

57 BRYN GLAS, RHOSLLANERCHRUGOG

FLOOD CONSEQUENCES ASSESSMENT

Final Report v1.1

July 2019

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Report Title **57 Bryn Glas, Rhosllanerchrugog**
Flood Consequences Assessment
Final Report v1.1

Client Dave Cottle Civil Engineering Ltd

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1 INTRODUCTION

1.1 PURPOSE OF REPORT

Weetwood Services Ltd ('Weetwood') has been instructed by Dave Cottle Civil Engineering Ltd to prepare a Flood Consequences Assessment (FCA) report for the proposed redevelopment of land at 57 Bryn Glas, Rhosllanerchrugog.

The assessment has been undertaken in accordance with the requirements of Technical Advice Note 15 (TAN15).

This report has been prepared in support of planning application P/2018/1047 and has been updated to address the comments within the Natural Resources Wales (NRW) consultation response letter dated 10 July 2019 (Ref: CAS-90953-R5W4).

1.2 STRUCTURE OF THE REPORT

The report is structured as follows:

- | | |
|------------------|---|
| Section 1 | Introduction and report structure |
| Section 2 | Presents national and local flood risk and drainage planning policy |
| Section 3 | Provides background information relating to the development site, the development proposals, ground conditions and existing site access arrangements |
| Section 4 | Assesses the potential sources of flooding to the development site |
| Section 5 | Presents flood risk mitigation measures based on the findings of the assessment |
| Section 6 | Addresses the effect of the proposed development on surface water runoff and presents an illustrative surface water drainage scheme to ensure that surface water runoff is sustainably managed and flood risk is not increased elsewhere. |
| Section 7 | Presents a summary of key findings |
| Section 8 | Presents the recommendations |

2 PLANNING POLICY AND GUIDANCE

2.1 NATIONAL PLANNING POLICY AND GUIDANCE

2.1.1 Technical Advice Note 15

The general approach of TAN15 is to set out a precautionary framework to guide planning decisions in areas at high risk of flooding. The overarching aim of the framework is, in order of preference, to:

- Direct new development away from those areas which are at a high risk of flooding.
- Where development has to be considered in high risk areas (i.e. Zone C) only those development which can be justified should be located in such areas.

2.1.1.1 Justification Test

In accordance with Paragraph 6 of TAN15 for the Justification Test to be passed it must be demonstrated that:

- i. Its location in Zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement; **or**,
- ii. Its location in Zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;

and,

- iii. It concurs with the aims of Planning Policy Wales (PPW) and meets the definition of previously developed land (PPW Fig 2.1); and,
- iv. The potential consequences of a flooding event for the particular type of development have been considered, and in terms of the criteria contained in sections 5 and 7 and appendix 1 found to be acceptable.

2.1.1.2 Surface Water Drainage

TAN15 provides an overview of the requirements for the management of surface water to ensure that development does not increase flood risk at the site or elsewhere.

Paragraph 8.3 of TAN15 states that *"the aim should be for new development not to create additional run-off when compared with the undeveloped situation, and for redevelopment to reduce runoff where possible. It is accepted that there may be practical difficulties in achieving this aim"*.

2.1.2 Welsh Government

2.1.2.1 Climate Change Allowances for Planning, August 2016

A consultation letter¹ and supporting guidance note² issued by Welsh Government in August 2016 sets out allowances for climate change for use in FCAs submitted in support of planning applications.

¹ Welsh Government consultation letter 23 August, 2016 (Ref: CL-03-16)

When considering new development proposals, TAN15 states that it is necessary to take account of the potential impact of climate change over the lifetime of development. The Welsh Government guidance note states that *"residential development is assumed to have a lifetime of 100 years while a lifetime of 75 years is assumed for non-residential developments. To ensure future development can provide a safe and secure living and /or working environment throughout its lifetime, national planning policy requires proposals in areas of high flood risk to be accompanied by an assessment of flooding consequences to and from the development, taking into account the impacts of climate change"*.

The climate change allowances detailed within the Welsh Government guidance note are informed by latest available information on climate change projections and allowances are provided for different epochs (periods) of time over the next century.

The guidance note should be applied to planning applications (full, outline and reserved matters) submitted from 1 December 2016.

2.1.2.1 Statutory Standards for Sustainable Drainage Systems

For applications submitted from 7 January 2019, the Flood and Water Management Act 2010 (Schedule 3) requires new developments to include Sustainable Drainage Systems (SuDS) features that comply with national standards.

New developments of more than one dwelling or where the area covered by construction work equals or exceeds 100 m² require approval before construction can commence from the SuDS Approval Body (SAB) to ensure compliance with the SuDS standards.

The SAB will also be required to adopt the SuDS unless the scheme serves only a single property or is a publically maintained road to which Section 41 of the Highways Act 1980 applies.

The statutory standards are as follows:

Standard 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 is discharged to a surface water body;
- Priority Level 4: Surface Water is discharged to surface water sewer, highway drain, or another drainage system;
- Priority Level 5: Surface water runoff is discharged to a combined sewer.

Standard 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 5 mm.
2. The surface water runoff rate for the 1:1 annual probability 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 1:100 annual probability event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.

² <https://gov.wales/docs/desh/publications/160831guidance-for-flood-consequence-assessments-climate-change-allowances-en.pdf>

4. The surface water runoff for events up to the 1:100 annual probability (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 1:100 annual probability 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.

Standard S3; Surface water quality management

Treatment for surface water runoff should be provided to prevent negative impacts on the receiving water quality and/or protect downstream drainage systems, including sewers.

Standard S4; Amenity

The design of surface water management systems should maximise amenity benefits.

Standard S5; Biodiversity

The design of the surface water management system should maximise biodiversity benefits.

Standard S6; Design of drainage or construction, operation and maintenance

1. All elements of the surface water drainage system should be designed so that they can be constructed easily, safely, cost-effective, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
2. All elements of the surface water drainage system should be designed to ensure maintain and operation can be undertaken (by the relevant responsible body) easily, safely, cost-effective, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
3. The surface water drainage system should be designed to ensure structural integrity of all elements under anticipated loading conditions over the design life of the development site, taking into account the requirement for reasonable levels of maintenance.

2.2 LOCAL PLANNING POLICY AND GUIDANCE

The Wrexham County Borough Council (WCBC) Unitary Development Plan (UDP) 1996 to 2011 expired at the end of 2015; however, this remains the adopted development plan for the county.

The Wrexham County Borough Council (WCBC) has submitted the Local Development plan (LDP) 2013-2028 to the Welsh Government. The LDP will replace the current Unitary Development plan, once adopted by Welsh Government.

The following policy is relevant in respects of flood risk:

Policy EC12 - Development and Flood Risk

Development (including the raising of land) within the defined flood plains will only be permitted if it:-

- a) Would not be subject to an unacceptable risk of flooding on-site; and/or
- b) Does not result in unacceptable risk of flooding on or off-site; and/or
- c) Does not adversely affect flood management or maintenance

WCBC is currently preparing a Local Development Plan (LDP) which will replace the current adopted UDP in spring 2019.

2.3 CONSENTS

An Environmental Permit for Flood Risk Activities may be required from the NRW for work:

- In, under, over or near a main river (including where the river is in a culvert)
- On or near a flood defence on a main river
- In the flood plain of a main river
- On or near a sea defence

Further information can be found at <https://naturalresources.wales/apply-for-a-permit/flood-risk-activities/flood-risk-activity-permits-information/?lang=en>.

If the location of an activity is on any watercourse that lies within an Internal Drainage District (IDD) an application will need to be made to NRW for a Flood Risk Activity Permit.

Ordinary Watercourse Consent may be required from the lead local flood authority for work to an ordinary watercourse. Undertaking activities controlled by local Byelaws (made under the Water Resources Act 1991) also requires the relevant consent.

2.4 RELEVANT DOCUMENTS

The assessment has been informed by the following documents:

- Local Flood Risk Management Strategy (LFRMS), WCBC, April 2013
- Preliminary Flood Risk Assessment (PFRA), WCBC, November 2017

3 SITE DETAILS AND PROPOSED DEVELOPMENT

3.1 SITE LOCATION

The site is located at the end of Bryn Glas in Rhosllanerchrugog at Ordnance Survey National Grid Reference SJ 289 459, as shown in **Figure 1**. The site is approximately 0.1 hectares (ha) in area.

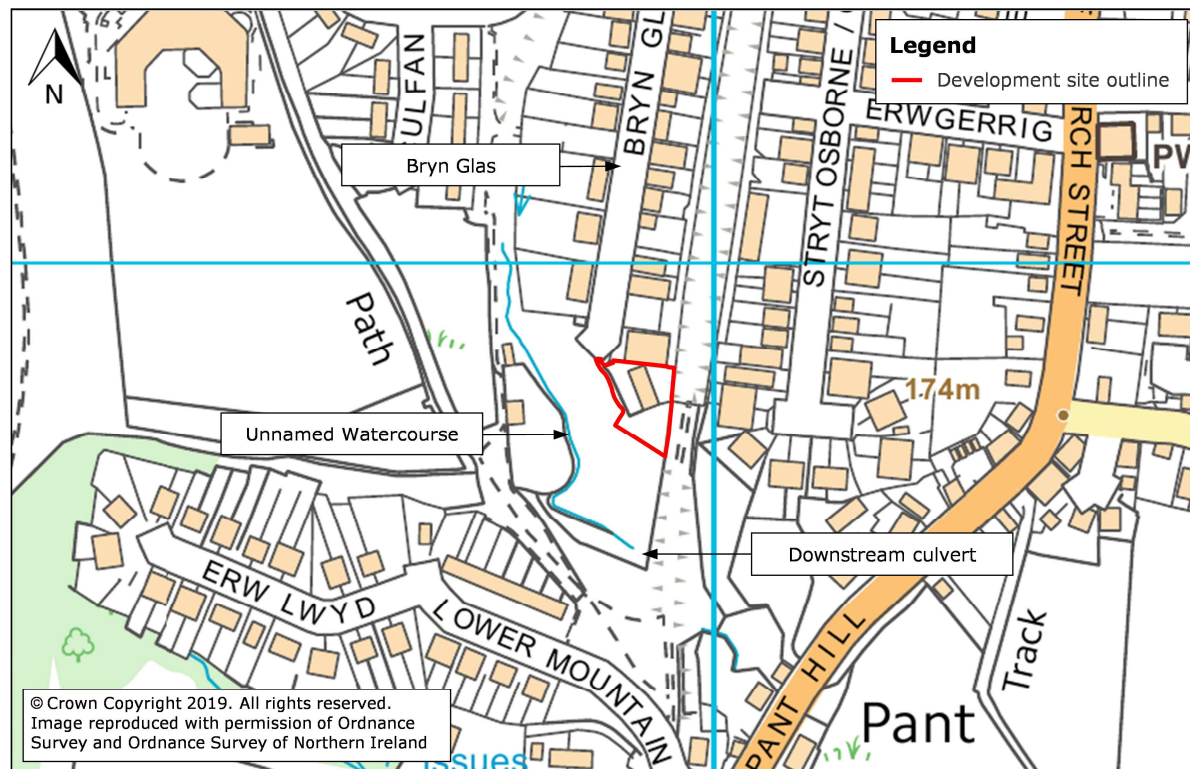


Figure 1: Site Location

3.2 EXISTING AND PROPOSED DEVELOPMENT

The existing site consists of a dwelling and associated hardstanding, along with some undeveloped land in the southern section of the site.

The proposed development is for the construction of three residential dwellings, along with an access road, associated hardstanding and amenity areas (**Appendix A**).

TAN15 classifies residential development as 'highly vulnerable' land use³.

3.3 WATERBODIES IN THE VICINITY OF THE SITE

There is an unnamed watercourse located approximately 20 m west of the site; this flows in a predominantly southerly direction and is classified as an 'ordinary watercourse'.

³ TAN15, Figure 2

The watercourse flows in open channel when parallel to the site, prior to entering a culvert approximately 40 m south of the site (**Figure 2**). The watercourse is also culverted upstream of the site, through the residential areas to the north.

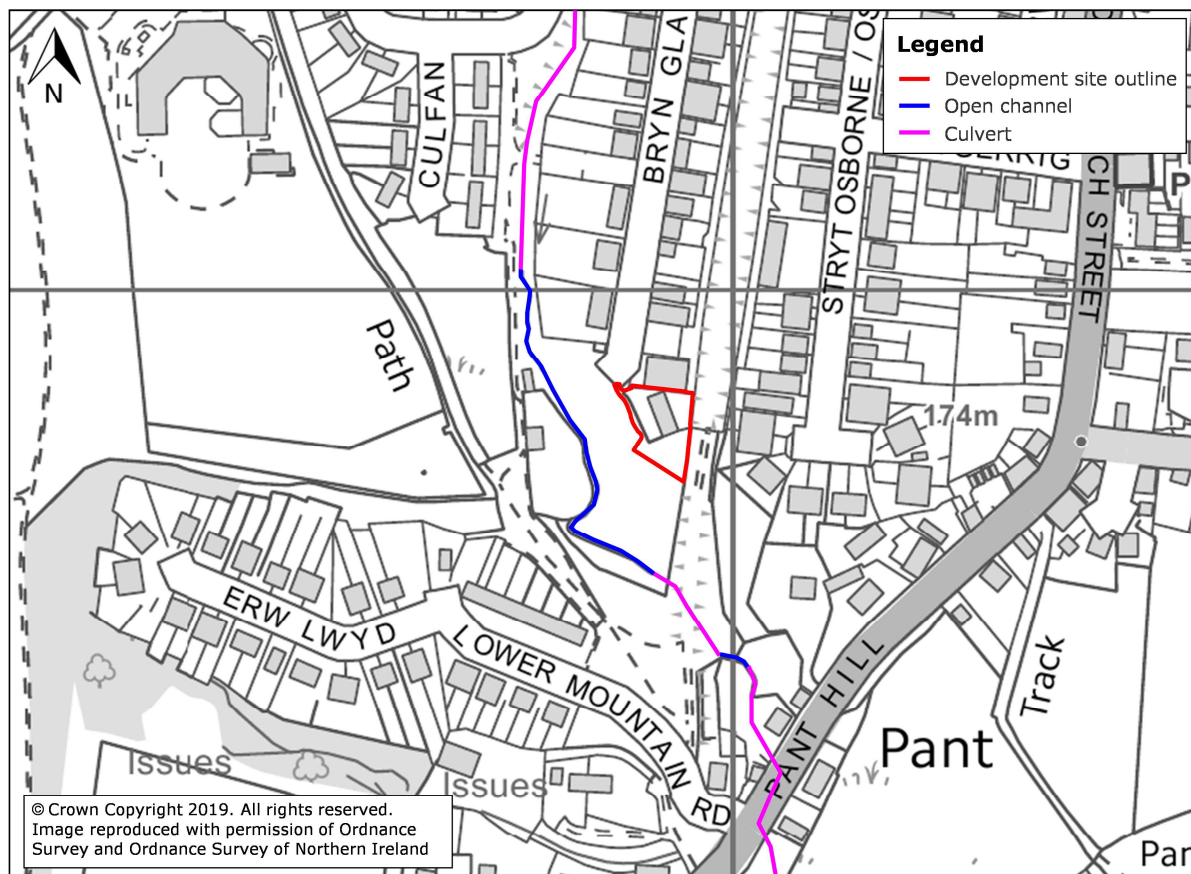


Figure 2: Ordinary Watercourse

3.4 GROUND CONDITIONS

According to the Soilscares maps produced by the National Soils Research Institute⁴, soil conditions at the site and within the surrounding area are described as 'slightly acid loamy and clayey soils with impeded drainage'.

British Geological Survey (BGS) borehole records⁵ located approximately 30 m south-west of the site identifies layers of sandy clay, sand and gravel, and boulder clay.

BGS Surface Geology mapping⁶ indicates the underlying bedrock formation comprises 'Mudstone, Siltstone and Sandstone', which is overlain by 'Till, Devensian - Diamicton' superficial deposits.

The site is shown to be located within a Secondary A bedrock aquifer.

⁴ Soilscares www.landis.org.uk/soilscares/

⁵ www.bgs.ac.uk/data/boreholescans/home.html, Ref: SJ24NE1122

⁶ <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

3.5 SITE LEVELS

Existing ground levels are provided on the development proposals in **Appendix A** (existing levels in are in grey).

These indicate ground levels within the site boundary are in the region of 165.41 to 169.78 m AOD, rising from south-west to north-east.

LiDAR data has been utilised to develop a digital elevation model as illustrated in **Figure 3**, to give an indication of site levels in the context of the surrounding area.

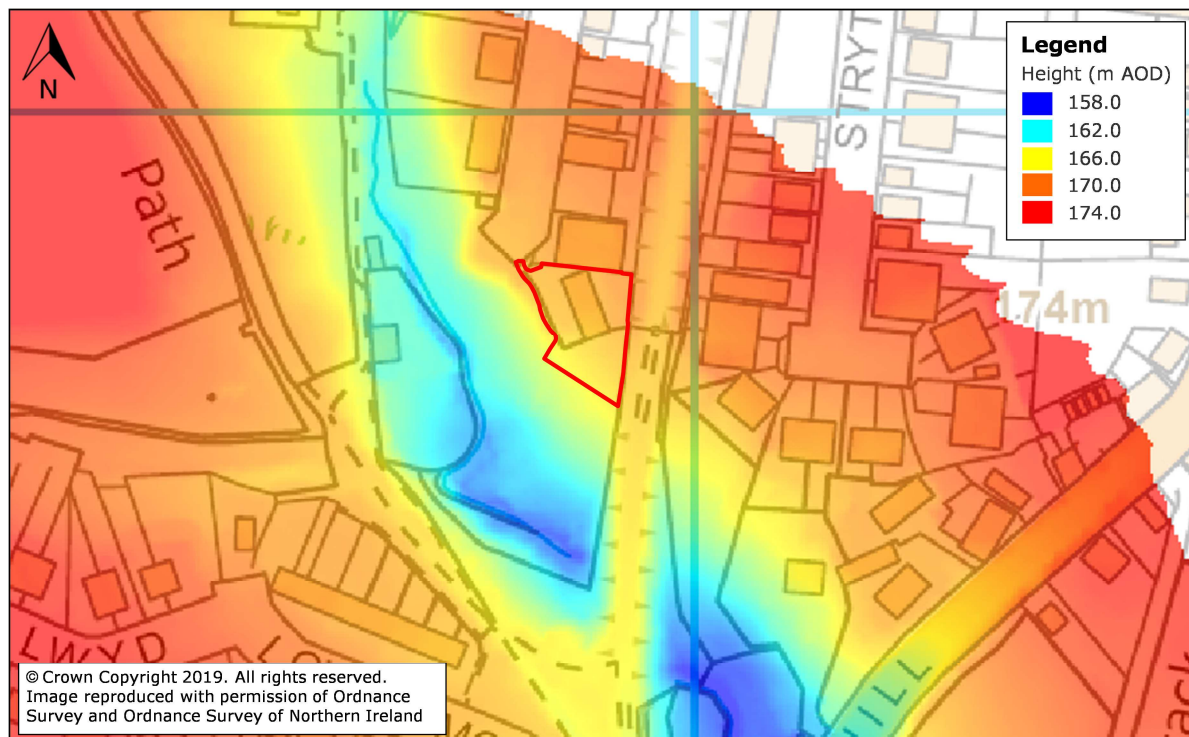


Figure 3: LiDAR

3.6 ACCESS AND EGRESS

Access and egress to the site is provided via Bryn Glas.

Levels along Bryn Glas are in the region of 168.7 to 171.4 m AOD.

4 REVIEW OF FLOOD RISK

4.1 FLOOD ZONE DESIGNATION

Flood zones refer to the probability of river and sea flooding. TAN15 defines flood zones as follows:

- Zone A: Considered to be at little or no risk of fluvial or tidal/coastal flooding.
- Zone B: Areas known to have been flooded in the past evidenced by sedimentary deposits.
- Zone C: Based on [the Natural Resources Wales] flood outline, equal to or greater than 0.1% (river, tidal or coastal). Zone C is subdivided into the following two zones:
 - Zone C1: Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.
 - Zone C2: Areas of the floodplain without significant flood defence infrastructure.

The flood zones are shown on the Development Advice Map. The zones do not account for possible future changes in flooding due to the impact of climate change or the presence of flood defences (although areas benefitting from flood defences may be indicated).

According to the Development Advice Map (**Figure 4**) the site is located in Zone A.

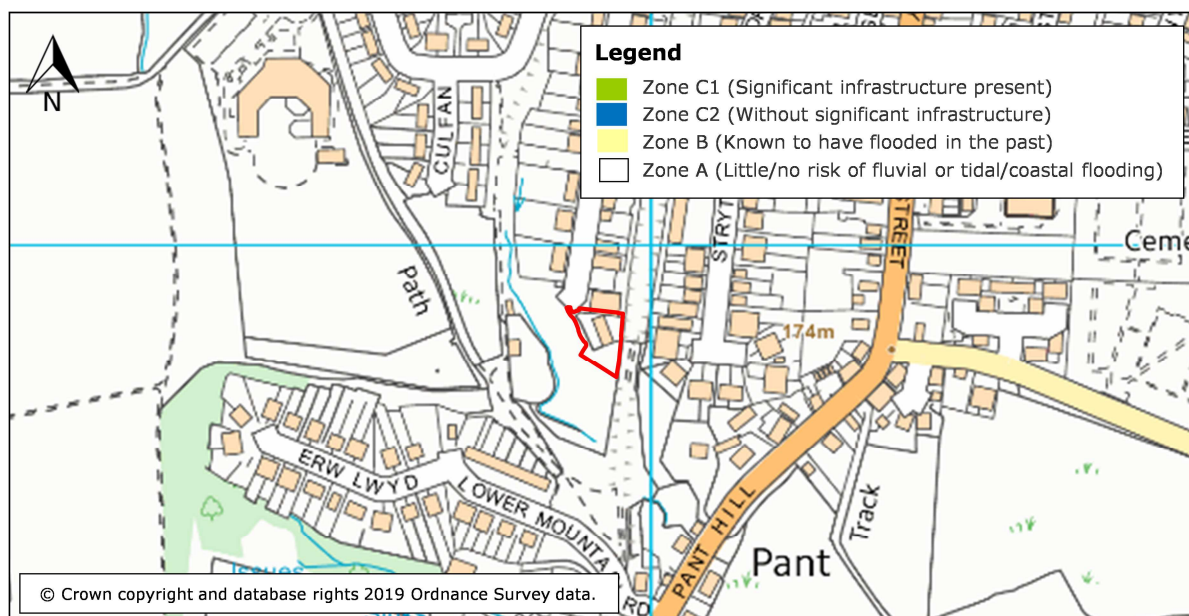


Figure 4: Development Advice Map
(Source: NRW website)

The Flood Risk Map (Rivers and Sea) (**Figure 5**) indicates that the site is located outside the 1:1,000 annual probability flood outline, thereby supporting the site's Zone A designation.

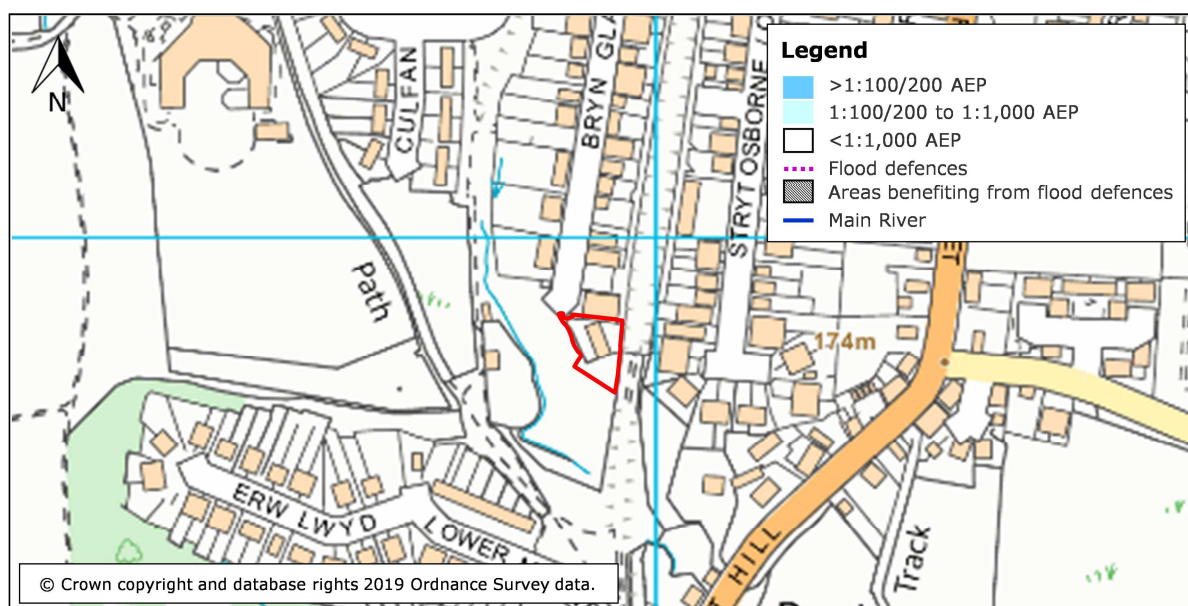


Figure 5: Flood Risk Map (Rivers and Sea)
(Source: NRW website)

4.2 HISTORICAL RECORDS OF FLOODING

According to NRW historic flood outlines⁷, there are no records of the site previously being affected by flooding.

4.3 FLUVIAL FLOOD RISK - UNNAMED WATERCOURSE

As discussed in **Section 3.3**, the unnamed watercourse is located 20 m to the west of the site.

The flood risk posed by the unnamed watercourse is not accurately represented on the NRW Flood Risk Map or on the Development Advice Map, due to its small catchment size.

In order to more accurately identify and assess the level of flood risk from the watercourses at the site a 1D-2D ESTRY-TUFLOW hydraulic model has been developed by Weetwood. Details of the hydraulic modelling study are provided in **Appendix B**.

4.3.1 Modelled Flood Levels - Baseline

The following events were modelled in order to establish the baseline scenario:

- 1:100 annual probability event
- 1:100 plus climate change (+CC) (20%) annual probability event
- 1:100 +CC (45%) annual probability event
- 1:1,000 annual probability event

Model output plots are provided in Annex D of **Appendix B**.

No flooding of the site would be expected during the 1:100, 1:100 +CC (20%) and 1:100 +CC (45%) annual probability events.

⁷ <http://lle.gov.wales/catalogue/item/HistoricFI/?lang=en>

The modelled peak flood level within the site boundary for the 1:1,000 annual probability event is provided in **Table 1**.

Table 1: Modelled Flood Level – Baseline

Annual Probability Event	Max Level (m AOD)
1:1,000	165.73

Some minor flooding of the south-western extremity of the site may be expected to a maximum depth of 0.32 m during the 1:1,000 annual probability flood event.

No flooding Bryn Glas would be expected in any of the aforementioned events

4.3.2 Structure Blockage

The Weetwood modelling study also assessed the impact of a 100% culvert blockage of the downstream culvert.

A 100% blockage of the culvert was modelled for the following events as a sensitivity assessment:

- 1:100 +CC (20%) annual probability event
- 1:1,000 annual probability event

Model output plots for the culvert blockage scenario are provided in Annex E of **Appendix B**.

Table 2 summarises the maximum flood level expected on site during the respective baseline blockage scenarios.

Table 2: Modelled Flood Levels – Blockage

Annual Probability Event	Max Level (m AOD)
1:100+CC (20%) with 100% blockage	166.54
1:1,000 with 100% blockage	166.59

Some flooding of the southern extremity of the site would be expected during the 1:100 +CC (20%) and 1:1,000 annual probability events with 100% blockage, with maximum flood depths of 1.13 and 1.18 m respectively.

No flooding of Bryn Glas would be expected during the aforementioned blockage events.

As requested by NRW⁸, the development proposals have been overlain on the baseline blockage flood outlines (**Figure 6**). It should be noted that outlines reflect existing flood risk at the site and not the risk to the proposed development, as the flood risk to the southern section of the site will be addressed by the mitigation measures proposed in **Section 5**.

⁸ As requested by NRW in consultation response letter CAS-90953-R5W4

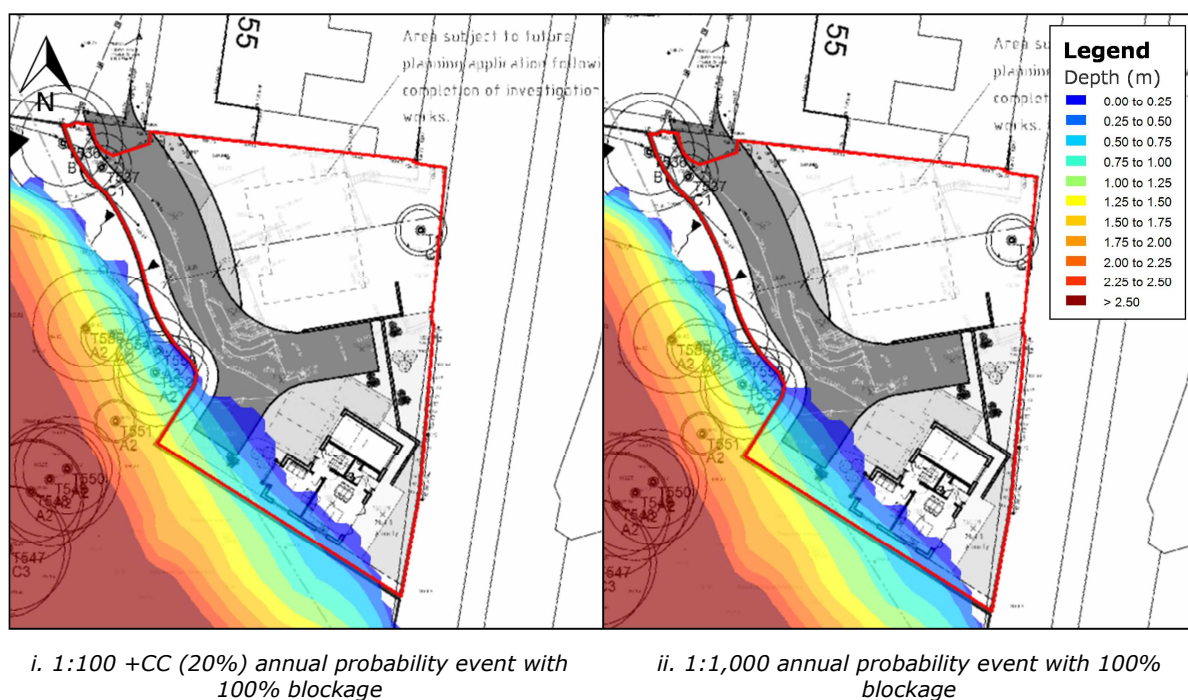


Figure 6: Existing Flood Depths – Blockage Scenario

4.4 FLOOD RISK FROM SURFACE WATER

The Surface Water Flood Risk map (**Figure 7**) indicates that site is at 'very low' risk of flooding.

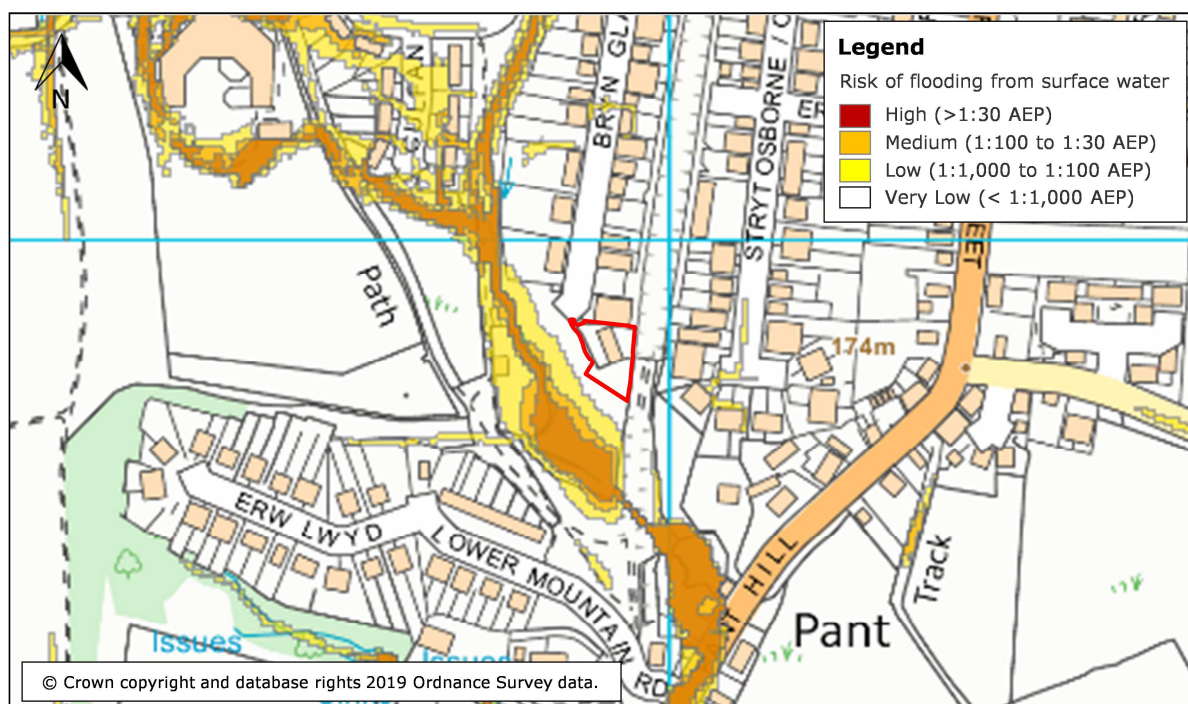


Figure 7: Surface Water Flood Risk
(Source: NRW website)

4.5 FLOOD RISK FROM RESERVOIRS, CANALS AND OTHER ARTIFICIAL SOURCES

There are no canals or other impounded waterbodies located within the immediate vicinity of the site. The Reservoir Flood Risk map indicates that the site is not at risk of flooding from such sources. The site is therefore not assessed to be at risk of flooding from reservoirs, canals or other artificial sources.

4.6 FLOOD RISK FROM GROUNDWATER

According to the BGS Groundwater Flooding Hazard map (**Figure 8**) the susceptibility to groundwater flooding is moderate.

In addition, the presence of the unnamed watercourse to the west of the site would be expected to convey elevated groundwater away from the site, reducing groundwater levels locally.

The residual risk of flooding from this source will be mitigated through the implementation of the measures proposed in **Section 5** of this report.

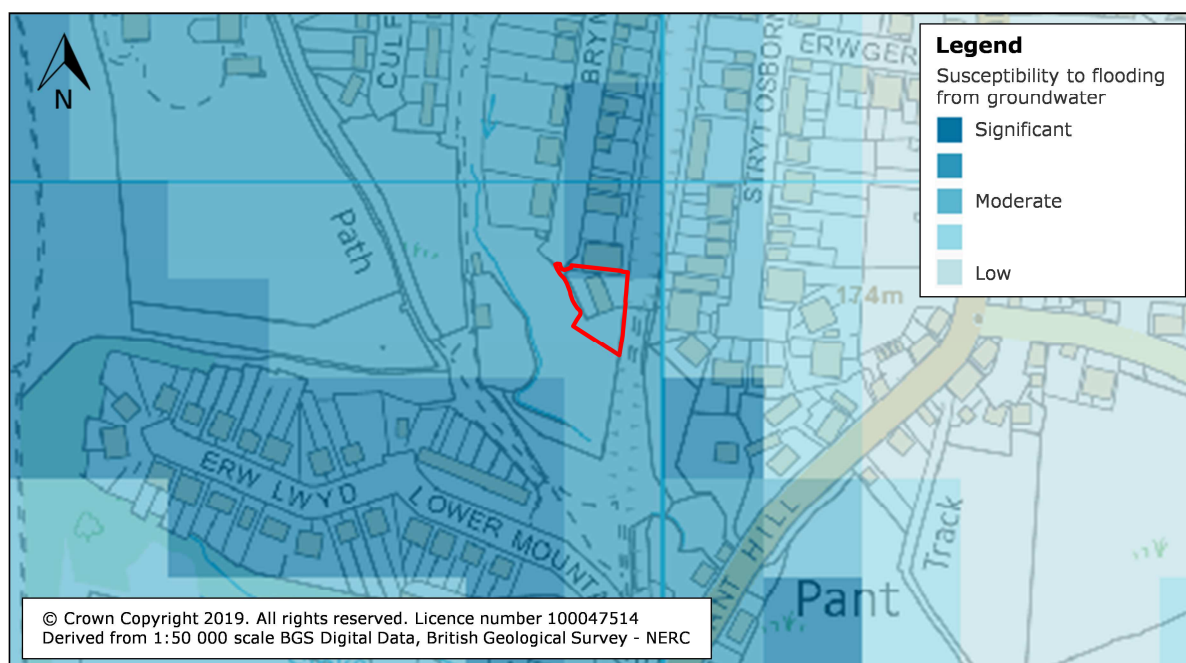


Figure 8: Groundwater Flooding Hazard Map
(Source: Findmaps)

5 FLOOD RISK MITIGATION MEASURES

The flood risk to the site from the unnamed watercourse and any residual risk of flooding from groundwater and surface will be mitigated through the implementation of the measures proposed within the following section of this report.

5.1 PROPOSED SITE LEVELS

5.1.1 Platform Levels

The platform level of the site, including all ancillary areas, will be set at a minimum level of 166.59 m AOD, which is the peak water level expected within the application boundary in the event of 1:1,000 annual probability event with 100% culvert blockage. As such, the development platform will remain dry during all modelled events.

This ensures compliance of the proposed development with Section A1.14 of TAN15.

5.1.2 Finished Flood Levels

It is recommended that finished floor levels should be set at a minimum of 166.74 m AOD, providing a freeboard of 150 mm above the peak water level in the event of 1:1,000 annual probability event with 100% culvert blockage.

In accordance with Building Regulations Approved Document C, finished floor levels should also be set at a minimum of 0.15 m above adjacent ground levels following reprofiling of the site.

This will, subject to the implementation of an appropriately designed surface water drainage scheme (**Section 6**), enable any potential overland flows to be conveyed safely across the site without affecting property.

This ensures compliance of the proposed development with Section A1.15 of TAN15.

5.2 PROPOSED MODELLING

The development proposals, with the mitigation measures detailed in **Section 5.1**, have been incorporated within the Weetwood model, which has been re-run for the proposed scenario.

An extract of the flood depths during the proposed blockage scenarios for the 1:100 +CC (20%) and 1:1,000 annual probability events are provided below in **Figure 9**. This demonstrates that the proposed development does not flood.

It should be noted the small encroachments along the southern boundary of the site are due to the coarseness of the model and do not represent actual flood risk to the proposed development.

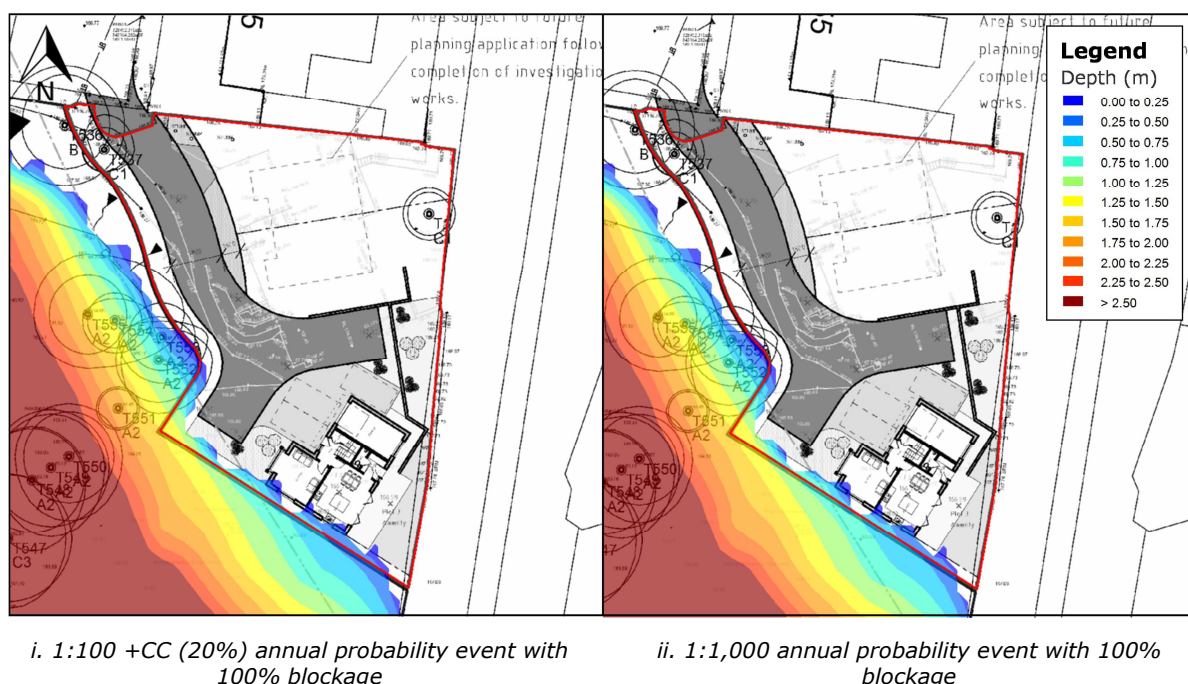


Figure 9: Proposed Flood Depths – Blockage Scenario

5.2.1 Flood Risk Elsewhere

Any proposal to modify ground levels should demonstrate that there is no increase in flood risk to the development itself, or to any existing buildings which are known to, or are likely to flood.

In accordance with A1.2 of TAN15 the consequences of the development on flood risk elsewhere should be assessed for up to the 1:1,000 annual probability event. It is understood that NRW seek to ensure that, where necessary, climate change and breach and blockage scenarios are considered for assessing the impact on flood risk elsewhere.

In order to quantify the impact on flood risk elsewhere, comparison plots have been produced showing the difference in flood depths between the baseline and proposed scenarios for the 1:100 +CC (20%) and 1:1,000 annual probability events, during the free-flowing and blockage scenarios (**Appendix C**).

There is generally no change to flood risk elsewhere, with flood depths offsite in the proposed scenario within +/- 5 mm of the depth flood during the baseline scenario for the same event. There is a small area of decrease in depths at the downstream extent of the model during the 1:1,000 annual probability event with 100% blockage scenario; however this is considered to be a modelling anomaly.

There is also a decrease in flood depths in the southern section of the site. This reflects where ground levels are to be raised up to provide the minimum proposed development platform level of 166.59 m AOD, and thus will no longer flood.

5.3 ACCESS AND EGRESS

Dry access and egress to the site should be provided to the north via Bryn Glas under all flood scenarios.

6 SURFACE WATER MANAGEMENT

6.1 SURFACE WATER DRAINAGE AT THE EXISTING SITE

It is assumed that the existing dwelling on site is served by an existing drainage system.

Based on existing topography, it is assumed surface water from the permeable land runs off towards the watercourse.

6.1.1 Existing Runoff Rates

The site has a total area of 0.1ha.

The greenfield surface water runoff rates for the site, calculated using the ICP SUDS method within MicroDrainage are presented in **Table 3**. Details of the input parameters and the output results are provided in **Appendix D**.

Table 3: Greenfield Runoff Rate

Annual probability of rainfall event	Greenfield Runoff Rate (l/s/ha)	Greenfield Runoff Rate for 0.10 ha Site (l/s)
1:1	2.3	0.2
QBAR	2.6	0.3
1:30	4.5	0.5
1:100	5.6	0.6

Given that the details of the drainage system serving the existing dwelling are unknown, the existing impermeable areas have been discounted from this assessment to ensure a conservative approach. Existing brownfield rates may be confirmed at the detailed design stage.

6.2 SURFACE WATER DRAINAGE AT THE DEVELOPED SITE

6.2.1 Disposal of Surface Water

In accordance with Welsh Government guidance, surface water runoff should be disposed of according to the following hierarchy: Rainwater collected for use; Into the ground (infiltration); To a surface water body; To a surface water sewer or highway drain

As detailed in **Section 3.4** the site is underlain by soils with impeded drainage. As such the disposal of surface water via infiltration is unlikely to be feasible; however, infiltration tests have not been undertaken at this stage. Such tests could be undertaken at the detailed design stage. It is subsequently proposed to direct all runoff from the developed site to the watercourse.

6.2.2 Post Development Impermeable Area

The area of impermeable surfaces within the development has been estimated to be 0.06 ha, based on **Appendix A**.

6.2.3 Peak Flow Control

The runoff rates as outlined in **Table 3** will be achieved so far as is practicable; however, it is recognised that a flow control with a diameter of less than 100 mm and/or a design discharge rate of 5.0 l/s may pose a risk of blockage to the drainage system. As such a minimum discharge rate of 5.0 l/s may be used in accordance with national guidance⁹.

6.2.4 Volume Control

Where reasonably practicable, for greenfield sites, the runoff volume from the proposed development to any highway drain, sewer or surface water body in the 1:100 annual probability, 6 hour rainfall event should not exceed the greenfield runoff volume for the same event.

This is usually addressed by designing a Long Term Storage (LTS) facility within the site. However, as outlined within the CIRIA SuDS Manual 2015 an alternative approach to managing extra runoff volumes from extreme events is to release all runoff (above the 1:1 annual probability event) from the site at a maximum rate of 2 l/s/ha or QBAR, whichever is the higher value.

It is therefore proposed to restrict peak discharge rates to the greenfield QBAR rate recognising a minimum rate of 5.0 l/s would apply in up to the 1:100 annual probability event, including an allowance for climate change.

6.2.5 Attenuation Storage

Attenuation storage will be provided to restrict surface water runoff generated across roofs and hardstanding.

The attenuation storage facility has been modelled using the Detailed Design module of MicroDrainage Source Control (**Appendix E**). The required storage volume has been sized to store the 1:100 annual probability rainfall event including a 30% increase in rainfall intensity in order to allow for climate change.

Assuming a peak discharge rate of 5.0 l/s and a design depth of 0.8 m, a total storage volume of 11.9 m³ would be required.

The storage volume could be accommodated within detention basin, with an area of 16.0 m², a depth of 0.8 m, which would fill to a depth of 0.782 m affording a 0.018 m freeboard.

Additional SuDS features, such as rainwater harvesting, permeable paving and filter drains may be incorporated into the surface water drainage strategy at the detailed design stage.

It should be noted that the calculations assume that all storage is provided within the formal attenuation storage facility; with no storage being provided in the proposed pipe network. At the detailed design stage the network should be modelled with a drowned outfall, recognising the flood risk associated with the watercourse.

6.2.6 Indicative Surface Water Drainage Layout

An indicative surface water drainage layout is provided in **Figure 10**.

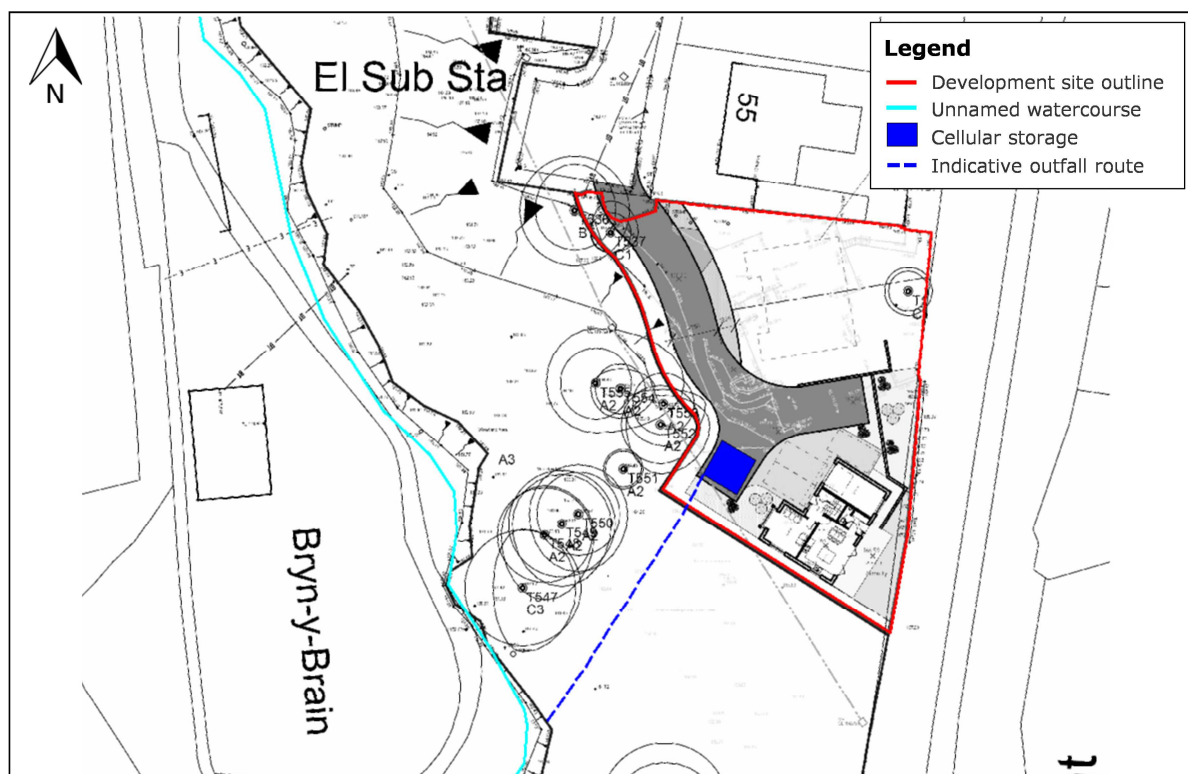


Figure 10: Indicative Surface Water Drainage Layout

6.2.7 Exceedance Routes

Flows resulting from rainfall in excess of the 1:100 annual probability rainfall event including an allowance for climate change would be expected to flow towards the watercourse, away from the proposed residential development.

6.2.8 Pollution Control

Detention basins can provide water quality benefits via the settlement of pollutants in still or slow moving water, adsorption by the soil, and biological activity. The potential for additional SuDS features to be utilised at the site would be investigated further at the detailed design stage.

6.2.9 Adoption and Maintenance of SuDS

The pipe network, designed to Sewers for Adoption (7th edition) standard, may be adopted by the sewerage undertaker.

SuDS in open spaces may be maintained by a management company.

An indicative maintenance schedule is presented in **Table 4**.

Table 4: Maintenance Requirements

Schedule	Required action	Frequency
Geo-cellular attenuation storage tank		
Regular maintenance	Inspect and identify any areas that are not operating correctly	Monthly for 3 months, then annually

Schedule	Required action	Frequency
	Remove debris from the catchment surface	Monthly
	Remove sediment from internal forebays	Annually, or as required
Remedial action	Repair inlet/outlet and vents	As required
Monitoring	Inspect catchpit manholes and note rate of sediment accumulation	Monthly in the first year and then annually
	Inspect inlet/outlet and vents to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years, or as required

6.2.10 Summary

The purpose of this report is to demonstrate that a surface water drainage strategy is feasible for the site given the development proposals and the land available. The proposals provide the opportunity for the inclusion of SuDS elements, ensuring that there will be no increase in surface water runoff from the proposed development. The storage calculations may be refined at the detailed design stage and a final decision made on the types of storage to be provided.

7 SUMMARY

This report has been prepared on behalf of Dave Cottle Civil Engineering Ltd and relates to the proposed redevelopment of land at 57 Bryn Glas, Rhosllanerchrugog.

According to the Flood Risk Map (Rivers and Sea) the proposed development is located outside the 1:1,000 fluvial annual probability flood outline and is therefore defined by TAN15 as being situated within Zone A.

In order to more accurately identify and assess the level of flood risk from the watercourses at the site a 1D-2D ESTRY-TUFLOW hydraulic model has been developed by Weetwood.

No flooding of the site would be expected in up to the 1:100 +CC (45%) annual probability event. Some minor flooding of the south-western extremity of the site area may be expected to a maximum depth of 0.32 m during the 1:1,000 annual probability flood event.

Some flooding of the southern extremity of the site would be expected during the 1:100 +CC (20%) and 1:1,000 annual probability events with 100% blockage, with maximum flood depths of 1.13 and 1.18 m respectively.

No flooding of Bryn Glas is expected during all of the aforementioned events.

The site is shown to be at 'very low' risk of flooding from surface water.

The site is not at risk of flooding from reservoirs, canals or other artificial sources.

There is a residual risk of flooding at the site from groundwater.

The platform level of the site, including all ancillary areas, will be set at a minimum level of 166.59 m AOD, which is the peak water level expected within the application boundary in the event of 1:1,000 annual probability event with 100% culvert blockage.

It is recommended that finished floor levels should be set at a minimum of 166.74 m AOD, providing a freeboard of 150 mm above the peak water level in the event of 1:1,000 annual probability event with 100% culvert blockage. In accordance with Building Regulations Approved Document C, finished floor levels should also be set at a minimum of 0.15 m above adjacent ground levels following reprofiling of the site.

This ensures that the proposed development will comply with Sections A1.14 and A1.15 of TAN15.

The proposal is not expected to impact flood risk elsewhere.

Dry access and egress to the site should be provided to the north of the site via Bryn Glas under all flood scenarios.

Surface water runoff from the developed site can be sustainably managed in accordance with planning policy.

8 RECOMMENDATIONS

This report has demonstrated that the proposed development may be completed in accordance with the requirements of planning policy subject to the following:

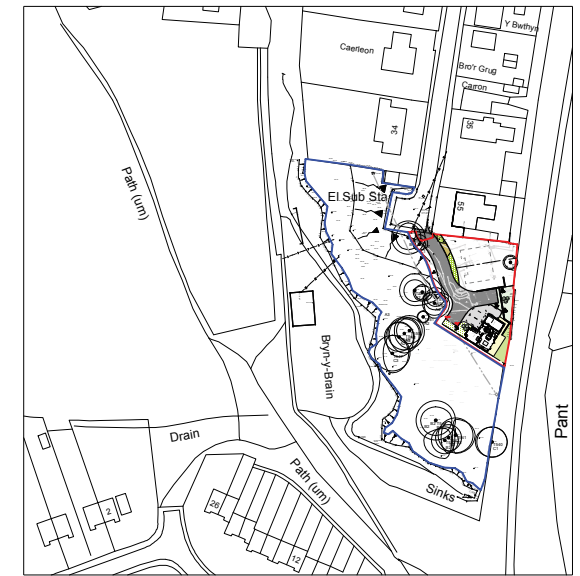
- Development platform level to be set at a minimum of 166.59 m AOD
- Finished floor levels to be set at a minimum of 166.74 m AOD
- The detailed drainage design to be submitted to and approved by the local planning authority prior to the commencement of development

APPENDIX A:

Development Proposals



Site Plan 1:500



Location Plan 1:1250

Landscaping

Soft

All garden areas to front and rear of dwellings to be laid to seed prior to completion, to provide a good quality grassed lawn.
Low level shrub planting to be used to complement lawn at the discretion of the occupier.

Hard

Adoptable roads to be constructed to an adoptable standard to local authority approval. Private driveways to be formed with tarmacadam finish to provide good quality surface for occupants to satisfaction of the Local Authority and client.

Pathways around dwellings to be formed with concrete paving slabs.
Paved areas to be laid with slight fall away from dwelling to discharge surface water.

Boundary Treatments.

Existing boundaries to remain as existing. Where areas of existing boundaries have deteriorated and new boundary's between plots contractor to install timber post and vertical timber board fencing to local authority approval.

Rev	Date	Detail	Initial
D	07/19	Application Site Amends	D.J.E.
C	06/19	Level Amends	D.J.E.
B	06/19	Plot 4 removed from App	D.J.E.
A	04/19	Plot 1 & 2 removed from App	D.J.E.

Project:

Proposed residential development at
57 Bryn Glas
Rhos, Wrexham

Title:
Site & Location
Plan

Scale: (A2)
1:500 &
1:1250

Drawn By:
D.J. Edwards

Date:
Oct 2018

Drawing No:
C063/022

Sheet:
1 of 1

blueprint
architectural services



Office 3K4,
Redwither Tower,
Redwither Business Park,
Wrexham. LL13 9XT
Tel: 01978 356500
www.blueprintarchitectural.com

APPENDIX B:

Hydraulic Modelling Study Report

Provided as a separate document.

APPENDIX C:

Model Plots – Flood Risk Elsewhere

Notes:

1. Do not scale from this drawing.

2. Map backdrop reproduced from Ordnance Survey digital map data. Crown Copyright under licence.

KEY:

Site Location

Depth (metres)

Decrease ($\geq 5\text{mm}$)

No Change ($< 5\text{mm}$)

Increase ($\geq 5\text{mm}$)

Weetwood

Development • Planning • Environment

70 Cowcross Street
London
EC1M 6EJ

Tel: 0203 757 5444
Email: info@weetwood.net

Client:

Dave Cottle Civil Engineering Ltd

Project Title:

57 Bryn Glas, Rhosllanerchrugog

Drawing Title:

Flood Risk Elsewhere;
1:100+CC (20%) AEP

Map Orientation:

Scale: 0 25 50 metres

Drawn:

DJ

Checked:

JA

Date:

16 July 2019

Drawing No:

3494_016-005_Q0100cc20_d

Rev:

B

This map illustrates the flood risk environment around the Bryn Glas site. The site itself is a small rectangular area outlined in red, situated between Bryn Glas Street and Church Street. The map features several key elements:

- Streets:** Bryn Glas Street, Church Street, Pant Hill, Pant Field, and various other local roads like Wern La and Erwgerrig.
- Topography:** Shaded areas indicate elevation changes, with labels for 176m and 174m.
- Flood Risk:** Shaded regions represent areas at risk of flooding, particularly along the Pant Hill and near the site.
- Infrastructure:** A 'Path' is shown running through the area, and 'Issues' and 'Sinks' are marked with arrows pointing to specific locations.
- Other Features:** A 'Track' is visible near Pant Hill, and a 'PW' (Public Works) area is marked near the site.

Notes:

1. Do not scale from this drawing.

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KEY:

Site Location

Depth (metres)

Decrease ($\geq 5\text{mm}$)

No Change ($< 5\text{mm}$)

Increase ($\geq 5\text{mm}$)

Weetwood

Development • Planning • Environment

70 Cowcross Street
London
EC1M 6EJ

Tel: 0203 757 5444
Email: info@weetwood.net

Client:

Dave Cottle Civil Engineering Ltd

Project Title:

57 Bryn Glas, Rhosllanerchrugog

Drawing Title:

Flood Risk Elsewhere;
1:1,000 AEP

Map Orientation:

Scale: 0 25 50 metres

Drawn:

Checked:

Date:

DJ

JA

16 July 2019

Drawing No:

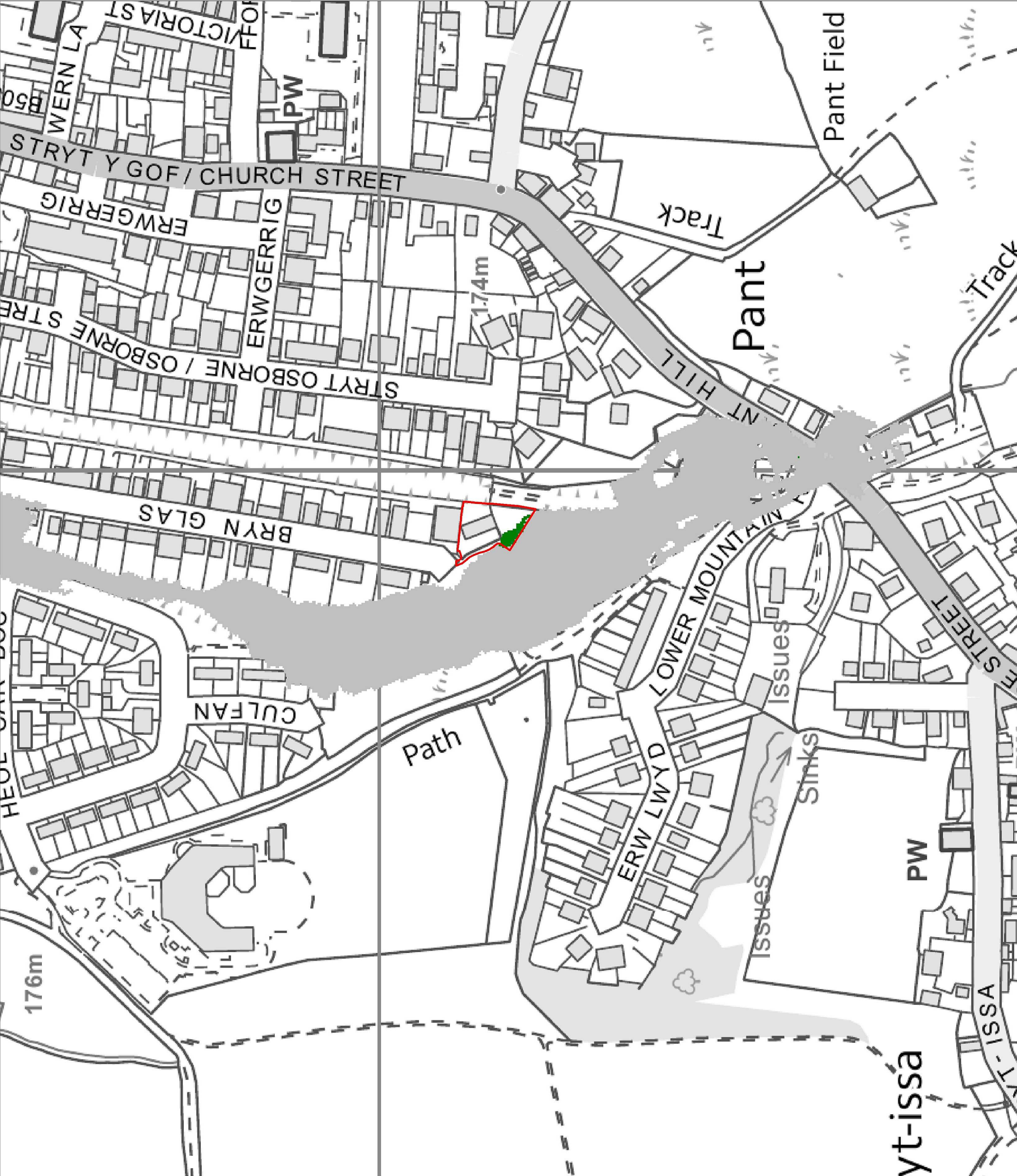
Rev:

3494_016-005_Q1000_d

B



Notes: 1. Do not scale from this drawing. 2. Map backdrop reproduced from Ordnance Survey digital map data. Crown Copyright under licence.		KEY: Site Location Depth (metres) Decrease (>= 5mm) No Change (< 5mm) Increase (>= 5mm)		Weetwood Development • Planning • Environment 70 Cowcross Street London EC1M 6EJ Tel: 0203 757 5444 Email: info@weetwood.net		Client: Dave Cottle Civil Engineering Ltd	Project Title: 57 Bryn Glas, Rhosllanerchrugog	Drawing Title: Flood Risk Elsewhere; Blockage 100% 1:100+CC (20%) AEP	Map Orientation: N W E S Scale: 02550metres	Drawn: DJ Checked: JA Date: 16 July 2019	Drawing No: 3494_017-008_Q0100cc20_d Rev: B
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Notes:

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KEY:

Site Location

Depth (metres)

Decrease ($\geq 5\text{mm}$)

No Change ($< 5\text{mm}$)

Increase ($\geq 5\text{mm}$)

Weetwood

Development • Planning • Environment

70 Cowcross Street
London
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Tel: 0203 757 5444
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Client:

Dave Cottle Civil Engineering Ltd

Project Title:

57 Bryn Glas, Rhosllanerchrugog

Drawing Title:

Flood Risk Elsewhere;
Blockage 100%
1:1,000 AEP

Map Orientation:

Scale: 0 25 50 metres

Drawn:

DJ

Checked:

JA

Date:

16 July 2019

Drawing No:

3494_017-008_Q1000_d

Rev:

B



APPENDIX D:

Greenfield Runoff Calculations

Weetwood		Page 1
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
Date 09/05/2019 15:06 File	Designed by LucyRaven Checked by	
Micro Drainage		Source Control 2018.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.300 Area (ha) 1.000 Urban 0.000 SAAR (mm) 938 Region Number Region 9 Results 1/s QBAR Rural 2.6 QBAR Urban 2.6 Q100 years 5.6 Q1 year 2.3 Q30 years 4.5 Q100 years 5.6		
©1982-2018 Innovyze		

APPENDIX E:

Surface Water Attenuation - Storage Volume Calculation

Weetwood		Page 1																																																																																																																																																																																																																																																																																		
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold																																																																																																																																																																																																																																																																																				
Date 12/06/2019 12:13 File 2019-06-12 3494 Q0100cc...																																																																																																																																																																																																																																																																																				
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Summary of Results for 100 year Return Period (+30%) Half Drain Time : 22 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Σ Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>0.544</td><td>0.544</td><td>0.0</td><td>5.0</td><td>5.0</td><td>8.3</td><td>O K</td></tr><tr><td>30 min Summer</td><td>0.652</td><td>0.652</td><td>0.0</td><td>5.0</td><td>5.0</td><td>9.9</td><td>O K</td></tr><tr><td>60 min Summer</td><td>0.695</td><td>0.695</td><td>0.0</td><td>5.0</td><td>5.0</td><td>10.6</td><td>O K</td></tr><tr><td>120 min Summer</td><td>0.647</td><td>0.647</td><td>0.0</td><td>5.0</td><td>5.0</td><td>9.8</td><td>O K</td></tr><tr><td>180 min Summer</td><td>0.549</td><td>0.549</td><td>0.0</td><td>5.0</td><td>5.0</td><td>8.3</td><td>O K</td></tr><tr><td>240 min Summer</td><td>0.420</td><td>0.420</td><td>0.0</td><td>5.0</td><td>5.0</td><td>6.4</td><td>O K</td></tr><tr><td>360 min Summer</td><td>0.251</td><td>0.251</td><td>0.0</td><td>5.0</td><td>5.0</td><td>3.8</td><td>O K</td></tr><tr><td>480 min Summer</td><td>0.164</td><td>0.164</td><td>0.0</td><td>4.9</td><td>4.9</td><td>2.5</td><td>O K</td></tr><tr><td>600 min Summer</td><td>0.125</td><td>0.125</td><td>0.0</td><td>4.7</td><td>4.7</td><td>1.9</td><td>O K</td></tr><tr><td>720 min Summer</td><td>0.110</td><td>0.110</td><td>0.0</td><td>4.1</td><td>4.1</td><td>1.7</td><td>O K</td></tr><tr><td>960 min Summer</td><td>0.092</td><td>0.092</td><td>0.0</td><td>3.4</td><td>3.4</td><td>1.4</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>0.075</td><td>0.075</td><td>0.0</td><td>2.5</td><td>2.5</td><td>1.1</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>0.062</td><td>0.062</td><td>0.0</td><td>1.9</td><td>1.9</td><td>0.9</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>0.055</td><td>0.055</td><td>0.0</td><td>1.5</td><td>1.5</td><td>0.8</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>0.046</td><td>0.046</td><td>0.0</td><td>1.1</td><td>1.1</td><td>0.7</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>0.041</td><td>0.041</td><td>0.0</td><td>0.9</td><td>0.9</td><td>0.6</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>0.038</td><td>0.038</td><td>0.0</td><td>0.8</td><td>0.8</td><td>0.6</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>0.035</td><td>0.035</td><td>0.0</td><td>0.7</td><td>0.7</td><td>0.5</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>0.033</td><td>0.033</td><td>0.0</td><td>0.6</td><td>0.6</td><td>0.5</td><td>O K</td></tr><tr><td>15 min Winter</td><td>0.624</td><td>0.624</td><td>0.0</td><td>5.0</td><td>5.0</td><td>9.5</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>101.613</td><td>0.0</td><td>11.4</td><td>16</td></tr><tr><td>30 min Summer</td><td>70.732</td><td>0.0</td><td>15.9</td><td>25</td></tr><tr><td>60 min Summer</td><td>47.182</td><td>0.0</td><td>21.2</td><td>42</td></tr><tr><td>120 min Summer</td><td>30.391</td><td>0.0</td><td>27.3</td><td>78</td></tr><tr><td>180 min Summer</td><td>23.098</td><td>0.0</td><td>31.2</td><td>112</td></tr><tr><td>240 min Summer</td><td>18.837</td><td>0.0</td><td>33.9</td><td>140</td></tr><tr><td>360 min Summer</td><td>14.109</td><td>0.0</td><td>38.1</td><td>196</td></tr><tr><td>480 min Summer</td><td>11.478</td><td>0.0</td><td>41.3</td><td>252</td></tr><tr><td>600 min Summer</td><td>9.770</td><td>0.0</td><td>44.0</td><td>308</td></tr><tr><td>720 min Summer</td><td>8.559</td><td>0.0</td><td>46.2</td><td>368</td></tr><tr><td>960 min Summer</td><td>6.937</td><td>0.0</td><td>49.9</td><td>490</td></tr><tr><td>1440 min Summer</td><td>5.145</td><td>0.0</td><td>55.6</td><td>734</td></tr><tr><td>2160 min Summer</td><td>3.805</td><td>0.0</td><td>61.6</td><td>1100</td></tr><tr><td>2880 min Summer</td><td>3.066</td><td>0.0</td><td>66.2</td><td>1428</td></tr><tr><td>4320 min Summer</td><td>2.257</td><td>0.0</td><td>73.1</td><td>2184</td></tr><tr><td>5760 min Summer</td><td>1.819</td><td>0.0</td><td>78.6</td><td>2928</td></tr><tr><td>7200 min Summer</td><td>1.539</td><td>0.0</td><td>83.1</td><td>3656</td></tr><tr><td>8640 min Summer</td><td>1.343</td><td>0.0</td><td>87.0</td><td>4296</td></tr><tr><td>10080 min Summer</td><td>1.197</td><td>0.0</td><td>90.5</td><td>5136</td></tr><tr><td>15 min Winter</td><td>101.613</td><td>0.0</td><td>12.8</td><td>16</td></tr></table>				Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	15 min Summer	0.544	0.544	0.0	5.0	5.0	8.3	O K	30 min Summer	0.652	0.652	0.0	5.0	5.0	9.9	O K	60 min Summer	0.695	0.695	0.0	5.0	5.0	10.6	O K	120 min Summer	0.647	0.647	0.0	5.0	5.0	9.8	O K	180 min Summer	0.549	0.549	0.0	5.0	5.0	8.3	O K	240 min Summer	0.420	0.420	0.0	5.0	5.0	6.4	O K	360 min Summer	0.251	0.251	0.0	5.0	5.0	3.8	O K	480 min Summer	0.164	0.164	0.0	4.9	4.9	2.5	O K	600 min Summer	0.125	0.125	0.0	4.7	4.7	1.9	O K	720 min Summer	0.110	0.110	0.0	4.1	4.1	1.7	O K	960 min Summer	0.092	0.092	0.0	3.4	3.4	1.4	O K	1440 min Summer	0.075	0.075	0.0	2.5	2.5	1.1	O K	2160 min Summer	0.062	0.062	0.0	1.9	1.9	0.9	O K	2880 min Summer	0.055	0.055	0.0	1.5	1.5	0.8	O K	4320 min Summer	0.046	0.046	0.0	1.1	1.1	0.7	O K	5760 min Summer	0.041	0.041	0.0	0.9	0.9	0.6	O K	7200 min Summer	0.038	0.038	0.0	0.8	0.8	0.6	O K	8640 min Summer	0.035	0.035	0.0	0.7	0.7	0.5	O K	10080 min Summer	0.033	0.033	0.0	0.6	0.6	0.5	O K	15 min Winter	0.624	0.624	0.0	5.0	5.0	9.5	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	15 min Summer	101.613	0.0	11.4	16	30 min Summer	70.732	0.0	15.9	25	60 min Summer	47.182	0.0	21.2	42	120 min Summer	30.391	0.0	27.3	78	180 min Summer	23.098	0.0	31.2	112	240 min Summer	18.837	0.0	33.9	140	360 min Summer	14.109	0.0	38.1	196	480 min Summer	11.478	0.0	41.3	252	600 min Summer	9.770	0.0	44.0	308	720 min Summer	8.559	0.0	46.2	368	960 min Summer	6.937	0.0	49.9	490	1440 min Summer	5.145	0.0	55.6	734	2160 min Summer	3.805	0.0	61.6	1100	2880 min Summer	3.066	0.0	66.2	1428	4320 min Summer	2.257	0.0	73.1	2184	5760 min Summer	1.819	0.0	78.6	2928	7200 min Summer	1.539	0.0	83.1	3656	8640 min Summer	1.343	0.0	87.0	4296	10080 min Summer	1.197	0.0	90.5	5136	15 min Winter	101.613	0.0	12.8	16
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960 min Summer	0.092	0.092	0.0	3.4	3.4	1.4	O K																																																																																																																																																																																																																																																																													
1440 min Summer	0.075	0.075	0.0	2.5	2.5	1.1	O K																																																																																																																																																																																																																																																																													
2160 min Summer	0.062	0.062	0.0	1.9	1.9	0.9	O K																																																																																																																																																																																																																																																																													
2880 min Summer	0.055	0.055	0.0	1.5	1.5	0.8	O K																																																																																																																																																																																																																																																																													
4320 min Summer	0.046	0.046	0.0	1.1	1.1	0.7	O K																																																																																																																																																																																																																																																																													
5760 min Summer	0.041	0.041	0.0	0.9	0.9	0.6	O K																																																																																																																																																																																																																																																																													
7200 min Summer	0.038	0.038	0.0	0.8	0.8	0.6	O K																																																																																																																																																																																																																																																																													
8640 min Summer	0.035	0.035	0.0	0.7	0.7	0.5	O K																																																																																																																																																																																																																																																																													
10080 min Summer	0.033	0.033	0.0	0.6	0.6	0.5	O K																																																																																																																																																																																																																																																																													
15 min Winter	0.624	0.624	0.0	5.0	5.0	9.5	O K																																																																																																																																																																																																																																																																													
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)																																																																																																																																																																																																																																																																																
15 min Summer	101.613	0.0	11.4	16																																																																																																																																																																																																																																																																																
30 min Summer	70.732	0.0	15.9	25																																																																																																																																																																																																																																																																																
60 min Summer	47.182	0.0	21.2	42																																																																																																																																																																																																																																																																																
120 min Summer	30.391	0.0	27.3	78																																																																																																																																																																																																																																																																																
180 min Summer	23.098	0.0	31.2	112																																																																																																																																																																																																																																																																																
240 min Summer	18.837	0.0	33.9	140																																																																																																																																																																																																																																																																																
360 min Summer	14.109	0.0	38.1	196																																																																																																																																																																																																																																																																																
480 min Summer	11.478	0.0	41.3	252																																																																																																																																																																																																																																																																																
600 min Summer	9.770	0.0	44.0	308																																																																																																																																																																																																																																																																																
720 min Summer	8.559	0.0	46.2	368																																																																																																																																																																																																																																																																																
960 min Summer	6.937	0.0	49.9	490																																																																																																																																																																																																																																																																																
1440 min Summer	5.145	0.0	55.6	734																																																																																																																																																																																																																																																																																
2160 min Summer	3.805	0.0	61.6	1100																																																																																																																																																																																																																																																																																
2880 min Summer	3.066	0.0	66.2	1428																																																																																																																																																																																																																																																																																
4320 min Summer	2.257	0.0	73.1	2184																																																																																																																																																																																																																																																																																
5760 min Summer	1.819	0.0	78.6	2928																																																																																																																																																																																																																																																																																
7200 min Summer	1.539	0.0	83.1	3656																																																																																																																																																																																																																																																																																
8640 min Summer	1.343	0.0	87.0	4296																																																																																																																																																																																																																																																																																
10080 min Summer	1.197	0.0	90.5	5136																																																																																																																																																																																																																																																																																
15 min Winter	101.613	0.0	12.8	16																																																																																																																																																																																																																																																																																
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Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold							
Date 12/06/2019 12:13 File 2019-06-12 3494 Q0100cc...							
Designed by LucyRaven Checked by							
Micro Drainage		Source Control 2018.1					
Summary of Results for 100 year Return Period (+30%)							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	0.746	0.746	0.0	5.0	5.0	11.3	O K
60 min Winter	0.782	0.782	0.0	5.0	5.0	11.9	O K
120 min Winter	0.677	0.677	0.0	5.0	5.0	10.3	O K
180 min Winter	0.493	0.493	0.0	5.0	5.0	7.5	O K
240 min Winter	0.312	0.312	0.0	5.0	5.0	4.7	O K
360 min Winter	0.139	0.139	0.0	4.8	4.8	2.1	O K
480 min Winter	0.108	0.108	0.0	4.0	4.0	1.6	O K
600 min Winter	0.094	0.094	0.0	3.5	3.5	1.4	O K
720 min Winter	0.085	0.085	0.0	3.0	3.0	1.3	O K
960 min Winter	0.074	0.074	0.0	2.5	2.5	1.1	O K
1440 min Winter	0.061	0.061	0.0	1.8	1.8	0.9	O K
2160 min Winter	0.052	0.052	0.0	1.4	1.4	0.8	O K
2880 min Winter	0.046	0.046	0.0	1.1	1.1	0.7	O K
4320 min Winter	0.039	0.039	0.0	0.8	0.8	0.6	O K
5760 min Winter	0.035	0.035	0.0	0.7	0.7	0.5	O K
7200 min Winter	0.032	0.032	0.0	0.6	0.6	0.5	O K
8640 min Winter	0.029	0.029	0.0	0.5	0.5	0.4	O K
10080 min Winter	0.028	0.028	0.0	0.4	0.4	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	70.732	0.0	17.8	27			
60 min Winter	47.182	0.0	23.8	46			
120 min Winter	30.391	0.0	30.6	84			
180 min Winter	23.098	0.0	34.9	118			
240 min Winter	18.837	0.0	38.0	144			
360 min Winter	14.109	0.0	42.7	194			
480 min Winter	11.478	0.0	46.3	248			
600 min Winter	9.770	0.0	49.2	308			
720 min Winter	8.559	0.0	51.8	364			
960 min Winter	6.937	0.0	55.9	482			
1440 min Winter	5.145	0.0	62.2	716			
2160 min Winter	3.805	0.0	69.0	1092			
2880 min Winter	3.066	0.0	74.2	1456			
4320 min Winter	2.257	0.0	81.9	2132			
5760 min Winter	1.819	0.0	88.0	2920			
7200 min Winter	1.539	0.0	93.1	3656			
8640 min Winter	1.343	0.0	97.5	4352			
10080 min Winter	1.197	0.0	101.3	5240			
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Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
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Micro Drainage		Source Control 2018.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.286	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.060

Time (mins)	Area
From:	To: (ha)
0	4 0.060

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Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
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Micro Drainage Source Control 2018.1		

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	16.0	0.0	0.801	1.0	0.0
0.800	16.0	0.0	2.000	1.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0109-5000-0800-5000
Design Head (m) 0.800
Design Flow (l/s) 5.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 109
Invert Level (m) 0.000
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	5.0
Flush-Flo™	0.241	5.0
Kick-Flo®	0.537	4.2
Mean Flow over Head Range	-	4.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	6.0	3.000	9.3	7.000	13.9
0.200	5.0	1.400	6.5	3.500	10.0	7.500	14.4
0.300	5.0	1.600	6.9	4.000	10.6	8.000	14.8
0.400	4.8	1.800	7.3	4.500	11.3	8.500	15.2
0.500	4.5	2.000	7.7	5.000	11.8	9.000	15.7
0.600	4.4	2.200	8.0	5.500	12.4	9.500	16.1
0.800	5.0	2.400	8.4	6.000	12.9		
1.000	5.5	2.600	8.7	6.500	13.4		

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Flood Consequences Assessments
Surface Water Drainage
Foul Water Drainage
Environmental Impact Assessments
River Realignment and Restoration
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Flood Defence Consent Applications
Sequential, Justification and Exception Tests
Utility Assessments
Expert Witness and Planning Appeals
Discharge of Planning Conditions

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