planning future developments within Wales, these maps are based on extreme flood events outlined by NRW and British Geological Survey (BGS) data. The DAM (**Appendix E**) identifies three key 'Flood Zones' for consideration, which are:

Flood Zone A

Areas considered to be at little or no risk of fluvial/tidal flooding.

Flood Zone B

Areas known to have historically flooded based on sedimentary evidence deposits.

Flood Zone C

Areas considered to be located on floodplain based on EA extreme flood outline data (equal to or greater than 0.1% fluvial/tidal flooding). This zone is subdivided into:

Zone C1 - Areas considered to be developed and served by significant infrastructure (flood defences).

Zone C2 - Areas considered to be located within natural floodplain without significant flood defences.



Figure 3: Development Advice Map extract (Welsh Government 2017)

- 4.1.2 The overall site is shown to be located within Flood Zone A on the DAM, as illustrated in **Figure 3**; Flood Zone A is an area considered to be at little/no flood risk.

4.2 Category of Development

- 4.2.1 TAN15 states that particular types of development may not be considered 'acceptable' based on their vulnerability to the consequences of flooding, identified on the DAM (as

described in TAN15; Section 5). The vulnerability of different land uses is described in detail in TAN15 however there are three key categories as summarised in **Table 1**.

Development Category	Description	Types
Emergency Services	Facilities which need to remain operational and accessible at all times.	❖ Hospitals & Ambulance Stations, ❖ Fire & Police Stations, ❖ Coastguard Stations.
Highly Vulnerable	Development where the ability of occupants to decide on whether they wish to accept the risk and manage the consequences associated with flooding is limited.	❖ Residential Developments, Hotels, Caravan Parks, Public Buildings. ❖ Power Stations, Chemical Plants, Waste Disposal.
Less Vulnerable	Development where the ability of occupants to decide on whether they wish to accept the risks associated with flooding is greater than 'highly vulnerable category'.	❖ General Industrial, ❖ Commercial Developments, ❖ Utilities Infrastructure, ❖ Transport.

Table 1: Development Category of Vulnerability (Source: TAN15: Section5)

- 4.2.2 The development proposals are for a residential development and as such will be classified as 'highly vulnerable' based on TAN15 guidance.

4.3 Acceptability Criteria

- 4.3.1 Various criteria are identified within TAN15 (Section 7), these are used to determine whether a proposed development is 'acceptable' based on the nature and scale of proposals. Appropriate management should also be considered with any potential consequences of potential flooding.
- 4.4.2 The overall site classified as highly vulnerable in accordance with TAN15 is located wholly within Flood Zone A and therefore considered not to be at risk from fluvial/tidal flooding. In accordance with TAN 15 highly vulnerable development is considered acceptable within Flood Zone A providing the Justification Test is passed and surface water is appropriately managed. Section 5.0 of this report assesses flood risk and the consequences of flooding in accordance with the above.

5.0 SOURCES OF FLOOD RISK

5.1 Fluvial Flood Risk

- 5.1.1 Information relating to the flood risk at the site has been obtained from the Welsh Government's DAM and the NRW online Flood Mapping (see **Appendix D** for full details).

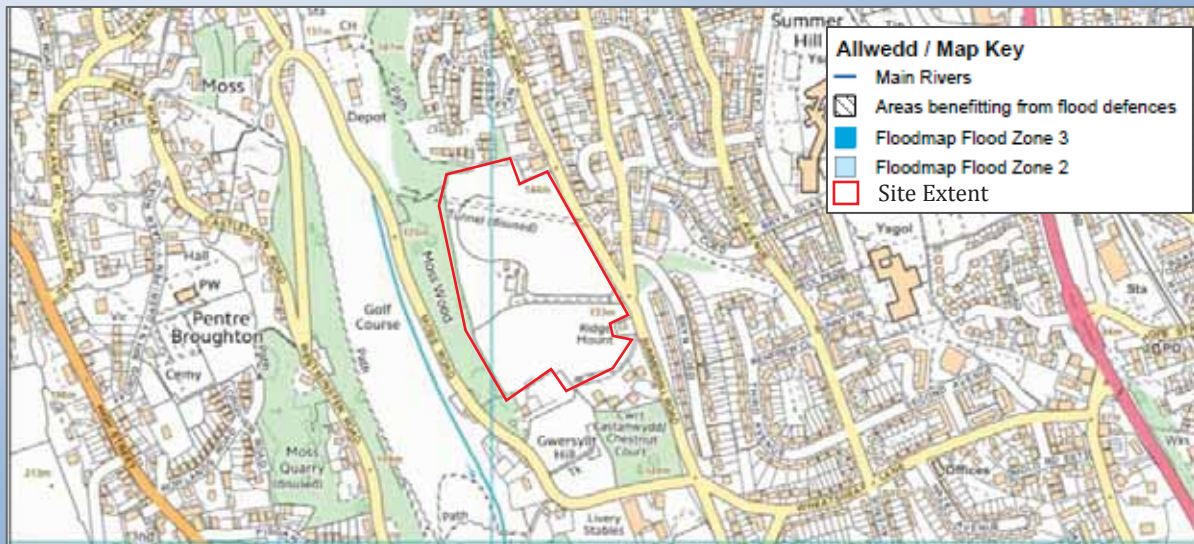


Figure 4: Fluvial/Tidal Flood Zone Map Extract (NRW, 2017)

- 5.1.2 The nearest Main River to the site is the River Alyn, located approximately 1.5km to the north-east of site. Multiple Ordinary Watercourses are located within 1km of the site. The nearest being the unnamed Ordinary Watercourse adjacent to Moss Road (within 100m to the west of site). This OW runs south away from the site, the site is elevated higher than this watercourse therefore flood risk from this source is considered low. NRW online flood mapping illustrates that downstream historical flooding (Zone B) is associated with this watercourse although no onsite flooding has been identified as part of this assessment.
- 5.1.3 Based on the flood mapping the site is considered to be at very low risk from flooding associated with fluvial/tidal sources (as illustrated in **Figure 4**). The NRW mapping also confirms the site is located within Flood Zone 1, which similarly to the DAM suggests the site is at little or no flood risk, similar to the DAM (Flood Zone A).

Flood Warning and Evacuation

- 5.1.4 As the site is located within Flood Zone A, the site is considered to be at little or no risk from fluvial/tidal flooding.
- 5.1.5 The proposed development site is not located within a NRW 'Flood Warning/ Alert Area' and the risk to the proposals is considered to be low.

- 5.1.6 Safe access and egress is maintained as the site and neighbouring areas are not located within the extents of the floodplain. The proposed dwellings will also remain flood free in the key design storm events.

5.2 Tidal Flood Risk

- 5.2.1 Due to the distance from the coast and estuarine waterways the risk of flooding from tidal sources is considered low.

5.3 Surface Water

- 5.3.1 Surface Water flooding occurs when rainwater is unable to drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. An increase in impermeable areas through development can reduce percolation rates at source, therefore increasing surface water run-off. If this run-off is not controlled effectively it can increase the frequency and extent of localised flooding in neighbouring areas of the catchment.
- 5.3.2 TAN15 states therefore that 'the aim should be for new development not to create additional run-off when compared with the undeveloped situation and re-development to reduce the overall run-off where possible' (Section 8.3).
- 5.3.3 Overall the development site is shown to be at 'very low' risk from surface water based on the NRW flood mapping (**Figure 5**). The proposed development is considered to be 'highly vulnerable' and will be located within areas of 'very low' risk of surface water flooding, therefore will be acceptable in accordance with TAN15.
- 5.3.4 Areas of higher surface water flood risk can be seen to the west of the site, this is associated with natural depressions and the Ordinary Watercourse within Moss Valley. Local topography protects the site from any pluvial flows associated with this source as the site is raised significantly in comparison to the Moss Valley.



Figure 5: Surface Water Flood Risk Map extract (NRW 2017)

- 5.3.5 The proposals are of 'highly vulnerable' nature and any residual risk associated with the residential proposals will be further reduced through the implementation of formal onsite infrastructure and effective surface water management. Refer to section 6.0 of this section assessment for further details on surface water management.

5.4 Pluvial Flood Risk

- 5.4.1 Intense rainfall that is unable to soak into the ground or enter drainage systems can run-off land and result in flooding. Local topography and the land use can have a strong influence on the direction and depth of flow. The volume and rate of overland flow from land can be exacerbated if development increases the percentage of impermeable area.
- 5.4.2 The topography of the development and surrounding area means there is little likelihood of significant flows impacting on the proposed development or on adjacent land/property as a result of the development proposals. Any pluvial flows generated by the site will need to be catered for within the proposed formal onsite surface water infrastructure. Further investigation as part of detailed design will confirm whether interception methods are required on the south/south-eastern boundary of site.
- 5.4.3 Any overland flows generated by the proposed development must be carefully controlled; safe avenues directing overland flow away from the proposed or existing adjacent buildings are advised.

5.5 Artificial Sources of Flood Risk

- 5.5.1 TAN15 suggests that in order for development to be 'justified' then all sources of flood risk must be considered both to the development site and arising from the development proposals and implemented against.

Reservoirs

- 5.5.2 NRW identify reservoirs as those holding over 25,000cu.m of water; an extract of NRW's online reservoir flood map is included in **Appendix D**. The NRW mapping illustrates that the development site is not located within the extents of flooding associated with any local reservoirs.

Canals

- 5.5.3 There are no canals within the immediate vicinity of the proposed development considered to present a flood risk to the site.

5.6 Groundwater Flood Risk

- 5.6.1 Groundwater flooding is caused by unusually high groundwater levels, it occurs as excess water emerges at the ground surface (or within manmade underground structures). Groundwater flooding tends to be more persistent typically lasting for weeks or months and it can result in significant damage to property.
- 5.6.2 In general terms groundwater flooding can occur from three main sources:

- If groundwater levels are naturally close to the surface, then this can present a flood risk during times of intense rainfall. No groundwater flood risk has been identified during consultation with the various interested parties.
- Seepage and percolation occur where embankments above ground level hold water. In these cases water travels through the embankment material and emerges on the opposite side of the embankment. At present there are no reported problems with groundwater flooding.
- Groundwater recovery/rebound occurs where the water table has been artificially depressed by abstraction. When the abstraction stops the water table makes a recovery to its original level. There is the potential for groundwater flooding in low lying areas where groundwater levels have been depressed below their pre-pumping conditions, where these were at or close to ground level. As with the seepage scenario the likelihood of flooding from this source is considered to be low.

- 5.6.3 No historical flooding associated with groundwater has been identified during the preparation of this FCA. Setting finished floor levels (FFL) a minimum of 150mm above the external levels (following any re-grade) should however mitigate any risk of flooding from this source, by providing avenues of overland flow.

5.7 Sewer Flood Risk

- 5.7.1 In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and waste water known as 'combined sewers'. Foul water flooding often occurs in areas prone to overland flow and can result when the sewer is overwhelmed by heavy rainfall and will continue until the water drains away. It can also occur when the sewer becomes blocked or is of inadequate capacity, this could lead to there being a high risk of internal property flooding with contaminated water.
- 5.7.2 Consultation with various parties including Welsh Water has not identified any existing sewer flood risk issues or historical flooding of the immediate site area, refer to **Appendix H**.

5.8 Historical and Anecdotal Flooding Information

- 5.8.1 An internet based search for flooding did not identify any historical flooding events that impacted on the proposed development area.
- 5.8.2 The WCBC Flood Risk Management Plan (FRMP) does not identify any past flooding of in the vicinity of the proposed development.
- 5.8.3 Consultation with the various interested parties including WCBC, WW and NRW also failed to highlight any recorded historical flooding in the immediate vicinity of the site.

5.9 Mitigation Measures and Residual Risks

- 5.9.1 As the site is located within Flood Zone A the site is considered to be at little or no risk from fluvial/tidal flooding. Some mitigation measures have however been discussed below to consider the residual risks associated with future climate change.

Mitigation Measures

- 5.9.2 As with any development it is advised that external levels fall away from the proposed buildings and any overland flows generated by the proposals are carefully controlled (safe avenues directing flow away from any existing and proposed buildings is advised).
- 5.9.3 To minimise the flood risk to the neighbouring development and conform to the guidance set out in TAN15, it is proposed that surface water run-off be managed effectively, ideally with the peak rates of run-off being restricted to the equivalent of the pre-development situation. Opportunities should also be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off.
- 5.9.4 The opportunity should also be sought to incorporate SuDS where feasible into the drainage management approach, this will be determined as part of detailed design however given the nature and scale of the proposals there will likely be scope to incorporate multiple SuDS measures within the scheme.
- 5.9.5 The development and its drainage systems should be designed to cope with intense storm events up to and including the 100 year return period rainfall event with an allowance for Climate Change (CC); based on the design life of the proposal this allowance will be in the form of 30%.
- 5.9.6 As with any drainage system blockages within either the foul or surface water system have the potential to cause flooding or disruption. It is important that should any drainage systems not be offered for adoption to either the Water Company or the Local Authority then an appropriate maintenance regime be scheduled with a suitably qualified management company for any private drainage systems.

Residual Risks

- 5.9.7 If an extreme rainfall event exceeds the design criteria for the drainage system it is likely that there will be some overland flows that are unable to enter the system, it is important that these potential overland flows are catered for within the proposed planning layout in the event that the capacity of the drainage system is exceeded.

6.0 SURFACE WATER MANAGEMENT

6.1 Pre-development Surface Water Run-off

- 6.1.1 The total site covers 5.419ha and is 97% permeable at present, based on indicative planning layouts only 3.331ha of the site is proposed to be developed. This figure has been used in our surface water calculations as it more accurately represents the proposed development area. No existing formal drainage structures are present onsite and it is assumed run-off generated by the existing impermeable areas informally discharges to ground overtime as does the permeable areas onsite.
- 6.1.2 The peak rates and volumes of run-off generated by the development area have been calculated for the peak events and are shown in **Table 3** (full details **Appendix J**). Based on indicative planning layouts only 3.331ha of the site is proposed to be developed, this figure has been used in our surface water calculations as it more accurately represents the proposed development area. The surface water run-off rates have been calculated using the IH124 Greenfield run-off method, utilising rainfall catchment characteristics from the provided by HR Wallingford, details of which are included **Appendix F**.

Site Area	Run-Off Rates				Run-Off Volumes	
	1 In 1 Year	1 In 30 Year	1 In 100 Year	QBAR	1 In 1 Year	1 In 100 Year
Greenfield (3.331ha)	6.2l/s	12.6l/s	15.5l/s	7.1l/s	208.7cu.m	680.3cu.m

Table 2: Pre-Development Surface Water Run-Off Rates and Volumes (Betts Associates 2017)

6.2 Post-development Surface Water Run-off

- 6.2.1 The residential nature of the proposals means that there will be an increase in the impermeable areas of the site, resulting in an increase in both the volume and the peak rates of run-off if flows are unrestricted. The proposed impermeable area is assumed to be 50% (1.661ha) of the development area based on the indicative layout (refer to **Appendix N**). The unrestricted post-development run-off rates and volumes have been calculated and detailed in **Table 3**, based on the assumed impermeable area and the FSR Rainfall Model.

Site Area	Run-Off Rates			Run-Off Volumes	
	1 In 1 Year	1 In 30 Year	1 In 100 Year +CC	1 In 1 Year	1 In 100 Year +CC
Brownfield Portion (1.661ha)	23.1l/s	53.0l/s	92.8l/s	81.1cu.m	554.0cu.m

Table 3: Post-Development Un-Restricted Run-Off Rates and Volumes (Betts Hydro, 2017)

- 6.2.2 The development proposals will provide significant betterment to the unrestricted rates noted above, the surface water run-off generated by the development area will mimic the pre-development situation, meaning betterment on the uncontrolled rates quoted above. The proposed discharge rates are discussed in Section 5.6 along with the drainage strategy.

6.3 Sustainable Drainage Systems (SuDS)

- 6.3.1 Sustainable Drainage Systems (SuDS) have the ability to address four core objectives: water quantity, water quality, amenity and biodiversity. In accordance with the NPPF, the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) and the SuDS Manual (CIRIA 753) SuDS should be specified wherever possible to manage surface water run-off generated onsite.
- 6.3.2 Where possible, peak surface water discharge rates to watercourses and sewers should be appropriately managed and where possible reduced. Preference should always be given to SuDS over the traditional methods of buried sewers wherever possible and practical.
- 6.3.3 It would be beneficial to implement wider green space/POS area(s) in one or more locations within site, where SuDS features could be implemented. Multiple benefits to using SuDS include the improvement of bio-diversity, aesthetics, ecology and water quality. Furthermore there may be the potential to utilise some SuDS features for conveyance/attenuation of surface water flows, opposed to the traditional below ground storage methods.



Figure 6: SuDS Photographs (SusDrain, 2012)

- 6.3.4 Should the ground conditions onsite prove favourable, this nature of development would suit a range of SuDS types associated with permeable surfaces, meaning the discharge of surface water would be dealt with at the source, limiting required attenuation and reducing the volume of surface water in the nearby sewer infrastructure. There may also be scope to include SUDS in the form of a pond/basin in POS areas. Detailed design should confirm whether this site would be suitable for incorporation of SuDS following more detailed analysis of levels, ground conditions and attenuation requirements.

6.4 Methods of Surface Water Management

- 6.4.1 In order for the development proposals to be justified in line with the guidance set out in TAN15, the development must not increase flood risk elsewhere within the catchment and where possible offer improvement on the pre-development situation, therefore surface water management is a key focus (see TAN15: Section 8).

- 6.4.2 There are three methods that have been reviewed for the management and discharge of surface water (detailed below), these may be applied individually or collectively to form a complete strategy. They should be applied in the order of priority listed below.

-  Discharge via infiltration
-  Discharge to watercourse
-  Discharge to sewerage system

6.5 Discharge via Infiltration

- 6.5.1 Any impermeable areas that can drain to soakaway or an alternative method of infiltration would significantly improve the sustainability of any surface water systems and be therefore justified within TAN15 guidance.
- 6.5.2 The British Geology Survey (BGS) mapping data indicates that ground conditions are as follows: -
Bedrock Geology Description: - Cefn Rock - Sandstone.
- 6.5.3 The Cranfield Soil and Agrifood Institute Soilscape soil type viewer identifies the soils as; slowly permeable seasonally wet acid loamy and clayey soils. Drainage is considered to be impeded to the local stream network.
- 6.5.4 Based on analysis of the online BGS and onsite Soakaway testing (results in **Appendix P**) it would be considered that infiltration could provide a suitable means of surface water management, based on the underlying strata and soil.
- 6.5.5 Testing confirms infiltration on the site to be viable, however as the site is at a steep gradient, due to engineering constraints, site wide implementation of soakaways may not be feasible. Detailed design will confirm the areas of the site appropriate for discharge via soakaway. Given the residential nature of the proposals it is likely domestic soakaways will be utilised where feasible with an appropriate highway infiltration method being adopted.
- 6.5.6 In terms of rates of discharge, the proposed rate of discharge should not exceed the existing percolation rates on the site as to not increase flood risk elsewhere. The restricted flow will generate a storage requirement during periods of intense rainfall.
- 6.5.7 The proposed onsite surface water drainage system will need to be sized to contain the 30yr return period event wholly below ground with overland run-off from storm events up to and including the 1 in 100 year return period storm event (with an allowance for climate change being contained onsite).
- 6.5.8 As the use of soakaways is feasible (in part) then there is a requirement for the maintenance and upkeep of any soakaway(s) to be considered (for the design life of the development). It is therefore strongly recommended that an appropriate maintenance regime be scheduled with a suitably qualified management company for any private drainage system(s).

6.6 Discharge to Watercourse

- 6.6.1 As infiltration may only provide a part solution (to be determined at detailed design) for a surface water management solution, then the next method in the hierarchical approach should be to discharge to a watercourse. Review of the online mapping identifies the nearest open channel watercourse for a potential, to be the unnamed Ordinary Watercourse, located 100m to the west of the site (within Moss Valley).
- 6.6.2 Consents/agreements will be required from WCBC and NRW for any works to the watercourse including agreement on any rates of discharge. Furthermore offsite works would be required to connect to the Ordinary Watercourse from site, early discussion will be required with land owners to confirm access/routing.
- 6.6.3 Further investigation is needed to confirm the topographic constraints would not restrict this drainage option although at present it is assumed the technical constraints of connecting to the watercourse would make it not viable. Detailed drainage design would need to confirm the feasibility of this approach, although given the topographic fall onsite it is likely that a pumped solution will be required
- 6.6.4 Anecdotal evidence suggests there is a possible culverted watercourse to the east of site as there is an identified surface water sewer outfall, however more information into the watercourse is unknown. Further investigation into this system is currently being undertaken including discussion with WCBC. This would be the preferred alternative point of connection following investigation into the routing of the system.
- 6.6.5 In order to comply with policy, the surface water run-off generated by the proposals will be required to be restricted to the pre-development greenfield situation to minimise the potential flood risk. A flow restriction will be most likely in the form of a Hydrobrake® or similar approved flow control device, and will result in onsite attenuation being required.

6.7 Discharge to Sewer

- 6.7.1 Should infiltration and a connection to an Ordinary Watercourse not offer viable surface water management solutions for the development, then the alternative would be a connection to the neighbouring public sewer network. WW sewer records identify multiply public surface water sewer assets within the vicinity of the site including a public surface water sewer (150mm) located 50m to the east of the site.
- 6.7.2 Detailed drainage design will be required to confirm feasibility of connecting to the surface water sewer. It is likely that a gravity solution will be achievable but again this will need to be confirmed following a more detailed review of levels at the next stage in the process.
- 6.7.3 Consents for works to the public sewer network will be required from WW and early discussion will be needed to identify any additional capacity constraints and preferred points for connection.

- 6.7.4 The surface water run-off generated by the proposals will be required to be restricted. It is likely that a more stringent discharge rates will be required compared to the previously required options. The restricted flow will generate a storage requirement during periods of intense rainfall. The stormwater storage figures quoted in **Appendix J** based on a restricted rate of 5l/s would likely be the requirement for outfall to the surface water sewer network (subject to confirmation with WW). These figures are estimates only and the detailed drainage design will determine with accuracy the stormwater storage requirements.

6.8 Climate Change

- 6.8.1 There are significant indications that the UK climate is changing; the nature of this change will vary based on regional and catchment differences, consensus is that effects will become more pronounced over the coming decades. With reference to TAN15 the most likely effects to be experienced within Wales are;
-  Increases in sea levels;
 -  Greater inflow into estuaries and the sea;
 -  Significant changes in rainfall patterns seasonally;
 -  Increased evapotranspiration;
- 6.8.2 Making 'provisions' for these anticipated future changes to flood risk is considered to be an important action, ensuring future 'sustainable development' within Wales as identified within TAN15; Section 2.1. Current expert opinion indicates the likelihood of more frequent short duration and high intensity rainfall events and the addition of more frequent periods of long duration rainfall meaning future flooding events will have a greater impact on the environment and society.
- 6.8.3 Any increase in the level of flood risk to the proposed development from Climate Change is likely to be related to the increase in rainfall intensity and duration and its impact upon the surface water drainage system, along with the potential impact of sea level rise and its associated impact on flood water levels.
- 6.8.4 Climate Change should be accounted for within the design and it is recommended that an increase in peak rainfall intensity of 30% is allowed for (to be confirmed following discussion with the LPA and WW).

7.0 FOUL WATER MANAGEMENT

- 7.1 At present it is assumed there are no foul water flows generated by the existing farm buildings.
- 7.2 It is proposed that foul water flows generated by the proposed development be connected into the public sewer network at the public foul water sewer (150mm) within Summerhill Road adjacent to the eastern boundary of site. A detailed drainage design may be necessary to accurately establish whether a gravity sewer connection to the public sewer network can be made.
- 7.3 Consent to discharge to the public sewer network will be required from WW and it is advised that early discussion is undertaken to determine their preferred points of connection, discharge rates and any additional system constraints. It is understood that a gravity solution should be achievable for the site as levels fall towards Summerhill Road, however detailed design will be required to determine with accuracy whether discharging the whole of site via gravity is feasible.

8.0 SUMMARY AND CONCLUSIONS

- 8.1 This Flood Consequence Assessment and Drainage Management Strategy (FCA&DMS) was commissioned by Macbryde Homes referred to hereafter as 'the client'. This report has been prepared to support a full planning application for a residential development on land to the east of Top Road in Summerhill (Wrexham).

Flood Risk

- 8.2 The development is located within Flood Zone A on the Development Advice Map and the nature of the proposals are considered as 'Highly Vulnerable'; this is considered 'acceptable' within Flood Zone A.
- 8.3 The FCA has reviewed all sources of flood risk to both the proposed development and to the existing adjacent development as a result of the proposals, including; fluvial, tidal, pluvial, groundwater, sewers and flooding from artificial sources. The development site is located within Flood Zone A and therefore at low flood risk.
- 8.4 The nearest Main River to the site is the River Alyn due to the proximity from site (approximately 1.5km) fluvial flood risk from this source is considered low. The nearest Ordinary Watercourse is located 100m to the west of the site, due to local topography the risk from this source is minimal and is considered accessible for emergency access and egress as the site is not located within the extents of the floodplain.
- 8.5 An Internet based search for flooding events did not recall identify historical flooding to the site. Initial consultation with Natural Resources Wales, Wrexham County Borough Council and Welsh Water has not identified any onsite historical flooding.
- 8.6 The proposed development has been justified in accordance with TAN15 and suitable mitigation measures have been proposed to ensure that the development is safe for its lifetime. This assessment illustrates that there is: minimal risk to life, minimal disruption to people, minimal potential damage to property and that proposals will have minimal impacts on flood risk generally.

Drainage Strategy

- 8.7 In accordance with the drainage hierarchy there are three methods that have been reviewed for the appropriate management and discharge of surface water, these have been applied in the order of priority; discharge via infiltration, to a watercourse and finally to public sewerage system. Based on the ground conditions identified online, it can be considered that infiltration could likely provide a viable full (if not part) surface water drainage solution for the site. In accordance with LPA's and WW requirements, Soakaway Testing to BRE365 has been undertaken and results show that infiltration will be a viable solution for surface water management in areas where not constrained by engineering requirements.
- 8.8 Soakaway test results show infiltration is viable, however due to the steep gradient of the site it may only offer a part solution (to be confirmed at the detailed design stage). The next method in the hierarchical approach should be to discharge to watercourse. Review

of the mapping indicates an Ordinary watercourse located 100m to the west of the site. However due to technical constraints this is likely to be infeasible. There is possibly a culverted watercourse to the east of the site which would provide a suitable point of outfall. Welsh Water sewer records identify surface water infrastructure to outfall into a likely culverted watercourse. Further investigation into the culverted watercourse is currently being undertaken. This option should be explored further following consents from any third party land owners, Natural Resources Wales and Wrexham County Borough Council.

- 8.9 Alternatively should infiltration (in part) and discharge to a watercourse not be feasible then the WW sewer records identify a public surface water sewer (150mm), approximately 50 metres to the east of site. Discussion with WW will be required for any works to the public sewer network and this should be agreed as part of detailed design stage.
- 8.10 It is proposed that SuDS systems are considered within the scheme to in part manage the surface water run-off generated. The development and its drainage systems should be designed to cope with intense storm events up to and including the 100 year return period rainfall event with an allowance for Climate Change (CC); based on the design life of the proposal this allowance will be in the form of 30%.
- 8.11 The nature of the proposals would suggest an opportunity to reduce the potential flood risk; opportunities should be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off. Based on the nature and scale of the development there will likely be the opportunity to implement various SUDS options in private (non-adopted) areas such as permeable paving, bio-filtration units and rainwater harvesting, along with pond/basin(s) within POS areas. Consideration into management and future adoption of any proposed SuDS will be required and detailed design should confirm feasibility following more detailed levels, capacity and attenuation review.
- 8.12 This Flood Consequence Assessment and Drainage Management Strategy is considered to be commensurate with the development proposals and in summary, the development can be considered appropriate in accordance with TAN15, providing the mitigation measures proposed are conformed to.

9.0 RECOMMENDATIONS

- 9.1 Any overland flows generated by the proposed development must be directed away from existing and proposed buildings; safe avenues of overland flow away from any existing and proposed buildings are advised. As with any development it is also advised that external levels fall away from property to minimise the flood risk from a variety of sources.
- 9.2 Opportunities should be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off. Based on the nature and scale of the development there will likely be the opportunity to implement various SUDS options in private (non-adopted) areas such as permeable paving, bio-filtration units and rainwater harvesting along with the potential area for POS and pond features. Although the exact SuDS to be implemented will be dependent on further investigation and confirmed at a later stage.
- 9.3 Detailed design needs to confirm the appropriate surface water drainage option for the scheme following further investigation.
- 9.4 Consideration into the potential stormwater attenuation requirements onsite due to the increase in impermeable areas is also recommended. Detailed drainage design will determine with accuracy any stormwater storage requirements following more detailed analysis of levels, capacity requirements and a final layout.
- 9.5 The proposed onsite surface water drainage system will need to be sized to contain the 30yr return period event wholly below ground with overland run-off from storm events up to and including the 1 in 100 year return period storm event with an allowance for climate change being contained onsite. Based on the design life this allowance for CC is in the form of a 30% increase in rainfall intensity.
- 9.6 Maintenance of any drainage systems not being offered for adoption (such as SuDS) is required to be considered for the design life of the development therefore as part of the proposals it is strongly recommended that an appropriate maintenance regime be scheduled with a suitably qualified management company for any private drainage systems within site.

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Cranfield University – <http://www.landis.org.uk/soilscapes/>

Environment Agency – www.environment-agency.gov.uk/

FloodProBE – <http://www.floodprobe.eu/>

Flood Forum – <http://www.floodforum.org.uk/>

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Flood Resilience Group – <http://www.floodresiliencgroup.org/frg/>

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Welsh Water - <http://www.dwrcymru.com/>

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APPENDIX A: LOCATION PLAN

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Location Plan

TOP ROAD, SUMMER HILL, GWERSYLLT.



OS X (Eastings)	331162
OS Y (Northings)	353357
Nearest Post Code	LL11 4QB
Lat (WGS84)	N53:04:23 (53.072990)
Long (WGS84)	W3:01:44 (-3.028913)
Lat, Long	53.072990, -3.028913
Nat Grid	SJ311533 / SJ3116253357
mX	-337177
mY	6962329

APPENDIX B: LEVELS INFORMATION

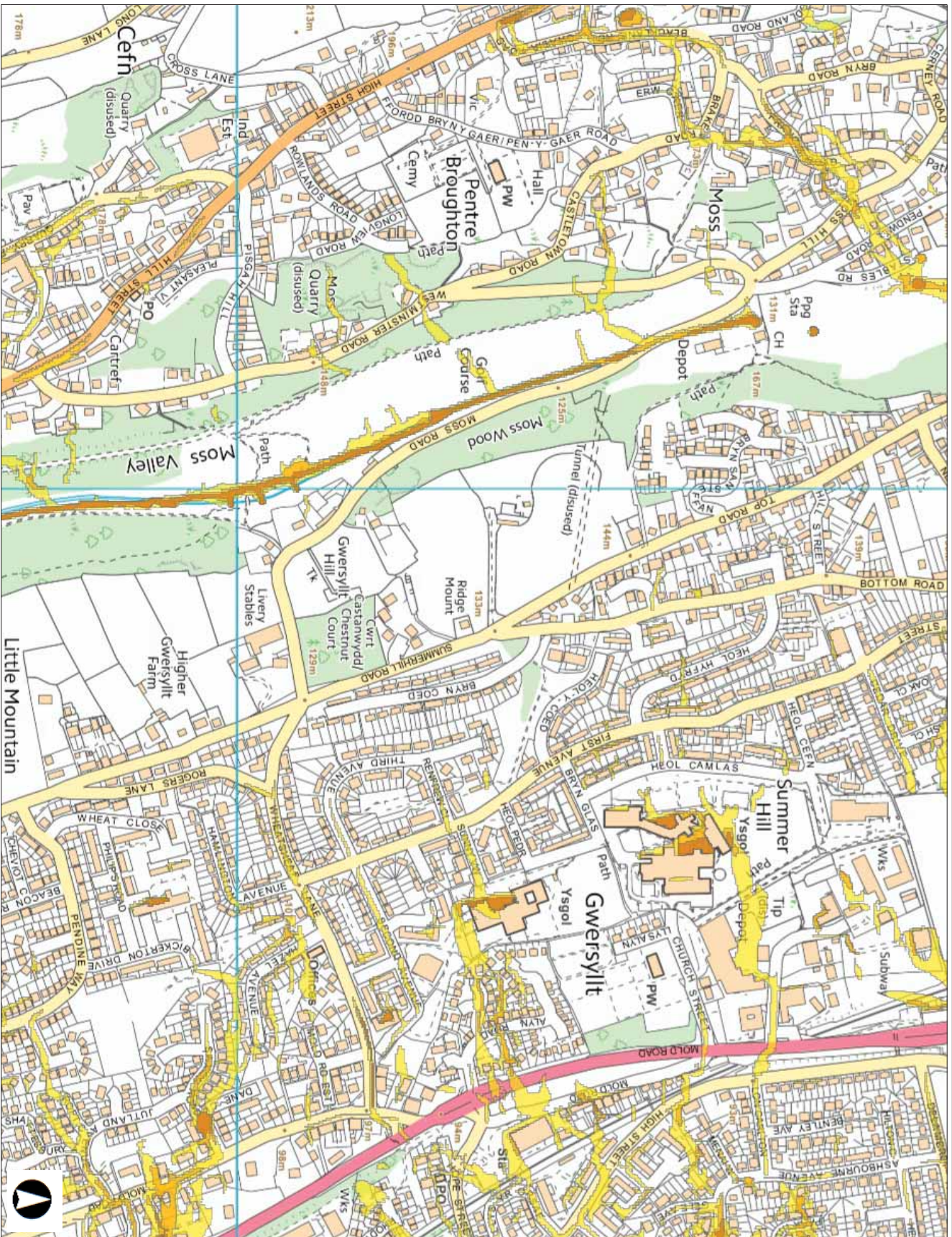
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APPENDIX C: PROPOSED PLANNING LAYOUT

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APPENDIX D: NRW/EA INFORMATION & CORRESPONDENCE

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Cyfoeth Naturiol Cymru
Natural Resources Wales

Top Road

Map Perygl Lifo gydd / Flood Risk Map

Allwedd / Map Key

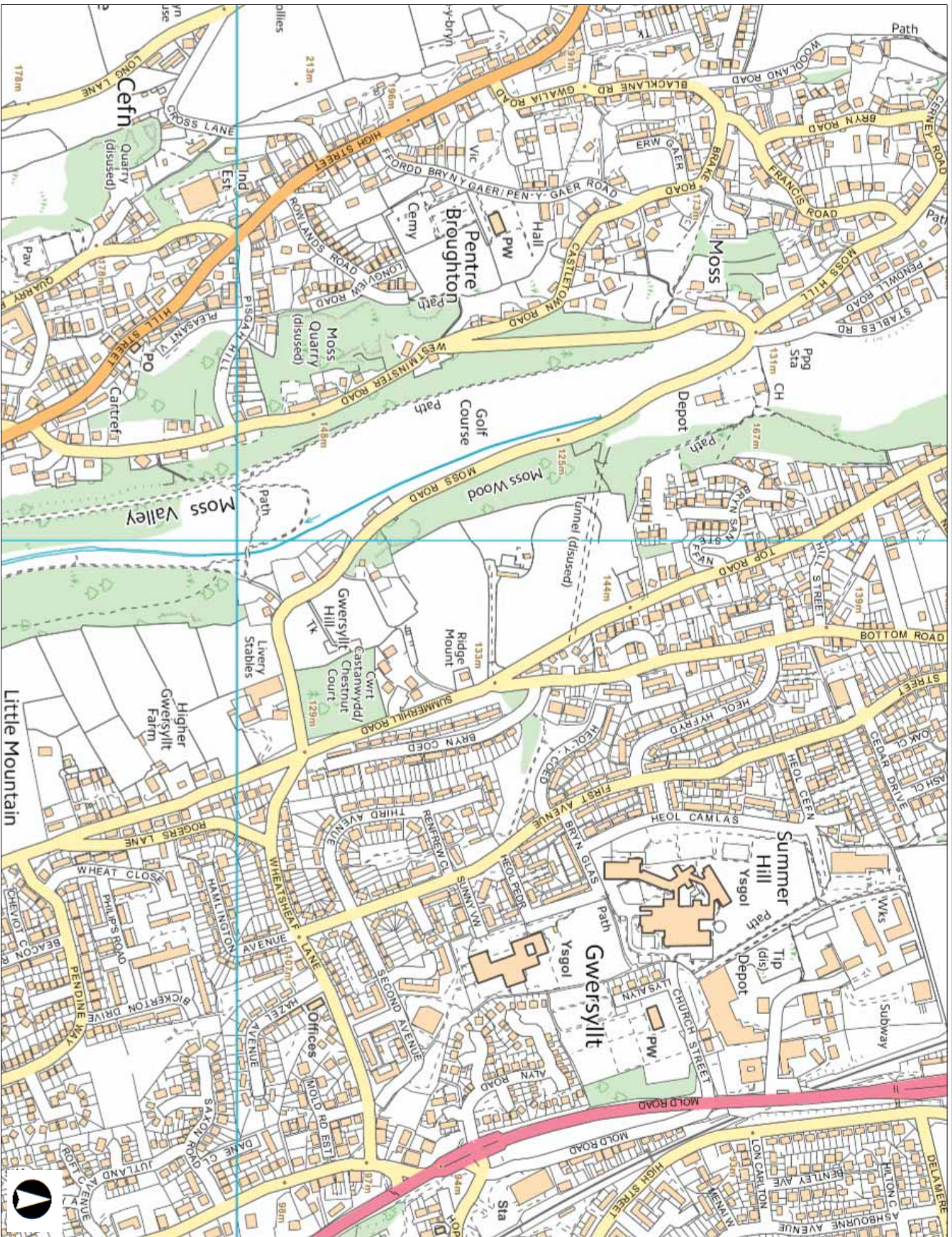
- High Surface Water Flood Risk - Extent
- Medium Surface Water Flood Risk - Extent
- Low Surface Water Flood Risk - Extent

Graddfa / Scale 1:5,001

Dyddiad / Date
03/05/2017

03
British National Grid
0
0.13
0.3
Kilometers

Ceir rhestr iawn o delerau ac amodau yn <https://naturalresources.wales/rhyddsastoriol-neu-dwy-gysylltu-ag-ymholiadau@cyfoethnaturiolcymru.gov.uk>. A full list of terms and conditions is available from the <https://naturalresources.wales/standardvoice-or-by-contacting-enquiries@naturalresources.wales.gov.uk>.
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Cyfoeth Naturiol Cymru
Natural Resources Wales

Top Road

Map Perygl Lifo gydd / Flood Risk Map

Allwedd / Map Key

Reservoir Depths

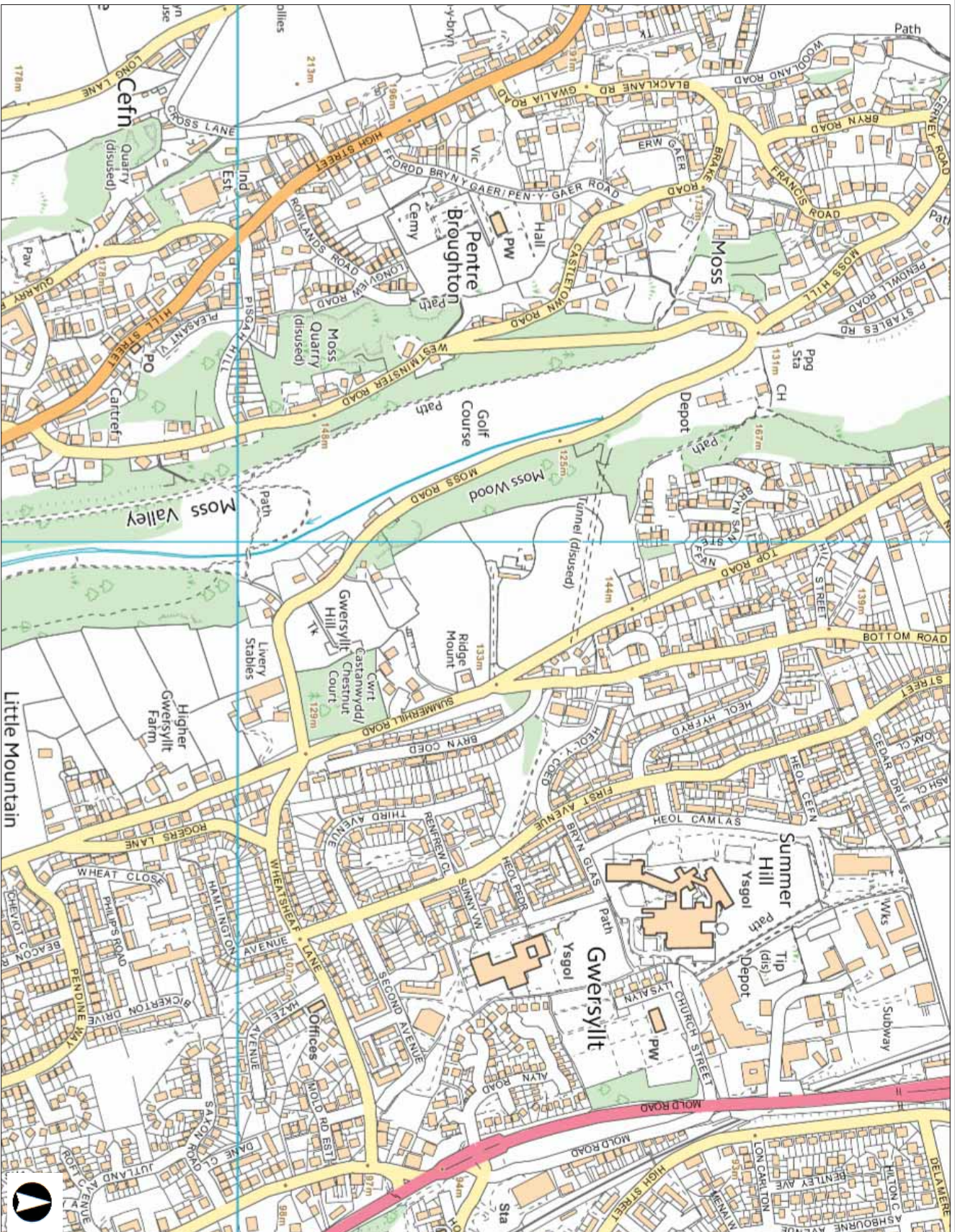
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0.3 - 2.0m
Greater than 2.0m

Graddfa / Scale 1: 4,999

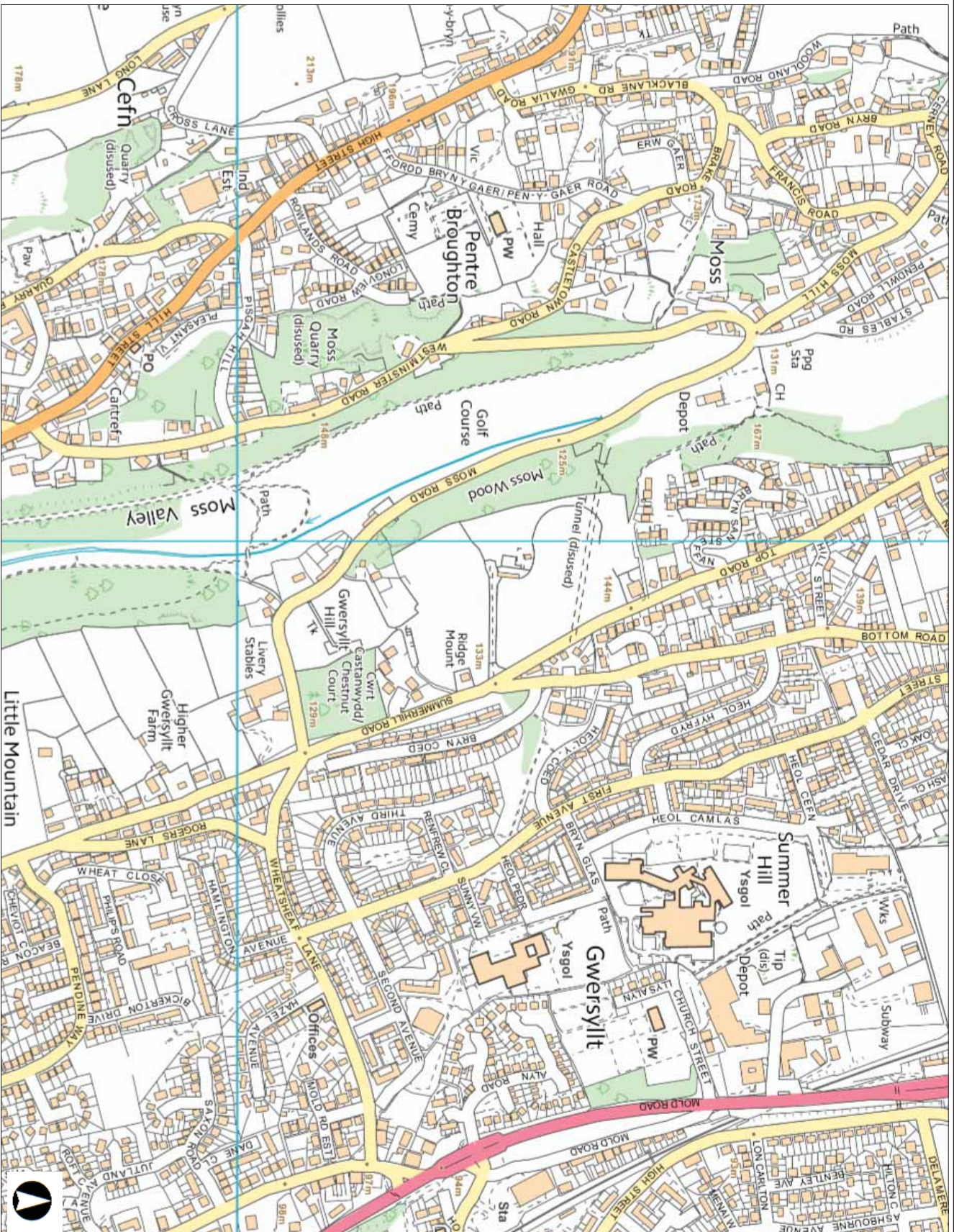
Dyddiad / Date

03/05/2017

Ceir rhestr lawn o delerau ac amodau yn <https://naturalresources.wales/rhyddsasatonol> neu drwy gyswllt ag ymholiadau@cyfoethnaturiolcymru.gov.uk. A full list of terms and conditions is available from the <https://naturalresources.wales/standardvoice> or by contacting naturalresources.wales.gov.uk © Crown copyright and database rights 2017 Ordnance Survey 100019741. Geological mapping: British Geological Survey © NERC. Centre for Ecology & Hydrology © NERC (CEH). Defra and Met Office © Crown copyright. © Cranfield University. © James Hutton Institute. Land & Property Services © Crown copyright and database right.



-  Main Rivers
-  Areas benefiting from flood defences
-  Floodmap Flood Zone 3
-  Floodmap Flood Zone 2



-  Main Rivers
-  Areas benefiting from flood defences
-  Risk of Flooding from Rivers & Sea
-  High
-  Medium
-  Low
-  Very Low

Patrick Taylor

From: Enquiries <enquiries@cyfoethnaturiolcymru.gov.uk>
Sent: 25 April 2017 09:57
To: Patrick Taylor
Subject: Thank you for your Enquiry - CAS-32718-P6D0 NRW:00305777

Diolch i chi am eich neges e-bost. **EichRhif Cyfeirnod: CAS-32718-P6D0**

Amcanwn ymateb i negesau e-bost erbyn y diwrnod gwaith canlynol. Gallai ymatebion y mae angen gwybodaeth fawr ar eu cyfer gymryd hyd at 20diwrnod.

Ewch at ein gwefan www.cyfoethnaturiolcymru.gov.uk, os gwelwch yn dda, am ragor o wybodaeth, neu galwch ein Canolfan GofalCwsmeriaid ar 0300 065 3000. Mae ar agor rhwng 8 o'r gloch y bore a 6 yr hwyr, o ddydd Llun hyd ddydd Gwener.

Digwyddiad

Er mwyn rhoi gwybod amachos o lygredd, gollwng gwastraff anghyfreithlon neu broblemau amgylcheddolbrys eraill, galwch ein Llinell Frys ar 0800 807060. Mae galwadau'n rhad ac amddim.

Diolch,

Cyfoeth Naturiol Cymru.

Thank you for your email, **Your reference number: CAS-32718-P6D0 .**

We aim to respond to emails by the next working day. Responses requiring detailed information may take up to 20 days.

Please visit our website www.cyfoethnaturiolcymru.gov.uk for more information, or call our customer care centre on 0300 065 3000 open 8am - 6pm Monday to Friday

Incident

To report a pollution incident, illegal dumping of waste or any urgent environmental problems, please call our free-phone Incident Hotline on 0800 807060.

Thank you,

Natural Resources Wales

APPENDIX E: DEVELOPMENT ADVICE MAP

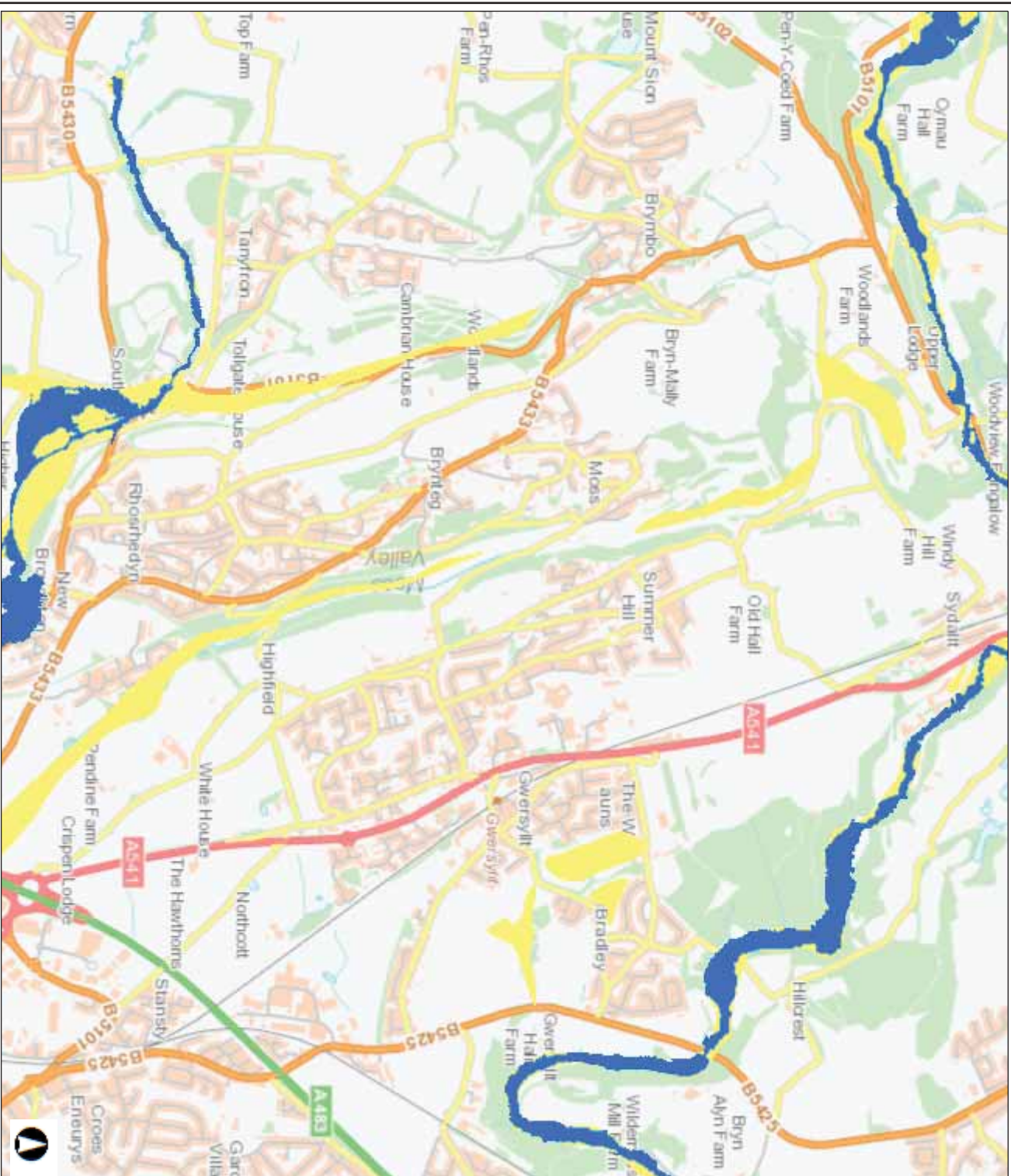
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NR

Map Perygl Llifogydd / Flood Risk Map

Alliwedd / Map Key

- Zone C1
- Zone C2
- Zone B
- Zone A



Graddfa / Scale 1: 25,000

Dyddiad / Date
19/04/2017

APPENDIX F: HR WALLINGFORD CALCULATIONS

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Calculated by: Patrick Taylor

Site name: Top Road.

Site location:

Site coordinates

Latitude: 53.07298° N

Longitude: 3.03011° W

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Reference: 5935771

Date: 2017-05-02T15:46:14

Methodology

IH124

Site characteristics

Total site area (ha)	3.331
----------------------	-------

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	802	802
Hydrological region	9	9
Growth curve factor: 1 year	0.88	0.88
Growth curve factor: 30 year	1.78	1.78
Growth curve factor: 100 year	2.18	2.18

Notes:

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

(2) Are flow rates < 5.0 l/s?

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	7.12	7.12
1 in 1 year (l/s)	6.26	6.26
1 in 30 years (l/s)	12.67	12.67
1 in 100 years (l/s)	15.52	15.52

APPENDIX G: TAN15 EXTRACTS

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Figure 1

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.

Figure 2

Development category	Types
Emergency services	hospitals, ambulance stations, fire stations, police stations, coastguard stations, command centres, emergency depots and buildings used to provide emergency shelter in time of flood
Highly vulnerable development	all residential premises (including hotels and caravan parks), public buildings (e.g. schools, libraries, leisure centres), especially vulnerable industrial development (e.g. power stations, chemical plants, incinerators), and waste disposal sites
Less vulnerable development	General industrial, employment, commercial and retail development, transport and utilities infrastructure, car parks, mineral extraction sites and associated processing facilities, excluding waste disposal sites

Summary of Policy Requirements

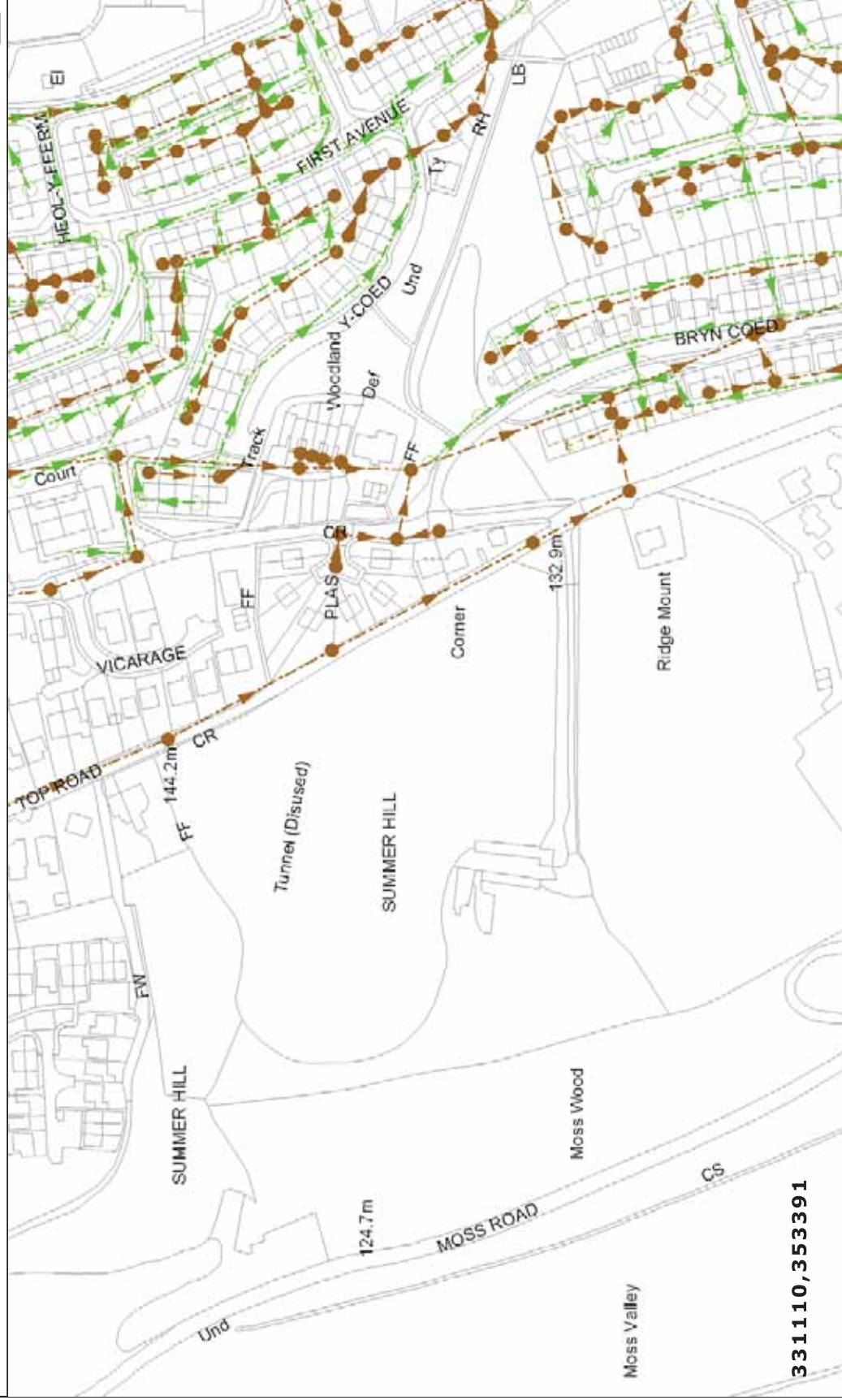
DAM	Development Type (Section 5)	Planning Requirements (Section 4)	Acceptability Criteria (Section 7 & Appendix 1)	Development Advice (Section 5, 6, 7 & Appendix 1)
A	Emergency services Highly vulnerable development Less vulnerable development Other	- Justification test not applicable - Refer to surface water requirements	No increase in flooding elsewhere	No constraints relating to river or coastal flooding, other than to avoid increasing risk elsewhere.
B	Emergency services	- 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. - Refer to surface water requirements	- Acceptable consequences for nature of use - Occupiers aware of flood risk - Escape/evacuation routes present - Effective flood warning provided - Flood emergency plans and procedures - Flood resistant design - No increase in flooding elsewhere	Generally suitable for most forms of development. Assessments, where required, are unlikely to identify consequences that cannot be overcome or managed to an acceptable level. It is unlikely, therefore, that these would result in a refusal of planning consent on the grounds of flooding.
	Highly vulnerable development		- Acceptable consequences for nature of use - Occupiers aware of flood risk - Escape/evacuation routes present - Effective flood warning provided - Flood emergency plans and procedures - No increase in flooding elsewhere - Occupiers aware of flood risk - No increase in flooding elsewhere	
	Less vulnerable development		No increase in flooding elsewhere	
	Other	Refer to surface water requirements	No increase in flooding elsewhere	
C1	Emergency services Highly vulnerable development Less vulnerable development	- Application of justification test (section 6), including acceptability of consequences (section 7 and appendix 1) - Refer to surface water requirements	- Acceptable consequences for nature of use - Flood defences adequate - Agreement for construction and maintenance costs secured - Occupiers aware of flood risk - Escape/evacuation routes present - Effective flood warning provided - Flood emergency plans and procedures - Flood resistant design - No increase in flooding elsewhere	Plan allocations and applications for all development can only proceed subject to justification in accordance with section 6 and acceptability of consequences in accordance with section 7 and Appendix 1.
	Other	- Application of acceptability of consequences (section 7 and appendix 1) - Refer to surface water requirements	- Acceptable consequences for nature of use - Occupiers aware of flood risk - Desirable if effective flood warning and evacuation routes/procedure provided depending on nature of proposal - No increase in flooding elsewhere	Plan allocations and applications for development should only be made if considered acceptable in accordance with section 7 and Appendix 1.

DAM	Development Type (Section 5)	Planning Requirements (Section 4)	Acceptability Criteria (Section 7 & Appendix 1)	Development Advice (Section 5, 6, 7 & Appendix 1)
C2	Emergency services Highly vulnerable development	The flooding consequences associated with Emergency Services and highly vulnerable development are not considered to be acceptable. Plan allocations should not be made for such development and planning applications not proposed.		
	Less vulnerable development	▪ Application of justification test (section 6) , including acceptability of consequences (section 7 and appendix 1) ▪ Refer to surface water requirements	▪ Acceptable consequences for nature of use ▪ Flood defences adequate ▪ Agreement for construction and maintenance costs secured ▪ Occupiers aware of flood risk ▪ Escape/evacuation routes present ▪ Effective flood warning provided ▪ Flood emergency plans and procedures	Plan allocations or applications for less vulnerable development can only proceed subject to justification in accordance with section 6 and acceptability of consequences in accordance with section 7 and Appendix 1.
	Other	▪ Application of acceptability of consequences (section 7 and appendix 1) ▪ Refer to surface water requirements	▪ Flood resistant design ▪ No increase in flooding elsewhere ▪ Acceptable consequences for nature of use ▪ Occupiers aware of flood risk ▪ Effective flood warning provided ▪ No increase in flooding elsewhere	Plan allocations and applications for development should only be made if considered acceptable in accordance with section 7 and Appendix

APPENDIX H: SEWER RECORDS & CORRESPONDENCE

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Scale: 1:2625



Dwr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general information and for the design of the apparatus. It is not to be taken as a warranty or a guarantee of the accuracy of the information, but the Company's apparatus and its correctness is relied upon in the event of excavations or other works made in the vicinity of the apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. The information which is supplied hereby by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 based upon the best information available and in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company are not necessarily up to date and the position of the underground apparatus may not be accurate. It must be understood that the Company does not accept any liability for any damage to property or persons caused by the use of the information furnished by the Company, and in particular, the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991, and the Company's right to be compensated for any damage to its apparatus.

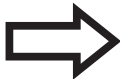
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**EXACT LOCATION OF
ALL APPARATUS TO
BE DETERMINED ON
SITE**

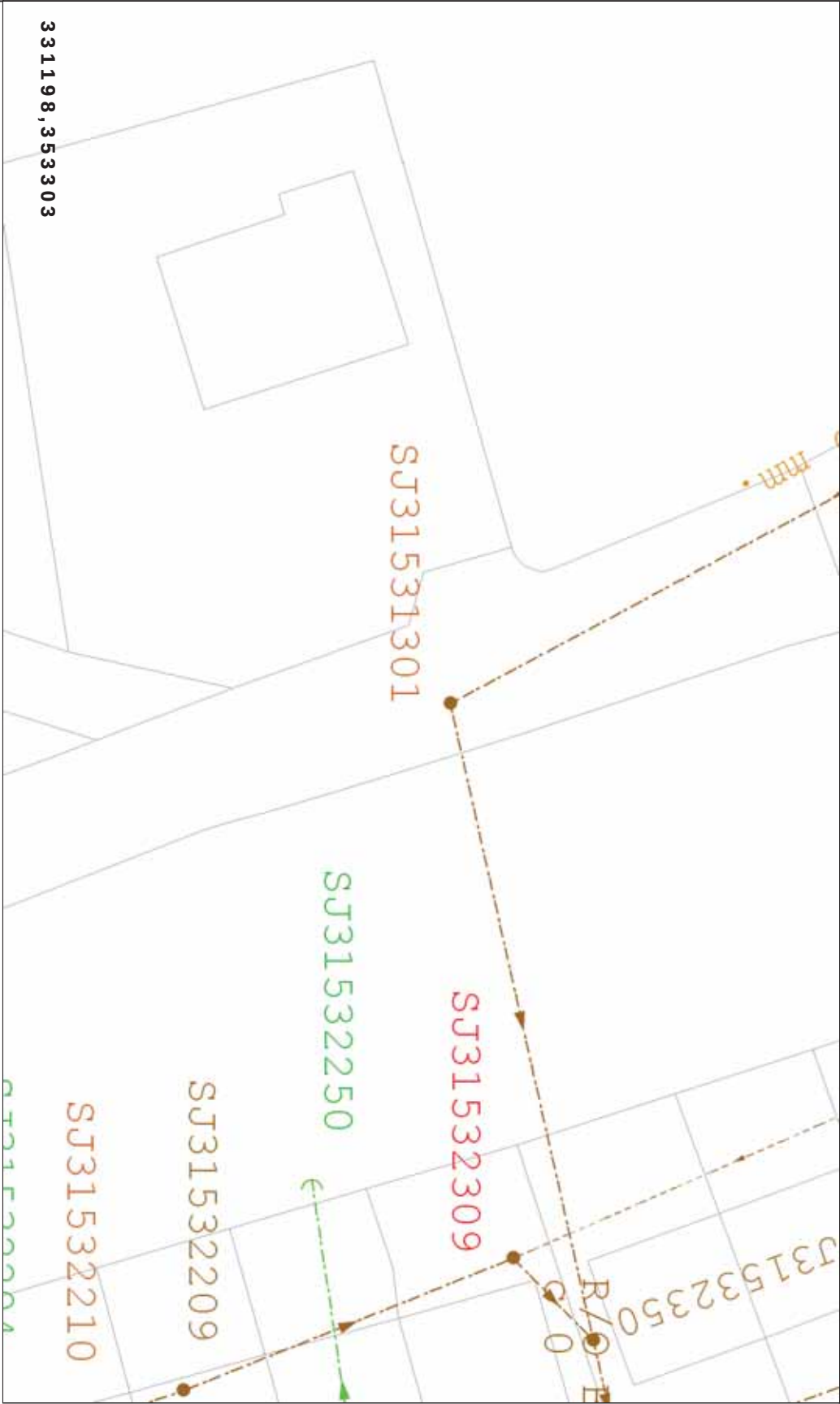


Dŵr Cymru
Welsh Water

05/05/2017



Scale: 1:322



331198,353303

LEGEND

- Clean Water
- Sluice Val
- Air Val, SINGLE
- Tap
- Pressure Reducing Valve
- Meter
- BULK Meter
- FH
- Cap
- Existing Main
- NON COMPANY
- Sewerage External
- Foul
- Surface Water
- Combined
- Rising Main
- Private
- Treatment Works
- Pumping Station
- Special Purpose
- Unknown End
- Change, Combined Overflow
- Outfall, FOUL
- Lamp Hole, Foul
- Private Sewer Transfer
- Lateral Drain
- Inspection Chamber

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EXACT LOCATION OF
ALL APPARATUS TO
BE DETERMINED ON
SITE

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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 the responsibility of the user to ensure that the anticipated presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation.

Patrick Taylor

From: Jones-Hughes Henry <Henry.Jones-Hughes@dwrcymru.com>
Sent: 19 April 2017 08:43
To: Patrick Taylor
Subject: RE: FCA Advice. Gwersyllt

Hello Patrick,

There are no known sewer flooding incidents within the boundary of this site

Regards
Henry



Henry Jones-Hughes
Development Control Officer | Developer Services | Wholesale Business Services | Services Dwr Cymru Welsh Water
Linea | Cardiff | CF3 0LT | T: 0800 917 2652 | www.dwrcymru.com

Developer Services have an on-line service at www.dwrcymru.com. Here you can find all the services available, complete application forms and also make payments. If you have a quotation you can pay for this on-line or alternatively by telephoning 0800 917 2652 using a credit/debit card.

We will respond to your email as soon as possible but you should allow up to 10 working days to receive a response. For most of the services we offer we set out the timescales that we work to on our Developer Services section of our website. Just follow this link <http://www.dwrcymru.com/en/Developer-Services.aspx> and select the service you require where you will find more information and guidance notes which should assist you. If you cannot find the information you are looking for then please call us on 0800 917 2652 as we can normally deal with any questions you have during the call.

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](#).

From: Patrick Taylor [mailto:patricktaylor@betts-associates.co.uk]
Sent: 18 April 2017 16:37
To: Jones-Hughes Henry <Henry.Jones-Hughes@dwrcymru.com>
Subject: FCA Advice. Gwersyllt

***** External Mail *****

Good Morning Henry,

TOP ROAD, SUMMER HILL, GWERSYLLT.

Please could you confirm whether you have any information that you feel would be valuable to a Flood Consequence Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and water levels; this would be greatly appreciated. Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Patrick Taylor BSc(Hons)
Graduate Flood Risk Analyst

APPENDIX I: LPA/LLFA CORRESPONDENCE

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Patrick Taylor

From: Carole Wright <Carole.Wright@wrexham.gov.uk>
Sent: 24 April 2017 09:58
To: Patrick Taylor
Cc: Neil Taunt
Subject: RE: FCA Advice. Gwersyllt
Attachments: HYD229 Gwersyllt Hill.pdf

Dear Patrick

Please find attached a plan with associated water related issues for the area in question. There are no specific constraints that would affect the site. The nearest historic flood events date back to 2013 and involve blocked gulleys.

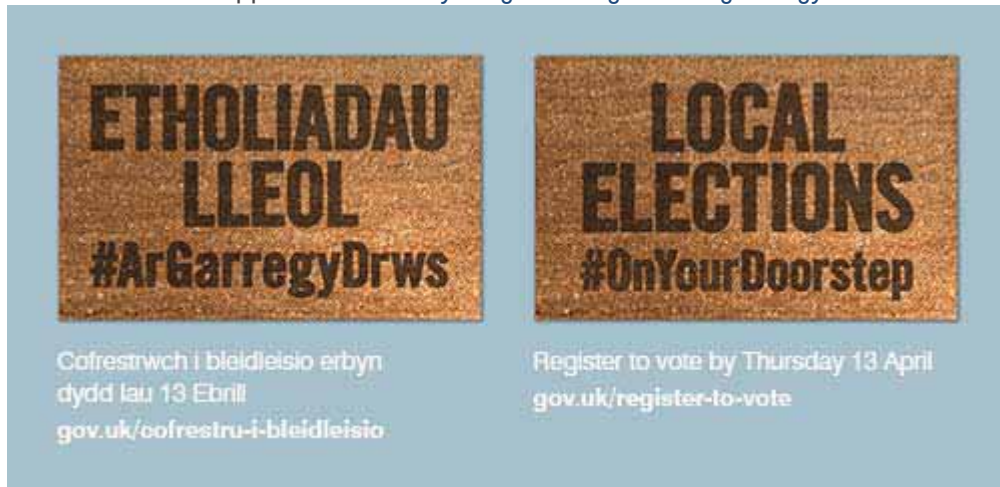
If I can be of any further assistance please do not hesitate to contact me.

Kind regards

Carole Wright

Carole Wright - BA MBCS

Technical Flood Support Officer - Swyddog Technegol Cefnogi Llifogydd



01978 729735

Wrexham County Borough Council, Environment and Planning Department Abbey Road South Wrexham Industrial Estate Wrexham LL13 9PW

Cyngor Bwrdeistref Sirol Wrecsam, Amgylchedd a Chynllunio De Ffordd yr Abaty Ystâd Ddiwydiannol Wrecsam Wrecsam LL13 9PW

wrexham.gov.uk | wrecsam.gov.uk

twitter.com/wrexhamcbc | twitter.com/cbswrecsam

facebook.com/wrexhamcouncil | facebook.com/cyngorwrecsam

From: Patrick Taylor [mailto:patricktaylor@betts-associates.co.uk]
Sent: 18 April 2017 16:40
To: flooding
Subject: FCA Advice. Gwersyllt

To whom it may concern,

TOP ROAD, SUMMER HILL, GWERSYLLT.

Please could you confirm whether you have any information that you feel would be valuable to a Flood Consequence Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and water levels; this would be greatly appreciated. Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Patrick Taylor BSc(Hons)
Graduate Flood Risk Analyst

BETTS HYDRO

Specialists in Drainage and Flood Risk

Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY

CHESTER OFFICE - 01244 289041

patricktaylor@betts-associates.co.uk
www.betts-associates.co.uk

CIVIL | STRUCTURAL | GEO-ENVIRONMENTAL | HYDROLOGY | FLOOD RISK MANAGEMENT
SUDS | STRUCTURAL SURVEYS | PARTY WALL DUTIES | INFILTRATION | GEO-TECHNICAL

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Rydym yn croesawu gohebiaeth yn Gymraeg. Byddwn yn ymateb i unrhyw ohebiaeth yn Gymraeg ac ni fydd hyn yn arwain at unrhyw oedi.

Ewch i weld - mi fedrwch chi dalu, rhoi gwybod, gwneud cais, dweud eich dweud, a dod o hyd i wybodaeth ar-lein yn www.wreccsam.gov.uk. Arbedwch bapur - meddyliwch cyn argraffu!

Mae'r neges e-bost hon ac unrhyw atodiadau wedi eu bwriadu ar gyfer yr unigolyn neu'r sefydliad y'i cyfeirir atynt yn unig. Am yr amodau llawn yngl?n â chynnwys a defnyddio'r neges e-bost hon, ac unrhyw atodiadau, cyfeiriwch at www.wreccsam.gov.uk/top_navigation/disclaimersw.htm

We welcome correspondence in Welsh. We will respond to any correspondence in Welsh and this will not lead to any delay.

Take a look - you can pay, report, request, have your say and find information online at www.wrexham.gov.uk. Save paper - think before you print!

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APPENDIX J: SURFACE WATER RUN-OFF CALCULATIONS

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SURFACE WATER RUN-OFF CALCULATION SHEET

Development	TOP ROAD, SUMMER HILL
Project No.	HYD229

Revision	A	Completed by	PT
Date	02.05.17	Checked by	KW



Areas		Catchment Characteristics	
Total Site	5.419 ha	SAAR	802 mm
Development Area (for SW Strategy)	3.331 ha	SPR	30 %
Existing Impermeable	0.137 ha	i_1	14.4 mm/hr
Existing Impermeable (for SW Strategy)	0.000 ha	i_{30}	31.8 mm/hr
Existing Pervious	3.194 ha	i_{100}	41.2 mm/hr
Existing Pervious (for SW Strategy)	3.331 ha		
Proposed Impermeable (total)	1.661 ha		

Run-off Rates				Volumes			
<i>Pre-development</i>				<i>Pre-development</i>			
Impermeable	1yr	0.0 l/s		Impermeable	1yr	0.0 cu.m	
	30yr	0.0 l/s			100yr	0.0 cu.m	
	100yr	0.0 l/s					
	50mm/hr	0.0 l/s		Pervious	1yr	208.7 cu.m	
					100yr	680.3 cu.m	
Pervious	1yr	6.2 l/s		Total	1yr	208.7 cu.m	
	30yr	12.5 l/s			100yr	680.3 cu.m	
	100yr	15.5 l/s					
	QBar	7.1 l/s		<i>Post-development</i>			
Total	1yr	6.2 l/s		Impermeable (total)	1yr	0.0 cu.m	
	30yr	12.5 l/s			100yr+CC	0.0 cu.m	
	100yr	15.5 l/s					
<i>Post-development</i>							
Impermeable (total)	1yr	66.6 l/s		Reduction (total)	100%	680.3 cu.m	
	30yr	146.6 l/s					
	100yr+CC	247.0 l/s					

Quick storage Estimates		low	high	mean	Imp. Area (ha)	Max. Discharge (l/s)	Rainfall	CC
Return Period	1yr	171	326	248.5	1.661	7.1	FEH	0
Return Period	30yr	542	852	697	1.661	7.1	FEH	0
Return Period	100yr+CC	1085	1593	1339	1.661	7.1	FEH	30%
Return Period	100yr+CC	1197	1753	1475	1.661	7.1	FEH	40%

Betts Associates Ltd		Page 1
Old Marsh Farm Barns Welsh Road Sealand Flintshire CH5 2LY		
Date 02/05/2017 15:39 File	Designed by patricktaylor Checked by	
Micro Drainage		Source Control 2014.1.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 1 Soil 0.300 Area (ha) 3.331 Urban 0.000 SAAR (mm) 800 Region Number Region 9 Results l/s QBAR Rural 7.1 QBAR Urban 7.1 Q1 year 6.2 Q1 year 6.2 Q30 years 12.5 Q100 years 15.5		
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Betts Associates Ltd		Page 1																										
Old Marsh Farm Barns Welsh Road Sealand Flintshire CH5 2LY																												
Date 02/05/2017 16:22 File	Designed by patricktaylor Checked by																											
Micro Drainage Source Control 2014.1.1																												
<u>Greenfield Runoff Volume</u> FSR Data <table> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> </tr> <tr> <td>M5-60 (mm)</td> <td>18.000</td> </tr> <tr> <td>Ratio R</td> <td>0.306</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>3.331</td> </tr> <tr> <td>SAAR (mm)</td> <td>802</td> </tr> <tr> <td>CWI</td> <td>117.436</td> </tr> <tr> <td>Urban</td> <td>0.000</td> </tr> <tr> <td>SPR</td> <td>30.000</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>32.20</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>680.259</td> </tr> </table>			Return Period (years)	100	Storm Duration (mins)	360	Region	England and Wales	M5-60 (mm)	18.000	Ratio R	0.306	Areal Reduction Factor	1.00	Area (ha)	3.331	SAAR (mm)	802	CWI	117.436	Urban	0.000	SPR	30.000	Percentage Runoff (%)	32.20	Greenfield Runoff Volume (m ³)	680.259
Return Period (years)	100																											
Storm Duration (mins)	360																											
Region	England and Wales																											
M5-60 (mm)	18.000																											
Ratio R	0.306																											
Areal Reduction Factor	1.00																											
Area (ha)	3.331																											
SAAR (mm)	802																											
CWI	117.436																											
Urban	0.000																											
SPR	30.000																											
Percentage Runoff (%)	32.20																											
Greenfield Runoff Volume (m ³)	680.259																											
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Old Marsh Farm Barns Welsh Road Sealand Flintshire CH5 2LY		
Date 02/05/2017 16:23 File	Designed by patricktaylor Checked by	
Micro Drainage Source Control 2014.1.1		

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.000
Ratio R	0.306
Areal Reduction Factor	1.00
Area (ha)	3.331
SAAR (mm)	802
CWI	117.436
Urban	0.000
SPR	30.000

Results

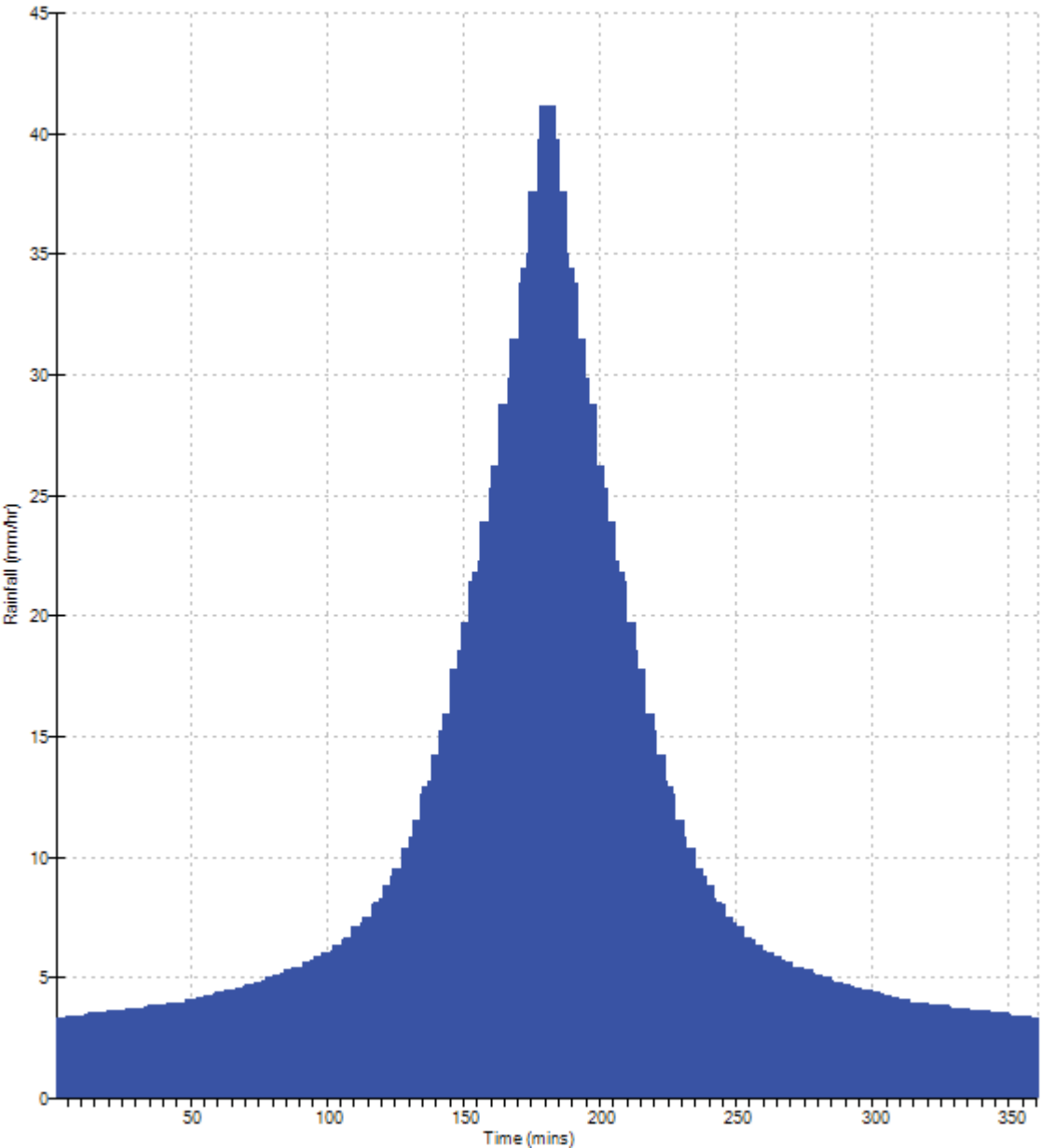
Percentage Runoff (%)	28.11
Greenfield Runoff Volume (m ³)	208.659

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Rainfall profile

Storm duration (mins) 360

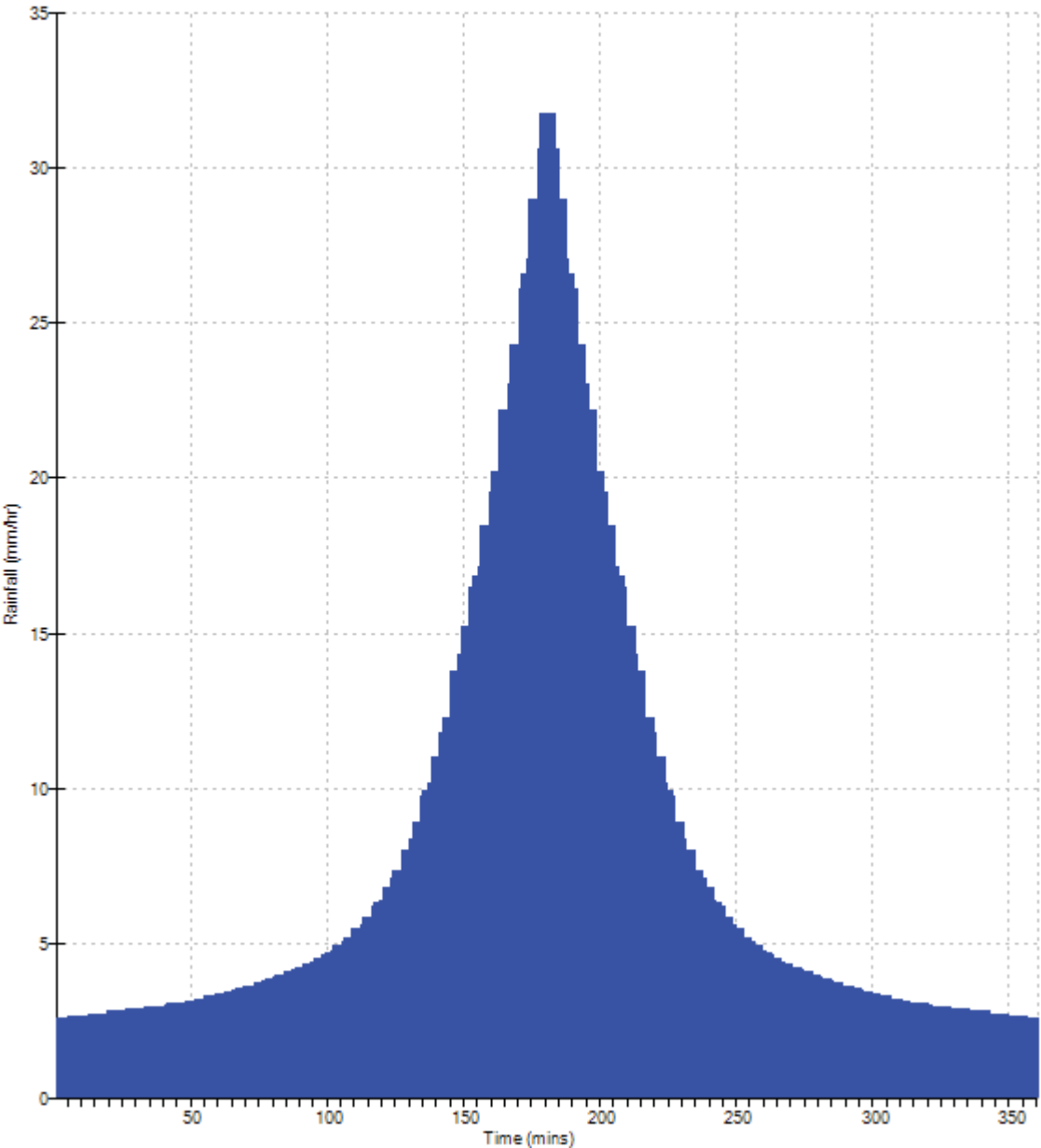
FSR Data
Region England and Wales
M5-60(mm) 18.000
Ratio R 0.311
Peak Intensity (mm/hr) 41.173
Ave. Intensity (mm/hr) 10.503
Return Period (years) 100



Rainfall profile

Storm duration (mins) 360

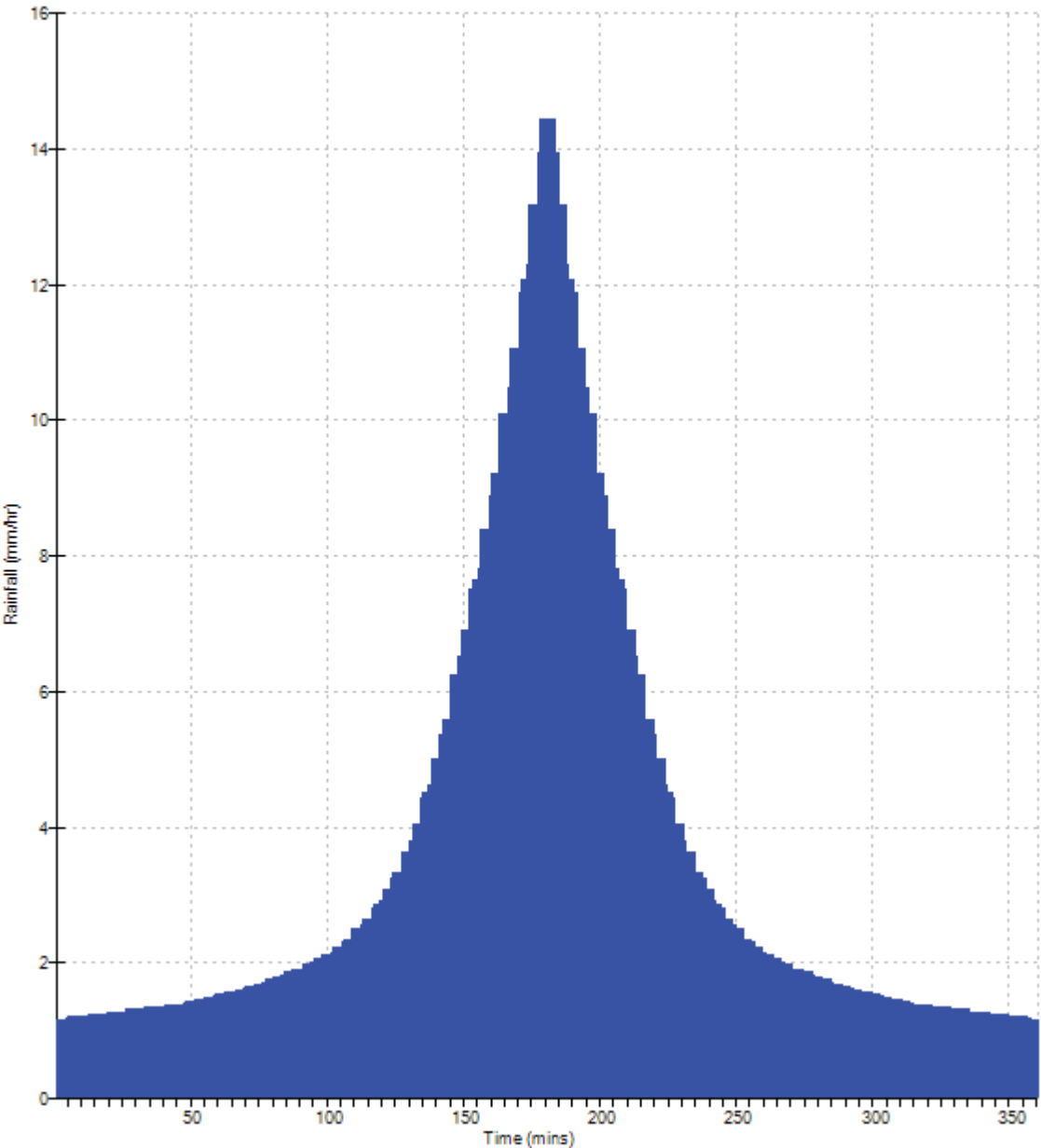
FSR Data
Region England and Wales
M5-60(mm) 18.000
Ratio R 0.311
Peak Intensity (mm/hr) 31.770
Ave. Intensity (mm/hr) 8.105
Return Period (years) 30



Rainfall profile

Storm duration (mins) 360

FSR Data
Region England and Wales
M5-60(mm) 18.000
Ratio R 0.311
Peak Intensity (mm/hr) 14.442
Ave. Intensity (mm/hr) 3.684
Return Period (years) 1



APPENDIX K: QUICK STORAGE ESTIMATES

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QUICK STORAGE ESTIMATES GREENFIELD RATE TOP ROAD, SUMMERHILL

1 YEAR RETURN PERIOD STORM EVENT

Micro Drainage		Variables			
Variables Results Design Overview 2D Overview 3D Vt	FSR Rainfall	Cv (Summer)	0.750		
	Return Period (years)	1	Cv (Winter)	0.840	
	Region	England and Wales	Impermeable Area (ha)	1.661	
	Map	M5-60 (mm)	18.000	Maximum Allowable Discharge (l/s)	7.1
		Ratio R	0.308	Infiltration Coefficient (m/hr)	0.00000
				Safety Factor	2.0
				Climate Change (%)	0
Micro Drainage		Results			
Global Variables require approximate storage of between 171 m³ and 326 m³. These values are estimates only and should not be used for design purposes.					

30 YEAR RETURN PERIOD STORM EVENT

Micro Drainage		Variables			
Variables Results Design Overview 2D Overview 3D Vt	FSR Rainfall	Cv (Summer)	0.750		
	Return Period (years)	30	Cv (Winter)	0.840	
	Region	England and Wales	Impermeable Area (ha)	1.661	
	Map	M5-60 (mm)	18.000	Maximum Allowable Discharge (l/s)	7.1
		Ratio R	0.308	Infiltration Coefficient (m/hr)	0.00000
				Safety Factor	2.0
				Climate Change (%)	0
Micro Drainage		Results			
Global Variables require approximate storage of between 542 m³ and 852 m³. These values are estimates only and should not be used for design purposes.					

QUICK STORAGE ESTIMATES

TOP ROAD, SUMMERHILL

100 YEAR RETURN PERIOD STORM EVENT + 30% CLIMATE CHANGE

Micro Drainage		Variables			
Variables Results Design Overview 2D Overview 3D Vt	FSR Rainfall	Cv (Summer)	0.750		
	Return Period (years)	100	Cv (Winter)	0.840	
	Region	England and Wales	Impervious Area (ha)	1.661	
	Map	M5-60 (mm)	18.000	Maximum Allowable Discharge (l/s)	7.1
		Ratio R	0.308	Infiltration Coefficient (m/hr)	0.00000
				Safety Factor	2.0
				Climate Change (%)	30

Micro Drainage		Results
Global Variables require approximate storage of between 1085 m³ and 1593 m³. These values are estimates only and should not be used for design purposes.		

100 YEAR RETURN PERIOD STORM EVENT + 40% CLIMATE CHANGE

Micro Drainage		Variables			
Variables Results Design Overview 2D Overview 3D Vt	FSR Rainfall	Cv (Summer)	0.750		
	Return Period (years)	100	Cv (Winter)	0.840	
	Region	England and Wales	Impervious Area (ha)	1.661	
	Map	M5-60 (mm)	18.000	Maximum Allowable Discharge (l/s)	7.1
		Ratio R	0.308	Infiltration Coefficient (m/hr)	0.00000
				Safety Factor	2.0
				Climate Change (%)	40

Micro Drainage		Results
Global Variables require approximate storage of between 1197 m³ and 1753 m³. These values are estimates only and should not be used for design purposes.		

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APPENDIX L: PFRA/SFRA INFORMATION

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3.2 Flood risk in Wrexham County Borough Council

A Preliminary Flood Risk Assessment was completed in 2011 in order to establish the level of flood risk across Wrexham CBC. The process looked specifically at flooding from surface water, ground water, ordinary watercourses and the interface with flooding from main rivers.

To ensure a consistent approach, DEFRA and WG identified a number of key risk indicators and their thresholds, to establish significant risk and to determine the existence of Flood Risk Areas.

The methodology was based upon the flood maps produced by the NRW to identify one kilometre squares where the flood risk exceeds a defined threshold. These squares are known as areas above the Flood Risk Threshold (Blue Squares). The key flood risk indicators and their thresholds for a 1km square were set as a minimum of two hundred people affected; a minimum of twenty businesses affected; two or more critical services.

A cluster of blue squares indicated that the area encapsulated was much more likely to experience flooding events. Where four or more blue squares were found to be adjacent within a 9km² area and more than 5000 people were predicted to be at risk, the area was considered to form an Indicative Flood Risk Area.

This process identified 20 no. blue squares within the County Borough (see Figure 3.2.1), and although a cluster of 10 squares was identified over Wrexham town, the population numbers contained were significantly below the threshold for an indicative flood risk area.

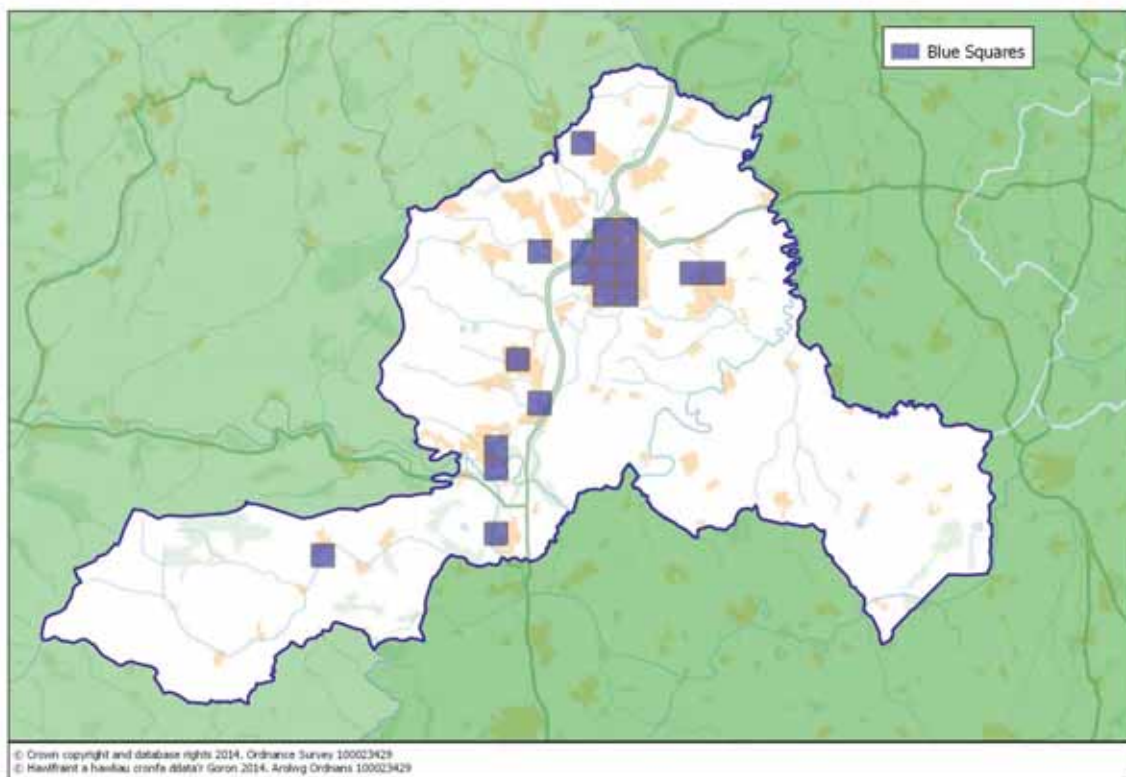
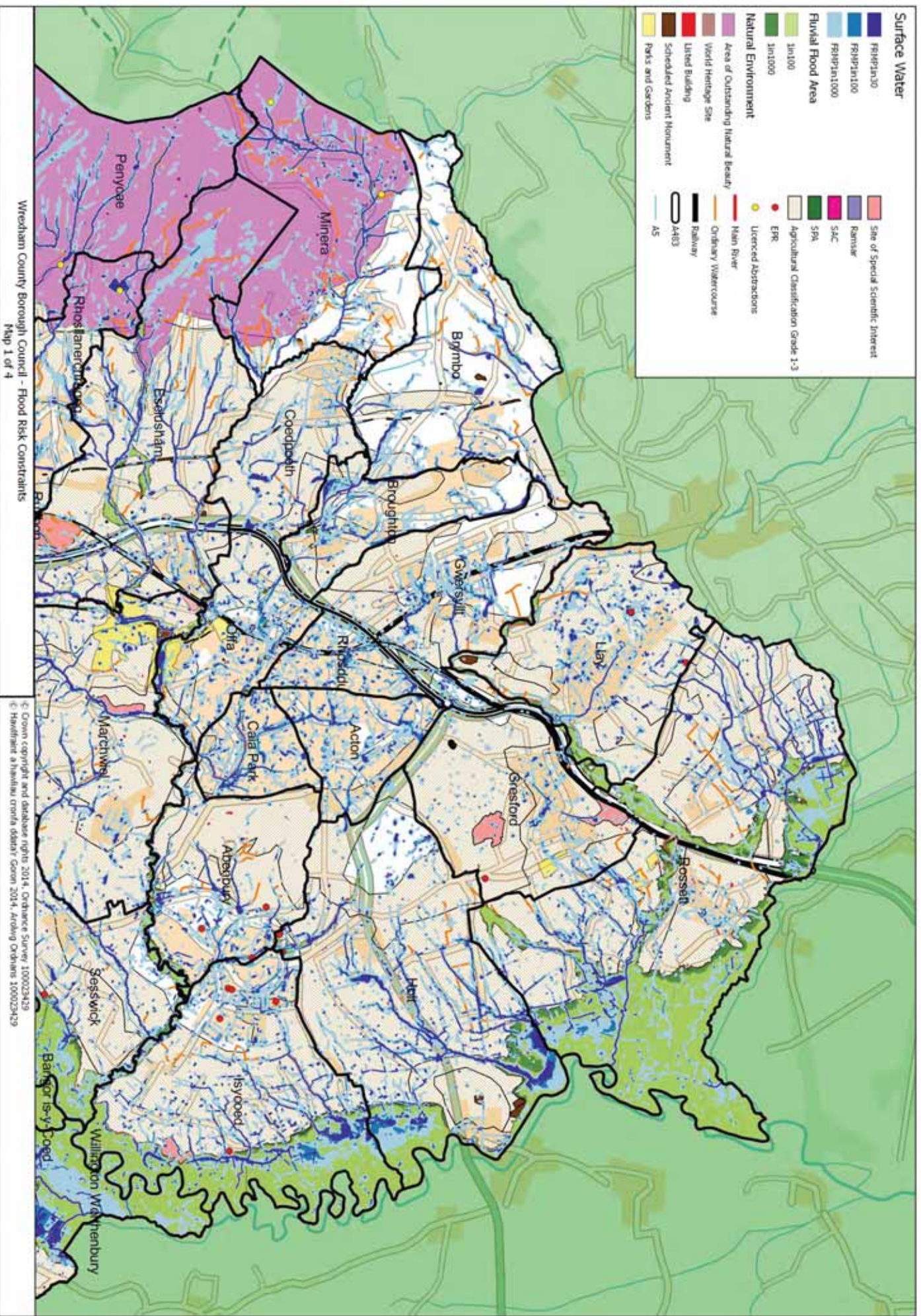


Figure 3.2.1: Blue squares across Wrexham CBC.



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APPENDIX M: OVERLAND FLOOD FLOW ROUTING

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DO NOT SCALE

LEGEND

OVERLAND FLOOD FLOWS



A		20.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	REV
REV	DATE	BY	DESCRIPTION	CHK	
FORMAL STATUS					



PROJECT:		TOP ROAD SUMMER HILL	
TITLE:			

DATE	ISSUED BY	ISSUED TO	DATE
APR 2017	11350	AI	CP
PROJECT No.		102	
HYD229		A	

DO NOT SCALE

LEGEND

OVERLAND FLOOD FLOWS



REV	DATE	BY	DESCRIPTION	CHK
A	20.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	
DRAWING STATUS				



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CONSULTING ENGINEERS

Units 6, 6A South Green Lane, Woking, Surrey, GU24 0JF
Tel: 01483 250770 Fax: 01483 250771
www.betts-hydro.co.uk

PROJECT			
TOP ROAD SUMMER HILL			
TITLE			
POST-DEVELOPMENT OVERLAND FLOOD FLOWS			
DATE	SCALE	DATE	SCALE
APR 2017	1:750 @ A1	DATE	SCALE
PROJECT No	HYD229	202	A

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APPENDIX N: IMPERMEABLE AREAS PLANS

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DO NOT SCALE

NOTES

PRE-DEVELOPMENT PERVIOUS AREAS - 5.287ha

PRE-DEVELOPMENT IMPERVIOUS AREAS - 0.137ha

TOTAL SITE AREA - 5.419ha



A	20.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	AW
REV	DATE	BY	DESCRIPTION	CHK
FORMAL STATUS				



PROJECT

TOP ROAD
SUMMER HILL

TITLE

PRE-DEVELOPMENT
IMPERVIOUS AREAS PLAN

DATE	ISSUED BY	ISSUED TO	DATE	ISSUED BY
APR 2017	11350	AI	CP	AW
HYD229	101	A		

NOTES

- TOTAL SITE AREA - 5.419ha
- POST-DEVELOPMENT IMPERMEABLE AREAS -
- ROOF - 0.572ha
- DRIVE - 0.400ha
- ROAD - 0.683ha
- TOTAL IMPERMEABLE AREAS - 1.655ha



A	20.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	HW
REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS				



PROJECT

TOP ROAD
SUMMER HILL

TITLE

POST-DEVELOPMENT
IMPERMEABLE AREAS PLAN

DATE	SCALE	DATE	SCALE	DATE	SCALE
APR 2017	1:750 @ A1	ISSUED	CP	CHECKED	HW
PROJECT No		DRAWING No		REV	
HYD229		201		A	

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APPENDIX O: DRAINAGE PLANS

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LEGEND

Site Extents

EXISTING SEWER INFRASTRUCTURE

Foul Water Sewer

Surface Water Sewer

EXISTING DRAINAGE FEATURES

Ordinary Watercourse/Land Drainage

Overland Flow

Assumed culverted watercourse

Notes:
THIS DRAWING IS NOT A DRAINAGE 'DESIGN' IT IS A PRELIMINARY DRAINAGE STRATEGY SHOWING INDICATIVE SEWER LOCATIONS.
NO HYDRAULIC SIMULATION OR ASSESSMENT OF THESE PROPOSALS HAS BEEN UNDERTAKEN.
PROPOSED POINTS OF CONNECTION TO THE EXISTING CULVERTS REQUIRE INVERT LEVELS TO BE ACCURATELY ESTABLISHED.
SURCHARGING OF THE PROPOSED OUTFALL WILL REQUIRE MODELLING TO SATISFY THE REQUIREMENTS OF UNITED UTILITIES ALONG WITH FULL HYDRAULIC ANALYSIS.

Surface water. Soakaway testing has been carried out on the site in which it was evidenced that infiltration would be a viable solution for surface water management at the site in areas where not constrained by engineering requirements.

As infiltration may only offer a part solution, an alternative would be to discharge surface water flows to the unnamed watercourse adjacent to moss road. However technical constraints concerned with the height of the site in relation this is unlikely to be feasible. Anecdotal evidence suggests a culverted watercourse is located to the east of the site although further investigation is required. Consents agreements to discharge would be required from WCBC.

Should connection to a watercourse not be viable, then the alternative would be a connection to the neighbouring public surface water sewer. There are multiple sewers within the vicinity of site and discussion with WW will identify their preferred point(s) of connection.

Foul Water. Foul water generated by the proposals is proposed to connect to the public foul water sewer (150mm dia) within Top Road. Discussion with WW will be required to identify the preferred point of connection. Detailed design will confirm the most suitable connection and whether a gravity solution for the site will be feasible.

LEGEND



Site Extents

EXISTING SEWER INFRASTRUCTURE



Foul Water Sewer



Surface Water Sewer

EXISTING DRAINAGE FEATURES



Ordinary Watercourse

PROPOSED DRAINAGE CONNECTIONS



1 Soakaway



2 SW outfall to assumed Culverted Watercourse



3 SW outfall to Public Sewer



Routing to connection



Foul Water

Notes:

THIS DRAWING IS NOT A DRAINAGE 'DESIGN' IT IS A PRELIMINARY DRAINAGE STRATEGY SHOWING INDICATIVE SEWER LOCATIONS.

NO HYDRAULIC SIMULATION OR ASSESSMENT OF THESE PROPOSALS HAS BEEN UNDERTAKEN.

PROPOSED POINTS OF CONNECTION TO THE EXISTING CULVERTS REQUIRE INVERT LEVELS TO BE ACCURATELY ESTABLISHED.

SURCHARGING OF THE PROPOSED OUTFALL WILL REQUIRE MODELLING TO SATISFY THE REQUIREMENTS OF UNITED UTILITIES ALONG WITH FULL HYDRAULIC ANALYSIS.

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APPENDIX P SOAKAWAY TEST RESULTS

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Key:

Location Symbols

- Trial Trenches to Investigate location of discussed tunnel
- Approximate Trial Pit Location
- Approximate Trial Pit Location (With Soak away)
- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location (With Install)
- Approximate Rotary Open Hole Location (40m)
- Trial Trenches to look for Mine Shafts

Notes:

Phase	Revision	Date	Issue	Drawn	MD
P1	-	02-05-2017	DRAFT	DW	MD
Client			Macbryde Homes Ltd		
Job No:			11-780		
Drawing No:			004		
Drawing Title:			NTS @ A3		
Drawing Date:			02-06-2017		
Drawing Time:			Exploratory Hole Location Plan		



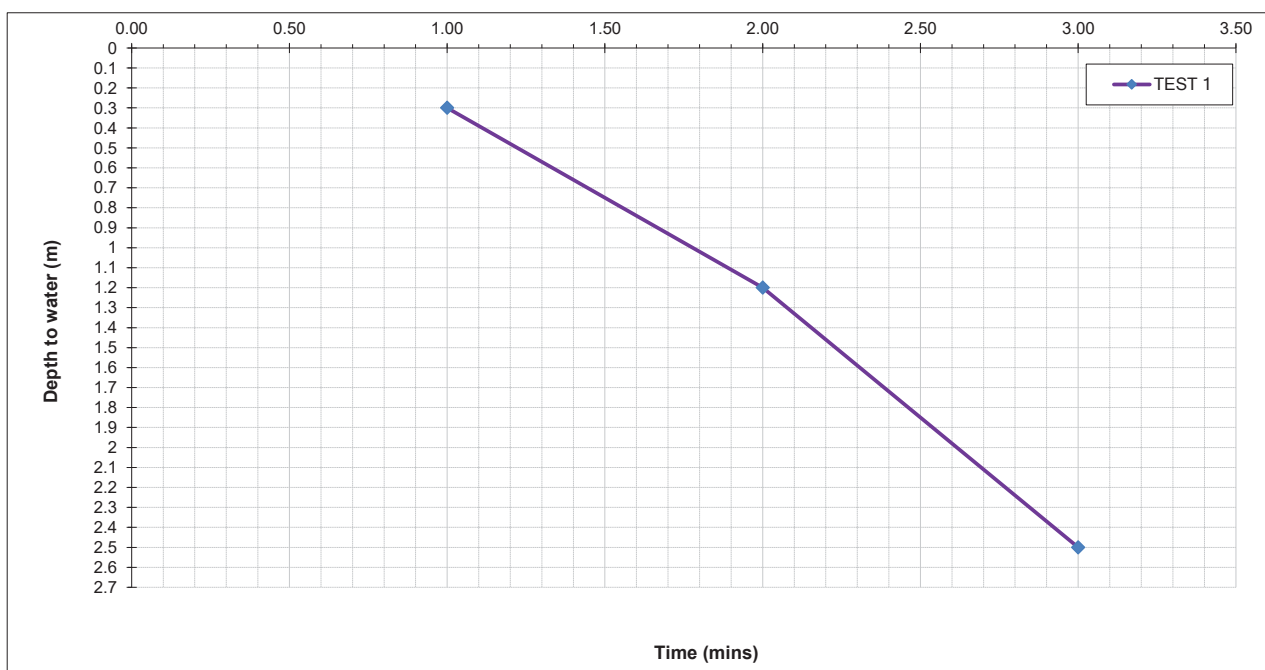
Environmental Energy Engineering
City Hallport & Business Centre
Eccles, Manchester, M30 7RU
Tel: 0161 707 9612
Email: info@e3p.co.uk
Website: www.e3p.co.uk

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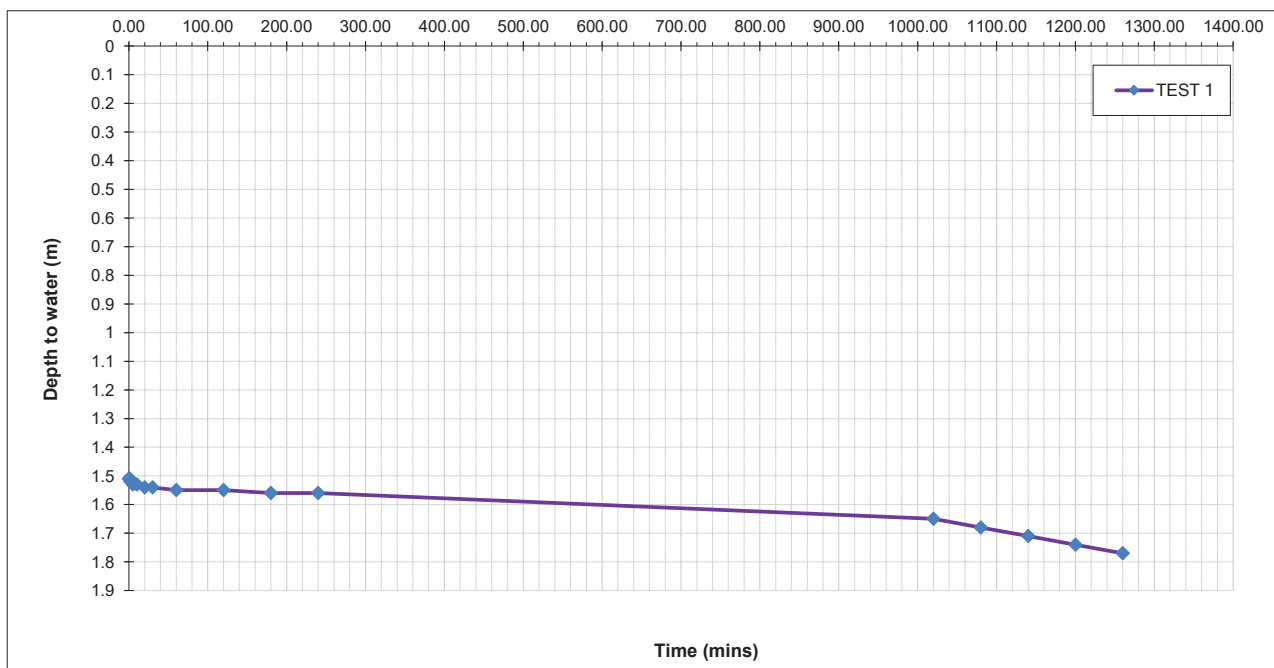
		Site: Top Road, Wrexham Job Number: 11-780 Date of Test: 23/05/2017		Trial Pit Number: SA102 Length: 1.80 m Width: 0.50 m Depth: 2.50 m Groundwater Level: N/A m			
		TEST 1		TEST 2		TEST 3	
		Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
		1.00	0.3				
		2.00	1.2				
		3.00	2.50				
Effective Storage Depth	m		2.20				
75% Effective Storage Depth	m		1.65				
(i.e. depth below GL)	m		0.85				
25% Effective Storage Depth	m		0.55				
(i.e. depth below GL)	m		1.95				
Effective Storage Depth 75%-25%	m		1.10				
Time to fall to 75% effective depth	mins		2.35				
Time to fall to 25% effective depth	mins		2.55				
V (75%-25%)	m3		0.99				
a (50%)	m2		5.96				
t (75%-25%)	mins		0.20				
SOIL INFILTRATION RATE	m/s		1.38E-02				

DESIGN SOIL INFILTRATION RATE, f	1.38E-02
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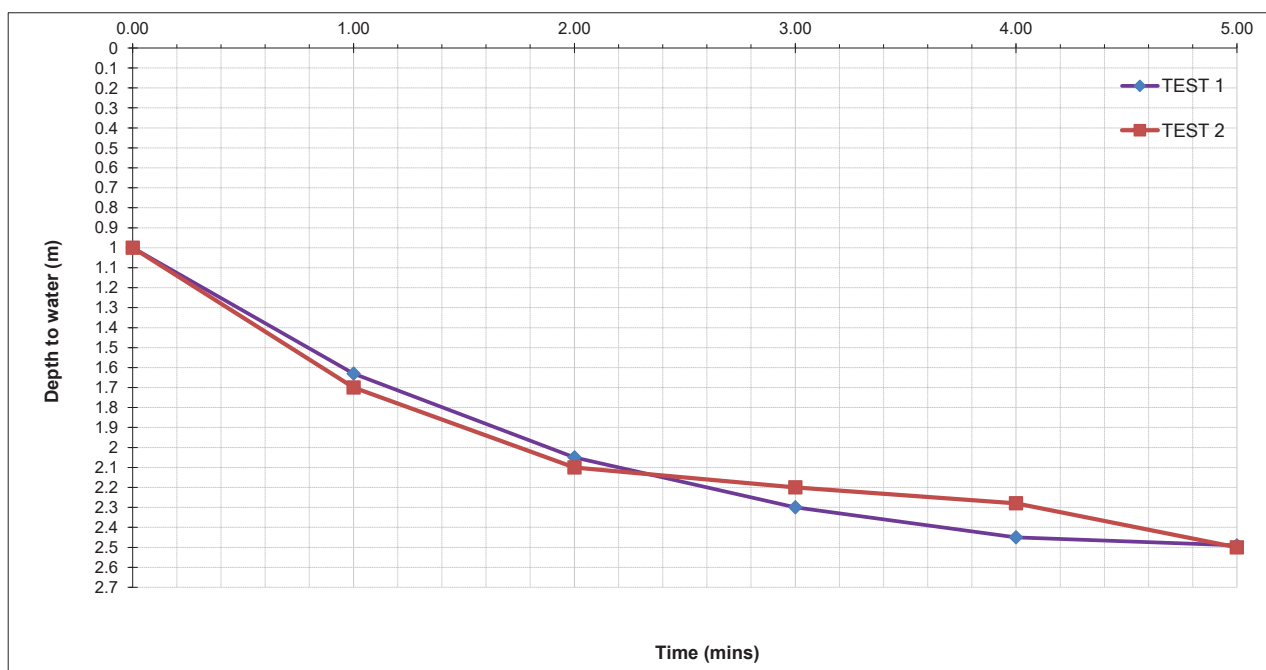
		Site: Top Road, Wrexham Job Number: 11-780 Date of Test: 23/05/2017		Trial Pit Number: SA103 Length: 1.80 m Width: 0.50 m Depth: 2.60 m Groundwater Level: N/A m		
Water soaked to 1.50m immediately then there was no further suitable soakage to determine a design infiltration rate.	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
	0.00	1.51				
	1.00	1.51				
	2.00	1.52				
	3.00	1.52				
	4.00	1.52				
	5.00	1.53				
	10.00	1.53				
	20.00	1.54				
	30.00	1.54				
	60.00	1.55				
	120.00	1.55				
	180.00	1.56				
	240.00	1.56				
	1020.00	1.65				
	1080.00	1.68				
1140.00	1.71					
1200.00	1.74					
1260.00	1.77					
Effective Storage Depth	m	1.09				
75% Effective Storage Depth	m	0.82				
(i.e. depth below GL)	m	1.78				
25% Effective Storage Depth	m	0.27				
(i.e. depth below GL)	m	2.33				
Effective Storage Depth 75%-25%	m	0.55				
Time to fall to 75% effective depth	mins	0.00				
Time to fall to 25% effective depth	mins	N/A				
V (75%-25%)	m3	0.49				
a (50%)	m2	3.41				
t (75%-25%)	mins	N/A				
SOIL INFILTRATION RATE	m/s	N/A				

DESIGN SOIL INFILTRATION RATE, f	N/A
---	------------



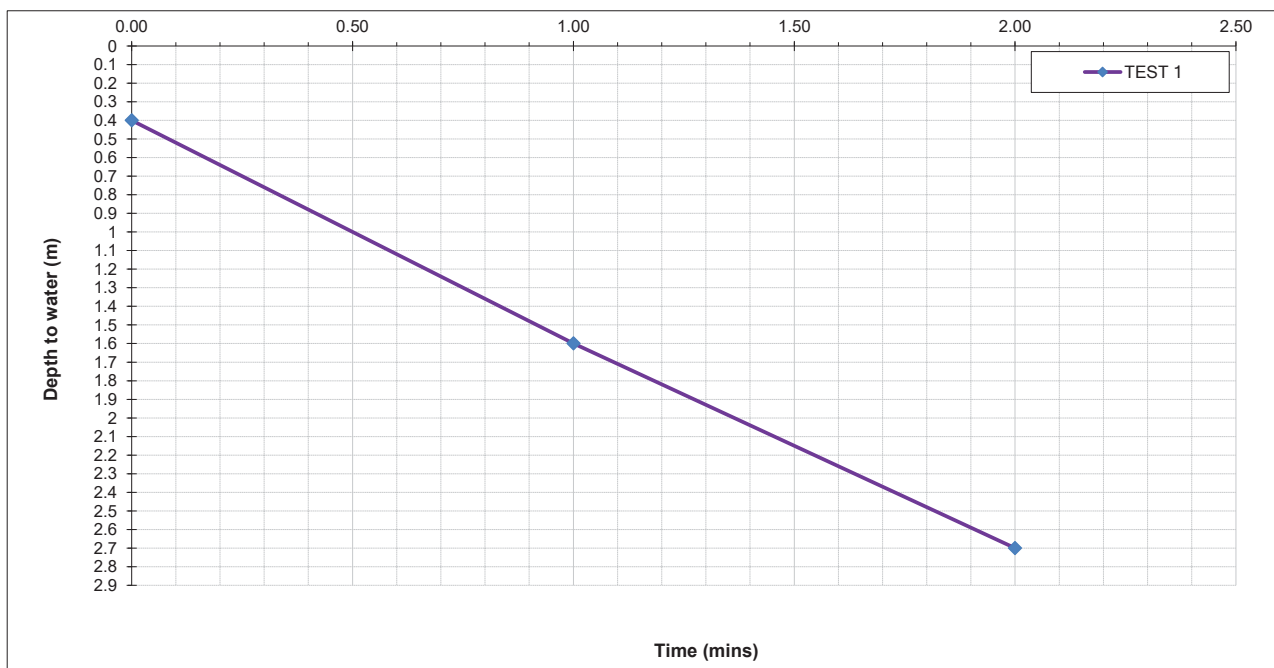
		Site: Top Road, Wrexham Job Number: 11-780 Date of Test: 23/05/2017		Trial Pit Number: SA104 Length: 1.80 m Width: 0.50 m Depth: 2.50 m Groundwater Level: N/A m			
		TEST 1		TEST 2		TEST 3	
		Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
		0.00	1	0.00	1		
		1.00	1.63	1.00	1.7		
		2.00	2.05	2.00	2.1		
		3.00	2.3	3.00	2.2		
		4.00	2.45	4.00	2.28		
		5.00	2.49	5.00	2.50		
Effective Storage Depth	m		1.50		1.50		
75% Effective Storage Depth	m		1.13		1.13		
(i.e. depth below GL)	m		1.38		1.38		
25% Effective Storage Depth	m		0.38		0.38		
(i.e. depth below GL)	m		2.13		2.13		
Effective Storage Depth 75%-25%	m		0.75		0.75		
Time to fall to 75% effective depth	mins		0.60		0.50		
Time to fall to 25% effective depth	mins		2.20		2.20		
V (75%-25%)	m3		0.68		0.68		
a (50%)	m2		4.35		4.35		
t (75%-25%)	mins		1.60		1.70		
SOIL INFILTRATION RATE	m/s		1.62E-03		1.52E-03		

DESIGN SOIL INFILTRATION RATE, f	1.52E-03
---	-----------------



		Site: Top Road, Wrexham Job Number: 11-780 Date of Test: 23/05/2017		Trial Pit Number: SA101 Length: 1.80 m Width: 0.50 m Depth: 2.70 m Groundwater Level: N/A m			
		TEST 1		TEST 2		TEST 3	
		Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
		0.00	0.4				
		1.00	1.6				
		2.00	2.70				
Effective Storage Depth	m		2.30				
75% Effective Storage Depth	m		1.73				
(i.e. depth below GL)	m		0.98				
25% Effective Storage Depth	m		0.58				
(i.e. depth below GL)	m		2.13				
Effective Storage Depth 75%-25%	m		1.15				
Time to fall to 75% effective depth	mins		0.50				
Time to fall to 25% effective depth	mins		1.50				
V (75%-25%)	m3		1.04				
a (50%)	m2		6.19				
t (75%-25%)	mins		1.00				
SOIL INFILTRATION RATE	m/s		2.79E-03				

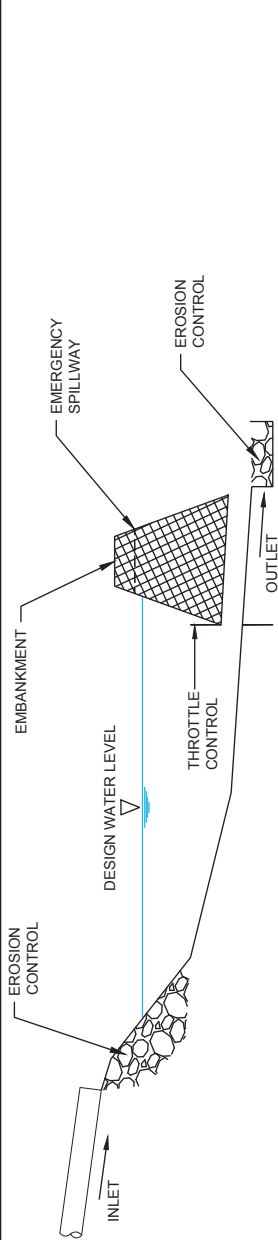
DESIGN SOIL INFILTRATION RATE, f	2.79E-03
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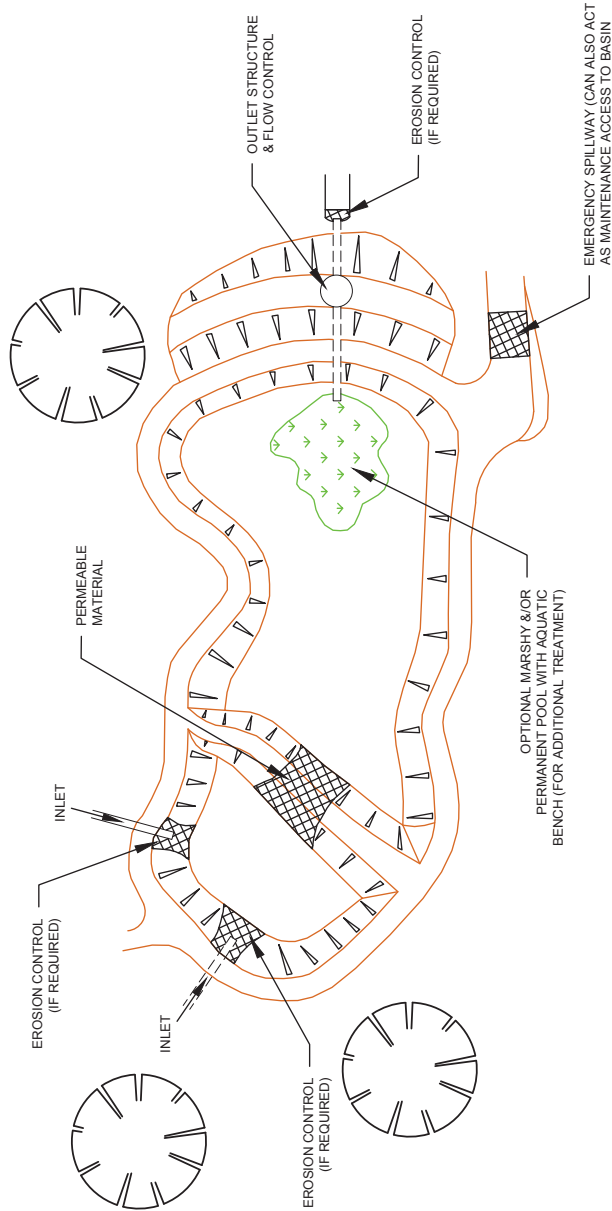
APPENDIX Q TYPICAL SUDS DETAIL

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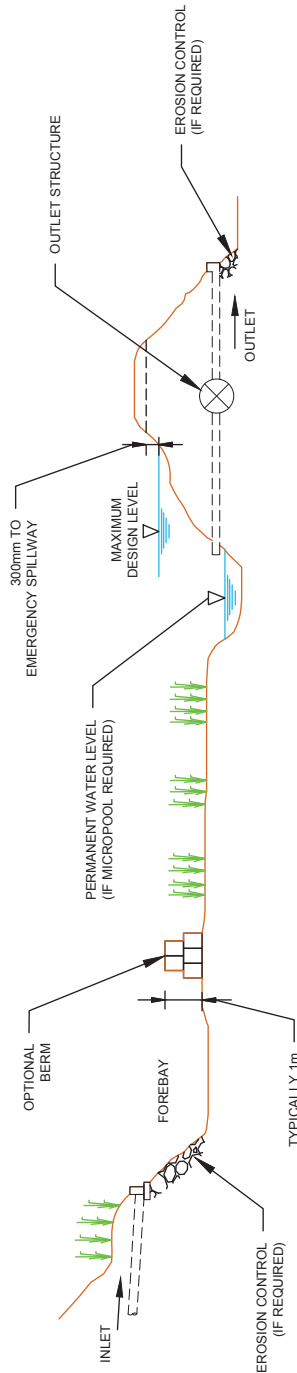
DO NOT SCALE



SCHEMATIC OF DETENTION
BASIN PROFILE



PLAN VIEW



ELEVATION

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS:

PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT:

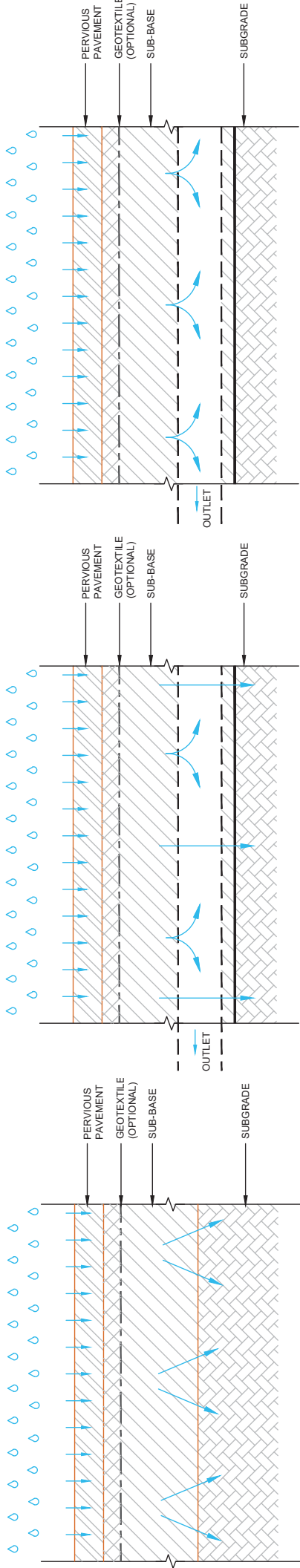
TYPICAL SUDS DETAIL

TITLE:

DETENTION BASINS

DATE:	SCALE:	SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN	RDN
PROJECT No:	BETTS	DRAWING No:	110	REV:
				A

DO NOT SCALE

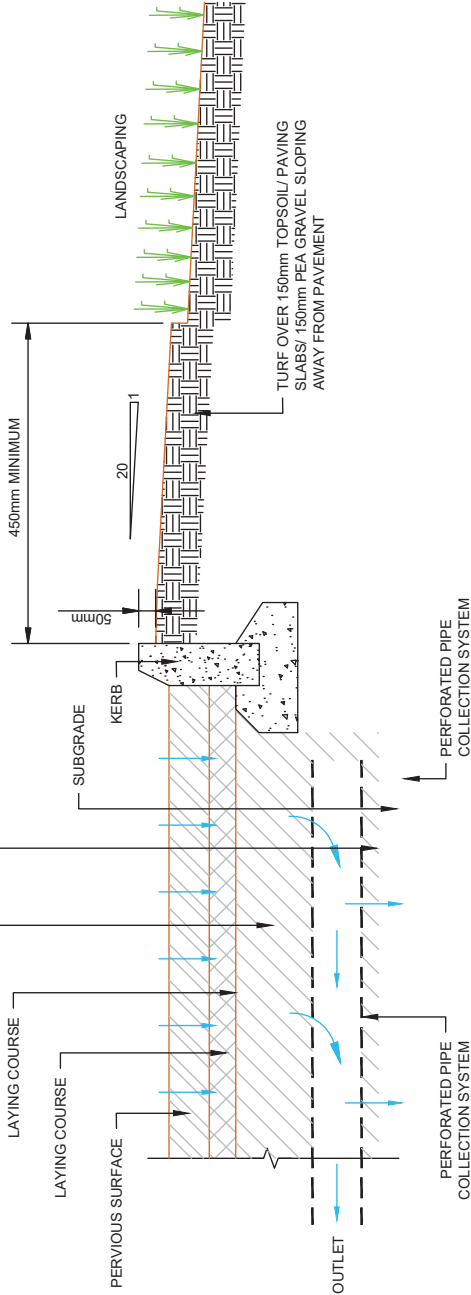


TYPE A: TOTAL INFILTRATION

TYPE B: PARTIAL INFILTRATION

TYPE C: NO INFILTRATION

AGGREGATE SUB-BASE (MAY BE REPLACED WITH GEOCELLULAR BLOCKS)



LANDSCAPING DETAIL

REV	DATE	BY	DESCRIPTION	CHK
-----	------	----	-------------	-----

DRAWING STATUS:

PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT:

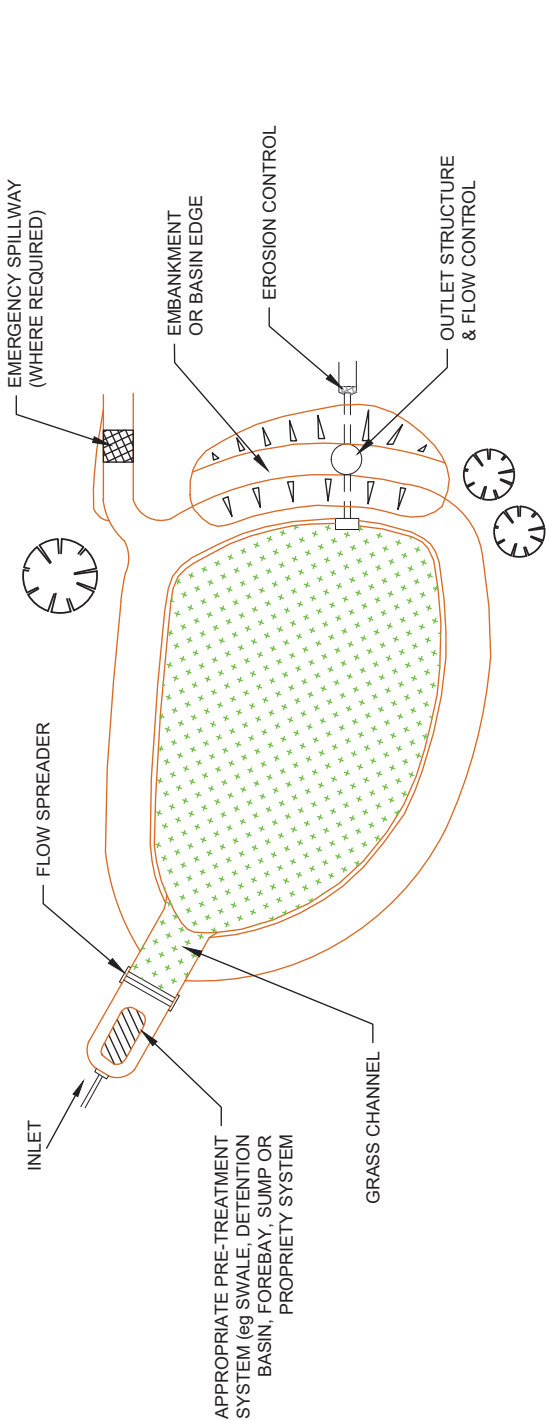
TYPICAL SUDS DETAIL

TITLE:

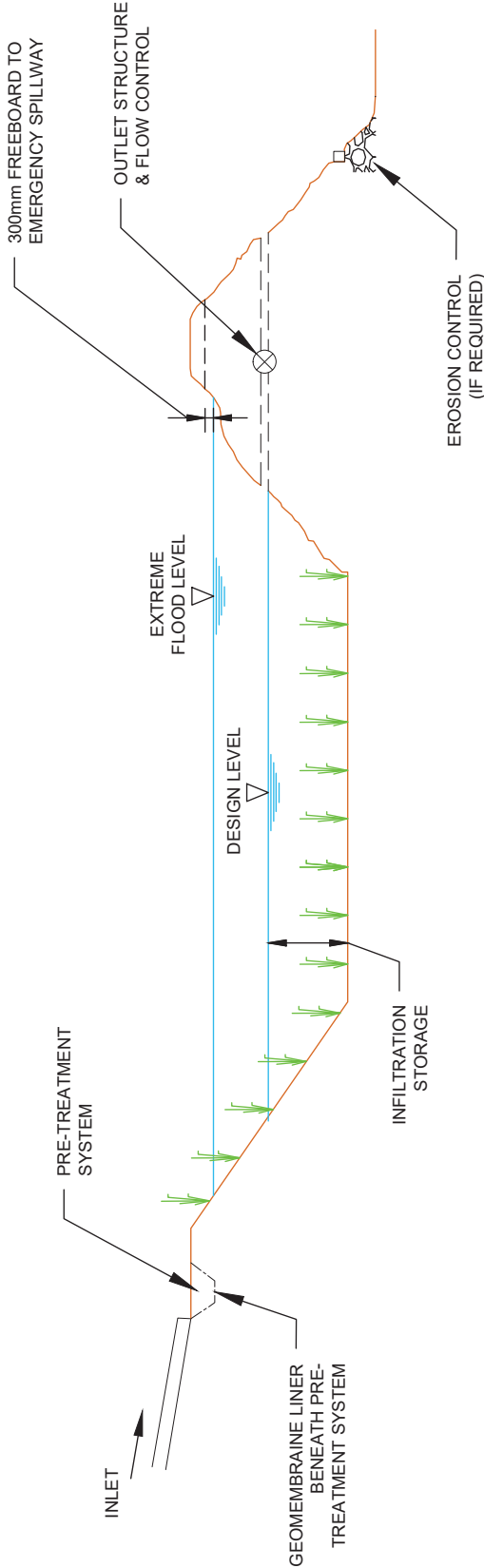
PERVIOUS PAVEMENTS

DATE: SEP 2014	SCALE @ A3	SIZE: CP	DRAWN: RDN	CHECKED: RDN
PROJECT No: BETTS	DRAWING No: 105	REV: A		

DO NOT SCALE



PLAN VIEW



REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY

BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL			
TITLE: INFILTRATION BASINS			
DATE: SEP 2014	SCALE: @ A3	SIZE: CP	CHECKED: RDN
PROJECT No: BETTS	DRAWING No: 109	REV: A	

APPENDIX R: NOTES OF LIMITATIONS

The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information.

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