BETTS HYDRO
CONSULTING ENGINEERS

LAND EAST OF TAN Y BONT
MAIN ROAD, RHOSROBIN
WREXHAM

FLOOD CONSEQUENCE ASSESSMENT
AND DRAINAGE MANAGEMENT STRATEGY

For

Castle Green Homes Limited
Unit 20
St Asaph Business Park
St Asaph
Denbighshire
LL17 0LJ

Castle Green HOMES

JANUARY 2023

This page has been intentionally left blank

LAND EAST OF TAN Y BONT
MAIN ROAD, RHOSROBIN
WREXHAM

FLOOD CONSEQUENCE ASSESSMENT AND DRAINAGE MANAGEMENT STRATEGY

Document Tracking Sheet

Document Reference: HYD574_TAN.Y.BONT.RHOSROBIN_FCA&DMS
Revision: 3.1
Date of Issue: 09.01.2023
Report Status: FINAL

Prepared by:
Hannah Buchanan BSc (Hons) *GradCIWEM*
Graduate Flood Risk Analyst

Checked by:
Kirsty Halliday *BSc (Hons) MCIWEM*
Flood Risk Analyst

Authorised by:
Richard Nicholas *BEng (Hons) MBA GMICE MCIWEM*
Director

Revision History:

Rev.:	Date:	Status:	Prepared by:	Checked by:	Issued by:
3.1	09.01.2023	FINAL	HB	KH	HB
3.0	04.01.2023	FINAL	HB	KH	HB
2.0	04.08.2021	FINAL	MB	KW	MB
1.0	09.02.2021	DRAFT	MB	KW	MB
0	05.02.2021	DRAFT	MB	KW	MB

Old Marsh Farm Barns
Welsh Road, Sealand
Flintshire CH5 2LY
Telephone: 01244 289 041

www.betts-associates.co.uk

This page has been intentionally left blank

EXECUTIVE SUMMARY

This Flood Consequence Assessment and Drainage Management Strategy was commissioned by Castle Green Homes Limited referred to hereafter as 'the client'. This assessment has been prepared to support a planning application for the construction of residential development on land east of Main Road in Rhosrobin, Wrexham.

Flood Risk

The total site covers 15.78ha and in accordance with TAN15, the proposals are highly vulnerable in nature. Consultation with the National Resources Wales, Wrexham County Borough Council and Welsh Water have been carried out and have not identified any historical flooding to the site. This assessment has reviewed all sources of flood risk both to the development, including fluvial, tidal, pluvial, groundwater, sewers, and flooding from artificial sources.

National Resources Wales' data sets show the site to be at very low risk from fluvial and tidal flood risk sources. The nearest Main River (River Alyn) is located 400m to the north. The flood risk to the site from the River Alyn is 'very low' due to its proximity from the site and the surrounding topography. Onsite land drainage features have been identified from a site walkover, although these features are understood to aid in the local drainage only and due to their small scale/nature the flood risk associated is understood to be low.

The primary source of flood risk to the site is considered to be from surface water flooding. The potential flood risks to the site from surface water will be managed and reduced, post-development, through appropriate levels design and incorporation of a sustainable drainage management system. Due to the relatively low flood risks identified as part of this assessment, the principle focus of this assessment is on the sustainable management of surface water run-off to ensure that no increased flood risk results from the proposals.

Drainage Strategy

In order for the development proposals to be justified in line with the guidance set out in SuDS Standards for Wales, new development must not increase flood risk elsewhere and where possible offer improvement on the pre-development situation. The sustainable drainage hierarchy has been considered in accordance with the Welsh SuDS Standards, which look to deal with surface water run-off as close to source as is practical.

The published online datasets have been reviewed to consider how favourable the underlying strata is to support a potential infiltration-based drainage solution. The online datasets and FEH catchment characteristics are further supported by BRE 365 Soakaway Testing undertaken by Tier Consult Ltd (Ref: T/14/1400-DS1/SGJ). The report identified there was a range of infiltration characteristics across the site.

It is therefore proposed that any impermeable areas that can drain to soakaway (or an alternative method of infiltration) should do so via appropriately designed infiltration-based solution, as this would significantly improve the sustainability of the surface water systems. There are potential locations for where larger scale infiltration methods might be suitable.

Detailed design will need to be undertaken to confirm the specific SuDS to be utilised following a more detailed analysis of levels, ground conditions and attenuation requirements, in conjunction with the SAB at Wrexham County Borough Council. The SAB have statutory

responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. This report is to support the proposed planning application and the full SAB approval will need to be sought separately by the developer.

To conclude, the development area has been considered in accordance with TAN15 and suitable mitigation measures have been proposed to ensure that the development is safe for its lifetime. This Flood Consequence Assessment and Drainage Management Strategy is 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.

CONTENTS

Figures & Tables

Abbreviations & Acronyms

BGS	British Geological Survey
CC	Climate Change
DAM	Development Advice Map
FCA	Flood Consequence Assessment
FEH	Flood Estimation Handbook
Ha	Hectare
HD	Hafren Dyfrdwy
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
SAB	SuDS Approving Body
SuDS	Sustainable Drainage Systems
TAN15	Technical Advice Note 15
UKCIP	United Kingdom Climate Impacts Programme
WCBC	Wrexham County Borough Council

This page has been intentionally left blank

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

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 A**).

Sustainable Drainage Approval Board (SAB) Requirements

1.1.3 From January 2019, all new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government standards for sustainable drainage. Schedule 3 of the Flood and Water Management Act 2010 (FWMA) establishes Wrexham County Borough Council as a SuDS Approving Body (SAB).

1.1.4 The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. The SAB application is undertaken separately to the planning permissions and developers are required to obtain both planning approval and SAB approval prior to commencement of any proposed construction works. This Flood Consequence Assessment and Drainage Management Strategy is to support the proposed planning application and SAB approval will need to be sought separately by the developer once more details are available for the drainage proposals.

1.2 Site Context

1.2.1 This Flood Consequence Assessment (FCA) has been prepared to support a full planning application for the construction of residential dwellings on undeveloped land located off Tan y Bont, Main Road, Rhosrobin, Wrexham. Outline planning approval for residential development has already been granted for the site by WCBC (Ref: P/2016/0189). The proposals will therefore be complete with access, car parking, external works and lighting, landscaping, boundary walls/fencing, external services, and drainage.

1.2.2 The proposals are Highly Vulnerable in nature and an FCA is required to justify that the proposed development proposals are appropriate. 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 area 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 Natural Resources Wales (NRW), Wrexham County Borough Council (WCBC) and Welsh Water (WW). The responses can be seen in **Appendix B, C** and **D**. The Local Planning Authority (LPA), WCBC (also acts as the Lead Local Flood Authority), will make the final decision about 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 development is accessed off Tan y Bont, (Main Road) and Plas Acton Road Rhosrobin, Wrexham. The Ordnance Survey National Grid Reference (OS NGR) for the site is E: 333085, N: 352580 and the nearest postcode is LL11 4RP. A Location Plan is included in **Appendix E**. The total site covers 15.78ha and is edged in red in **Figure 1**. To the north of site is Plas Acton Road and residential dwellings, to the east of site is the A483 with further residential dwellings located beyond. To the south of site is Main Road with residential and commercial development located further south and to the east of site lies a railway line and undeveloped land, as illustrated in **Figure 1**.

Figure 1: Existing Site Features Plan (Google Maps, 2021)

2.2 Existing and Historical Land Use

2.2.1 The development site is currently undeveloped agricultural land and comprises of low-density vegetation, with some taller shrubs along the field boundaries. As illustrated in **Figure 1**, there are existing onsite land drainage features present within the centre of site, although the full function of these is not currently known. Historically the site was utilised for agricultural purposes.

2.2.2 The mapping has also identified that Wat's Dyke (a linear earthworks feature) is located crossing the site from the south towards the northern corner. An offset from this asset has also been indicated on the planning layout. No other historical uses have been identified during the preparation of this report.

2.3 Site Walkover

2.3.1 A site walkover was undertaken by Betts Hydro in January 2021 after a prolonged heavy rainfall event. The site walkover identified that there are existing onsite land drainage features present within the centre of site where naturally low-lying areas are located. Also, within the natural low-lying areas across the site there was evidence of ponding/standing water and saturated ground adjacent to some field boundaries. field boundaries, as shown within **Figure 2**. The A483 is raised relative to the site and run-off naturally conveys across the site towards the south/south-eastern boundary meaning flows are restricted from leaving the site extents due to the elevated bypass.

Figure 2: Site Features and Observations Plan (Betts Hydro, 2021)

2.4 Topography

2.4.1 TAN15 requires all sources of flood risk to be considered, taking into consideration the existing terrain and ground levels. A detailed site topographical survey has been undertaken and reviewed as part of this FCA's (it is included in **Appendix G** for reference). The levels onsite are shown to range from 97.5AOD along the south-western boundary, down to 81.9mAOD within the northern corner of site.

2.5 Justification for Development

2.5.1 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).

2.5.2 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 risks.

2.5.3 The development proposals are of a Highly Vulnerable nature but will be located solely within Flood Zone A. Mitigation measures are proposed to safeguard the development against any potential residual flood risks identified and it is considered that the proposals can be justified in accordance with TAN15 Guidance.

3.0 DEVELOPMENT PROPOSALS

3.1 Nature of the development

3.1.1 This assessment has been prepared to support a planning application for the construction of 219no. residential dwellings on undeveloped land off Main Road in Rhosrobin, Wrexham. As indicated in the planning layout (see snippet in **Figure 3**), the proposals will be complete with access, car parking, external works, landscaping, walls/fencing, external services, and drainage (full plan in **Appendix H**).

Figure 3: Proposed Planning Layout (Castle Green Homes, 2023)

3.1.2 The total site area covers 15.78ha, although based on the planning layout the development area will cover a smaller area of 6.51ha (represented by the green dotted line in **Figure 3**. The development area is 100% permeable at present, however given the proposals, the impermeable areas of the site will increase because of development. For this assessment, the post-development impermeable areas are assumed to increase to 66% of the development area, equating to 4.30ha.

3.2 Development Constraints

3.2.1 Onsite land drainage features have been identified from a site walkover the mapping, this feature is understood to aid in the local drainage only, and it is likely that there will be development constraints associated. The site layout (**Appendix H**) shows that the proposals will interact with some of the existing land drainage features identified onsite during the walkover and it is therefore proposed that further investigation is undertaken at an early stage to identify their full purpose.

3.2.2 Welsh Water (WW) sewer records have identified a public foul water sewer located onsite (see sewer records in **Appendix C**). There is also a requirement to provide maintenance offsets from the centreline of public sewers, where they are located onsite. Where appropriate offsets cannot be achieved then diversion may be required, subject to consent. Early discussion with WW is advised for any proposed works to the public sewer network. Based on the layout an appropriate offset has been allowed for.

3.2.3 Review of the mapping has also identified that Wat's Dyke (a linear earthworks feature) is located crossing the site from the south towards the northern corner. An offset from this asset has been included within the planning layout.

3.2.4 All new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government standards for sustainable drainage. The SAB (WCBC) have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. The SAB application is undertaken separately to the planning permissions and this assessment is to support the proposed planning application.

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 developments within Wales, these maps are based on extreme flood events outlined by the Natural Resources Wales (NRW) and British Geological Survey (BGS) data (TAN15).

4.1.2 The site is located with Flood Zone A, as illustrated in **Figure 4** and the DAM (**Appendix B**) identifies what these three keys 'Flood Zones' are considered to represent in terms of flood risk. The flood zone classifications are noted as:

- ***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.*

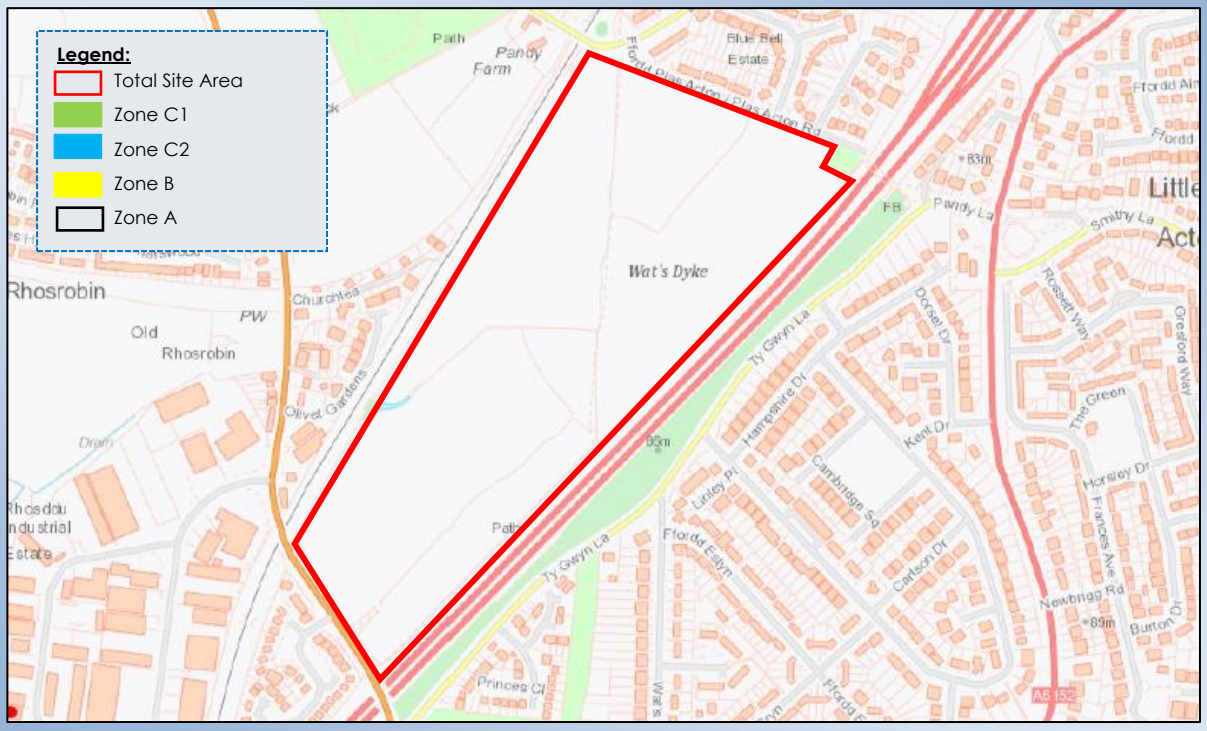


Figure 4: Development Advice Map extract (Welsh Government, 2023)

4.2 Category of Development

4.2.1 TAN15 states that types of development may not be considered 'acceptable' based on their vulnerability to the consequences of flooding, identified on the DAM. The vulnerability of different land-uses is described in detail in TAN15 however there are

three key categories as summarised in **Table 1**. The development proposals are 'highly vulnerable' in nature, based on the planning proposals and TAN15 guidance.

DEVELOPMENT CATEGORY	DESCRIPTION	TYPES
EMERGENCY SERVICES	Facilities which always need to remain operational and accessible.	❖ 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)

4.3 Acceptability Criteria

4.3.1 Various criteria are identified within TAN15 (Section 7), these are used to determine whether this development is 'acceptable' based on the nature and scale of proposals. Appropriate management should be considered with any proposed consequences of potential flooding.

4.3.2 The nature of use will be highly vulnerable in accordance with TAN15, however this development is located wholly within Flood Zone A, therefore the proposals are not at risk from fluvial/tidal flooding. In accordance with TAN15 highly vulnerable development is considered acceptable within Flood Zone A, providing surface water is appropriately managed. Sections 5.0 and 6.0 of this report assess the potential consequences of flood risk and considered appropriate management for surface water in accordance with the above.

5.0 SOURCES OF FLOOD RISK

5.1 Fluvial & Tidal Flood Risk

5.1.1 In accordance with TAN15 new development should "be guided to locations at little or no risk from all sources of flooding" and the consequences of flooding to and from the proposals should be considered to ensure no increased flood risk will result from the proposals. Information relating to the flood risk at the site has been obtained from the Welsh Government's DAM and the Natural Resources Wales online Flood Mapping (see **Appendix B** for full details).

5.1.2 The DAM shows the development area is located within Flood Zone A, however, this section of the report will refer to the potential flood risk in terms of the more detailed NRW data sets that show risk to the site from fluvial and tidal sources. Based on the fluvial flood risk mapping (**Figure 5**), the site is predicted to be at very low risk from fluvial and tidal flooding.

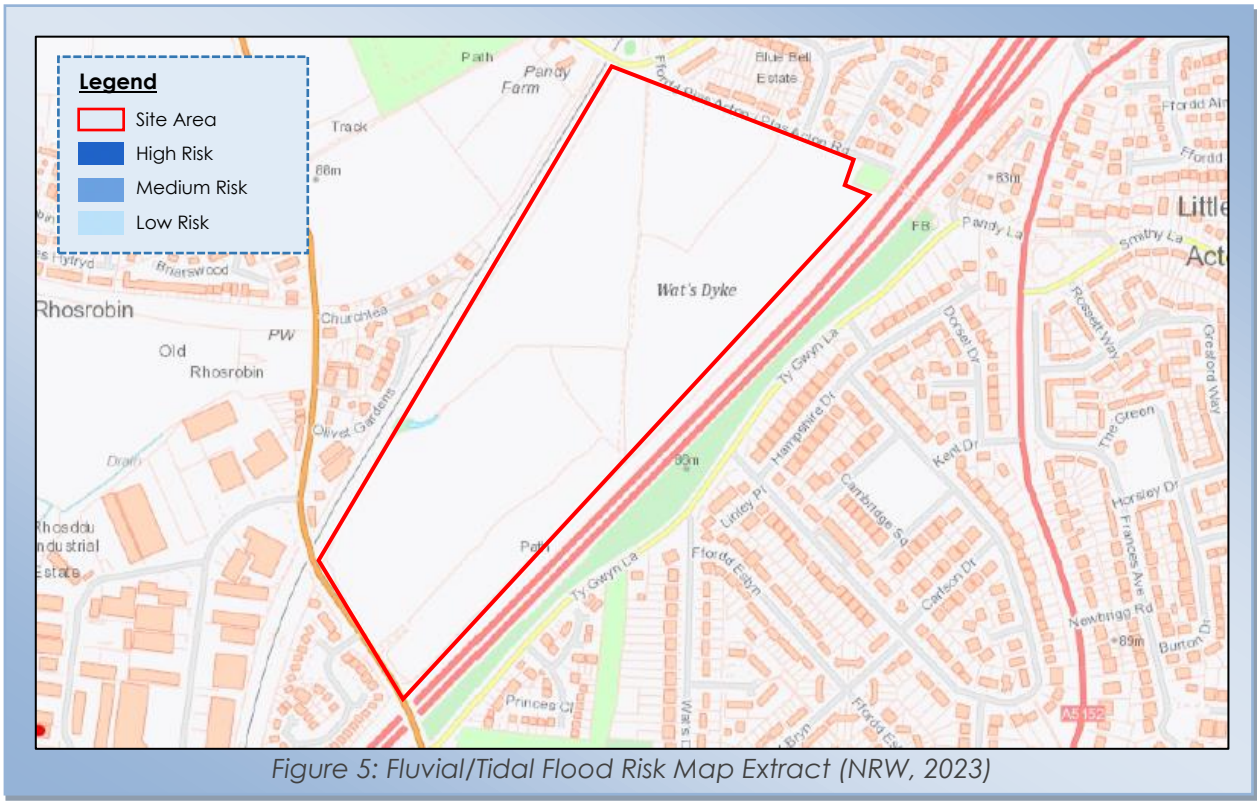


Figure 5: Fluvial/Tidal Flood Risk Map Extract (NRW, 2023)

5.1.3 The nearest Main River (River Alyn) is located 400m to the north of site. This Main River has been considered as part of the national flood mapping datasets and the potential flood risks represented in the long-term government flood maps. The risk to the site from the River Alyn is 'very low' due to its proximity from the site and the surrounding topography (see full mapping in **Appendix B**).

5.1.4 Onsite land drainage features have been identified from a site walkover, these features are understood to aid in the local drainage only, and it is likely that there will be development constraints associated. Due to their scale and nature the proposed flood risk from these sources is understood to be low. The site layout (**Appendix H**) shows that the proposals will interact with some of these existing features and it is therefore

proposed that further investigation into these features is undertaken at an early stage to identify their full purpose (incoming connections, any offsite connectivity).

5.1.5 Consultations with the key authorities including National Resources Wales, the Lead Local Flood Authority and the Local Planning Authorities have not identified any historical flooding at the site or the need to undertake a more detailed assessment of flood risk for this asset.

5.2 Surface Water

5.2.1 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 can reduce the ability for percolation therefore increasing surface water run-off. If this run-off is not controlled effectively, it can increase localised flooding in neighbouring areas of the catchment.

Figure 6: Surface Water Flood Risk Map Extract with Layout Overlay (NRW & Betts Hydro, 2023)

5.2.2 TAN15 states that 'the aim should be for new development not to create additional run-off when compared with the undeveloped situation' and that any new

development should look to reduce the overall run-off where possible to provide betterment on the existing situation (Section 8.3).

5.2.3 The site is shown to mostly be at very low risk from surface water based on the NRW online mapping (**Figure 6**). There are some areas onsite at higher risk from surface water flooding, these areas correspond with the naturally low-lying areas onsite located within the centre and northern corner of site.

5.2.4 When the proposed planning layout is overlaid with the surface water flood extent plan, it can be stated that the proposed development areas will remain within those parts of the site at very low to low risk form surface water flooding. The areas shown to be at highest flood risk are located within undeveloped areas or areas designated for surface water attenuation.

5.2.5 Residual risk from surface water flooding will be managed and reduced, post-development through appropriate levels design and incorporation of a sustainable drainage management system. Natural flow routes will be maintained where practical, and a formal sustainable surface water drainage regime will be implemented to manage existing and proposed surface water run-off.

5.2.6 In order to further mitigate for any residual risks, it is advised that (following any re-grade of the site) finished floor levels are elevated above the external levels to provide safe overland flood routes for excess surface water run-off.

5.3 Pluvial Flood Risk

5.3.1 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 surrounding areas are a mix of developed and undeveloped greenfield land, the risk of pluvial run-off onto the site from these areas is considered to be minimal due to the natural ground levels which fall away from site and the manmade surface water infrastructure in place to cater for the developed areas.

5.3.2 The volume and rate of overland flow from land can be exacerbated if development increases the percentage of impermeable area. Any pluvial flows generated by the site will need to be catered for within the proposals through appropriate spatial management and inclusion of surface water management infrastructure. Any overland flows generated by the site must be carefully controlled, with safe avenues directing flow away from the proposed or existing adjacent buildings being advised.

5.4 Artificial Sources of Flood Risk

5.4.1 TAN15 suggests that for development to be 'justified' then all sources of flood risk must be considered both to the development area and arising from the proposals.

Reservoirs

5.4.2 Reservoirs are bodies of water holding over 25,000cu.m of water and based on the National Resources Wales reservoir flood mapping, the proposed development area

would not be influenced by any flooding associated with the nearest reservoir breach/overtopping event.

Canals

5.4.3 There are no canals within the immediate vicinity of the site and therefore the risk to the proposals from canal associated flooding is low.

5.4.4 Irrespective, it is advised that external levels fall away from the proposed property (where feasible) to minimise the flood risk from a variety of sources. By keeping the finished floor levels elevated relative to the externals, this should help create an overland flood flow route in the event of a breach or any other source of flooding that could lead to overland flows including reservoir or canal flooding.

5.5 Groundwater Flood Risk

5.5.1 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.

5.5.2 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.
- 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.
- 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.

5.5.2 No groundwater flood risk has been identified during consultation with the various interested parties or in review of the SFCA. Any mitigation proposed to safeguard the development against more primary flood risk sources would also be suitable to mitigate for other potential residual sources such as groundwater flooding.

5.6 Sewer Flood Risk

5.6.1 In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and wastewater 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 sewers become blocked or is of inadequate capacity, this could lead to there being a high risk of internal property flooding with contaminated water.

5.6.2 Welsh Water (WW) sewer records have identified a public foul water sewer located onsite (see sewer records in **Appendix C**). There will also be a requirement to provide maintenance offsets from the centreline of public sewers, where they are located onsite. Based on the site layout an appropriate offset has been allowed for.

5.6.3 Consultation with WW did not identify any existing sewer flood risk issues directly to the site or within the neighbouring areas associated with the public sewer network (refer to **Appendix C**). During the walkover however the highway was observed to be flooded, at the entrance to Plas Acton Road (see **Appendix F**). It is currently not known if this was linked to WW or LPA assets.

5.7 Historical and Anecdotal Flooding Information

5.7.1 Review of WCBC Preliminary Flood Consequence Assessment did not identify any historical flooding to the site area, this was supported by the findings in the Strategic Flood Risk Assessment (some general mapping extracts have been included in **Appendix I**).

5.7.2 Discussions with WCBC confirmed they have no records of historical flooding directly at the site. Furthermore, consultations with NRW and WW have also failed to highlight any recorded historical flooding relevant to this FCA.

5.7.3 As discussed in Section 2.3, during the walkover however the highway was observed to be flooded, at the entrance to Plas Acton Road (see **Appendix F**). It is currently not known if this was linked to WW or LPA assets. There was also evidence of ponding/standing water and saturated ground adjacent to some field boundaries. field boundaries, as shown within **Figure 2**. The A483 is raised relative to the site and run-off naturally conveys across the site towards the south/south-eastern boundary meaning flows are restricted from leaving the site extents due to the elevated bypass.

5.8 Mitigation Measures and Residual Risks

5.8.1 The development area is shown to be located within Flood Zone A on the DAM and is at low risk of flooding from the key sources reviewed. Mitigation measures have however been considered below to safeguard the proposals against residual flood risks associated with climate change over the lifetime. These measures either reduce the vulnerability of the development or improve the resilience of the proposals in the potential extreme scenarios.

Mitigation Measures

5.8.2 For 'highly vulnerable' development located within Flood Zone A, it is typical to set the Finished Floor Levels (FFL) of residential dwellings to a minimum of 150mm above the existing ground levels. Furthermore, by ensuring the FFLs are raised sufficiently above the proposed external levels (following any re-grade) should provide additional mitigation against the risk of overland flows associated with flooding from a variety of sources, including groundwater and surface water.

5.8.3 Any overland flows generated by the development must be carefully controlled and safe avenues directing overland flows way from any proposed properties is advised. Any natural conveyance routes should be maintained through the site, where practical. Where this is not practical then provision will need to be made to intercept and convey flows safely through the proposals to outfall as they would naturally.

5.8.4 Onsite land drainage features have been identified from a site walkover the mapping, this feature is understood to aid in the local drainage only, and it is likely that there will be development constraints associated. The current planning layout (**Appendix H**) shows that the proposals will impact upon the existing land drainage ditches in part, it is therefore proposed that further investigation into is undertaken of these features to confirm their nature and connectivity at an early stage in case allowances have to be made within the layout to keep these features.

5.8.5 Welsh Water (WW) sewer records have identified a public foul water sewer located onsite (see sewer records in **Appendix C**). There will be a requirement to provide maintenance offsets from the centreline of public sewers, where they are located onsite; where offsets cannot be achieved then diversion may be required. Early discussion with WW is advised for any proposed works to the public sewer network, this includes any proposed diversion work where this is required to accommodate the proposals. Based on the site layout an appropriate offset has been allowed for.

5.8.6 Review of the mapping has also identified that Wat's Dyke (now a linear earthwork) is located crossing the site from the south towards the northern corner of site. An offset from this asset has been included within the site layout.

5.8.7 All new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government standards for sustainable drainage. The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments.

5.8.8 To minimise the flood risk to the neighbouring properties and conform to the guidance set out in TAN15, it is proposed that surface water run-off be managed effectively and sustainably in accordance with best practice and standard guidance. It is recommended that the peak rates of surface water run-off generated by the proposals be restricted to the equivalent of the pre-development greenfield situation.

5.8.9 The proposed onsite surface water drainage system will need to be sized to contain the 1 in 30yr return period event below ground with exceedance from storm events up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change being contained onsite.

5.8.10 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 should be scheduled with a suitably qualified management company for these private drainage systems.

Residual Risks

5.8.11 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

6.0.1 In order for the development proposals to be justified in line with the guidance set out in TAN15, development must not increase flood risk elsewhere within the catchment and were possible offer improvement on the pre-development situation. Surface water management is therefore a key focus. The Welsh Government: 'Statutory standards for sustainable drainage systems' (2018) are aimed at ensuring that the most effective drainage scheme is delivered for protecting and enhancing both the natural and built environment. Standard S1 comprises of five levels, which are discussed in detail in this assessment subsequently. The five levels are:

- Priority Level 1: Surface water runoff is collected for use.
- Priority Level 2: Surface water runoff is infiltrated to ground.
- Priority Level 3: Surface water runoff is discharged to a surface water body.
- Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system.
- Priority Level 5: Surface water runoff is discharged to a combined sewer.

6.1 Priority Level 1: Surface water runoff is collected for use.

6.1.1 Surface water re-use is applicable for residential properties. An external water butt is recommended to be installed on each dwelling to promote external water re-use. Internal rainwater harvesting systems are not proposed. In line with section G1.4 of the 'Statutory standards for sustainable drainage systems', internal rainwater harvesting is not proposed for this site as:

- There is no foreseeable demand for non-potable water on the site throughout its design life.
- There is no foreseeable need to harvest water at the site and Welsh Water have not identified potential stresses on mains water supplies in this area.
- The use of rainwater harvesting is not a cost-effective part of the solution for managing surface water runoff on the site, taking account of the potential water supply benefits of such a system.

6.2 Priority Level 2: Surface water runoff is infiltrated to ground.

6.2.1 Any proposed 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 justified in line with TAN15. The published online datasets have initially been reviewed to consider how favourable the underlying strata is to support a potential infiltration-based solution at the site.

6.2.2 The British Geology Survey (BGS) mapping data indicates that ground conditions comprise of Salop Formation (Mudstone, Sandstone and Conglomerate) with superficial deposits of Sand and Gravel. Furthermore, the Cranfield Soil and Agrifood Institute Soilscapes soil type viewer identifies the soils to be freely draining slightly acid loamy soils. Furthermore, based on the FEH catchment data, the soil factor for the area has been identified to be 0.1, which suggest the soils are very permeable (based on a scale of 0.1 to 0.5, with 0.5 being impermeable). These conditions would suggest

support to a full infiltration-based surface water management regime at the site due to the underlying strata.

6.2.3 The online datasets and FEH catchment characteristics are further supported by BRE 365 Soakaway Testing undertaken by Tier Consult Ltd (Ref: T/14/1400-DS1/SGJ). The report identified there was a range of permeable and not permeable areas onsite. The permeable soils that were encountered had infiltration rates ranging from a low value of 5.18x10-6 m/s to the highest value of 3.52x10-6m/s. Following review of the site plan and topography, a possible location for an infiltration basin, based on the Soakaway results has been shown in **Figure 7**.

Figure 7: Proposed Drainage Strategy Plan Extract (Betts Hydro, 2023)

6.2.4 It is further recommended that permeable roads and permeable driveways are implemented where feasible, as illustrated in within **Figure 7**. Areas onsite that are unable to discharge directly to ground due to ground conditions will be lined and have a connection into the onsite infiltration basin proposed adjacent to the northern boundary of site where positive infiltration results were identified.

6.2.5 The specific drainage infrastructure to be implemented will be confirmed during the detailed design stage following discussion with all relevant parties and confirmation of the ground conditions at the specific drainage locations.

6.2.6 In terms of discharge rates, in accordance with the Statutory Technical Standards for Sustainable Drainage Systems in Wales (2018), the proposed discharge rates should not exceed the existing percolation rates on the site, to be confirmed following onsite testing. The surface water drainage system proposed will need to be sized to contain up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change.

Sustainable Drainage Systems

6.2.7 From January 2019, all new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government standards for sustainable drainage. Schedule 3 of the Flood and Water Management Act 2010 (FWMA) establishes Wrexham County Borough Council as a SuDS Approving Body (SAB).

6.2.8 The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. The SAB application is undertaken separately to the planning permissions and developers are required to obtain both planning approval and SAB approval prior to commencement of any proposed construction works.

6.2.9 Sustainable Drainage Systems (SuDS) can address the four key sustainability objectives embedded in this policy including providing space for water (water quantity), improving water quality and biodiversity, along with providing valuable amenity/ recreational space in new development sites. Using SuDS onsite will reduce the volume of surface water entering the downstream watercourse and sewer network which is the preferred approach.

Figure 8: SuDS Photographs (SusDrain, 2012)

6.2.10 Promoting SuDS to deal with surface water at source will limit the requirement for hard engineering-based attenuation and conveyance (see examples in **Figure 8**). Given the scale of development being proposed and evidence of a positive infiltration

characteristics onsite there is opportunity to incorporate SuDS methods such as attenuation pond/basin(s) to assist with the proposed surface water drainage regime (if designed appropriately), as shown within the proposed planning layout.

6.2.11 It is also proposed that permeable paving and bio-filtration (tree pits) are implemented in non-adopted areas where at all feasible to allow the first 5mm of rainfall to be dealt with at source as identified in the SuDS Manual. By including measures such as these the surface water run-off is being dealt with at source and this will assist locally with surface water management (subject to optimum ground conditions).

6.2.12 Detailed design will need to be undertaken to confirm the specific SuDS to be utilised following a more detailed analysis of levels, ground conditions and attenuation requirements, in conjunction with the SAB at Wrexham County Borough Council. The SAB (WCBC) have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. This report is to support the proposed planning application and the full SAB approval will need to be sought separately by the developer in due course.

Maintenance

6.2.13 The maintenance of communal drainage features such as an infiltration basin will be the responsibility of SAB and the maintenance of private drainage features such as water butts and individual property soakaways will be the responsibility of individual property owners. Maintenance of shared permeable surfaces (permeable paved access roads and parking areas) can be arranged through appointment of a site management company. A full SuDS maintenance and management plan will be prepared following the detailed design stage to consider appropriate management of all the proposed drainage systems.

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

6.3.1 If infiltration is unable to offer a full surface water management solution for the site then the alternative discharge method would be to discharge into the nearest watercourse. As discussed previously, the nearest Main River (River Alyn) is located 400m to the north of site though 3rd party land and the onsite land drainage features are understood to aid in the local drainage only (no formal offsite connections have been identified as part of this assessment). There are therefore no smaller watercourses located in proximity to site suitable for handling surface water discharge from the proposed development site.

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

6.4.1 As a connection to the watercourse is not likely to be feasible, should infiltration not provide a full management solution then the alternative method would be a connection to the neighbouring public sewer network. WW sewer records identify limited public surface water sewer assets within the neighbouring area and WW would not accept a surface water connection from the development to the onsite public foul water sewer network. Further discussion with WW would be needed to ascertain their

preferred connection point should a surface water connection be required. There are therefore no proposals to connect into the sewer network or highway drain at this stage as infiltration testing was positive.

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

6.5.1 As discussed above, should infiltration and a connection to the watercourse not be feasible then the alternative method would be a connection to the neighbouring public sewer network. Further discussion with WW would be needed to ascertain their preferred connection point should a surface water connection be required. There are therefore no proposals to connect into the sewer network or highway drain at this stage as infiltration testing was positive.

6.6 Climate Change

6.6.1 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

6.6.2 Making 'provisions' for these anticipated future changes to flood risk is 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.

6.6.3 Any increase in the level of flood risk to the potential 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. Climate Change should be accounted for within the design and it is recommended that an increase in peak rainfall intensity of 40% is allowed for as identified within TAN15 and SuDS Standards for Wales.

7.0 FOUL WATER MANAGEMENT

7.1 Consultation with WW has been carried out to obtain the sewer records, which have identified there is a public foul water sewer (150mm dia. & 600mm dia.) located entering site from the south-western boundary and crosses the site to the northern corner (refer to sewer records within **Appendix C**). As the site is undeveloped at present, there are no onsite foul water flows currently generated thus no existing foul water connections present.

7.2 The proposals will be to have a new formal connection to the public foul sewer (150mm dia.) located on-site. Detailed drainage design will be required to confirm this strategy and identify whether a site wide gravity connection is feasible, although given the existing fall across the site this is anticipated to be feasible.

7.3 Consents and relevant agreements will be required from WW prior to commencement of works and early discussion is undertaken early to establish whether there are any additional constraints which need to be considered. A connection is proposed to be made on the site to avoid offsite construction activities and third-party access consent.

7.4 Based on the proposals for the construction of 219no. residential dwellings, the approximate peak foul water flows generated have been calculated to be 10.14l/s. This rate is calculated based on 4000 litres per dwelling per 24 hours; the guidance contained within Sewers for Adoption (SfA).

8.0 SUMMARY AND CONCLUSIONS

8.1 This Flood Consequence Assessment and Drainage Management Strategy was commissioned by Castle Green Homes Limited referred to hereafter as 'the client'. This assessment has been prepared to support a planning application for the construction of residential development on land east of Main Road in Rhosrobin, Wrexham.

Flood Risk

8.2 The total site covers 15.78ha and in accordance with TAN15, the proposals are highly vulnerable in nature. Consultation with the National Resources Wales, Wrexham County Borough Council and Welsh Water have been carried out and have not identified any historical flooding to the site. A site walkover was undertaken by Betts Hydro in January 2021 after a prolonged heavy rainfall event. The site walkover identified ponding/standing water and saturated ground adjacent to some field boundaries. This assessment has reviewed all sources of flood risk both to the development, including fluvial, tidal, pluvial, groundwater, sewers, and flooding from artificial sources.

8.3 National Resources Wales' data sets show the site to be at very low risk from fluvial and tidal flood risk sources. The nearest Main River (River Alyn) is located 400m to the north. The flood risk to the site from the River Alyn is 'very low' due to its proximity from the site and the surrounding topography. Onsite land drainage features have been identified from a site walkover, although these features are understood to aid in the local drainage only and due to their small scale/nature the flood risk associated is understood to be low.

8.4 The primary source of flood risk to the site is considered to be from surface water flooding. The potential flood risks to the site from surface water will be managed and reduced, post-development, through appropriate levels design and incorporation of a sustainable drainage management system. Due to the relatively low flood risks identified as part of this assessment, the principle focus of this assessment is on the sustainable management of surface water run-off to ensure that no increased flood risk results from the proposals.

Drainage Strategy

8.5 In order for the development proposals to be justified in line with the guidance set out in SuDS Standards for Wales, new development must not increase flood risk elsewhere and where possible offer improvement on the pre-development situation. The sustainable drainage hierarchy has been considered in accordance with the SuDS Standards for Wales, which look to deal with surface water run-off as close to source as is practical.

8.6 The published online datasets have been reviewed to consider how favourable the underlying strata is to support a potential infiltration-based solution at the site. The online datasets and FEH catchment characteristics are further supported by BRE 365 Soakaway Testing undertaken by Tier Consult Ltd (Ref: T/14/1400-DS1/SGJ). The report identified there was a range of infiltration characteristics across the site.

8.7 It is therefore proposed that any impermeable areas that can drain to soakaway (or an alternative method of infiltration) should do so via appropriately designed infiltration-based solution, as this would significantly improve the sustainability of the

surface water systems. There are potential locations for where larger scale infiltration methods might be suitable.

8.8 It is further recommended that permeable roads and permeable driveways are implemented where feasible to allow the first 5mm of rainfall to be dealt with at source as identified in the SuDS Manual. The specific drainage infrastructure to be implemented will be confirmed during the detailed design stage following discussion with all relevant parties and confirmation of the ground conditions.

8.9 The surface water drainage system proposed will need to be sized to contain up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change. In terms of discharge rates, in accordance with the SuDS Manual (CIRIA 753) and the SuDS Standards for Wales (2018). The proposed discharge rates should not exceed the existing percolation rates onsite.

8.10 Detailed design will need to be undertaken to confirm the specific SuDS to be utilised following a more detailed analysis of levels, ground conditions and attenuation requirements, in conjunction with the SAB at Wrexham County Borough Council. The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. This report is to support the proposed planning application and the full SAB approval will need to be sought separately by the developer.

8.11 To conclude, the development area has been considered in accordance with TAN15 and suitable mitigation measures have been proposed to ensure that the development is safe for its lifetime. This Flood Consequence Assessment and Drainage Management Strategy is 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 For 'highly vulnerable' development located within Flood Zone A, it is typical to set the Finished Floor Levels (FFL) of residential dwellings to a minimum of 150mm above the existing ground levels. Furthermore, by ensuring the FFLs are raised sufficiently above the proposed external levels (following any re-grade) should provide additional mitigation against the risk of overland flows associated with flooding from a variety of sources, including groundwater and surface water.

9.2 Any overland flows generated by the development must be carefully controlled and safe avenues directing overland flows way from any proposed properties is advised. Any natural conveyance routes should be maintained through the site, where practical. Where this is not practical then provision will need to be made to intercept and convey flows safely through the proposals to outfall as they would naturally.

9.3 Onsite land drainage features have been identified from a site walkover the mapping, this feature is understood to aid in the local drainage only, and it is likely that there will be development constraints associated. The current planning layout (**Appendix H**) shows that the proposals will impact upon the existing land drainage ditches in part, it is therefore proposed that further investigation into is undertaken of these features to confirm their nature and connectivity at an early stage in case allowances have to be made within the layout to keep these features.

9.4 Welsh Water (WW) sewer records have identified a public foul water sewer located onsite (see sewer records in **Appendix C**). There will be a requirement to provide maintenance offsets from the centreline of public sewers, where they are located onsite; where offsets cannot be achieved then diversion may be required. Early discussion with WW is advised for any proposed works to the public sewer network, this includes any proposed diversion work where this is required to accommodate the proposals. Based on the site layout an appropriate offset has been allowed for.

9.5 Review of the mapping has also identified that Wat's Dyke (now a linear earthwork) is located crossing the site from the south towards the northern corner of site. An offset from this asset has been included within the site layout.

9.6 All new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government standards for sustainable drainage. The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments.

9.7 To minimise the flood risk to the neighbouring properties and conform to the guidance set out in TAN15, it is proposed that surface water run-off be managed effectively and sustainably in accordance with best practice and standard guidance. It is recommended that the peak rates of surface water run-off generated by the proposals be restricted to the equivalent of the pre-development greenfield situation.

9.8 The proposed onsite surface water drainage system will need to be sized to contain the 1 in 30yr return period event below ground with exceedance from storm events up

to and including the 1 in 100yr return period storm event with a 40% allowance for climate change being contained onsite.

9.9 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 should be scheduled with a suitably qualified management company for these private drainage systems.

BIBLIOGRAPHY & REFERENCES

Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities – Environment Agency/DEFRA 2016
CIRIA 522: Sustainable urban drainage systems – design manual for England and Wales (2000).
CIRIA 523: Sustainable urban drainage systems – best practice manual (2001).
CIRIA 609: Sustainable drainage systems. Hydraulic, structural and water quality advice (2004).
CIRIA 624: Development and flood risk – guidance for the construction industry (2004).
CIRIA 635: Designing for Exceedance in urban drainage: Good practice (2006).
CIRIA 644: Building Greener (2007).
CIRIA 753: The SUDS manual (2015).
Flood Risk to People – Phase 2 (FD2321/TR2), DEFRA and the Environment Agency (2006).
Flood estimation for small catchments: Institute of Hydrology Report No.124, NERC (1994).
Flood Estimation Handbook, Centre for Ecology and Hydrology (1999).
Planning Policy Statement 25: Development and Flood Risk (2006).
Sewers for Adoption 7th Edition, WRc (2012).

Web-based References

Bingmaps – http://www.bing.com/Maps/
British Geological Survey – http://www.bgs.ac.uk/opengeoscience/home.html
Chronology of British Hydrological Events – www.dundee.ac.uk/
CIRIA – http://www.ciria.org/
Cranfield University – http://www.landis.org.uk/soilscapes/
FloodProBE – http://www.floodprobe.eu/
Flood Forum – http://www.floodforum.org.uk/
Flood London – http://www.floodlondon.com/
Flood Resilience Group – http://www.floodresiliencegroup.org/frg/
Google Maps – http://maps.google.co.uk/
Natural Resources Wales – https://naturalresources.wales/?lang=en
Streetmap – http://www.streetmap.co.uk/
US Army Corps of Engineers – http://www.hec.usace.army.mil/software/hec-ras/
Watertight International – http://www.watertightinternational.com/
Welsh Water - http://www.dwrcymru.com/

APPENDIX A: TAN15 and SuDS STANDARDS FOR WALES EXTRACTS

This page has been left intentionally blank

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	
	Less vulnerable development		• Occupiers aware of flood risk • 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

3. Standards

Standard S1 – Surface water runoff destination

This Standard addresses the use of surface water by the development and where it should be discharged. The aim is to ensure that runoff is treated as a resource and managed in a way that minimises negative impact of the development on flood risk, the morphology and water quality of receiving waters and the associated ecology. This will ensure that early consideration is given to the use of rainwater harvesting systems to both manage runoff and deliver a source of non-potable water for the site where practical. Where it is not, prioritisation should be given to infiltration. Discharges to sewerage systems must be limited where possible.

S1 Surface water runoff destination

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

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

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

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

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

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

Guidance on Standard S1 – Surface water runoff destination

G1.1 As much of the runoff as possible (subject to technical or cost constraints) should be discharged to each destination before a lower priority destination (level) is considered.

G1.2 Depending on the site characteristics, drainage from different parts of the site could have different drainage destinations.

G1.3 Depending on the quantity of runoff and the potential for a particular destination to manage that runoff, small events may discharge to a higher level while larger events may need to make use of lower priority destinations.

Level 1 – Rainwater collected for use

G1.4 Water is a valuable resource and rainwater should be collected (harvested) for non-potable use where practicable. This not only reduces potable water demand, but it can also reduce the volume of surface water runoff requiring disposal. One or more of the following **exception criteria** needs to be demonstrated if rainwater harvesting (RWH) is not used:

- There is no foreseeable demand for non-potable water on the site throughout its design life;
- There is no foreseeable need to harvest water at the site as the relevant water undertaker's water resources and drought management plans do not identify potential stresses on mains water supplies;
- The use of rainwater harvesting is not a viable/ cost-effective part of the solution for managing surface water runoff on the site, taking account of the potential water supply benefits of such a system.

G1.5 Rainwater harvesting tanks can be sized for capturing the runoff from large rainfall events as well as water supply. The design of rainwater harvesting systems for management of large events should be in accordance with BS 8515 appendix A (2009, revision 2013)[6]. This can contribute to a significant reduction in runoff volume, helping to meet the requirements of volume control of runoff (Standard S2).

G1.6 In most cases, rainwater harvesting alone will not be adequate to deal with the site drainage and provision will be required for an overflow to a Level 2 or lower priority destination.

G1.7 RWH systems, whether designed for water supply or surface water management as well, will contribute effectively to meeting the criterion on Interception (Standard S2).

Level 2 – Discharge of surface water into the ground

G1.8 Surface runoff not collected for use in accordance with Level 1 should be discharged by infiltration (a process that allows water to percolate into the ground) to the maximum extent possible at any location across the site. A lower priority destination should only be used for any residual runoff that cannot be

[6] http://shop.bsigroup.com/ProductDetail/?pid=000000000030260364

served by infiltration provided one or more of the following **exception criteria** can be demonstrated:

- **Permeability**: the use of infiltration drainage is not practicable due to the lack of permeability of the soil for disposing of runoff;

- **Ground Instability**: the use of infiltration drainage would result in a risk of instability through ground movement or subsidence;

- **Pollution of groundwater or receiving surface waters**: the use of infiltration drainage would pose an unacceptable risk of pollution of groundwater or surface water bodies:

  - as a result of existing contaminants on the site being mobilised; or

  - as a result of activities in the area draining to the infiltration device (for example an area where there is the storage or handling of chemicals or fuels); or

  - as a result of the sensitivity of the groundwater or surface waterbody;

- **Groundwater flooding**: the use of infiltration drainage would result in an unacceptable risk of flooding from groundwater;

- **Infiltration into a combined sewer**: the use of infiltration may cause ingress of flow into a combined sewer which might result in an increased risk of flooding or pollution on the site or downstream.

G1.9 Guidance on meeting the exception criteria is provided in the clauses below.

G1.10 Infiltration systems can be designed for any scale of event and any size of runoff area. The larger the event or contributing area, the larger the required storage volume and/or infiltration area will be. The optimum size will depend on the rate of infiltration, the space available and cost of storage, and the feasibility and costs associated with managing events larger than that for which the system is designed.

G1.11The infiltration component should discharge from full to half-full within a reasonable time so that the risk of it not being able to manage a subsequent rainfall event is minimised. Where components are designed to manage the 1 in 10 year or 1 in 30 year event, it is usual to specify that half emptying occurs within 24 hours. If components are designed to infiltrate events greater than the 1 in 30 year event, designing to half empty in 24 hours can result in very large storage requirements and, with agreement from the drainage approving body, it may be appropriate to allow longer half emptying times. This decision should be

based on an assessment of the performance of the system and the risk and consequences of consecutive rainfall events occurring.

G1.12 Drainage design should always aim to infiltrate as much runoff as is safe and practicable.

G1.13 A large site may have a range of soil characteristics. Infiltration should be utilised to the greatest extent possible in each area.

G1.14 Guidance on designing an infiltration system is provided in the SuDS Manual CIRIA C697[7].

Infiltration Rates

G1.15 Disposal of significant events using solutions such as soakaway units or infiltration basins usually requires infiltration rates of the order of 1×10^{-5} m/s or higher. However, effective infiltration can be achieved with lower rates under units such as permeable pavements due to the large storage and infiltrating surface area available and the removal of sediment which would otherwise blind the infiltration surface.

G1.16 Geological and hydrological mapping and data at the British Geological Survey[8] can provide an indication of infiltration potential, based on the characteristics of the soil layers. However site inspection, testing, trial pits and boreholes should be used to determine the site characteristics used in the drainage design.

G1.17 In order to account for both uncertainties over soil infiltration rates and their possible reduction in performance over time, and the consequence of inadequate performance, a factor of safety should be used in sizing the infiltration unit or assessing its performance. This is set out in Table G1.1.

[7] https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

[8] http://www.bgs.ac.uk/products/hydrogeology/infiltrationSuds.html

Table G1.1 Suggested factors of safety for use for hydraulic design of infiltration systems

Size of area to be drained	Consequences of failure		
	No damage or inconvenience	Minor inconvenience (e.g. surface water on car parking)	Damage to buildings or structures, or major inconvenience (e.g. flooding of roads)
< 100m^2	1.5	2	10
100-1000m^2	1.5	3	10
>1000m^2	1.5	5	10

Ground Instability

G1.18 Geotechnical investigations may be required to ensure that the ground conditions are suitable for infiltrating surface water runoff. The frequent discharge of water into the soil can change the soil characteristics, either chemically or structurally, and the suitability of infiltration may be limited or not appropriate even when stabilisation techniques are used.

G1.19 Where infiltration systems lie beneath trafficked surfaces, consideration should be given to structural loading and any likely weakening of the soil due to saturation. Where the soil structural strength may be compromised, the pavement layers should be designed to carry the traffic loads, or infiltration avoided by using an appropriate lining.

G1.20 Where runoff is discharged into the infiltration system or natural infiltration processes are being significantly enhanced within 5m of an existing or proposed building or buildings, the risk of building instability should be assessed by a geotechnical engineer and appropriate mitigation provided. If the risk cannot be effectively mitigated then infiltration should be avoided or be located a minimum of 5m from a building or buildings or such a distance agreed by the geotechnical engineer.

G1.21 Diffuse infiltration at or near the surface using permeable surfaces (or other similar approaches taking direct rainfall or very small catchments with a similar area to the infiltration surface) close to the building should not normally pose a risk to the structure. Any such proposals within 3 metres of a building should be assessed by a geotechnical engineer.

G1.22 Under some circumstances, the infiltration of water into soils (including superficial deposits and bedrock geology) can have serious implications for the stability of slopes. An assessment of potential risks should be made in accordance with *Planning Policy Wales*[9] guidance on dealing with unstable and

[9] http://wales.gov.uk/topics/planning/policy/ppw/?lang=en

contaminated land and infiltration ruled out where the risks are considered significant. A checklist for considering site suitability for infiltration is available[10].

G1.23 The assessment of collapsible deposits should consider potential geo-hazards such as shrinkage, swelling and dissolution of rocks. Sources of information include the British Geological Survey's GeoSure maps, which provide an indication of the relative susceptibility of an area to the six types of geohazards. Their GeoSure[11] national data sets and reports provide general geological information as well as information on geohazards and hydrogeological risks that can help planning decisions. GeoSure data gives information on:

- Compressible ground,
- Landslides (slope instability),
- Running sand,
- Shrinkage or swelling,
- Soluble rocks (dissolution).

G1.24 A report should be provided giving details of geo-hazards where ground stability is an issue.

G1.25 The local authority may request an accompanying ground investigation to determine if the geological deposits are susceptible to these hazards and possible causes. Testing should follow the procedures set out in Eurocode 7 Part 2 and BS5930[12].

Pollution of groundwater or receiving surface waters

G1.26 The use of infiltration systems should not be discounted simply because the site is or was contaminated. Where possible, remediation strategies should be developed in conjunction with drainage system design to allow the safe use of infiltration where this is practicable. Regard needs to be given to the cost effectiveness of using infiltration drainage in this situation in comparison to alternative SuDS options.

G1.27 Infiltration systems are suitable in contaminated sites where:

[10] CLG Development on unstable Land Annex2: Subsidence and planning http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/documents/planningandbuilding/pdf/147474.pdf

[11] http://www.bgs.ac.uk/products/geosure/

[12] http://shop.bsigroup.com/ProductDetail/?pid=000000000030238211

- The infiltration surfaces are located in areas that are either not contaminated and consequently require no remediation based on risk assessment or have been appropriately remediated.[13]

- The infiltration can take place in isolation from the contaminated layer.

G1.28 Infiltration to ground should only occur if the surface water has been suitably treated considering the degree of contamination of the surface water runoff and the groundwater category (see Standard S3).

Groundwater flooding

G1.29 An assessment should be undertaken of the potential effect of infiltration on groundwater levels local to any infiltration component and the potential wider impact of multiple infiltration components within the site, with respect to groundwater flood risk. The use of infiltration for steep sites can increase the risk of springs developing lower down the slope in layered geology/steep topography.

Infiltration into combined sewers increasing the flood or pollution risk

G1.30 Where a proposed infiltration system is located in the vicinity of a foul or combined sewer which is susceptible to infiltration (as a result of its level, location and structural condition), and there is considered to be an enhanced risk of pollution or flood risk as a result, then consideration should be given as to the most appropriate mitigation action to take. This may be to reduce or avoid the use of infiltration at that location, or for the sewerage undertaker to address the structural state of the sewer.

Level 3 – Discharge to a surface water body

G1.31 Surface runoff not collected for use in accordance with Level 1 or discharged to ground in accordance with Level 2 should be discharged to a receiving surface water body. A lower priority destination should only be used provided one or more of the following **exception criteria** can be shown to apply:

- **Access**: It is not reasonably practicable to convey the surface runoff to the water body – See Box 1 for further guidance;

- **Drainage by use of pumps**: Discharge to a surface water body would require the use of pumping, and discharge to a lower level destination would not require pumping and could be delivered more cost-effectively.– see Box 2 for further guidance;

[13] The risk assessment should be supplied to the local authority and follow recognised groundwater risk assessment procedures

- **Increase in flood risk**: The discharge would result in an unacceptable increase in the risk of flooding – see Box 3 for further guidance.

Box 1 Access

B1.1 Where drainage is to pass to any downstream system, the applicant should agree acceptable flow conditions with those responsible for the downstream systems.

B1.2 Considerations that could make a conveyance route to the receiving water body not reasonably practicable include:

- **Distance**: Taking into account the size of the development, where the distance from the nearest point in the site to the surface water body, or an existing non-piped drainage system is significantly greater than the distance to a sewer and the connection would be significantly more expensive;

- **Inappropriate or inadequate access**: for construction, operation or maintenance purposes, including right of access, which cannot be overcome or mitigated;

- **Health and safety risks** associated with construction, operation or maintenance activities (which can be avoided by the use of a lower priority Standard) are unacceptable;

- **Inadequate** protection for the conveyance system due to land use along the drainage route (avoidable by using a lower priority Standard).

B1.3 Where the site is not adjacent to the receiving surface water body, access to the intervening land will be required. The proposals must therefore be acceptable to neighbours and landowners affected by the construction and operation of the scheme. The right to discharge to the proposed receiving surface water body should be agreed with the riparian owners at the point of discharge. Where land ownership is an issue, the local authority will need evidence that any necessary easements are in place before agreeing the drainage proposal. Where a developer cannot obtain the right to discharge, the local authority may be able to obtain such a right through its powers under paragraph 29(1) of Schedule 1 of the Flood and Water Management Act 2010. These allow it to construct and maintain new works for the purpose of flood risk management.

Box 2 - Pumping requirements

B2.1 Because of the ongoing energy and maintenance requirements of pumping water and the risks associated with failure, pumping should be avoided where possible.

B2.2 The need for pumping may mean that discharge to a surface water body is not the right solution for the site, and a lower priority destination should be used instead. However, an assessment should be undertaken to establish which solution could be delivered more cost-effectively, taking account of all enhanced flooding and pollution risks, and risks associated with pump failure or poor performance.

B2.3 Pumping should only be used for parts of the site that cannot be drained by gravity. Pumping to a surface water body or lower priority destinations can only take place where it can be demonstrated that there is the capacity to accept the flow rates proposed.

B2.4 Where pumping of surface water has to take place, and the drainage system is to be adopted (and not privately owned), the developer should ensure that the adopting organisation has agreed in principle to adopt a pumping station, before putting in the planning application. Pumping stations should be designed and built to the standards set out in Sewers for Adoption 7 unless an alternative requirement is agreed with by the proposed adoption organisation.

B2.5 Where the downstream drainage system has a pumping station, the developer will need to demonstrate that adequate capacity is available.

Box 3 - Increased risk of flooding

B3.1 The design of any off-site drainage system should demonstrate that the scheme does not adversely affect off-site flood risk. This includes the receiving surface water body and any location between the site and the outfall.

B3.2 A discharge to a surface water sewer, highways drain or combined sewer may be considered if the risk of flooding associated with the receiving surface water body is so high that surface water discharges from the development site at any reasonable rate of flow are disallowed and the following conditions are met:

- there is no alternative water body to which part or all of the discharge can be made; and
- full account has been taken of on-site attenuation or multiple component systems to restrict storm discharges; and
- there is no equivalent increase in flood risk from the drainage system or the receiving water into which it discharges; and
- the owners of the receiving drainage systems agree.

B3.3 Relevant local guidance, including the Local Flood Risk Management Strategy should be examined for the acceptability of discharging to the proposed water body.

Level 4 – Discharge to a surface water sewer or highway drain

G1.32 Surface runoff not collected for use in accordance with Level 1 or discharged to ground in accordance with Level 2 should be discharged to a receiving surface water body. If this is not possible and the exception criteria under level 3 are met, the runoff may be discharged to a surface water sewer or a highway drain. A lower priority Standard should only be used if one or more of the following **exception criteria** can be shown to apply:

- **Access**: It is not reasonably practicable to convey the surface runoff to a surface water sewer or highway drainage system – See G1.33 for further guidance;
- **Drainage by use of pumps**: If it is not possible to discharge the surface water to a surface water sewer or highway drainage system without the use of pumping – see Box 2 for guidance ;

Increase in flood risk: The discharge would result in an unacceptable increase in the risk of flooding – see Box 3 for guidance

G1.33 Any connection to a sewer may require both a Water Industry Act 1991 Section 104 (adoption) and Section 106 (Connection) agreements from the sewerage undertaker.

Level 5 – Discharge to a combined sewer

G1.34 There is a strong presumption against a discharge to combined sewer. It is the least preferred option, because of the water quality problems that may be caused by sewerage flooding and/or increased discharges from Combined Sewer Overflows to surface water bodies.

G1.35 Surface runoff not discharged in accordance with Levels 1 to 4 may be discharged to a public combined sewer with the agreement of the sewerage undertaker; providing it has capacity to accommodate the additional flows and that the requirements set out in the clauses below are met.

G1.36 For the purposes of this Standard, a combined sewer is a sewer intended to receive both foul sewage and surface runoff and does not include a sewer intended to receive only foul sewage, even if it has the capacity to accommodate additional flows, or has an element of surface water in it already. It is not permissible to connect surface water runoff to a foul sewer.

G1.37 The risks associated with surface water runoff entering the combined sewer and resultant possible pollution from backflow or surcharge should be guarded against, including consideration of the use of non-return valves at appropriate locations.

G1.38 Provision should be made for separation and removal of sediments and oils before connection to a combined sewer.

G1.39 The possibility of the developer funding disconnection of surface water entering the combined sewer at locations either upstream or downstream of the site connection should be investigated with the sewerage undertaker and the local authority to mitigate the impact of the runoff into the sewer from the development.

Standard S2 – Surface water runoff hydraulic control

The aim of Standard S2 is to manage the surface water runoff from and on a site to protect people on the site from flooding from the drainage system for events up to a suitable return period, to mitigate any increased flood risk to people and property downstream of the site as a result of the development, and to protect the receiving water body from morphological damage.

S2 Surface water runoff hydraulic control

1) Surface water should be managed to prevent, so far as possible, any discharge from the site for the majority of rainfall events of less than 5mm.
2) The surface water runoff rate for the 1 in 1 year return period event (or agreed equivalent) should be controlled to help mitigate the negative impacts of the development runoff on the morphology and associated ecology of the receiving surface water bodies.
3) The surface water runoff (rate and volume) for the 1% (1 in 100 year) return period event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.
4) The surface water runoff for events up to the 1% (1 in 100 year) return period (or agreed equivalent) should be managed to protect people and property on and adjacent to the site from flooding from the drainage system.
5) The risks (both on site and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be considered. Where the consequences are excessive in terms of social disruption, damage or risk to life, mitigating proposals should be developed to reduce these impacts.
6) Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or

blockage), and the associated flood risks managed where possible.

Guidance on Standard S2 - Surface water runoff hydraulic control

G2.1 This Standard applies to discharges to surface water bodies, surface water sewers or combined sewerage systems. However where the surface water body is unaffected by either the discharge rate or volume of runoff (e.g. an estuary, the sea or a water body identified in the Local Flood Risk Management Strategy (LFRMS) as not needing hydraulic control of runoff to it), the hydraulic management control requirements are limited to the drainage service provisions for the site and adjacent areas that could be affected by the performance of the drainage system.

G2.2 Where a LFRMS sets out an approach to managing surface water runoff from developments (defining specific discharge controls for the location of development) which stipulates more stringent requirements than this Standard, the requirements of the LFRMS take precedence.

G2.3 The status of the receiving water may influence the regulatory requirements of the site discharge rate or volume requirements. Agreement on the discharge limits and the right to discharge should be obtained from the responsible body and/or the landowner.

G2.4 Where discharges are made to a sewer or highway drain, agreement of the discharge limits will need to be made with the owner (Local authority, Water company etc.) as they may require more onerous constraints to be applied.

G2.5 Consideration should be given to likely future pressures on the site drainage system in accordance with current guidance, such as increasing intensity of rainfall due to climate change, and increasing impervious surface area due to urban creep.

G2.6 Drainage solutions should take into account historical information on all forms of flooding and ground water levels during extended wet periods.

G2.7 A suitable model should be used to design the drainage system to a level of detail which effectively represents the conveyance and storage of the drainage system and is able to demonstrate its performance for all relevant hydrological conditions. An appropriate runoff model should be used which predicts the impervious and pervious area response appropriate for the rainfall event being used.

G2.8 Attenuation storage is likely to be required to limit discharge of runoff from the site. There should be a presumption for the use of surface storage features in preference to underground systems as they tend to be more adaptable and can also provide partial treatment and other benefits. Permeable pavements can be regarded as surface storage in this context.

G2.9 In determining the maximum water levels, flows and attenuation storage volumes, the critical duration rainfall event should be determined. Note that different critical durations may apply to different storage elements used on a site.

G2.10 Where the risk of blockage of flow control structures in meeting the limiting discharge requirements is considered to be significant, appropriate protective measures should be implemented or the proposals modified.

Interception of runoff

G2.11 When rainfall takes place on greenfield sites there is, for the majority of rainfall events during the year, no discernible surface water runoff to receiving water bodies. The rainwater normally evapotranspires, or in winter it can result in river base flow replenishment and/or groundwater recharge. However, impermeable surfaces generate runoff from virtually all rainfall events, and this change in runoff characteristics can have a negative impact on the morphology and ecology of receiving water bodies. Interception aims to mimic greenfield runoff conditions.

G2.12 The overall pollution load from site runoff is closely linked to the total volume of runoff. Therefore prevention of runoff from the majority of all small rainfall events and reducing runoff volume from larger events can contribute effectively to reducing the pollution load to receiving surface water bodies. This is particularly important in the summer, when diluting flows in receiving watercourses are often low.

G2.13 Meeting the Interception criterion is not expected during particularly wet periods when permeable surfaces and subsoils are saturated, so it is more appropriate to set compliance requirements on a probabilistic basis (i.e. Interception should be delivered for a proportion of all events, either per season or on an annual basis). A suggested target is that 80% compliance should be achieved during the summer and 50% in winter.

G2.14 Interception mechanisms are based on runoff volume reduction using rainwater harvesting, evapotranspiration and infiltration processes. Infiltration rates of soils can be marginal (in terms of their use for infiltration system design for large events), but they can be extremely effective at providing Interception. This reinforces the importance of vegetative and soil based SuDS components being used.

G2.15 For smaller sites, a simplified approach to delivering Interception can be used based on assumed compliance of various drainage components. See Table G2.1 for details of these assumptions.

G2.16 The use of continuous rainfall series with detailed simulation models which model infiltration and evapotranspiration can also be used to demonstrate the effectiveness of any design for meeting Interception requirements.

Table G2.1 Interception mechanisms with assumed compliance

Systems	**Interception methods that can be assumed to be compliant for zero runoff for the first 5mm rainfall for 80% of events during the summer and 50% in winter *.**
Green roofs	All surfaces that have green roofs.
Rainwater harvesting systems	All surfaces drained to rainwater harvesting systems designed to BS 8515, whether for surface water management or just water supply, provided the RWH system design is based on regular daily demand for non-potable water from surface water runoff.
Soakaway/ infiltration systems	Areas of the site drained to systems that are designed to infiltrate runoff for events greater than a 1 month return period. Note: design of the infiltration system should be in accordance with the SuDS manual, RP 156 or BRE 365 or any other appropriate recognised approach.
Permeable surfaces	All permeable surfaces, whether lined or not, can be assumed to comply provided there is no additional area drained to the permeable pavement. Where the surface also drains an adjacent impermeable area, compliance can be assumed for all soil types where the system is unlined as long as the additional paved area is no greater than the permeable area. Where the infiltration capacity of the ground below the permeable surface is greater than $1x10^{-6}$m/s, up to 5 times the permeable surface area can be added as additional contributing area. Where the permeable surface also drains an adjacent impermeable area and is lined, compliance cannot be deemed to have been achieved and additional downstream Interception components will be required (*).

Systems	**Interception methods that can be assumed to be compliant for zero runoff for the first 5mm rainfall for 80% of events during the summer and 50% in winter *.**
Swales	Roads drained by swales (even those which are lined - providing the linings are at least 500mm below the base of the swale), where the longitudinal gradient of the swale is less than 1:100, are suitable for Interception delivery for impermeable surface areas up to 5 times the base of the vegetated surface area receiving the runoff. Swales steeper than 1:100 cannot be deemed to provide Interception unless additional effective Interception design can be demonstrated. For areas other than roads, any swale which is unlined and has a gradient which is less than 1:100 and has an infiltration capability greater than $1x10^{-6}$m/s can be assumed to comply with Interception for a contributing area up to 25 times the base of the swale. Interception cannot be deemed to have been provided for impermeable areas draining to a swale within 5m from the swale outlet, unless the swale is flat and has a slightly raised outlet to create a temporary storage zone to encourage infiltration before runoff takes place. Greater loading ratios can be achieved by providing flat swales with greater temporary storage and infiltration, but these require detailed design based on the use of appropriate continuous rainfall series.
Infiltration trenches	Roads drained by infiltration trenches can be considered to provide Interception.
Detention basins	Areas of the site drained to detention basins with a flat unlined base (without specific provision for routing low flows directly to the outlet) can be assumed to comply where the drained impermeable surface area is less than 5 times the vegetated surface area receiving the runoff for any soil type. The area of the basin that is assumed to contribute to interception of runoff should be below the outlet level of the basin.

Detention basins (Continued)	Areas up to 25 times the base area of the basin can be assumed to meet interception requirements where infiltration rates are greater than $1x10^{-6}$m/s. Higher loading ratios can be achieved where specific provision is made for water being stored below the outlet pipe and higher infiltration rates exist. Where a basin is designed to infiltrate runoff, specific provision should be made for the upstream control of sediments to minimise risks of waterlogging, high maintenance costs and reduced component amenity value.
Bioretention areas and rain gardens	Areas of the site drained to unlined bioretention components can be assumed to comply (*) where the impermeable surface area is less than 5 times the vegetated surface area receiving the runoff.
Ponds	Areas drained by ponds (with a permanent water pool is effectively maintained by the outlet structure) are assumed not to deliver Interception

** Where individual components do not provide sufficient Interception for the area draining to them, Interception capacity can also be provided by downstream components. Detailed calculations will be needed to demonstrate compliance in this case.*

Morphological protection of receiving surface water bodies

G2.17 A bank-full event for a stream or river tends to equate to about a 1:1 or 1:2 year event. By aiming to replicate greenfield runoff rates for this size of event, the receiving watercourse can be protected from erosion and the resulting morphological and ecological damage. For previously developed sites, site runoff rates should be reduced to the greenfield rates wherever possible.

G2.18 By limiting discharges to sewers (and surface waters), replicating the greenfield runoff rate will reduce the impact on downstream capacity. If discharging to a combined sewer, this also reduces the impact on CSO spills and downstream wastewater treatment works.

G2.19 The assessment of peak runoff rates from greenfield, previously developed and proposed development sites, and the design of attenuation storage systems is set out in the SuDS Manual[14].

[14] https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

This page has been intentionally left blank

APPENDIX B: NRW CORRESPONDENCE & FLOOD MAPPING

This page has been left intentionally blank

Megan Berry

From: Megan Berry
Sent: 20 January 2021 11:05
To: 'datadistribution@cyfoethnaturiolcymru.gov.uk'
Subject: Product 5,6 & 7
Attachments: LOCATION PLAN.pdf

To whom it may concern,

Land east of Tan y Bont, Main Road, Rhosrobin, Wrexham

Please could you confirm whether you have any information that you feel would be valuable to a FCA&DMS for the above site (location plan attached), including details of historical flooding and Specific Drainage Requirements; this would be greatly appreciated. If there are any other specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) MCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Consulting Engineers

Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
Chester +44 (0)1244 289041

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

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

DO NOT SCALE

LEGEND

- Planning Application Boundary
- Development Area
- Wat's Dyke
- Railway

NRW Surface Water Extents

- Low Risk
- Medium Risk
- High Risk

REV	DATE	BY	DESCRIPTION	CHK
D	09/01/23	HB	PRELIMINARY FOR REVIEW	KH

DRAWING STATUS:

BETTS HYDRO
CONSULTING ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 enquiries@betts-associates.co.uk

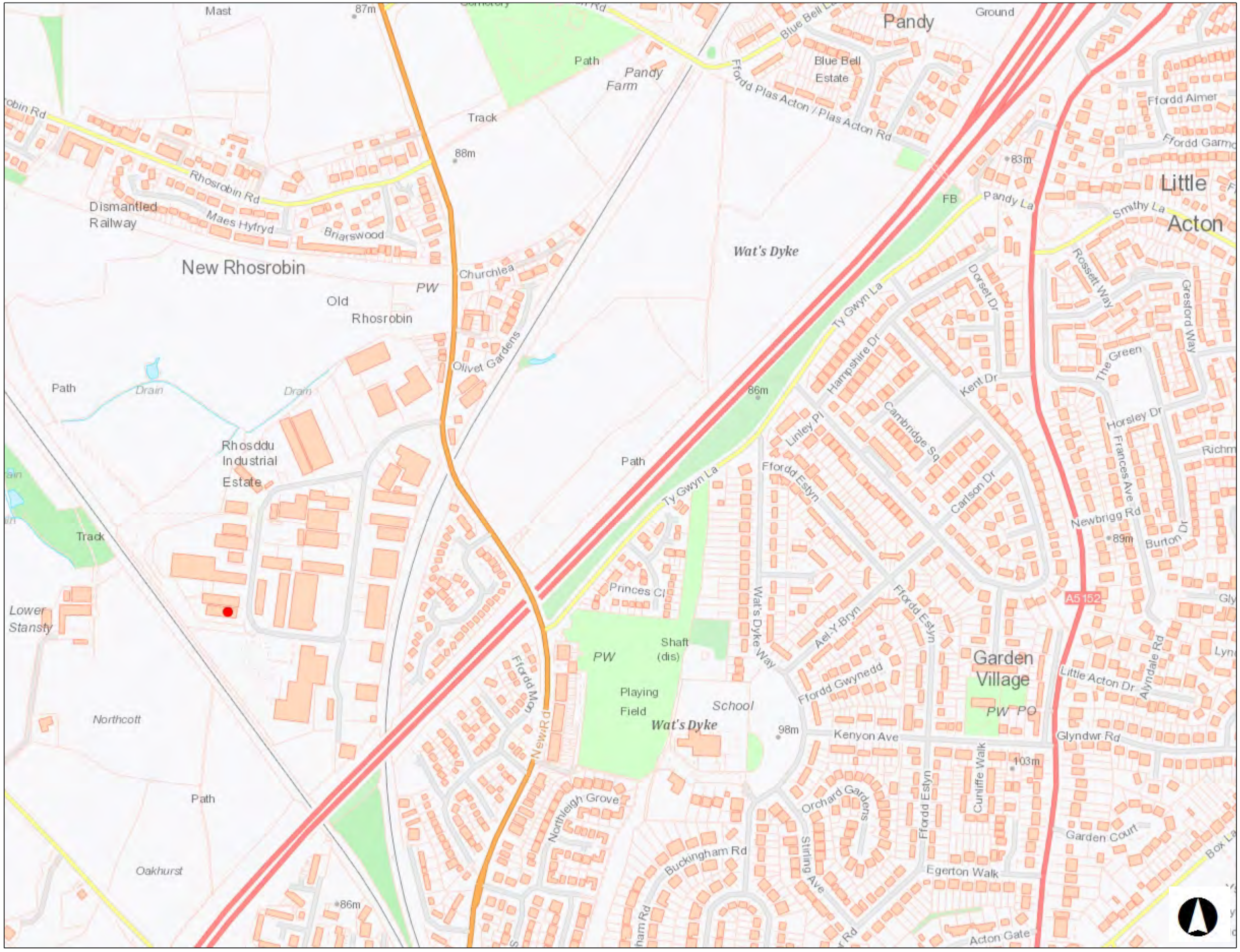
Castle Green HOMES

PROJECT:
Land East of Tan y Bont, Main Road, Rosrobin, Wrexham

TITLE:
Surface Water Flood Risk Extent Mapping and Site Layout T Overlay Plan

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
JAN 2023	NTS @ A3	HB	KH

PROJECT No:	DRAWING No:	REV:
HYD574	202	D



Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Perygl Llifogydd / Flood Risk Map - DAM

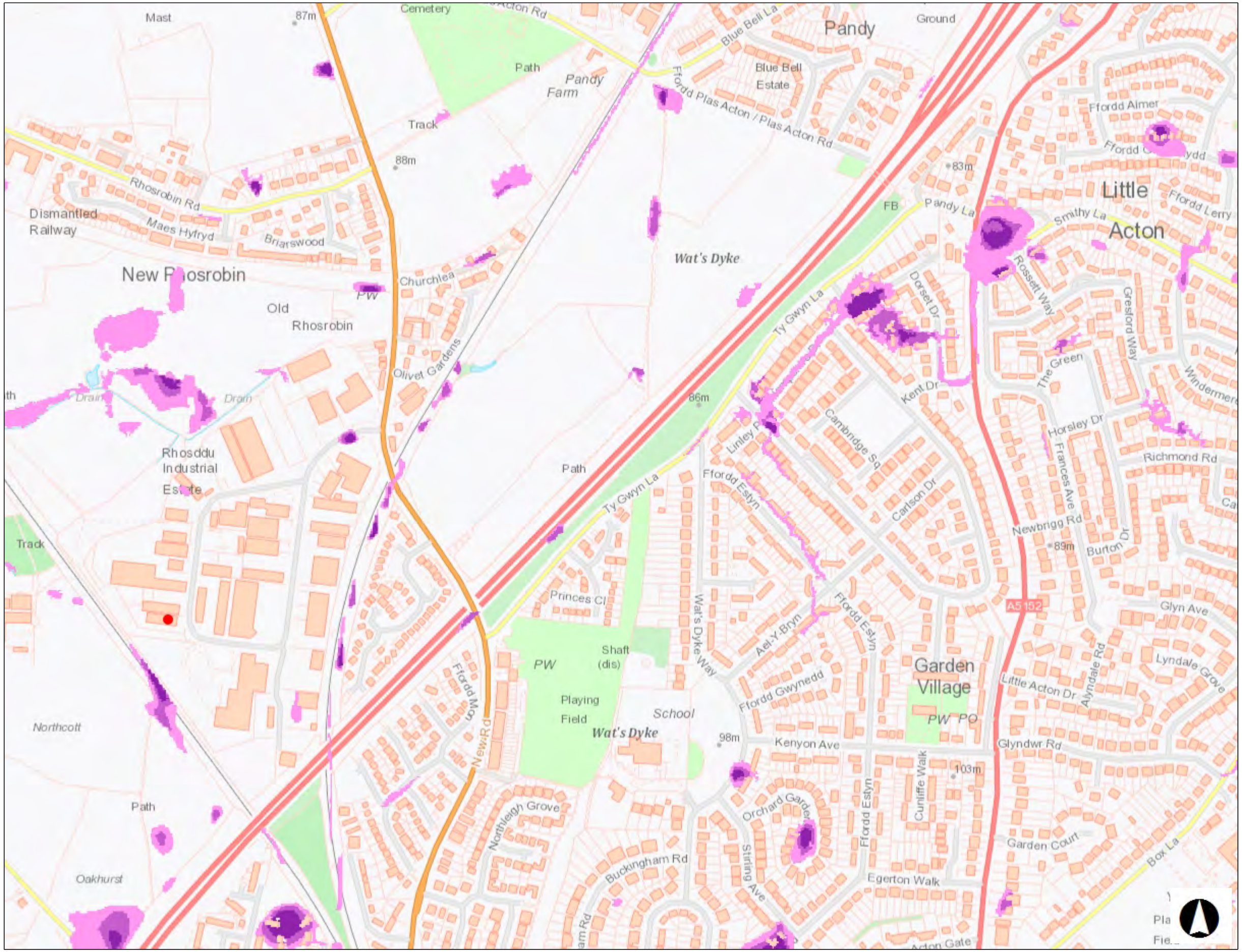
Allwedd / Map Key

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

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
20/01/2021

0.3 0 0.13 0.3
British_National_Grid Kilometers



Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Perygl Llifogydd / Flood Risk Map - SURFACE WATER

Allwedd / Map Key

Surface Water and Small Watercourses Extent - Low Risk

Low Extent

Surface Water and Small Watercourses Extent - Medium Risk

Medium Extent

Surface Water and Small Watercourses Extent - High Risk

High Extent

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
20/01/2021

0.3 0 0.13 0.3

British_National_Grid Kilometers

Main Rivers

Flood Defences

Areas Benefitting from Flood Defences

- Rivers
- Sea
- Rivers and Sea

Risk Level Under Review

- Risk Level Under Review

Flood Risk from Rivers

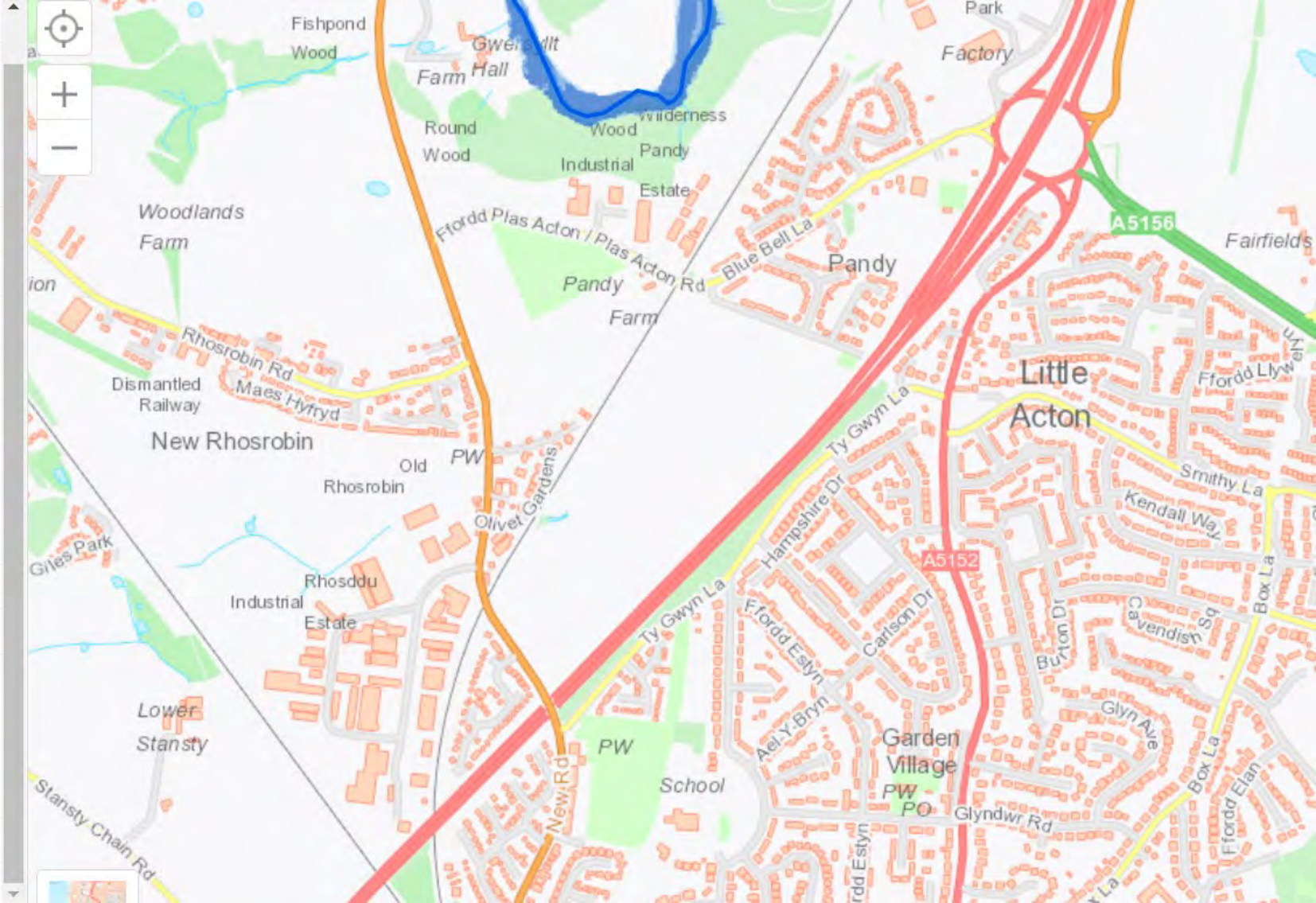
Flood Risk from Rivers - Extent

- High
- Medium
- Low

Flood Risk from the Sea

Flood Risk from the Sea

- High
- Medium
- Low



APPENDIX C: WW SEWER CORRESPONDENCE

This page has been left intentionally blank

Megan Berry

From: Megan Berry
Sent: 20 January 2021 11:05
To: 'Sewerage.Services@dwrcymru.com'
Subject: Sewer Flood Risk
Attachments: LOCATION PLAN.pdf

To whom it may concern,

Land east of Tan y Bont, Main Road, Rhosrobin, Wrexham

Please could you confirm whether you have any information that you feel would be valuable to a FCA&DMS and an SAB application (price and procedure) for the above site (location plan attached), including details of historical flooding and Specific Drainage Requirements; this would be greatly appreciated. If there are any other specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) MCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Consulting Engineers

Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
Chester +44 (0)1244 289041

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

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

Dŵr Cymru
Welsh Water

Developer Services
PO Box 3146
Cardiff
CF30 0EH

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

Gwasanaethau Datblygu
Blwch Post 3146
Caerdydd
CF30 0EH

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

Wrexham County Council
16 Lord Street
WREXHAM
LL11 1LG

Date: 17/03/2016
Our Ref: PLA0018231
Your Ref: P/2016/0189

Dear Sir

Grid Ref: SJ3326452778 333264 352778
Site: Land East of Tan Y Bont Rhosrobin
Development: Residential Development - up to 189 dwellings

We refer to your planning consultation relating to the above site, and we can provide the following comments in respect to the proposed development.

We would request that if you are minded to grant Planning Consent for the above development that the **Conditions and Advisory Notes** provided below are included within the consent to ensure no detriment to existing residents or the environment and to Dwr Cymru Welsh Water's assets.

SEWERAGE

Conditions

Following previous discussions with the applicant and Wrexham Planning Department we have previously established that the local sewer network would have to be hydraulically modelled and we have agreed that the use of a Grampian style condition could protect the public sewerage assets by ensuring that a Hydraulic Modelling Assessment and any reinforcement work is undertaken prior to occupation.

Previous applications have indicated that a development of up to 400 houses may take place on this site. I understand that the current application is look to obtain consent for 189 dwellings. Although there is a marked difference in the number of properties proposed, there is still likely to be an impact on the local network. We are satisfied with the the use of the following condition which has been put forward by Wrexham Council.

Development shall not commence until a scheme for the provision of foul sewerage infrastructure has been submitted to and approved in writing to the Local Planning Authority. No dwelling shall be occupied until foul sewerage infrastructure has been provided in full and in strict accordance with the scheme as approved.

Please be advised that the scope and cost of the solutions identified within the Hydraulic Modelling Assessment should be made available to all parties once completed.

Please ensure that any officer reports associated with this application and advisory notes highlight the need for this work to be undertaken.

In addition to the above condition, we request that should planning be permitted the following conditions are placed on the planning decision notice.

No surface water and/or land drainage shall be allowed to connect directly or indirectly with the public sewerage network

Reason: To prevent hydraulic overloading of the public sewerage system, to protect the health and safety of existing residents and ensure no pollution of or detriment to the environment

No development shall commence until a drainage scheme for the site has been submitted to and approved in writing by the local planning authority. The scheme shall provide for the disposal of foul, surface and land water, and include an assessment of the potential to dispose of surface and land water by sustainable means. Thereafter the scheme shall be implemented in accordance with the approved details prior to the occupation of the development and no further foul water, surface water and land drainage shall be allowed to connect directly or indirectly with the public sewerage system.

Reason: To prevent hydraulic overloading of the public sewerage system, to protect the health and safety of existing residents and ensure no pollution of or detriment to the environment.

The proposed development site is crossed by a 150mm and a 225mm public foul sewer with the approximate position being marked on the attached Statutory Public Sewer Record. Under the Water Industry Act 1991 Dwr Cymru Welsh Water has rights of access to its apparatus at all times. No part of the building will be permitted within 3 metres either side of the centreline of the public sewer.

Reason: To protect the integrity of the public sewer and avoid damage thereto.

Advisory Notes

The applicant may need to apply to Dwr Cymru / Welsh Water for any connection to the public sewer under S106 of the Water industry Act 1991. If the connection to the public sewer network is either via a lateral drain (i.e. a drain which extends beyond the connecting property boundary) or via a new sewer (i.e. serves more than one property), it is now a mandatory requirement to first enter into a Section 104 Adoption Agreement (Water Industry Act 1991). The design of the sewers and lateral drains must also conform to the Welsh Ministers Standards for Gravity Foul Sewers and Lateral Drains, and conform with the publication "Sewers for Adoption"- 7th Edition. Further information can be obtained via the Developer Services pages of www.dwrcymru.com

The applicant is also advised that some public sewers and lateral drains may not be recorded on our maps of public sewers because they were originally privately owned and were transferred into public ownership by nature of the Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011. The presence of such assets may affect the proposal. In order to assist us in dealing with the proposal the applicant may contact Dwr Cymru Welsh Water on 0800 085 3968 to establish the location and status of the apparatus. Under the Water Industry Act 1991 Dwr Cymru Welsh Water has rights of access to its apparatus at all times.

SEWAGE TREATMENT

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

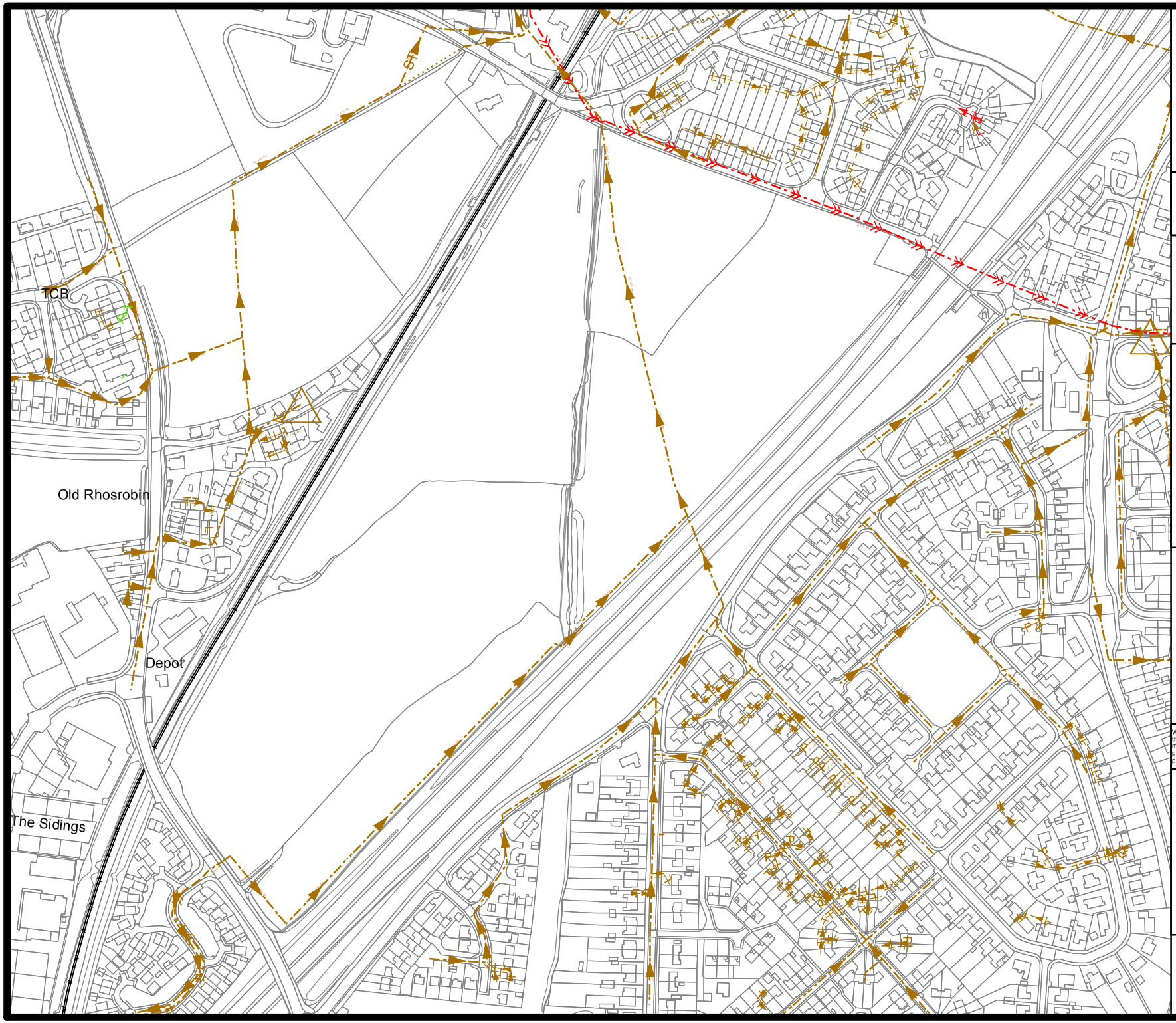
Our response is based on the information provided by your application. Should the proposal alter during the course of the application process we kindly request that we are re-consulted and reserve the right to make new representation.

If you have any queries please contact the undersigned on 0800 917 2652 or via email at **developer.services@dwrcymru.com**

Please quote our reference number in all communications and correspondence.

Yours faithfully,

Henry Jones-Hughes
Development Control Officer
Developer Services



Dŵr Cymru
Welsh Water

PLA0018231

N
W E
S

LEGEND(Representative of most common features)

Waste network:

- Foul chamber
- Surface water chamber
- Combined chamber
- Combined sewer overflow
- Special purpose chamber
- Treatment works
- Pumping station
- Outfall
- Lamphole
- Storm Overflow
- Rising main
- Gravity sewer
- Private sewer
- Private sewer subject to Sect. 104 adoption agreement
- Private Sewer Transfer
- Lateral Drain
- Inspection Chamber

NB: Sewer symbol colour indicates the type.

RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former S24 sewers (for indicative purposes only)

Notes:

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

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

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

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Map Ref:	333264 352778
Map scale:	1:4,000
Printed by:	
Printed on:	

APPENDIX D: LLFA/LPA CORRESPONDENCE

This page has been left intentionally blank

Megan Berry

From: Megan Berry
Sent: 20 January 2021 11:05
To: 'contact-us@wrexham.gov.uk'
Subject: FCA&DMS and an SAB application (price and procedure)
Attachments: LOCATION PLAN.pdf

To whom it may concern,

Land east of Tan y Bont, Main Road, Rhosrobin, Wrexham

Please could you confirm whether you have any information that you feel would be valuable to a FCA&DMS and an SAB application (price and procedure) for the above site (location plan attached), including details of historical flooding and Specific Drainage Requirements; this would be greatly appreciated. If there are any other specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) MCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO
Consulting Engineers

Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
Chester +44 (0)1244 289041

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

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

APPENDIX E: LOCATION PLAN

This page has been left intentionally blank

LOCATION PLAN

HYD574 Land east of Tan y Bont, Main Road, Rhosrobin, Wrexham

OS X (Eastings)	333085
OS Y (Northings)	352580
Nearest Post Code	LL11 4RP
Lat (WGS84)	N53:03:59 (53.066252)
Long (WGS84)	W3:00:00 (-3.000054)
Lat,Long	53.066252,-3.000054
Nat Grid	SJ330525 / SJ3308552580
mX	-333964
mY	6961083

APPENDIX F: SITE WALKOVER INFORMATION

This page has been left intentionally blank

PANDY

PLAS ACTON ROAD

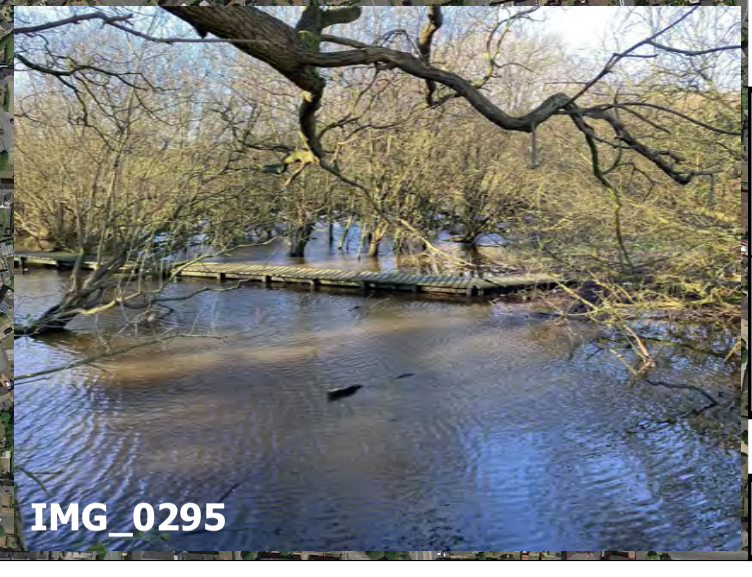
IMG_0260
IMG_0264
IMG_0275
IMG_0282
IMG_0283
IMG_0286
IMG_0280
IMG_0289
IMG_0302
IMG_0305
IMG_0304
IMG_0298
IMG_0297
IMG_0301
IMG_0290
IMG_0306
IMG_0308
IMG_0295
IMG_0294

A483

Main Road (B5425)

RHOSDDU INDUSTRIAL ESTATE

0 100 200 m



DO NOT SCALE

LEGEND

- Site Boundary
- Land Drain Ditch
- Standing Water & Ponding Areas
- Photo Ref
- Existing Manhole

REV	DATE	BY	DESCRIPTION	CHK
A	21/01/21	KW	PRELIMINARY FOR REVIEW	RN

DRAWING STATUS:

BETTS HYDRO
CONSULTING ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 enquiries@betts-associates.co.uk

Castle Green HOMES

PROJECT:
Land East of Tan y Bont,
Main Road, Rosrobin,
Wrexham

TITLE:
EXISTING FEATURES PLAN
(Following Site Observations from walkover on 21st Jan 2021)

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
JAN 2021	NTS @ A3	KW	RN

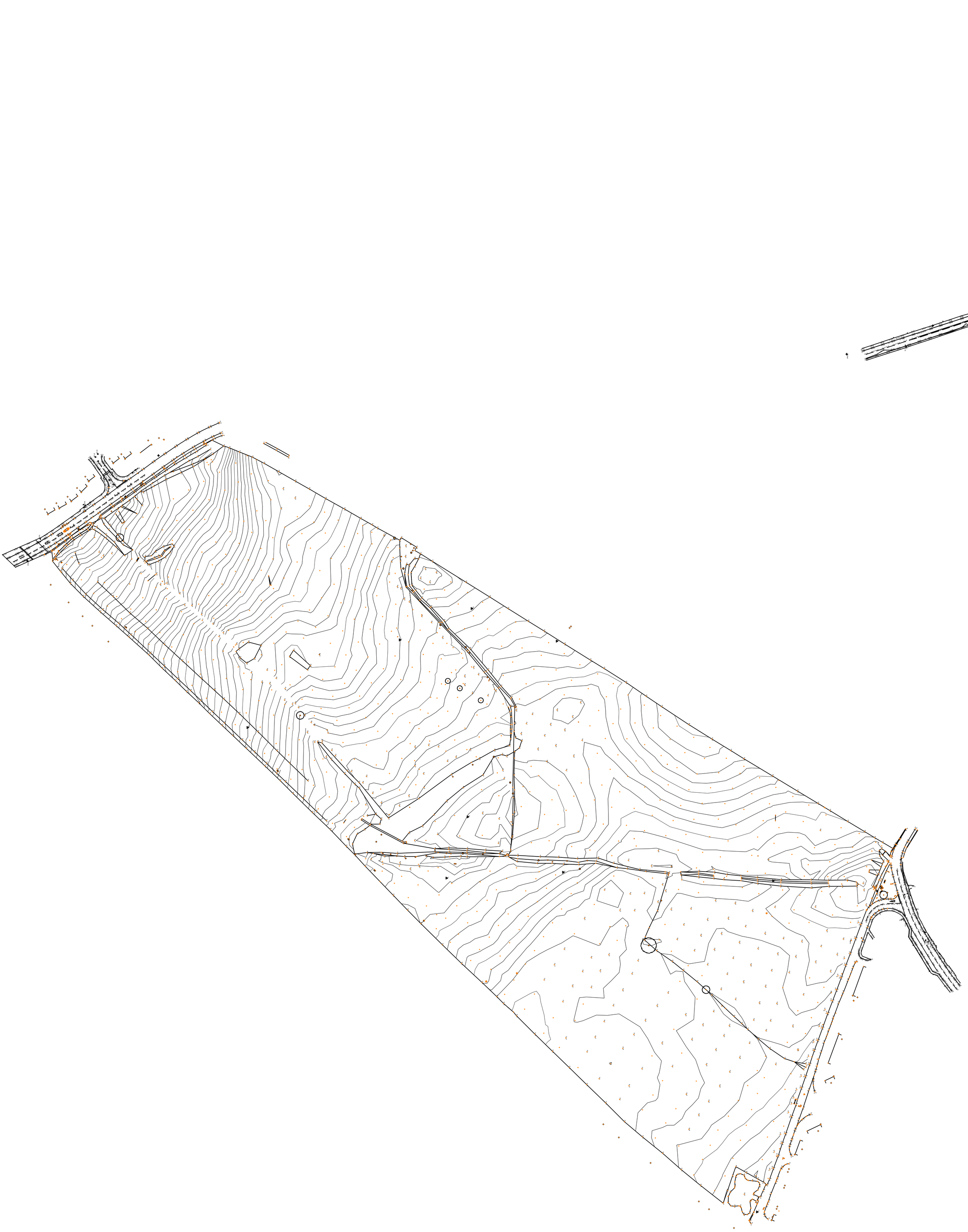
PROJECT No:	DRAWING No:	REV:
HYD574	100	A


GIVE
WAY

This page has been intentionally left blank

APPENDIX G: TOPOGRAPHIC SURVEY

This page has been left intentionally blank



APPENDIX H: PROPOSED PLANNING LAYOUT

This page has been left intentionally blank

Key:

- Site Boundary
- 1.8m high boundary fence
- 1.8m high screen wall / fence
- Private Drive
- Indicative Landscaping
- Number of parking spaces proposed to Semi-Detached and Detached Dwellings
- Parking space allocation to Terraced Dwellings
- Knee rails to parking bays to Mid-Terraced Dwellings
- Affordable Housing
- Existing Sewer & Easement

RHOSROBIN - SCHEDULE OF ACCOMMODATION

HOUSETYPE	DESCRIPTION	SQFT	NUMBER	PERCENTAGE
Clwyd (Affordable)	2 Bed, 2 Storey, Mid-Terrace	705 SQFT	26	11.87
Elwy (Affordable)	3 Bed, 2 Storey, End-Terrace	822 SQFT	18	8.22
Dyfi (Affordable)	2 Bed, 2 Storey,Undercroft	859 SQFT	3	1.37
AP2D (Affordable)	2 Bed, 2 Storey, Mid-Terrace	895 SQFT	4	1.83
SP3B (Affordable)	3 Bed, 2 Storey, End-Terrace	1015 SQFT	4	1.83
Oakley	2 Bed, 2 Storey, Mid-Terrace	705 SQFT	8	3.65
Ingleton	3 Bed, 2 Storey, Semi-detached, End Terrace	821 SQFT	14	6.39
Marlow Semi	3 Bed, 2 Storey, Semi-detached	987 SQFT	30	13.70
Sunningdale	3 Bed, 2.5 Storey, Semi-detached	1022 SQFT	24	10.96
Henley	3 Bed, 2 Storey	1040 SQFT	14	6.39
Oxford	3 Bed, 2 Storey	1040 SQFT	13	5.94
Stratford	3 Bed, 2 Storey	1055 SQFT	22	10.05
Broadway	4 Bed, 2 Storey	1170 SQFT	9	4.11
Beaumont	4 Bed, 2 Storey	1234 SQFT	16	7.31
Wentworth	4 Bed, 2 Storey	1344 SQFT	14	6.39
TOTAL		**214895 SQFT**	**219**	
Gross Site Area		39 Acres	15.78 Hectares	
Maintained Land within Green Barrier		14.09 Acres	5.70 Hectares	
Landscaped POS within Green Barrier		9.27 Acres	3.75 Hectares	
Development Area POS		1.25 Acres	0.51 Hectares	
Undevelopable: Entrance, Single-Sided Road & Existing Landscaping		0.3 Acres	0.12 Hectares	
NETT SITE AREA:		**14.09 ACRES**	**5.70 HECTARES**	
Gross Density:		5.62 Units/Acre	38.41 Units/Hectare	
NETT DENSITY:		**15.54 UNITS/ACRE**	**38.41 UNITS/HECTARE**	
Gross Footage:		5512.69 SQFT/Acre	1265.53 SQM/Hectare	
NETT FOOTAGE:		**15258.69 SQFT/ACRE**	**3502.88 SQM/HECTARE**	

Rev:	Description:	Date:
A	Blocks updated and mix amended	08.10.20
B	APD layout added	19.10.20
C	Road layout and mix amended.	01.12.20
D	Additional plots added increasing number to 189.	05.01.21
E	Schedule corrected.	07.01.21
F	LEAP indicated	11.01.21
G	Turning heads by plots 118, 79 and between plots 25-26 extended to following vehicle tracking report.	26.01.21
H	Amends following planning officer comments.	07.04.21
I	Amends following planning officer comments.	25.05.21
J	Amends following planning officer comments.	15.06.21
K	Cycle path added on North West part of the site.	01.07.21
L	Plots 1-5 repositioned away from Diverted HV Cable.	05.07.21
M	Amends following comments from the Tree Officer. Parking indicated for plot 27, Parking numbering corrected for plots 165 - 175.	18.10.21 03.11.21
N	Amends to plots near site entrance following review of levels. Internal issue.	-.-11.21
O	Plots 44-47, 97, 100, 101, 118, 160, 161 Handed. Burlington Roof configuration corrected.	16.02.22
P	Substation and PRI resized.	04.05.22
Q	Amends to area around plots 106-116.	15.06.22
R	Number increased from 189 to 220	22.09.22
S	Amends from comments back from Planning	14.11.22
T	Turning head in front of plot 152 extended.	05.01.23

Castle Green
Unit 20,
St. Asaph Business Park, St Asaph,
Denbighshire. LL17 0LJ.
Tel. 01745 536677

Site: Main Road, Rhosrobin, Wrexham

Title: Proposed Site Plan (1 of 2)

Scale: 1:1000@A1

Date: 18.07.19

Ref: RHRO-SP01

Rev: T

APPENDIX I: PFRA/SPRA INFORMATION

This page has been left intentionally blank

Volume Pumps (HVP's) pumps were brought in to extract the excess surface water in to the river system.

In Wrexham County Borough there were no areas identified as significant risk threshold with an affected population, greater than 5,000 people. Within the Wrexham County Borough Council Preliminary Flood Risk Assessment (PFRA) 2011[6], 20 1km square areas of 200 properties, 20 businesses or 1 critical infrastructure have been identified. These are areas which do not meet the statutory flood risk areas of 5,000 people but areas which are locally significant. These areas are concentrated around Wrexham, Llay Industrial Estate, Wrexham Industrial Estate and urban villages of Gwersyllt, Rhosllanerchrugog, Ruabon, Coedpoeth, Cefn Mawr, Acrefair, Chirk and Glyn Ceiriog, Ceiriog Valley. This local threshold will continue to form the basis of the LFRMS supported by continuing collection of information on local flood events.

The PFRA (2011) 1km2 squares show that local flood risk could potentially affect 20,696 properties. The Environment Agency maps on surface water show a total number of 451 properties within areas susceptible to surface water flooding. The Environment Agency Flood map for surface water shows that 1922 properties could potentially be affected by 1 in 30 flood event, and 5312 properties are shown at risk from the 1 in 200 flood map for surface water. To date, the County Borough has received 383 flooding incidents.

The flooding events that have occurred this year 2012-2013 within the County Borough l have varied in size and caused different patterns of events. In April prolonged and heavy rainfall caused problems associated with surface water run off and river flooding alerts in Acrefair and Rossett. The events in July and August were associated with surface water flooding and flash flooding in urban villages of Gwersyllt, Gresford, Marford, Llay and Burton Green. In September, flooding events covered the borough causing surface water and river flooding to the Alyn and surrounding farmland around Holt, Farndon and Rossett.

The flood risk areas for Wrexham are listed in Figure 1.8 shows the PFRA squares in relation to the community council areas and shows how many properties, business or infrastructure could be affected. The table compares this information in relation to the EA Areas Susceptible to Surface Water Flooding and Flood Map for Surface Water, groundwater flooding areas, the historic flood outline and flood zones, canal flooding from Civic Canal and River Trust and sewer flooding from Welsh Water and the historical flooding data captured by the LLFA. The table also shows how these areas relate to the policy areas of the River Dee Catchment Plan and River Dee Basin Management Plan. Figure 1.9 will help identify the highest risk areas for the implementation of measures (L1-11) and forthcoming flood risk maps and flood risk management plans.

Environment Agency River Dee Catchment Flood Management Plan (2010)
Flood risk is the combination of the likelihood (or probability) of a particular flood event occurring and the consequence (or impact) of the flood event if it occurred. within a one year period. This is known as an Annual Exceedance Probability which is expressed as a % AEP and is the probability of a particular flood event (or size) occurring in one year. Flood risk is likely to be exacerbated by climate

[6] WCBC (2011) Preliminary Flood Risk Assessment

change, and UKC09 projections indicate that rainfall will change significant with 90% probability, wetter winters causing higher river flow, especially when combined with sea level rise and more frequent and intense extreme rainfall events. The main sources of flood risk in Wrexham County Borough include river flooding, surface water flooding, some sewer, ground water and ordinary watercourse flooding.

Flooding has occurred at many locations throughout the River Dee Catchment Flood Management (CFMP) area, mostly from the main River Dee and its major tributaries but also from several small watercourses. Significant floods were recorded in 1890, 1946, and 2000.
The River Dee CFMP [7] identifies a number of populated areas which are affected include Rossett, Holt, Wrexham, Coedpoeth and Rhosllanerchrugog. In 2000, flooding was widespread across the catchment to places which have never flooded before

In the River Dee catchment area, a 1% AEP event could affect approximately 4,200 properties. In the County Borough of Wrexham there are considered to be 100-500 number of properties within Wrexham and Bangor on Dee and between 50-100 properties in Cefn Mawr at risk from flooding. This would equate to a flood risk to 0.5% of the population in 2010 and is because large amounts of area that are at risk of flooding from fluvial sources forms agricultural low land areas. There are limitations to this data given the lack of historic records associated with surface water flooding.

The CFMP (2010) has six policy areas cross the catchment area. These policy areas are incorporated into sub area action plans. The key policy options 2, 3 and 4 for Wrexham are listed in Figure 1.7 below.

Figure 1.7 River Dee Catchment Management Policies for Wrexham

Policy 2: Middle Dee, Bangor on Dee and East of the Borough
Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions.
This policy will tend to be applied where the overall level of risk to people and property is low to moderate. It may no longer be value for money to focus on continuing current levels of maintenance of existing defences if we can use resources to reduce risk where there are more people at higher risk. We would therefore review the flood risk management actions being taken so that they are proportionate to the level of risk

Policy 3: Lower Dee (Rossett, Holt Farndon and Main Alyn West of Wrexham
Areas of low to moderate flood risk where we are generally managing existing flood risk effectively;
This policy will tend to be applied where the risks are currently appropriately managed and where the risk of flooding is not expected to increase significantly in the future. However, we keep our approach under review,
looking for improvements and responding to new challenges or information as they emerge. We may review our approach to managing flood defences and other flood

[7] EA (2010) The River Dee Catchment Management Plan

risk management actions, to ensure that we are managing efficiently and taking the best approach to managing flood risk in the longer term.

Policy 4: Wrexham (Rossett to Erddig and Rhostyllen)
Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change;
This policy will tend to be applied where the risks are currently deemed to be appropriately-managed, but where the risk of flooding is expected to significantly rise in the future. In this case we would need to do more in the future to contain what would otherwise be increasing risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

The sub areas relevant to Wrexham County Borough include, Sub area 1:Upper Dee, Sub Area 2: Main Alyn, Sub Area 3: Middle Dee , Sub Area 4 Wrexham and Sub Area 5: Lower Dee. For each of these sub areas there are a list of partners, an outline of the issues, and outline of the policy approach required and actions required to implement them.

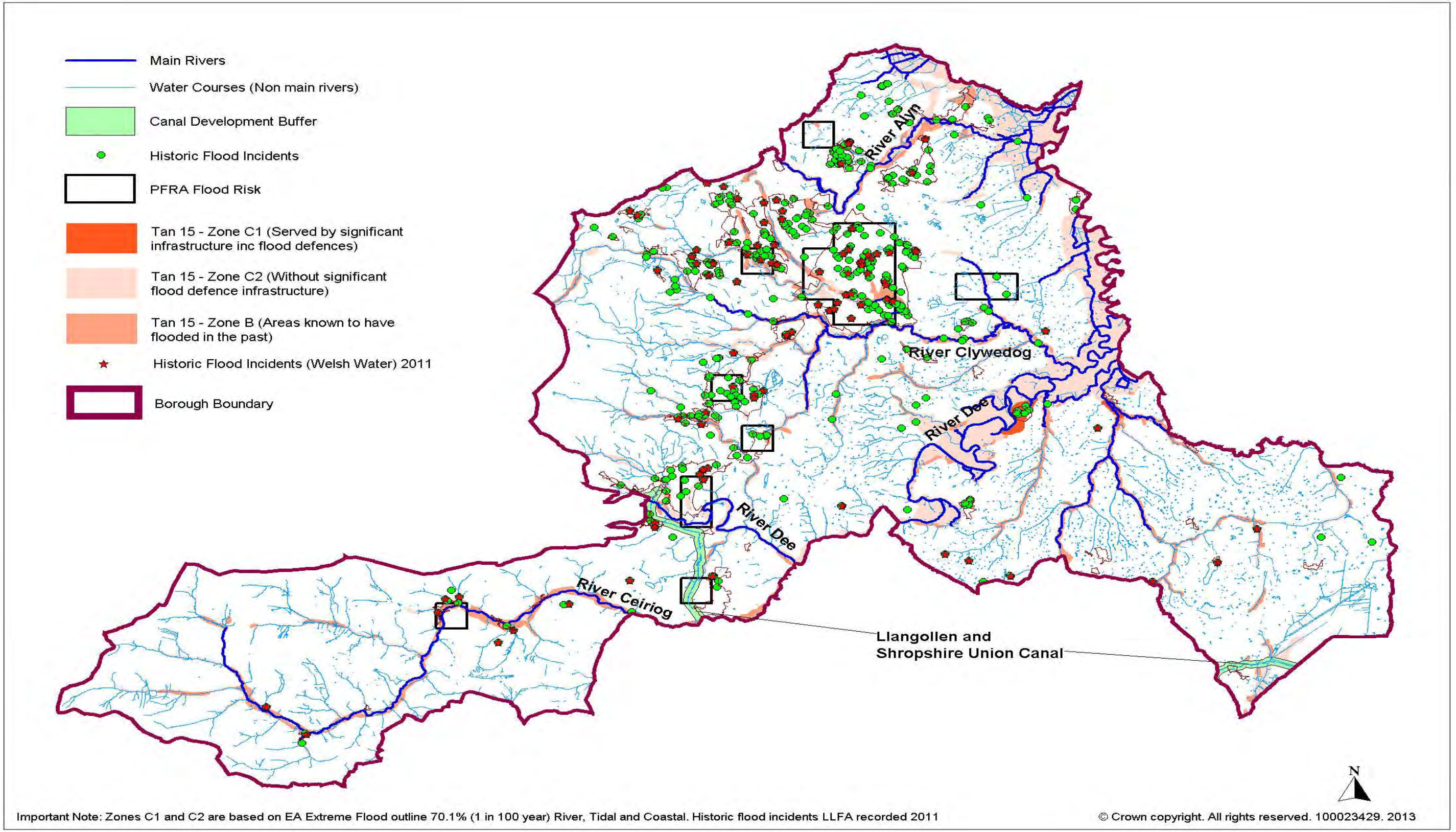
Environment Agency River Dee Basin Management Plan (2009)
The River Dee is considered as part of a wider river basin including the river, its tributaries and estuary. The source of the Dee is near Bala and the whole basin includes Llyn Tegid Special Area of Conservation (SAC) through to the Dee Estuary (SPA) including reservoirs at Llyn Tegid, Celyn and Brenig. The Dee is of high biodiversity value due to its originally low nutrient status and high quality riparian habitats. Its interest includes a number of species that are typical of high quality rivers with low nutrient levels in the water. Of particular note is the use of the River Dee as a migration route by Atlantic salmon, up to spawning grounds in the river, some of which are within Wrexham County Borough.

The River Basin Management Plan current status of the water environment states that 28% of the surface waters are at good or better ecological/potential status now. 51% of the assessed surface waters are at a good or better ecological status now. 108 surface water bodies have been assessed for ecology and 72 have been assessed for biology. The River Dee and Bala lake is a SAC, is vulnerable to specific flood risk management measures and pressures in relating to canalised stretches altering habitats, collapsing embankments, nutrient levels, provision of water resource locally and to parts of the West Midlands and North West of England, recreational disturbance, siltation from construction and invasive species.

Limitations

There are limitations to the data provided with each source of information varying in format and level of detail. Improvements in the recording system have been identified and are included as a measure of the LFRMS. Once adopted and monitored improvements in flood risk information held by the Lead Local Flood Authority will inform local flood risk management approach and ongoing review of the strategy.

Figure 1.8 Flood Risk Assessment across Wrexham County Borough (Local Flood Risk Management Strategy 2012)



and mapping them against green spaces, initiatives for investment and improvements can be identified. It provides evidence of existing initiatives within the regional area which includes Stamford Brook and Northern Gateway which demonstrate the principles of this policy approach to Lower River Dee and actions required. This action plan forms one of two areas that have been prioritised for green infrastructure investment under the Green Infrastructure Framework.

Natural approaches to flood risk management is more sustainable and cost effective than hard engineering defences and can bring added benefits to wildlife and amenity to regenerated areas and urban spaces. The Environment Agency has conducted research and there evidence to demonstrate the benefits of this approach. Natural approaches can include techniques which use land to temporarily store water away from high risk areas, reconnect rivers to floodplains, lengthening watercourses to a more natural alignment, restoring peat bogs, blocking artificial drainage channels, reforesting floodplains, green roofs, permeable paving, and surface water attenuation ponds

Improvements to the collection of data onto a single mapping system for the local authority ensures that different functions take account or have regard to local flood risk and their interrelatedness. That will facilitate the analysis and monitoring of flood event patterns in relation to existing assets and infrastructure. Highlighting repeat issues or issues in regards to maintenance. The development of an annual asset maintenance schedule will ensure that the required ordinary watercourse consents will be scheduled and pre-application discussions can limit the issues in regards to design, ecology or proposed methods involved. The investigation process and asset register can reduce costs associated with flood damage from flood events and reduce the costs from repetitive actions which do not resolve the issues associated with the source of the flooding. Small measures, that could save long term higher costs associated with the continued flood risk we can anticipate from Climate Changes.

The Lead Local Flood Authority has permissive power to designate structures which affect flood risk so the owners can not alter or remove the structures. This designation procedure is assessed and has to satisfy four conditions for the consideration of formal designation. These four conditions are;
Condition 1: that the designating authority thinks the existence or location of the structure or feature affects a flood risk or coastal erosion risk;
Condition 2: that the designating authority has flood or coastal erosion risk management functions in respect of the risk which is affected;
Condition 3: that the structure or feature is not already designated by another authority;
Condition 4: that the owner of the structure or feature is not a designating authority;

Designation and asset maintenance can reduce the consequences and improve the approaches of flood risk management within the Borough. The flooding events that have occurred this year 2012-2013 within the Borough Council have varied in size and caused different patterns of events. In April prolonged and heavy rainfall caused problems associated with surface water run off and river flooding alerts in Acrefair and Rossett. The events in July and August were associated with surface water flooding and flash flooding in urban villages of Gwersyllt, Gresford, Marford, Llay and Burton Green. In September, flooding events covered the borough

The identification of communities at risk and vulnerable people can be assessed through the careful use of datasets across the Authority. Using the principles of the Community Flood Plans in Rossett and Bangor on Dee, and utilising the databases held on the private rented sector, council owned assets.

Wrexham County Borough Council in partnership with Environment Agency is committed to ensuring that everyone in the County Borough of Wrexham is informed or aware of the risks of local flooding. This awareness and information sharing is important to enable households and businesses to adopt suitable resistance and resilience measures.

In Wales, six pilot studies have been completed, two of these areas include Prestatyn and Pwllheli and provide important lessons in regards to the importance of awareness rising and adaptation to climate change. Climate change and adaptation forms an important role within all flood risk management measures.

The Multi-agency Flood Plan (MAFP) (2010) provides the framework produced by North Wales Resilience Forum and Multi Agency Response Plan for Major Emergencies (2010) for Emergency responses within the Borough. There are flood warning systems in place for Alyn Catchment, Rossett, Lower Dee Valley Llangollen to Chester, Lower Dee and Bangor on Dee.

The Area Flood Partnership includes representatives from the Council's Emergency Management Response Teams, Lead Local Flood Authority, Flood Risk Management Authorities and communities of Bangor on Dee, Rossett .This group hold meetings throughout the year and exercises every three years.

The Local Authority has an Emergency Planning Team (EP) and out of hours service with contact numbers, information and advice available on the website. During working hours flood event calls are dealt with by the Contact Centre through the Pride in Your Streets and passed to; Emergency Planning, Environment, Housing, or Public Protection. Most of the calls received are directed to Environment Street Scene section because of their responsibilities in regards to highways and land drainage.

In an Emergency flooding event, an established emergency response will be initiated. Flooding events are monitored carefully and co-ordination of information and updates across the various departments, external organisations and emergency responders are very important

The LFRMS has the potential to adversely affect such features, especially aquatic features as a result of any flood management measures that are implemented. Construction, land use change, changes in flood regime and frequency or changes in water levels that have the potential to adversely affect nature conservation and biodiversity features. Conversely, such changes present opportunities to enhance the condition of existing habitats and create new habitats. Trees form important character and functions within areas for biodiversity and drainage and flood risk alleviation. Trees within urban areas and Green Networks are important to flood risk management approach of quality, quantity and amenity.

This page has been intentionally left blank

APPENDIX J: SURFACE WATER CALCULATIONS

This page has been left intentionally blank

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Megan Berry
Site name:	Land east of Tan y Bont, Rhosrobin,
Site location:	Wrexham

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.06794° N
Longitude:	2.99819° W
Reference:	1219511427
Date:	Jan 28 2021 14:41

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 6.51

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.86
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.08

Hydrological characteristics

	Default	Edited
SAAR (mm):	759	759
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 30 years:	1.78	1.78
Growth curve factor 100 years:	2.18	2.18
Growth curve factor 200 years:	2.46	2.46

Notes

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

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

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

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		5.6
1 in 1 year (l/s):		4.93
1 in 30 years (l/s):		9.97
1 in 100 year (l/s):		12.21
1 in 200 years (l/s):		13.78

SURFACE WATER RUN-OFF CALCULATION SHEET

BETTS HYDRO
CONSULTING ENGINEERS

Development	Land east of Tan y Bont, Rhosrobin, Wrexham
Project No.	HYD574

Revision	B	**Completed by**	HB
Date	04/01/2023	**Checked by**	KH

Areas

Total Site	15.780	ha	
Development Area[1]	6.510	ha	
Existing Impermeable	0.000	ha	
Existing Impermeable[2]	0.000	ha	
Existing Pervious	15.780	ha	
Existing Pervious[2]	0.000	ha	
Proposed total impermeable	4.300	ha	66%

Catchment Characteristics

SAAR	773	mm			
SPR	0.51				
BFI	0.86				
i_1	17.5	mm/hr	d_1	21.1	mm
i_{30}	37.5	mm/hr	d_{30}	57.5	mm
i_{100}	49.5	mm/hr	d_{100}	75.9	mm

Run-off Rates

Pre-development

Impermeable ------	1yr	0.0	l/s
	30yr	0.0	l/s
	100yr	0.0	l/s
	40mm/hr[3]	0.0	l/s
Pervious[4] ------	1yr	4.9	l/s
	30yr	10.0	l/s
	100yr	12.2	l/s
	QBar[5]	5.6	l/s
Total ------	1yr	4.9	l/s
	30yr	10.0	l/s
	100yr	12.2	l/s

Post-development (without control)

Impermeable[6] ------	1yr	209.1	l/s
	30yr	448.5	l/s
	100yr+40%CC	827.8	l/s

Volumes

Pre-development

Impermeable ------	1yr	0.0	cu.m
	30yr	0.0	cu.m
	100yr	0.0	cu.m
Pervious[4] ------	1yr	627.3	cu.m
	30yr	1443.7	cu.m
	100yr	1954.4	cu.m
Total ------	1yr	627.3	cu.m
	30yr	1443.7	cu.m
	100yr	1954.4	cu.m

Post-development

Impermeable[6] ------	1yr	905.2	cu.m
	30yr	2471.2	cu.m
	100yr	3262.4	cu.m

1/ The 'development area' removes areas of POS and/or landscaped areas of the wider site that are to remain as existing.
2/ On occasion the existing impermeable area cannot be evidenced to connect and a reduction is applied.
3/ 50mm/hr is used for BRegs calculations and often used by Water Companies when considering allowable post-development rates of discharge. (Rational Method)
4/ The Greenfield rates and of run-off have been calculated using the UK SUDS Calculator
5/ QBar is the estimated flood flow for the 2.33yr return period event and is often used as a post-development rate restriction.

6/ Post-development run-off is only considered from the impermeable area when the proposed post-development impermeable area >50% in accordance with the EA Guidance Preliminary rainfall runoff management for developments (W5-074/A/TR1/1 rev E (2012).

NB. The catchment characteristics are from the FEH catchment, the UK SUDS Calculator and Microdrainage.
NB. The rainfall intensities and depths are calculated for the 6hr duration rainfall event (peak summer intensity)

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.000
Ratio R	0.322
Areal Reduction Factor	1.00
Area (ha)	6.510
SAAR (mm)	773
CWI	114.419
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	48.29
Greenfield Runoff Volume (m^3)	1954.408

Greenfield Runoff Volume

FSR Data

Return Period (years)	30
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.000
Ratio R	0.322
Areal Reduction Factor	1.00
Area (ha)	6.510
SAAR (mm)	773
CWI	114.419
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	46.27
Greenfield Runoff Volume (m^3)	1443.709

Greenfield Runoff Volume

FSR Data

Return Period (years)	1
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	18.000
Ratio R	0.322
Areal Reduction Factor	1.00
Area (ha)	6.510
SAAR (mm)	773
CWI	114.419
Urban	0.000
SPR	47.000

Results

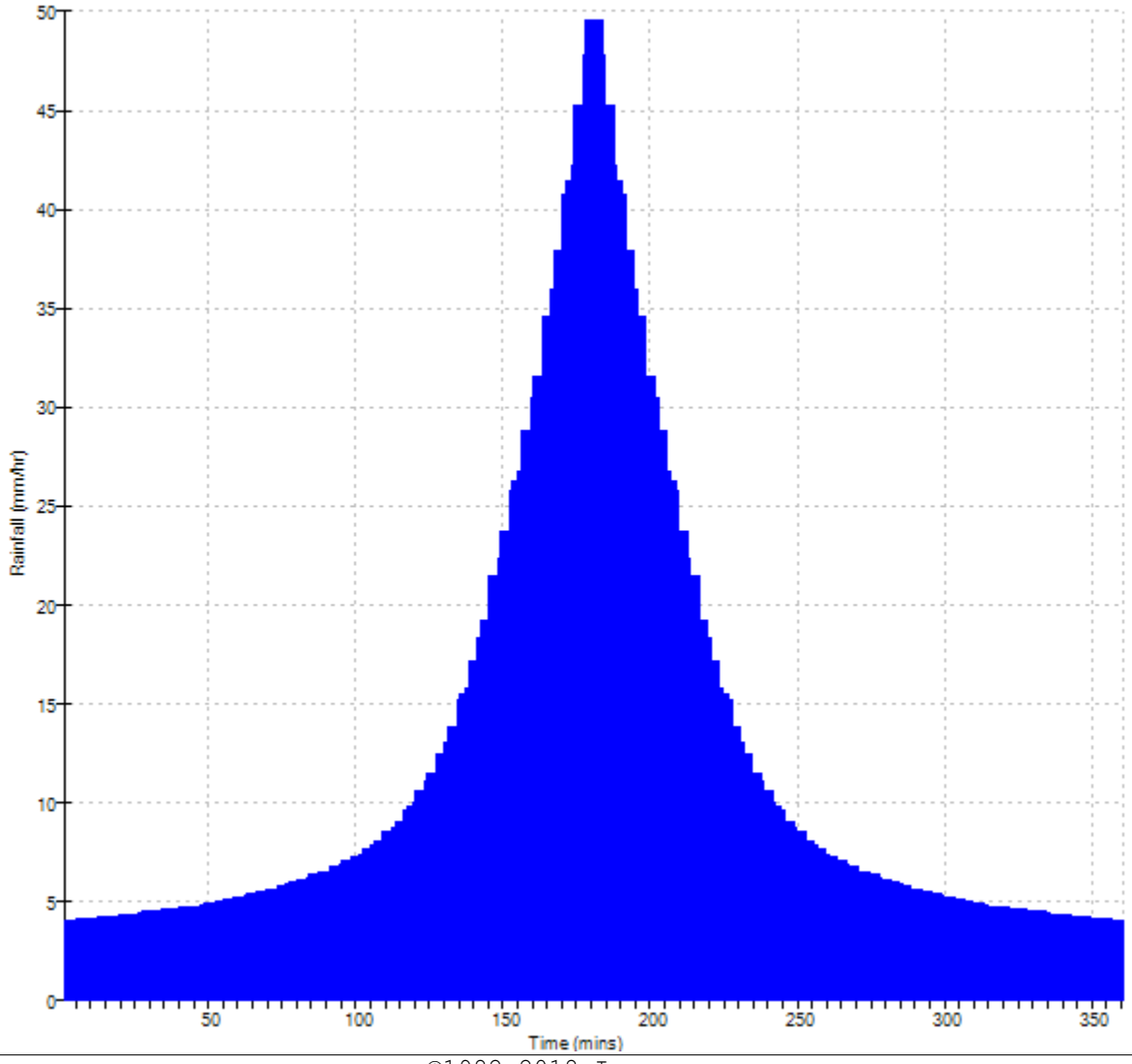
Percentage Runoff (%)	44.35
Greenfield Runoff Volume (m^3)	627.315

Rainfall profile

Storm duration (mins) 360

FEH Data

FEH Rainfall Version	2013
Site Location	GB 333264 352762 SJ 33264 52762
Data Type	Point
Peak Intensity (mm/hr)	49.568
Ave. Intensity (mm/hr)	12.645
Return Period (years)	100.0

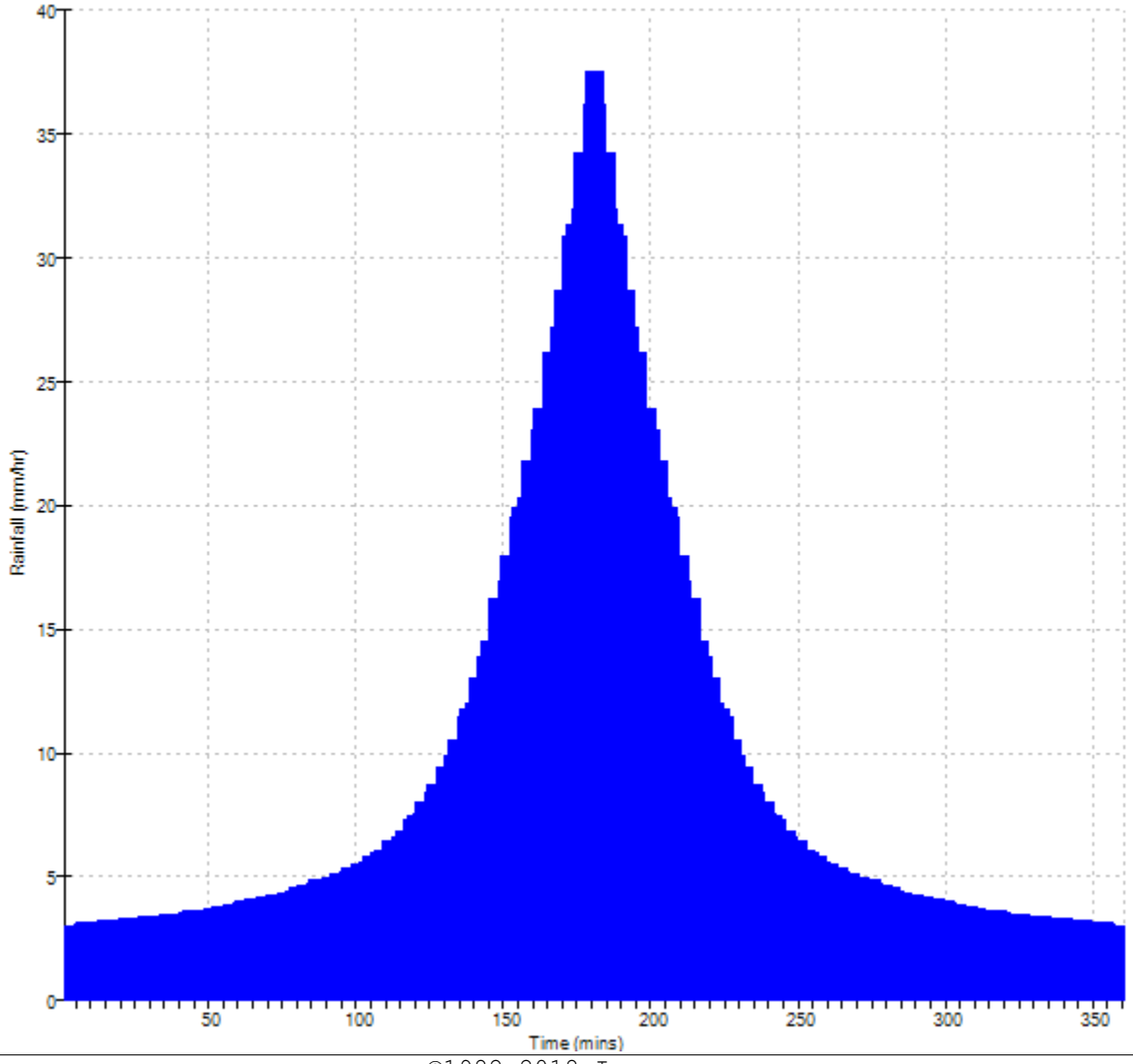


Rainfall profile

Storm duration (mins) 360

FEH Data

FEH Rainfall Version	2013
Site Location	GB 333264 352762 SJ 33264 52762
Data Type	Point
Peak Intensity (mm/hr)	37.546
Ave. Intensity (mm/hr)	9.578
Return Period (years)	30.0

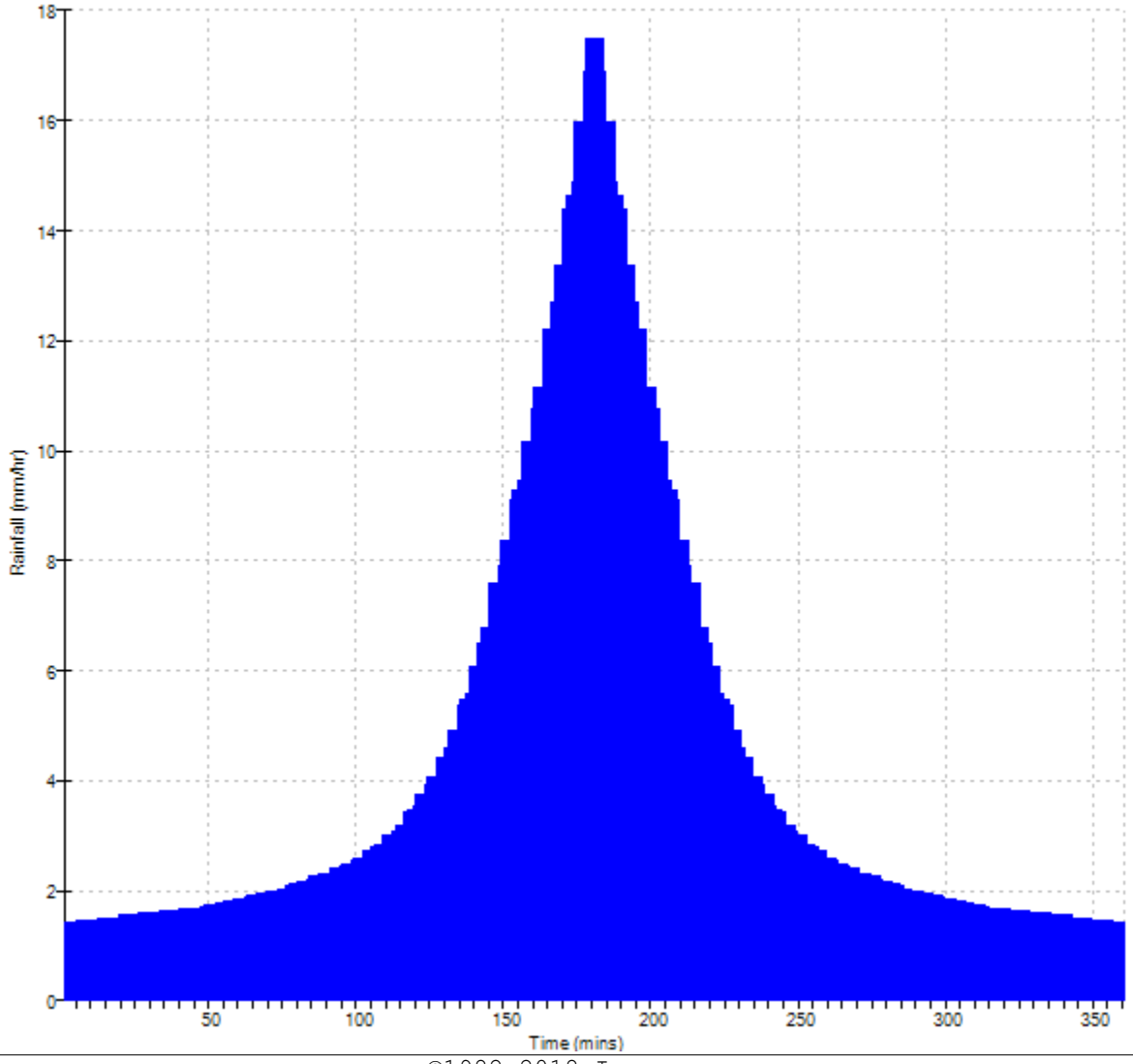


Rainfall profile

Storm duration (mins) 360

FEH Data

FEH Rainfall Version	2013
Site Location	GB 333264 352762 SJ 33264 52762
Data Type	Point
Peak Intensity (mm/hr)	17.505
Ave. Intensity (mm/hr)	4.466
Return Period (years)	2.0



This page has been intentionally left blank

APPENDIX K: DRAINAGE PLANS

This page has been left intentionally blank

DO NOT SCALE

LEGEND

- Site Boundary
- Wat's Dyke
- Railway
- Public Foul Water MH
- Public Foul Water Sewer

Topogrphis Survey

REV	DATE	BY	DESCRIPTION	CHK
A	21/01/21	KW	PRELIMINARY FOR REVIEW	RN

DRAWING STATUS:

BETTS HYDRO
CONSULTING ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 enquiries@betts-associates.co.uk

Castle Green HOMES

PROJECT:

Land East of Tan y Bont,
Main Road, Rosrobin,
Wrexham

TITLE:

Pre-Development
Drainage Plan

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
JAN 2021	NTS @ A3	MB	RN

PROJECT No:	DRAWING No:	REV:
HYD574	200	A

DO NOT SCALE

LEGEND

- Planning Application Boundary
- Development Area
- Railway
- Wat's Dyke
- Public Foul Water Sewer
- Proposed Surface Water Sewer
- Permeable Driveways
- Infiltration Basin
- Proposed Foul Water Sewer

REV	DATE	BY	DESCRIPTION	CHK
D	09/01/23	HB	PRELIMINARY FOR REVIEW	KH

DRAWING STATUS:

BETTS HYDRO
CONSULTING ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 enquiries@betts-associates.co.uk

Castle Green HOMES

PROJECT:

Land East of Tan y Bont,
Main Road, Rosrobin,
Wrexham

TITLE:

Preliminary Drainage Strategy

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
JAN 2023	NTS @ A3	HB	KH

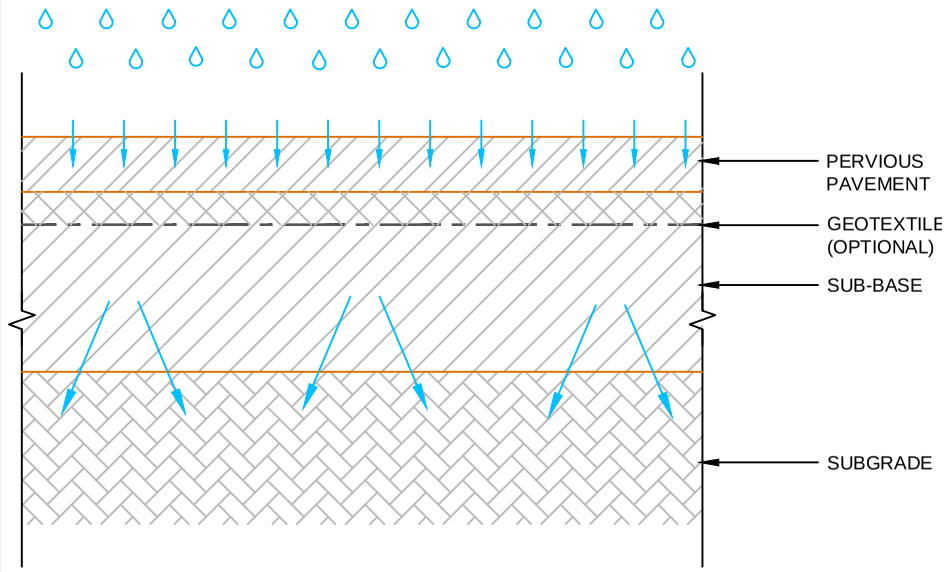
PROJECT No:	DRAWING No:	REV:
HYD574	201	D

This page has been intentionally left blank

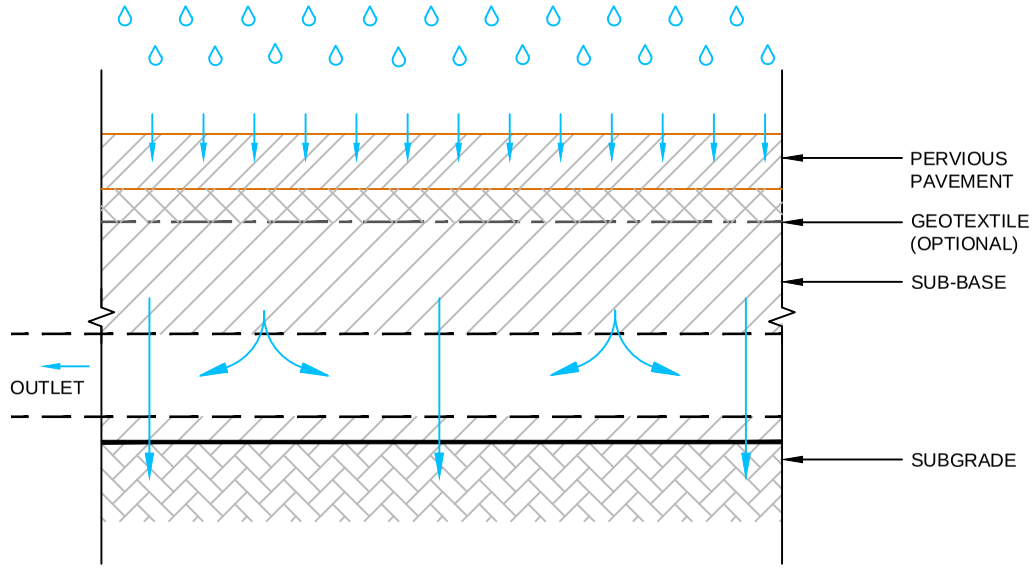
APPENDIX L: SUDS EXAMPLES

This page has been left intentionally blank

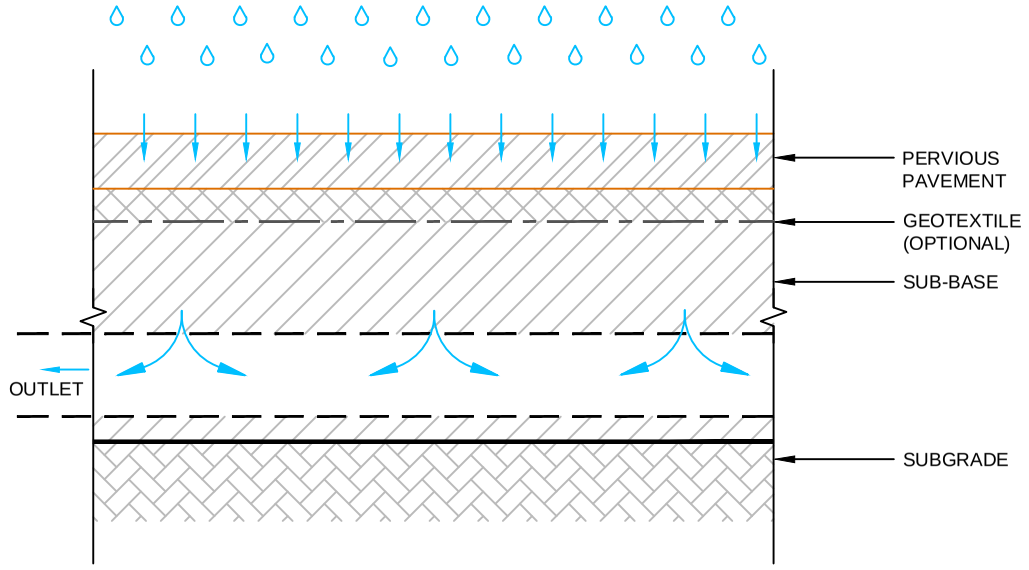
DO NOT SCALE



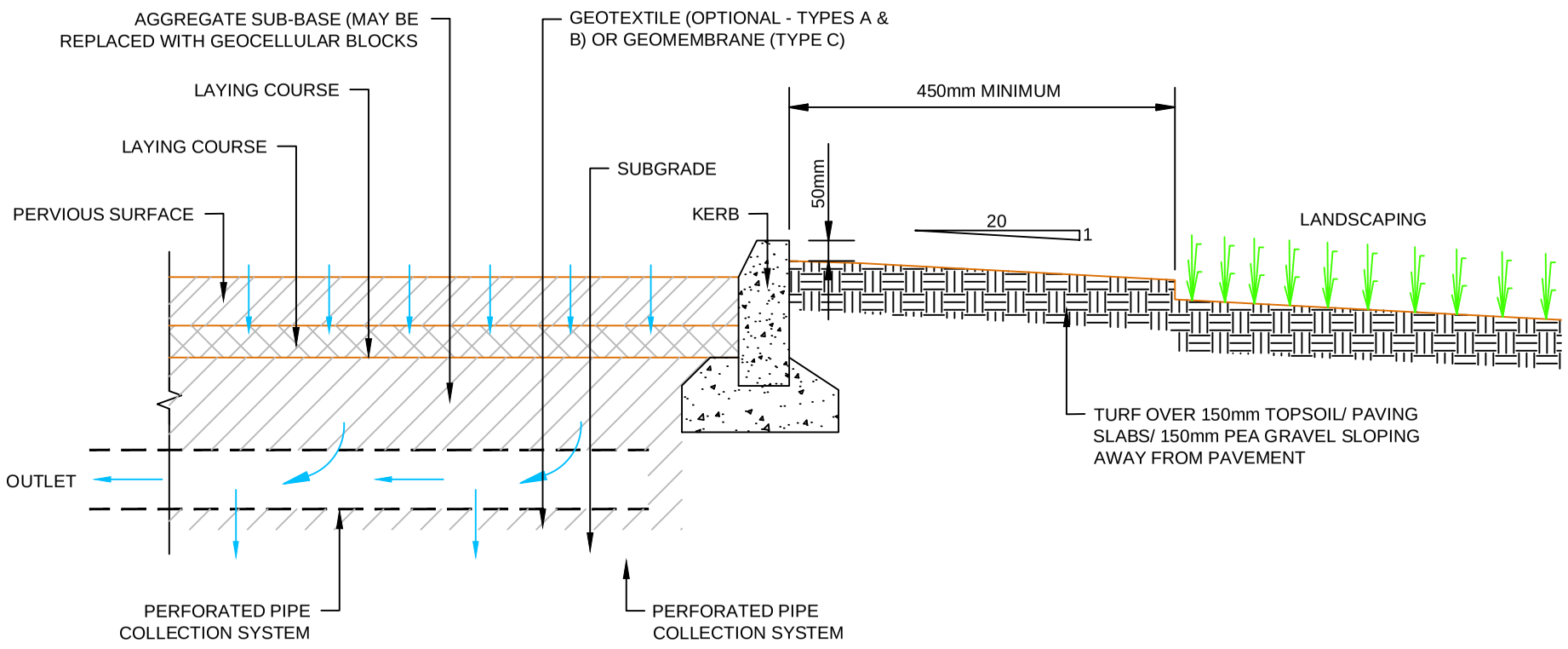
TYPE A: TOTAL INFILTRATIPN



TYPE B: PARTIAL INFILTRATION



TYPE C: NO INFILTRATION



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

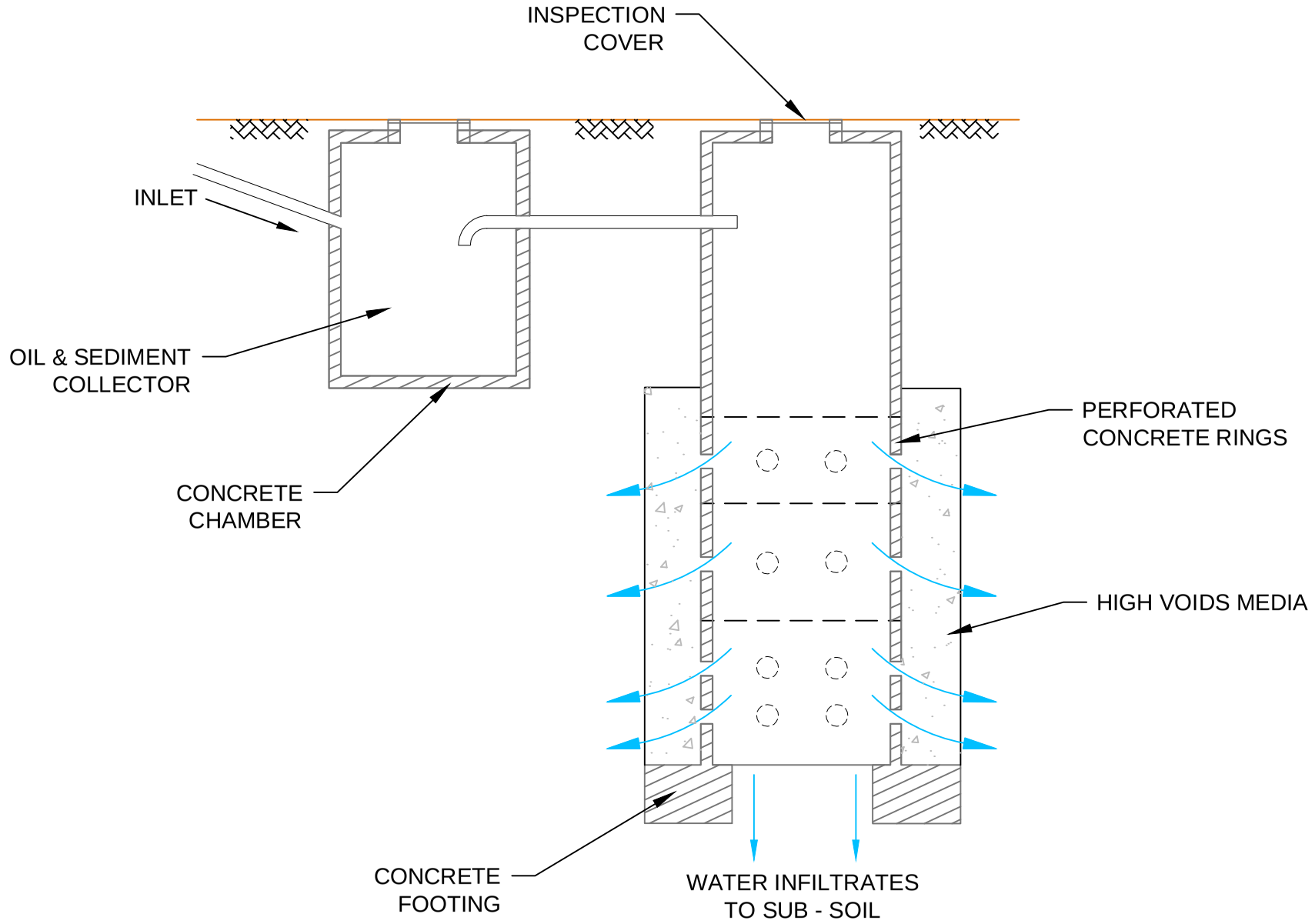
PROJECT: TYPICAL SUDS DETAIL

TITLE: PERVIOUS PAVEMENTS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	105	A

DO NOT SCALE



SOAKAWAY DETAILS (INCLUDING PRE-TREATMENT DEVICE)

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

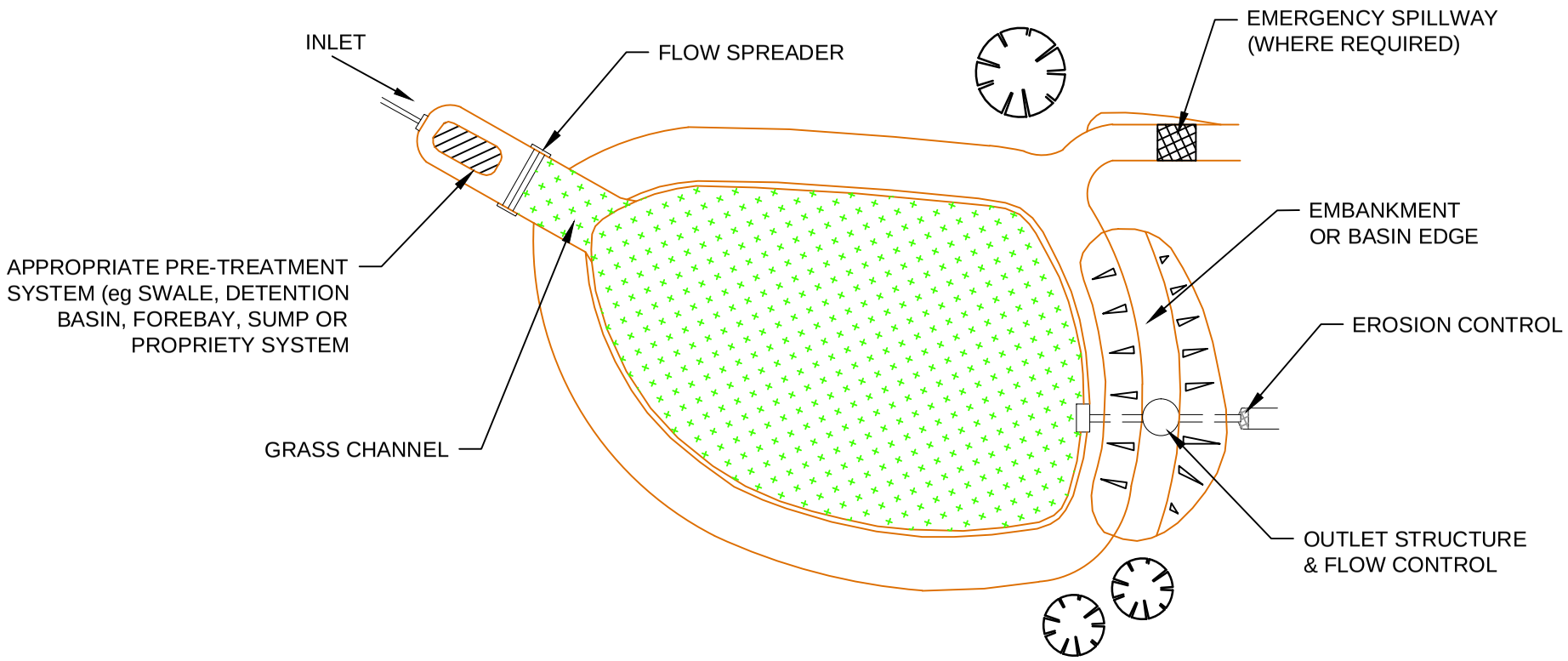
PROJECT: TYPICAL SUDS DETAIL

TITLE: SOAKAWAYS

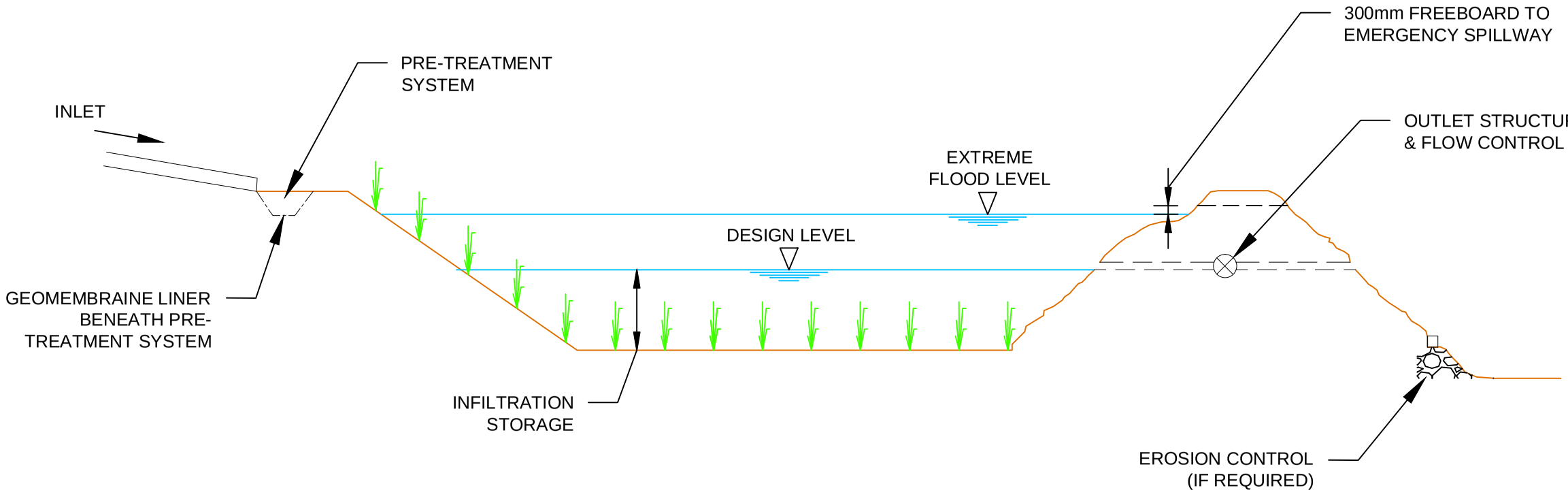
DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	108	A

DO NOT SCALE



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

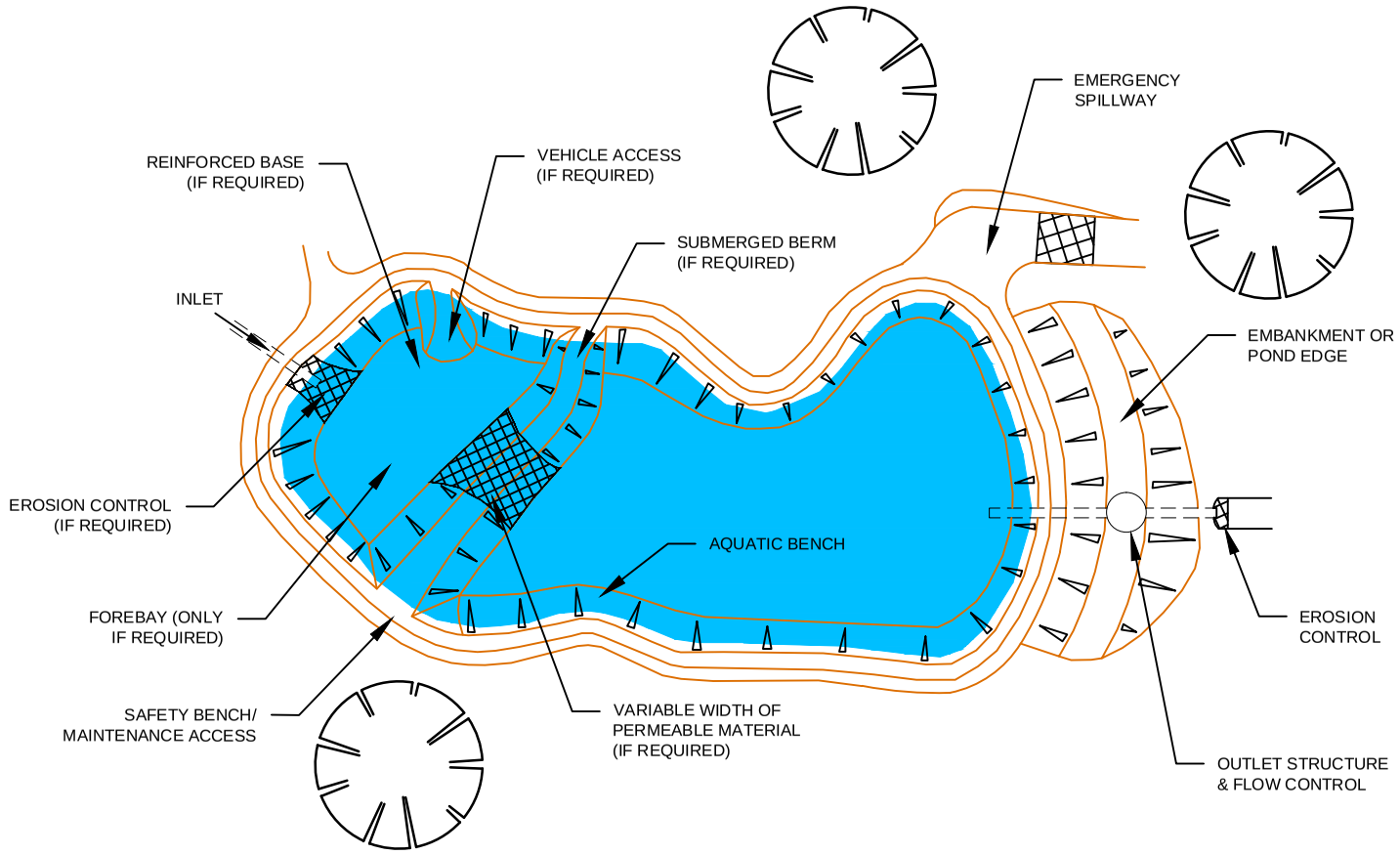
PROJECT: TYPICAL SUDS DETAIL

TITLE: INFILTRATION BASINS

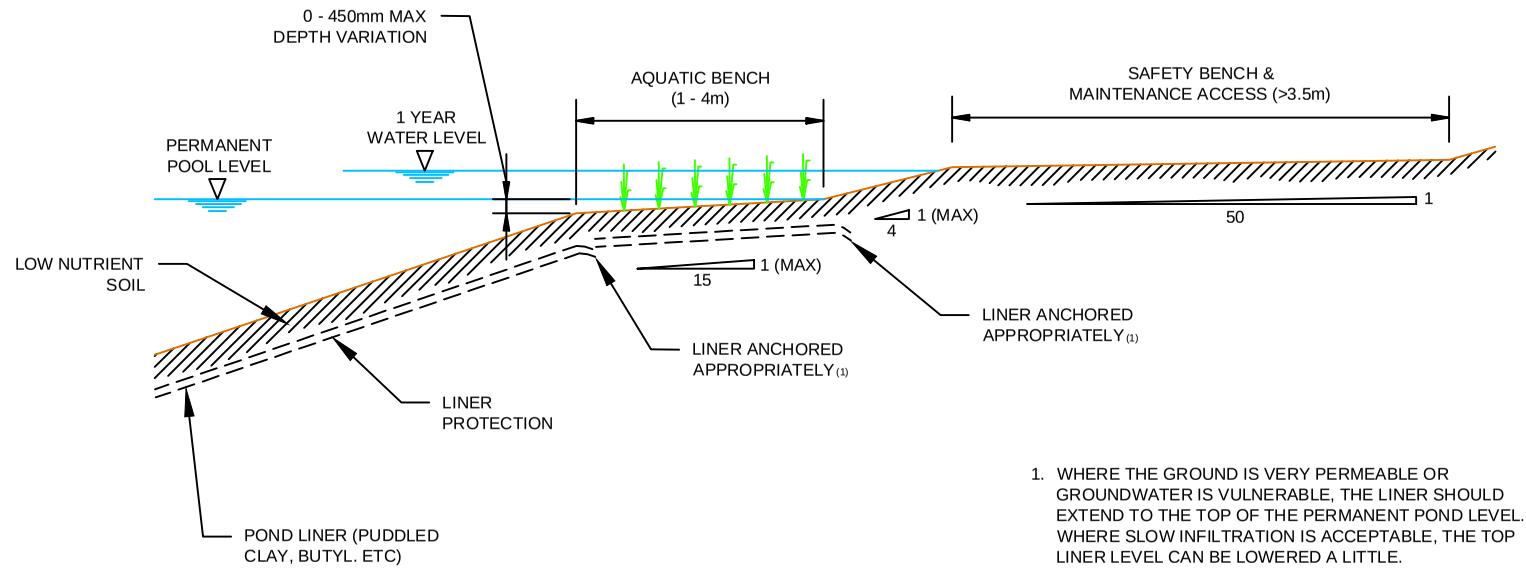
DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	109	A

DO NOT SCALE

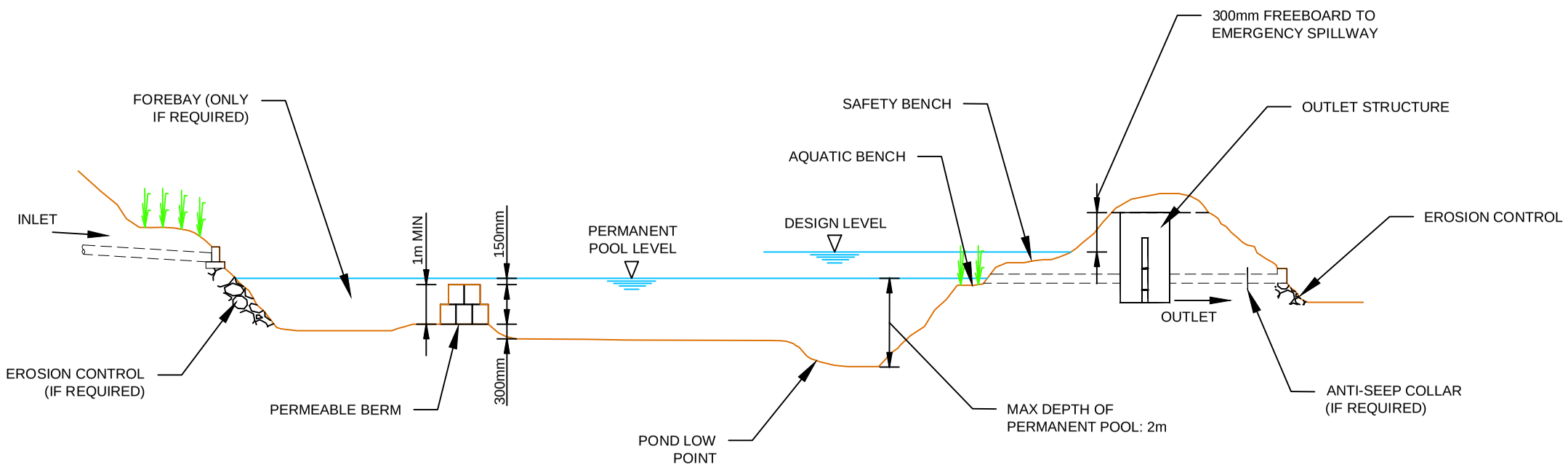


PLAN VIEW



1. WHERE THE GROUND IS VERY PERMEABLE OR GROUNDWATER IS VULNERABLE, THE LINER SHOULD EXTEND TO THE TOP OF THE PERMANENT POND LEVEL. WHERE SLOW INFILTRATION IS ACCEPTABLE, THE TOP LINER LEVEL CAN BE LOWERED A LITTLE.

TYPICAL POND EDGE GEOMETRY



PROFILE

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

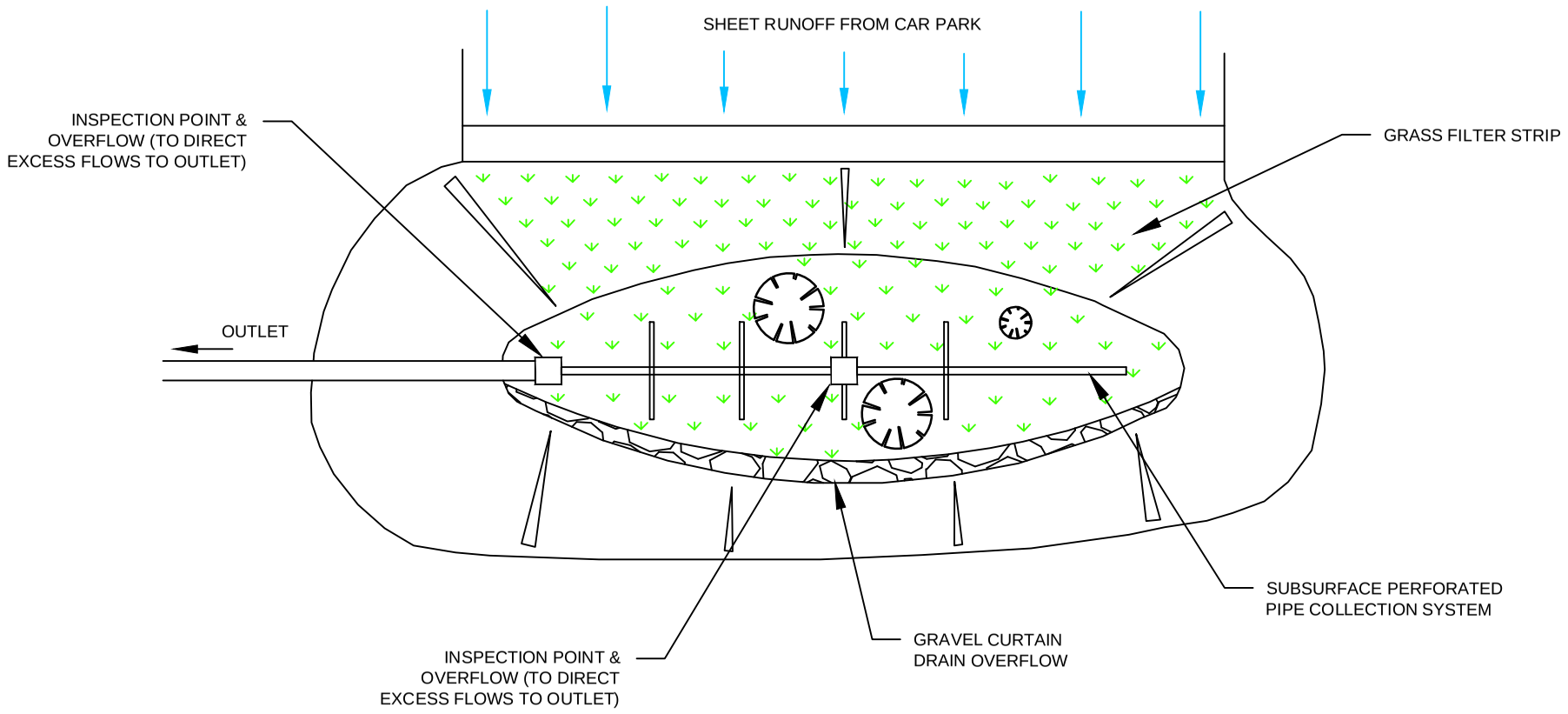
PROJECT: TYPICAL SUDS DETAIL

TITLE: WET PONDS

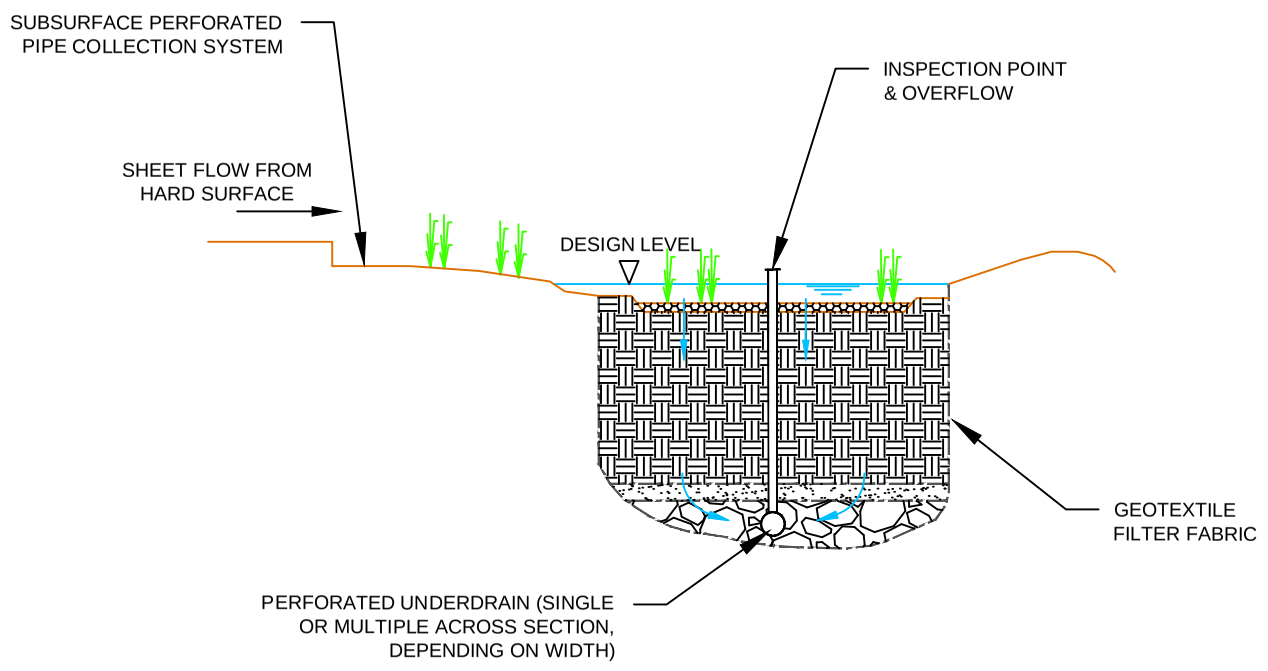
DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	111	A

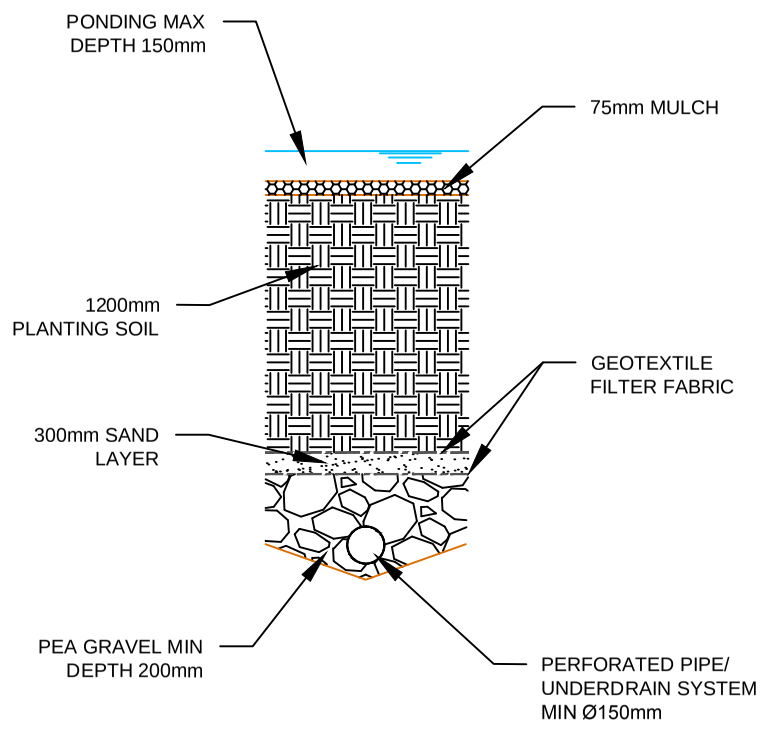
DO NOT SCALE



PLAN VIEW



PROFILE



TYPICAL SECTION

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: BIORETENTION APPLICATIONS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	112	A

APPENDIX M: 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.

This report was prepared by Betts Hydro Ltd for the sole and exclusive use of the titled client in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

This document has been prepared for the titled project only and should any third party wish to use or rely upon the contents of the report, written approval from Betts Hydro Ltd must be sought.

Betts Hydro Ltd accepts no responsibility or liability for the consequences of this document being used for the purpose other than that for which it was commissioned and for this document to any other party other than the person by whom it was commissioned.