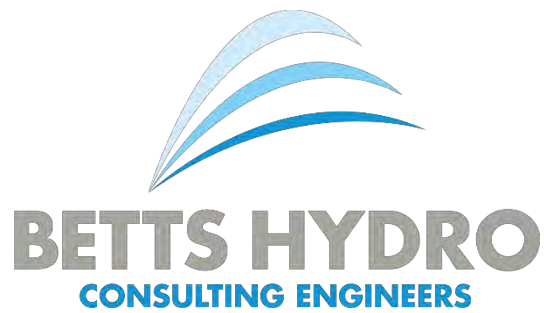




**BEDWELL ROAD
CROSS LANES, WREXHAM**

**FLOOD CONSEQUENCE ASSESSMENT &
DRAINAGE MANAGEMENT STRATEGY**



For

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D.S. Jones & Co.

JUNE 2017

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**BEDWELL ROAD
CROSS LANES, WREXHAM**

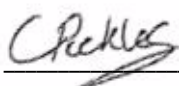
**FLOOD CONSEQUENCE ASSESSMENT &
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Document Tracking Sheet

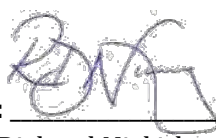
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EXECUTIVE SUMMARY

This Flood Consequence Assessment has been prepared to support an outline planning application for a residential development on land off Bedwell Road in Cross Lanes. The total site covers 1.247ha and is predominantly permeable at this time, although the proposed development areas covers a smaller portion of the wider site (1.025ha). The whole site is shown to be located within Flood Zones A and C2 based on the Development Advice Map, however the development area is located within Flood Zone A only.

Flood Risk

The FCA has reviewed all sources of flood risk to both the proposed development and to the existing adjacent development as a result of the proposals. The site is shown to predominantly be located within Flood Zone 1, with the northern boundary being within in Flood Zones 2 and 3. The nearest watercourse to the site is Clywedog Stream, which runs parallel to the northern boundary of the site. The primary flood risk to the development proposals is considered to be the fluvial associated with the adjacent watercourse. Clywedog Stream is an Ordinary Watercourse and discussion with the Lead Local Flood Authority (Wrexham County Borough Council) has been undertaken to identify the potential flood risks to the site.

Wrexham County Borough Council has identified that hydraulic modelling of Clywedog Stream and its tributaries was undertaken in 2009 this data has been used within our assessment as its confirmed to be the most accurate up-to-date available. The hydraulic modelling provide predicted top water levels (at multiple cross-sections adjacent to site) for the various modelled flood events. The predicted flood water levels have been compared to the existing ground levels on the site to more accurately ascertain the level of fluvial flood risk to the proposals. It can be stated that the extents of the floodplain in the modelled events would encroach out of channel and partly into the wider site. However, not all of the site is proposed to be residentially developed as an intra-sequential approach to flood risk has been adopted.

The residential (highly) vulnerable development is proposed to be located solely within Flood Zone 1 and will remain flood free in the 1% AEP and 0.1% AEP events (based on the hydraulic modelling undertaken). The overall fluvial flood risk to the residential proposals is considered to be low. The proposed development has been justified in accordance with TAN15 and suitable mitigation measures proposed to ensure that the development is safe. It would be recommended that the proposed dwellings onsite have a minimum finished floor level set 600mm above the predicted Top Water Level in the 1% AEP+CC event. Based on the model outputs at the cross sections onsite the minimum finished floor level should be 37.28mAOD.

Review of the topographic survey shows that the existing ground level (within the development area) is currently 37.28mAOD, therefore the proposed finished floor level will likely be raised higher than the required minimum to safeguard against flooding due to other engineering constraints. It is advise following any re-grade onsite that the finished floor levels are raised above the external levels to provide avenues for overland flow which could result from other residual flood risk sources. No level raising within the floodplain to account for these proposals is anticipated, therefore there is no requirement for compensatory floodplain storage.

As part of the overall site is identified to be at risk from fluvial flooding, it would be recommended that future occupants sign up to the flood warning service provided by Natural Resources Wales

in the event of a future flood incident impacting the neighbouring river catchment. The proposed residential development will be located within the lesser flood risk areas only however consideration has been given to safe emergency access and egress. As the proposed access road is located within Flood Zone 1 and the dwelling are proposed to have mitigation to cater for any residual flood risks, safe access and egress will be maintained from Bedwell Road.

Review of online resources and consultation with various interested parties has failed to identify any significant historical flooding events to have impacted on the site. The site is shown to be at varying risk from flooding associated with surface water and reservoirs however as the primary flood risk is fluvial the mitigation proposed to cater for these flood risks would also cater for any risk associated with the other potential sources of flood risk.

Drainage Strategy

A key focus should also be on the effective management of surface water run-off generated by the proposals. Based on the ground conditions identified online, it can be considered that infiltration drainage is likely to provide a suitable surface water management method disposal for the flows generated by the proposed development (Soakaway Testing to BRE365 will be required to be undertaken).

It is proposed that surface water run-off generated by the proposals discharge to the Clywedog Stream on the northern boundary of site (should testing evidence infiltration will not be feasible). The existing ground levels onsite predominantly fall towards the northern boundary and therefore a gravity solution could be feasible (subject to further analysis as part of detailed design stage). Consents from the Lead Local Flood Authority (Wrexham County Borough Council) will be required for works effecting the Ordinary Watercourse, including agreement of any outfall structures and discharge rates.

The surface water run-off generated by the proposals will be required to be restricted to minimise the flood risk. In accordance with the policy all sites (greenfield and brownfield) should endeavour to achieve as close to pre-development greenfield rates as is viable. When considering the development area a pre-development greenfield rate (QBar) of 4.6l/s has been calculated. Given the constraints of flow control devices however, the minimum discharge rate from the site will be 5.0l/s this is based on the minimum flow through the orifice plate (based on standard diameter size).

The restricted flow will generate a storage requirement during the extreme storm events. It would be beneficial to implement SuDS onsite in accordance with recent policy changes, to provide water quality and attenuation benefits for the site. Detailed design should confirm which methods would be most suitable for incorporation following more detailed analysis of levels and layout.

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

CONTENTS

Document Tracking Sheet.....	iii
EXECUTIVE SUMMARY	v
Figures & Tables.....	viii
Specialist Software.....	ix
Abbreviations & Acronyms.....	ix
1.0 INTRODUCTION	11
1.1 Planning Policy Context	11
<i>Technical Advice Note 15 (TAN15)</i>	11
1.2 Site Context	11
1.3 Consultation.....	11
2.0 EXISTING SITE BACKGROUND	12
2.1 Location	12
2.2 Existing and Historical Land Use.....	12
2.3 Topography	13
2.4 Justification for Development.....	13
3.1 Nature of the development.....	14
4.0 TECHNICAL ADVICE NOTE 15 (TAN15)	15
4.1 Flood Zone Classification.....	15
4.2 Category of Development.....	16
4.3 Acceptability Criteria	16
5.0 SOURCES OF FLOOD RISK	17
5.1 Fluvial Flood Risk	17
<i>Main Rivers</i>	17
<i>Ordinary Watercourses</i>	17
<i>Mitigation</i>	20
<i>Flood Warning and Evacuation</i>	20
5.2 Tidal Flood Risk.....	21
5.3 Surface Water	21
5.4 Pluvial Flood Risk	22
5.5 Artificial Sources of Flood Risk	23
<i>Reservoirs</i>	23
<i>Canals</i>	24
5.6 Groundwater Flood Risk.....	24
5.7 Sewer Flood Risk.....	24
5.8 Historical and Anecdotal Flooding Information	25
5.9 Mitigation Measures and Residual Risks	25

<i>Mitigation Measures</i>	25
<i>Residual Risks</i>	26
6.0 SURFACE WATER MANAGEMENT	27
6.1 Pre-development Surface Water Run-off.....	27
6.2 Post-development Surface Water Run-off.....	27
6.3 Sustainable Drainage Systems (SuDS)	27
6.4 Methods of Surface Water Management.....	28
6.5 Discharge via Infiltration.....	29
6.6 Discharge to Watercourse.....	29
6.7 Discharge to Sewer.....	31
6.8 Climate Change	31
7.0 FOUL WATER MANAGEMENT	32
8.0 SUMMARY AND CONCLUSIONS	33
9.0 RECOMMENDATIONS	35
BIBLIOGRAPHY & REFERENCES	36
Web-based References.....	36

Figures & Tables

Figure 1: Aerial Photograph of site (Bing Maps, 2017)	12
Figure 2: Planning Proposals (D. S. Jones & CO, 2017)	14
Figure 3: Development Advice Map extract (Welsh Government, 2017)	15
Table 1: Development category of vulnerability (Source: TAN15: Section5)	16
Figure 4: Flood Zone Map Extract (NRW, 2017)	17
Figure 5: Cross-Section Locations within the Hydraulic Model (WCBC, 2009).....	18
Table 2: predicted flood water levels along Clywedog Stream (WCBC, 2009)	18
Figure 6 Floodplain Extents Plan with Layout overlay (Betts Hydro, 2017).....	19
Figure 7: Flood Warning and Alert Areas Map extract (NRW, 2017).....	20
Figure 8: Surface Water Flood Risk Map extract (NRW, 2017).....	21
Figure 9: Surface Water Hazard Map extract (NRW, 2017).....	22
Figure 10: Reservoir Flood Map Extract (NRW 2017).....	23
Table 3: Pre-Development Surface Water Run-Off Rates (Betts Hydro, 2017)	27
Table 4: Post-Development Un-Restricted Run-Off Rates and Volumes (Betts Hydro, 2017)	27
Figure 11: SuDS Photographs (SusDrain, 2012).....	28
Figure 12: Preliminary Drainage Strategy Plan extract (Betts Hydro, 2017)	30
Table 5: Estimated Stormwater Storage Requirements (Betts Hydro, 2017).....	30

APPENDIX A:	TAN15 EXTRACTS.....
APPENDIX B:	NRW/EA INFORMATION & CORRESPONDENCE.....
APPENDIX C:	SEWER RECORDS & CORRESPONDENCE.....
APPENDIX D:	LPA/LLFA CORRESPONDENCE
APPENDIX E:	LOCATION PLAN.....
APPENDIX F:	EXISTING LEVELS INFORMATION
APPENDIX G:	PROPOSED PLANNING LAYOUT
APPENDIX H:	DEVELOPMENT ADVICE MAP
APPENDIX I:	HYDRAULIC MODEL REPORT
APPENDIX J:	FLOODPLAIN PLANS.....
APPENDIX K:	SURFACE WATER RUN-OFF CALCULATIONS AND ATTENUATION ESTIMATES....
APPENDIX L:	FEH CATCHMENT DATA & DESCRIPTIONS
APPENDIX M:	IMPERMEABLE AREAS PLANS
APPENDIX N:	PFRA/SFRA INFORMATION.....
APPENDIX O:	OVERLAND FLOOD FLOW ROUTING PLANS
APPENDIX P:	AERIAL DRAINAGE PLANS.....
APPENDIX Q:	NOTES OF LIMITATIONS.....

Specialist Software

-  Flood Estimation Handbook FEH CD-ROM (v.3.0) – Determination of Catchment Descriptors and depths of rainfall.
-  MicroDrainage WinDES (v.14.1) – Calculation of Greenfield run-off rates IH124/ICP-SUDS, Greenfield run-off volumes, rates of rainfall and stormwater storage estimates.

Abbreviations & Acronyms

AEP	Annual Exceedance Probability
BGL	Below Ground Level
BGS	British Geological Survey
CC	Climate Change
CFMP	Catchment Flood Management Plan
DAM	Development Advice Map
EA	Environment Agency
FCA	Flood Consequence Assessment
FEH	Flood Estimation Handbook
FZ	Flood Zone

Ha	Hectare
IDB	Internal Drainage Board
LDP	Local Development Plan
LFRDP	Local Flood Risk Development Plan
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	Metres Above Ordnance Datum
NGR	National Grid Reference
NRW	National Resources Wales
NSRI	National Soil Resource Institute
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPW	Planning Policy Wales
QSE	Quick Storage Estimate
SFCA	Strategic Flood Consequence Assessment
SuDS	Sustainable Urban Drainage Systems
SMP	Shoreline Management Plan
SWMP	Surface Water Management Plan
TAN15	Technical Advice Note 15
TWL	Top Water Level
UKCIP	United Kingdom Climate Impacts Programme
WCBC	Wrexham County Borough Council
WW	Welsh Water

1.0 INTRODUCTION

1.1 Planning Policy Context

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

Technical Advice Note 15 (TAN15)

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

1.2 Site Context

- 1.2.1 This Flood Consequence Assessment (FCA) has been prepared to support an outline planning application for a residential development on land in Cross Lanes (Wrexham). The proposals will be complete with access, car parking, external works and lighting, landscaping, boundary walls and fencing, external services and drainage. The proposals are considered to be Highly Vulnerable in accordance with the guidance found in TAN15, given their residential nature.
- 1.2.2 The development site is bounded to the north by Clywedog Stream which is considered to be Ordinary Watercourse by Natural Resources Wales. The site is shown to predominantly be located within Flood Zone A on the Development Advice Map (DAM). There is a floodplain associated with the Ordinary Watercourse and Flood Zones B and C are therefore shown to extend out of channel in places. The residential development will adopt an intra-sequential approach and minimise the potential flood risk by placing the residential development wholly within the extents of Flood Zone A.
- 1.2.3 A FCA is required to justify that the proposed development is appropriate with reference to TAN15, this FCA will provide justification that;
- The consequences of flooding to that development and elsewhere have been fully considered and implemented against for the lifetime of the development;
 - No increase in flooding will occur to the development site or surrounding area due to the proposals including flooding from surface water and sewers;

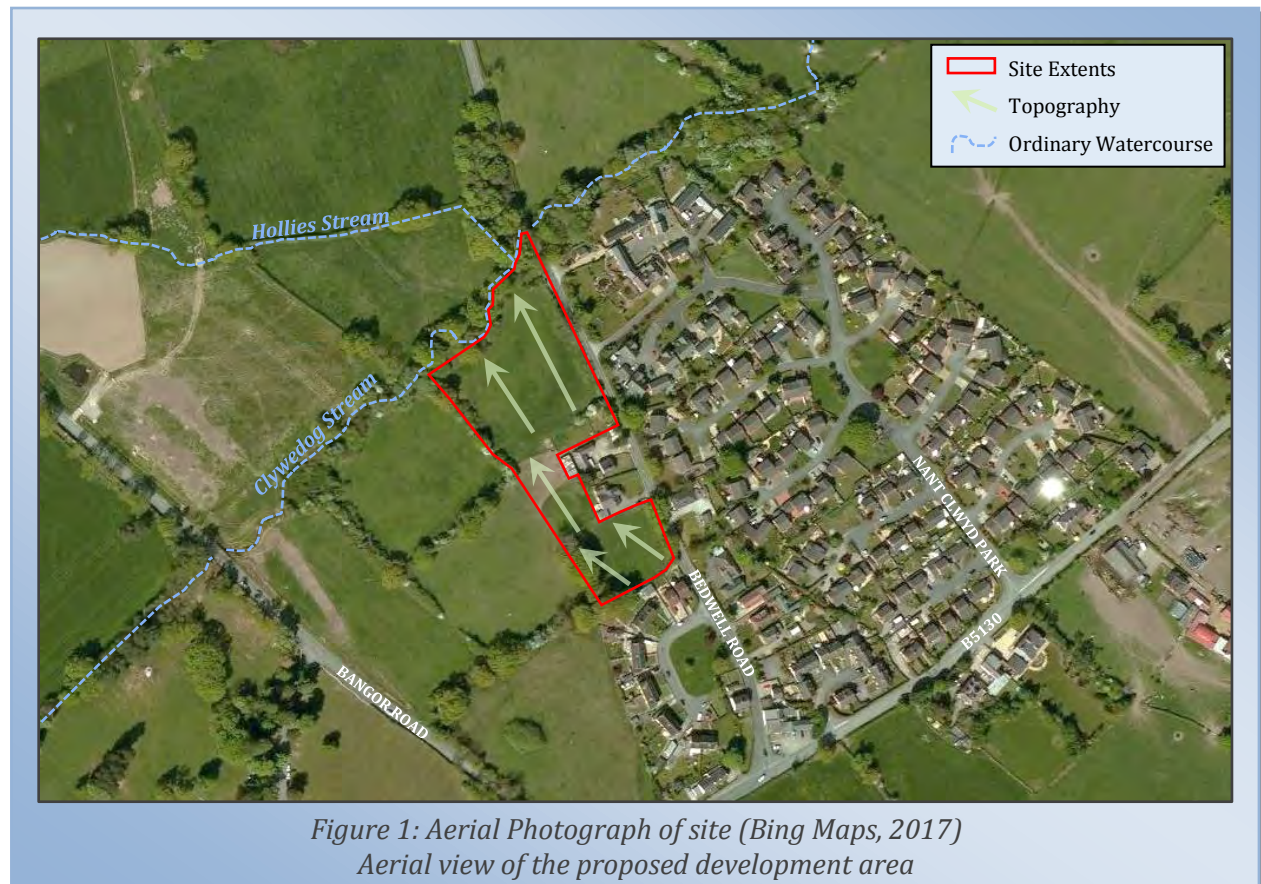
1.3 Consultation

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

2.0 EXISTING SITE BACKGROUND

2.1 Location

- 2.1.1 The development is accessed off Bedwell Road in Cross Lanes (near Wrexham). The Ordnance Survey National Grid Reference (OS NGR) for the site is E: 337522, N: 347194 and the nearest postcode is LL13 0TR. The site covers 1.247ha and is predominantly undeveloped (used for agricultural purposes), the site is edged in red in **Figure 1** (see location plan in **Appendix E**).
- 2.1.2 The site is bounded to the north by Clywedog Stream, which is an Ordinary Watercourse flowing in a north-easterly direction to out-fall into the River Clywedog over 2km to the north-east of the site (illustrated in **Figure 1**). To the east of site is Bedwell Road, with the residential settlement of Cross Lanes beyond and to the south of the site lies residential dwellings accessed off Bedwell Crescent, with the B5130 beyond. Finally, to the west of the site lies undeveloped agricultural land with the A525 (Bangor Road) beyond.



2.2 Existing and Historical Land Use

- 2.2.1 The preparation of this report has identified that the development site is predominantly undeveloped and used for agricultural purposes (grazing) at this time. No other historical uses have been determined during this assessment. Vehicular access to the site is currently off Bedwell Road and this will continue to be the access point following development.
- 2.2.2 The site is currently classified as 'less vulnerable' by the Local Planning Authority, the nature of land-use will however increase to 'highly vulnerable' due to the residential nature of the proposals in accordance with TAN15.

2.3 Topography

- 2.3.1 TAN15 requires all sources of flood risk to be considered and analysed with reference to the current levels of the site, a topographical survey has been reviewed as part of this FCA; such is included in **Appendix F**.
- 2.3.2 The existing ground levels on site vary, however generally fall from the southern boundary toward the watercourse on the northern boundary (see illustration in **Figure 1**). Existing ground levels range from 42.68mAOD in the southern corner of the site and 35.5mAOD in the north-eastern corner of the site (adjacent to the Clywedog Stream). Bedwell Road bounds the eastern boundary of the site and following review of the topographic survey the site is lower than this neighbouring highway.

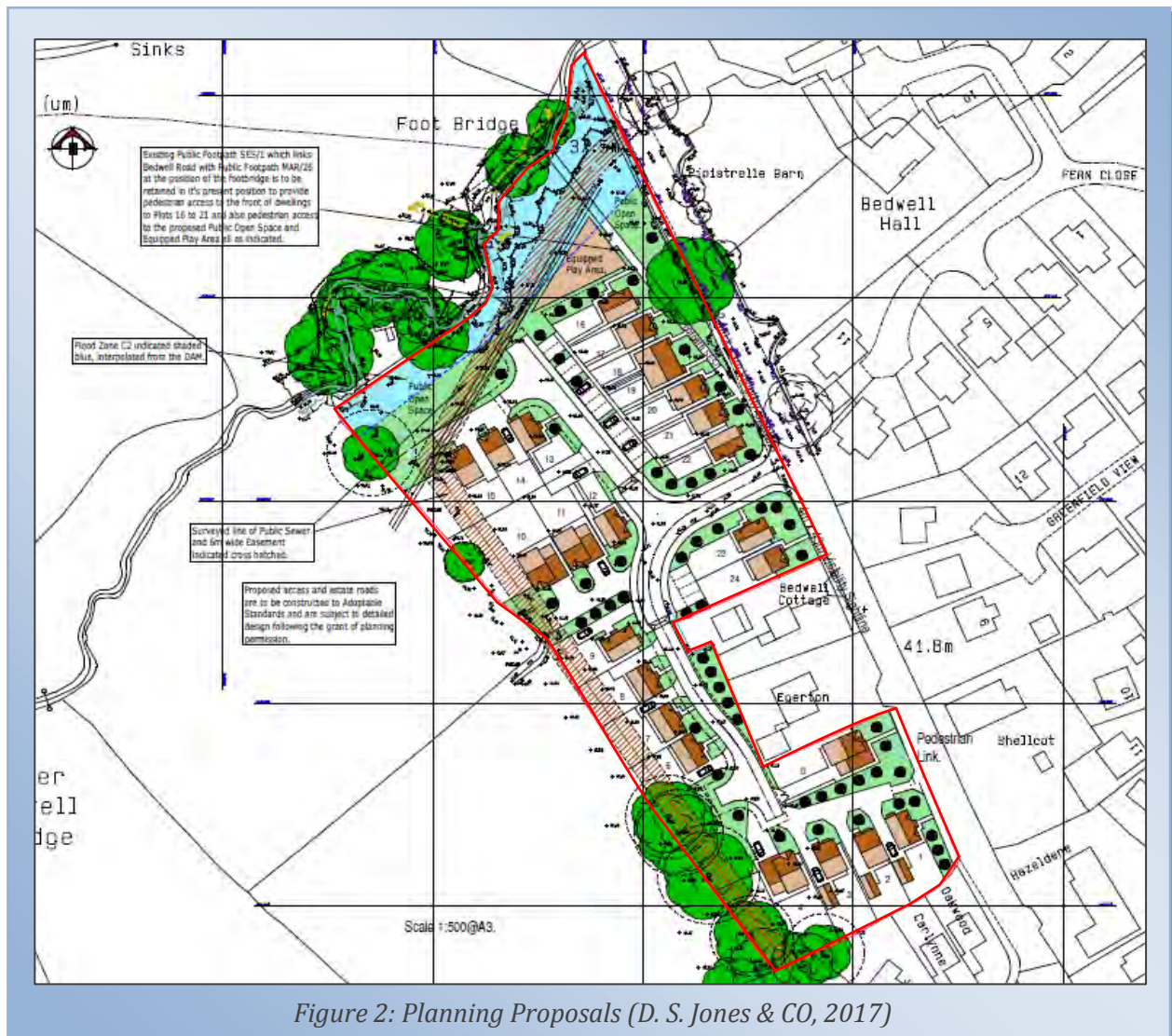
2.4 Justification for Development

- 2.4.1 Planning Policy Wales (5th Ed. – November 2012) states that the Welsh Government is committed to promoting ‘sustainable development’ by providing for homes, infrastructure, investment and jobs in a way which is consistent with sustainable development principles PPW Sec. 2.2). The FCA will be considerate to the nature and scale of the proposals and will review flood risk to and from the development along with considering any appropriate mitigation measures based on the identified sources of risk.
- 2.5.2 The development proposals are of a highly vulnerable nature and will be located solely within Flood Zone A. The development will ensure the provision of residential housing within the least vulnerable areas of the site, with public open space (POS) areas steered to those areas onsite where floodplain extents are anticipated.

3.0 DEVELOPMENT PROPOSALS

3.1 Nature of the development

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



- 3.1.2 The site area (red edge) covers 1.247ha and is predominantly undeveloped at present although there are some existing hardstanding areas covering 11% of the site. The proposed development area will cover a smaller portion of the wider site (1.025ha). In light of the nature and scale of the proposals, the post-development impermeable areas will increase, to approximately 40% of the development area based on indicative planning proposals.
- 3.1.3 The proposals will be to maintain a buffer from the existing watercourse running parallel to the northern boundary of the site. This buffer will incorporate some Public Open Space (POS) along with the typical easement requirements in accordance with both NRW and WCBC's requirements. There may be scope to incorporate some SuDS methods into this buffer area (subject to more detailed analysis), more information is included in Section 6.0.

4.0 TECHNICAL ADVICE NOTE 15 (TAN15)

4.1 Flood Zone Classification

- 4.1.1 The Welsh Government Development Advice Map (DAM) is to be utilised when considering and determining flood risk associated with planning future developments within Wales, these maps are based on extreme flood events outlined by the Natural Resources Wales (NRW) and British Geological Survey (BGS) data (TAN15). The DAM (**Appendix H**) identifies three key 'Flood Zones' for consideration, which are:

Flood Zone A

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

Flood Zone B

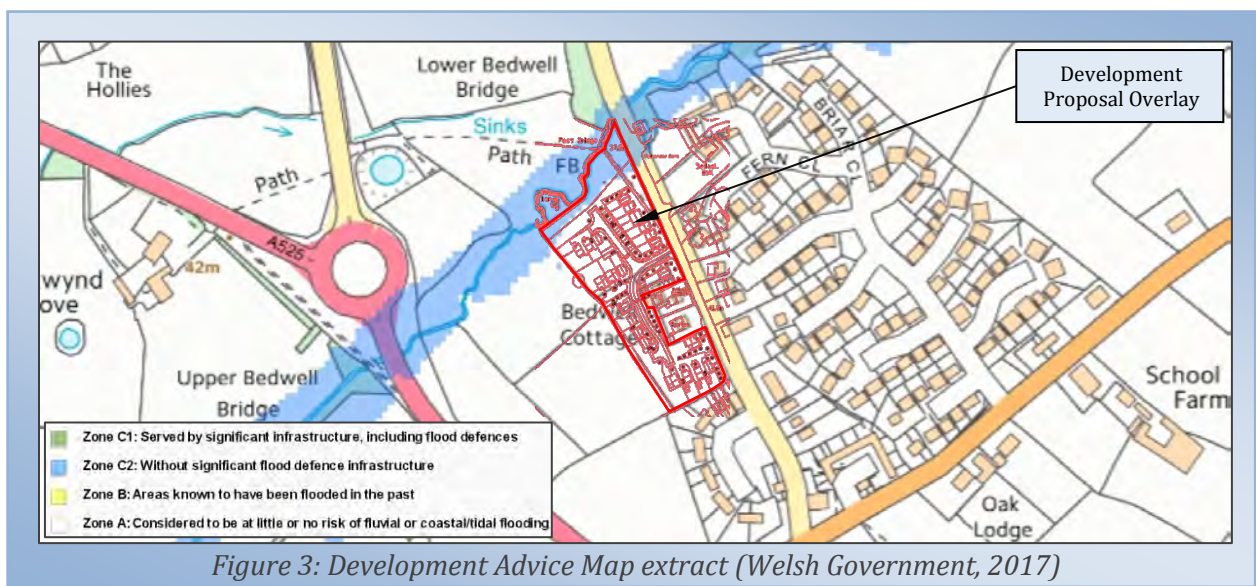
Areas known to have historically flooded based on sedimentary evidence deposits.

Flood Zone C

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

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

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



- 4.1.2 The overall site is shown to be located within Flood Zone A and Flood Zone C2 on the DAM, as illustrated in **Figure 3**. Flood Zone A is an areas considered to be at little/no flood risk, whereas Flood Zone C1 is an area considered to be at risk of fluvial or coastal/tidal flooding, without 'significant flood defence infrastructure being present infrastructure'.
- 4.1.3 As illustrated in **Figure 3**, the proposed residential (highly vulnerable) development will be steered to those areas of the site at lesser flood risk (Flood Zone A). The less vulnerable Public Open Space areas will be located within those areas shown to be within Flood Zone C2.

4.2 Category of Development

- 4.2.1 TAN15 states that particular types of development may not be considered 'acceptable' based on their vulnerability to the consequences of flooding, identified on the DAM. The vulnerability of different land uses is described in detail in TAN15 however there are three key categories as summarised in **Table 1**.

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

Table 1: Development category of vulnerability (Source: TAN15: Section5)

- 4.2.2 The development proposals are considered to be 'highly vulnerable' in nature based on TAN15 guidance. The highly vulnerable residential development will be situated in Flood Zone A (with the less vulnerable POS areas being located within Flood Zone C2).

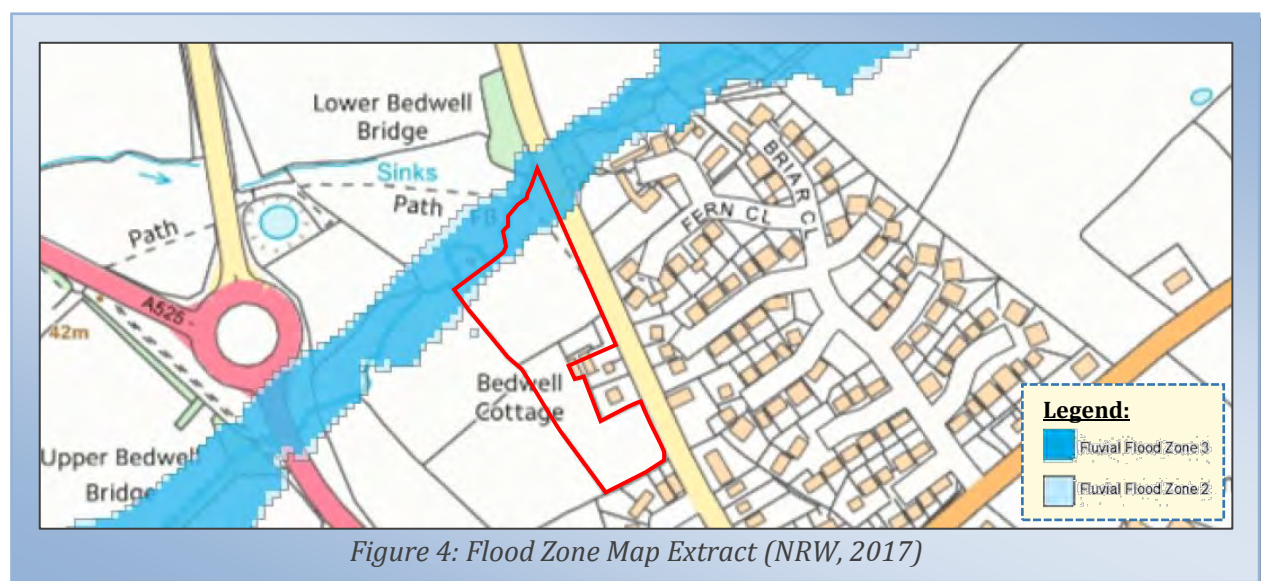
4.3 Acceptability Criteria

- 4.3.1 Various criteria are identified within TAN15 (Section 7), these are used to determine whether a proposed development is 'acceptable' based on the nature and scale of proposals. Appropriate management should be considered with any proposed consequences of potential flooding.
- 4.4.2 The overall site is located partly within Flood Zone C2 and considered to be at risk from fluvial/tidal flooding, however the proposed residential development area will be confined to those areas within site within Flood Zone A. Highly vulnerable development is considered acceptable within Flood Zone A providing the justification test is passed and surface water is considered. Sections 5.0 and 6.0 of this report assess flood risk and the consequences of potential flooding in accordance with the above.

5.0 SOURCES OF FLOOD RISK

5.1 Fluvial Flood Risk

- 5.1.1 Information relating to the flood risk at the site has been obtained from the Welsh Government's DAM and the NRW online Flood Mapping (see **Appendix B** for full details).
- 5.1.2 The nearest watercourse to the site is Clywedog Stream, which runs parallel to the northern boundary of the site, the Hollies Stream connects into this watercourse near to the northern corner of the site before it is culverted beneath Bedwell Road and flows north-east to discharge into the River Clywedog approximately 2km from the site. The development site is shown to predominantly be located within Flood Zone 1, with the banks of the watercourse to the north being exceeded in places, resulting in Flood Zones 2 and 3 encroaching into the wider site (see Flood Zone Map Extract in **Figure 4**).



Main Rivers

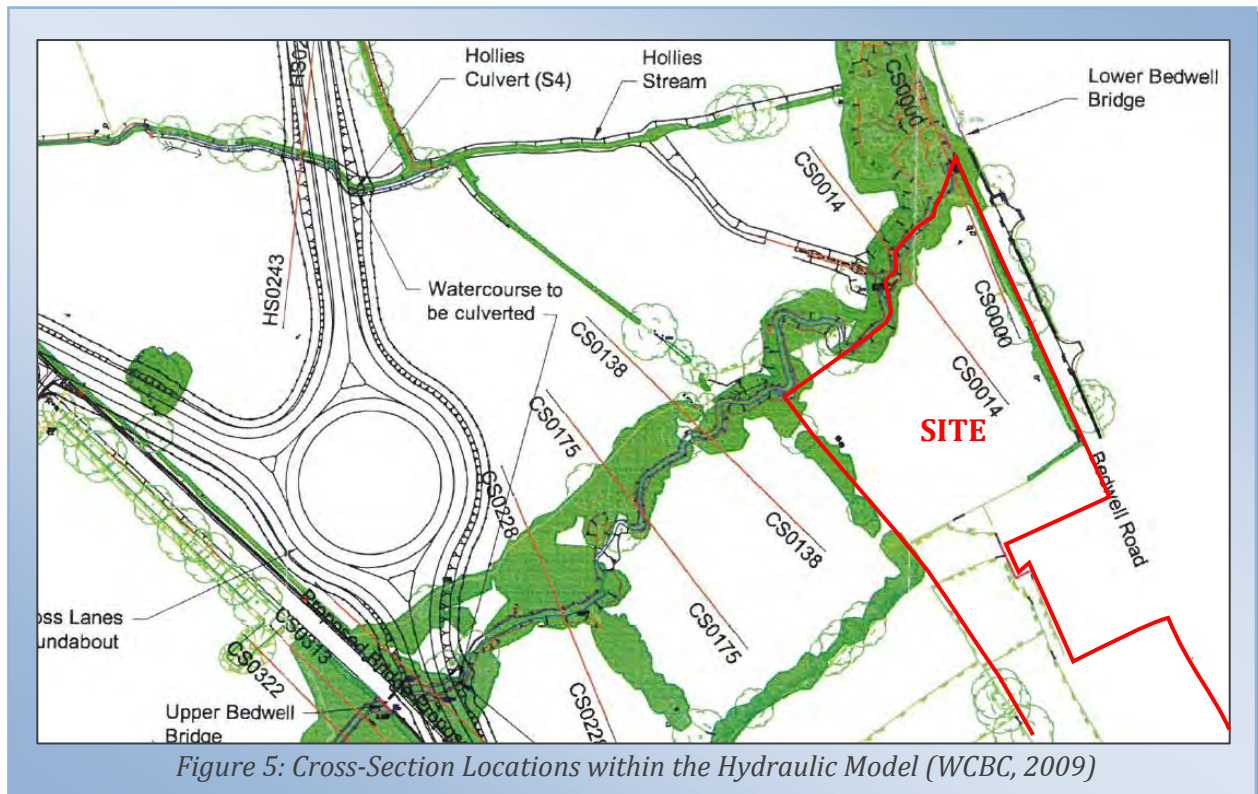
- 5.1.3 The River Clywedog is considered to be Main River by NRW and consultation with NRW has been undertaken in accordance with TAN15 to determine the extents and potential depths of flooding onsite resulting from this source. NRW have confirmed that they have no information relevant to the proposed development site due to its proximity from the Main River models. They recommended however that further discussion with the Lead Local Flood Authority (WCBC) be undertaken as both Clywedog Stream and the Hollies Stream are considered to be Ordinary Watercourses.

Ordinary Watercourses

- 5.1.4 Clywedog Stream flows adjacent to the northern boundary of the site and the fluvial flood risks to the site are considered to be associated with this watercourse. Clywedog Stream is considered to be Ordinary and therefore discussion with the Lead Local Flood Authority has been undertaken to identify if there has been hydraulic modelling of this watercourse.
- 5.1.5 Correspondence with Wrexham County Borough Council has identified that hydraulic modelling of Clywedog Stream and its tributaries was undertaken in 2009 prior to the construction of the new link road to the Industrial Estate. The model report was provided for review and is included within the **Appendix I**. WCBC have confirmed that this is the most up

to date modelling they have for Clywedog Stream and therefore the results have been considered in relation to the potential flood risk at the site.

- 5.1.6 The modelling results identified the predicted top water levels at various locations along Clywedog Stream for both the baseline scenario (prior to road construction) and the proposed scenario (post-construction). The hydraulic modelling was undertaken by Capita Symonds on behalf of WCBC and included various cross-sections along Clywedog Stream; **Figure 5** is an extract from the model report showing the location of the cross-sections used within the modelling in relation to the site.



- 5.1.7 The upstream cross section is considered to be upstream of the site boundary as indicated above, although the other cross sections are located along the length of watercourse adjacent to the site. Given that the Wrexham Industrial Estate Road has now been constructed the 'proposed scenario' results have been considered within our assessment as they represent the most up-to-date situation.

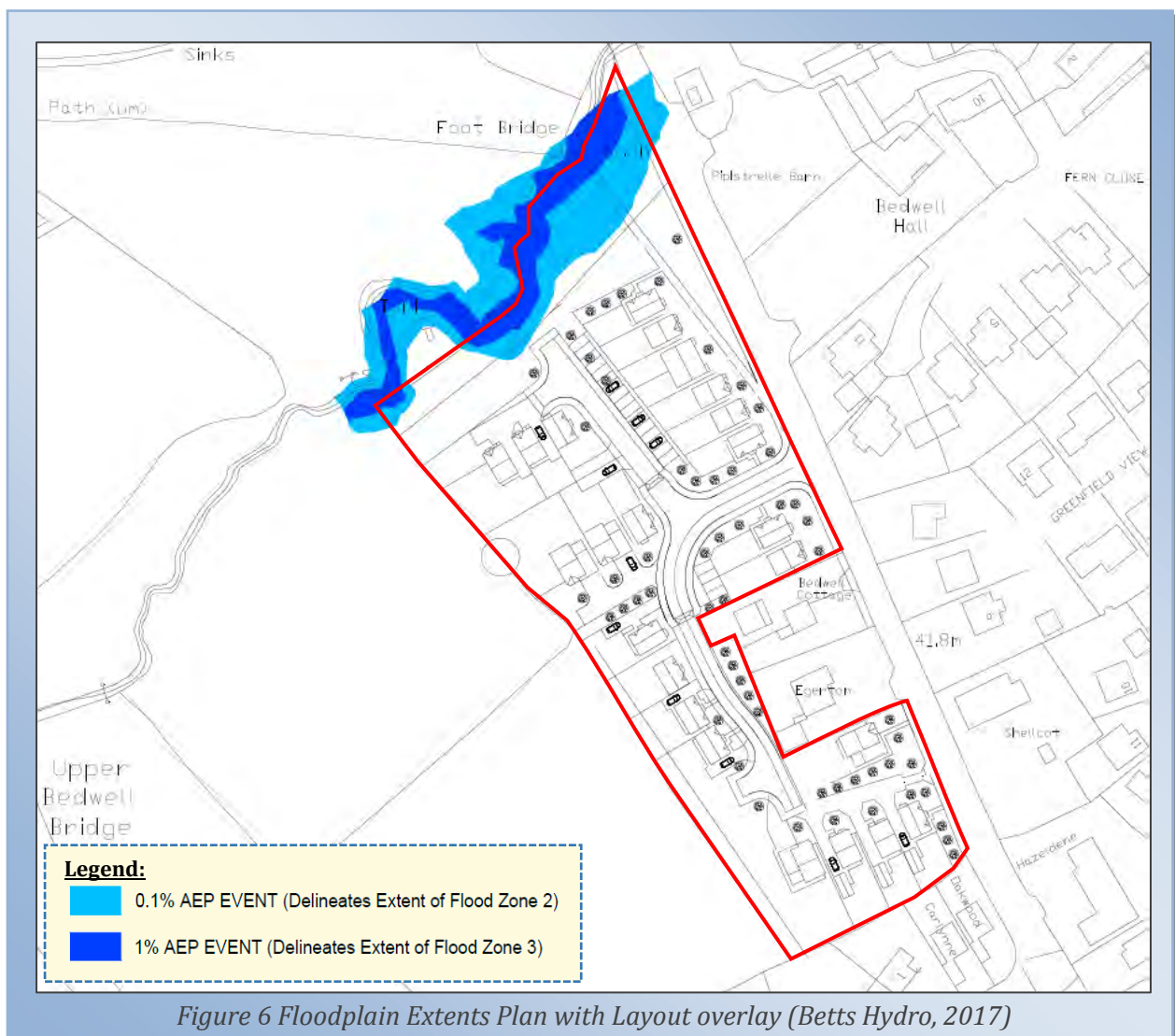
CROSS SECTION REFERENCE	FLUVIAL MODEL RESULTS FOR RETURN PERIOD EVENTS		
	1% AEP EVENT	1% AEP EVENT + 20% CC	0.1% AEP EVENT
CS0138	37.56 mAOD	37.61 mAOD	37.73 mAOD
CS0014	36.66 mAOD	36.68 mAOD	36.79 mAOD
FOOTBRIDGE	36.78 mAOD	36.85 mAOD	36.94 mAOD
CS0000	36.75 mAOD	36.81 mAOD	36.91 mAOD

Table 2: predicted flood water levels along Clywedog Stream (WCBC, 2009)

- 5.1.8 **Table 2** indicates the predicted top water levels at the key cross-sections for the design flood events (as indicated within the full model report). The existing ground levels on the site have been reviewed with these predicted top water levels to more accurately ascertain the level of

fluvial flood risk to the site from Clywedog Stream. Onsite the existing ground levels range from 42.68mAOD in higher southern portion of site to 35.5mAOD in the lower areas neighbouring the watercourse. It can therefore be stated that the extents of the floodplain in the modelled events would encroach out of channel and partly into the site.

- 5.1.9 Not all of the site is proposed to be residentially developed based on the indicative planning proposals, we have therefore reviewed the indicative layout, with the existing ground levels and the predicted TWL's to determine whether the residential (highly vulnerable) proposals will be at risk in the key design storm events. The residential development proposals have been specifically located wholly within Flood Zone 1 following a sequential approach to minimising flood risk, therefore the overall flood risk to the proposals are low.



- 5.1.10 To assist in showing that the proposed development has been sequentially steered towards the areas considered to be at lowest flood risk, a composite floodplain plan has been prepared based on the predicted TWL's in the hydraulic assessment and the existing ground levels onsite (**Appendix J**). The indicative proposals have also been overlaid onto the floodplain plan to clearly show the extents of the floodplain in relation to the site. As illustrated in **Figure 6**, the residential dwellings will be located within the extents of Flood Zone 1 and outside of the extents of floodplain associated with both the 1% AEP and 0.1% AEP events. The only

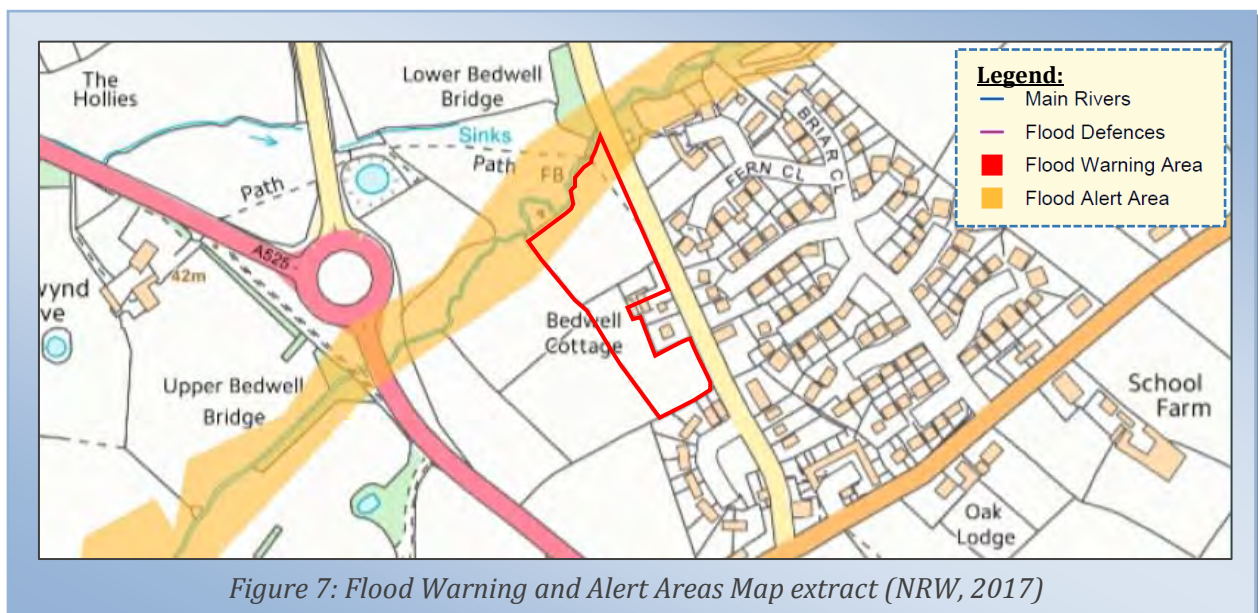
proposals within the extent of the floodplain will be the public open space (POS) areas which are considered to be less vulnerable in comparison to the other proposals onsite.

Mitigation

- 5.1.11 Typically it would be recommended that the residential dwellings have a minimum Finished Floor Level (FFL) set to safeguard against potential residual flood risks. Although there will be no residential dwellings located within the floodplain extents, it would still be recommended that the dwellings onsite have a minimum FFL set 600mm above the predicted TWL in the 1% AEP+CC event. Based on the most relevant cross-section (CS0014) the FFL should be 37.28mAOD. Review of the topographic survey shows that the minimum existing ground level within the proposed development area is 37.28mAOD therefore it is likely that the proposed FFL will be significantly higher than the required minimum to safeguard against flooding.
- 5.1.12 The residential proposals adopted an intra-sequential approach to flood risk and as such will be situated within those areas of least flood risk (Flood Zone 1). No level raising within the floodplain to account for these proposals is anticipated, therefore there is no requirement for compensatory floodplain storage.

Flood Warning and Evacuation

- 5.1.13 As part of the overall site is identified to be at risk from fluvial flooding, consideration has been given to safe emergency access and egress. The primary flood risk to site is from Clywedog Stream (which is a tributary of the River Clywedog). NRW's flood mapping has identified that those areas of the site shown to be located within the floodplain are also located within their Flood Alert area (see mapping in **Appendix B**; extract in **Figure 7**).



- 5.1.14 Although the residential proposals will not be located within the floodplain or flood alert areas it would still be recommended that future residents sign up to the Floodline Service provided by NRW for the River Clywedog. This would provide residents with up-to-date alerts keeping them informed during any potential future flood event.
- 5.1.15 The residential development will take place within those areas of site at least flood risk, however there is still a requirement to consider safe access and egress in accordance with

TAN15. The primary access route into site will be from Bedwell Road (eastern boundary of site). The Flood Zone map provided by NRW shows that at the point of access, Bedwell Road is located within Flood Zone 1 and therefore at little/no fluvial flood risk. Safe access and egress will therefore be maintained from Bedwell Road, when traveling south towards the B5130, Cross Lanes.

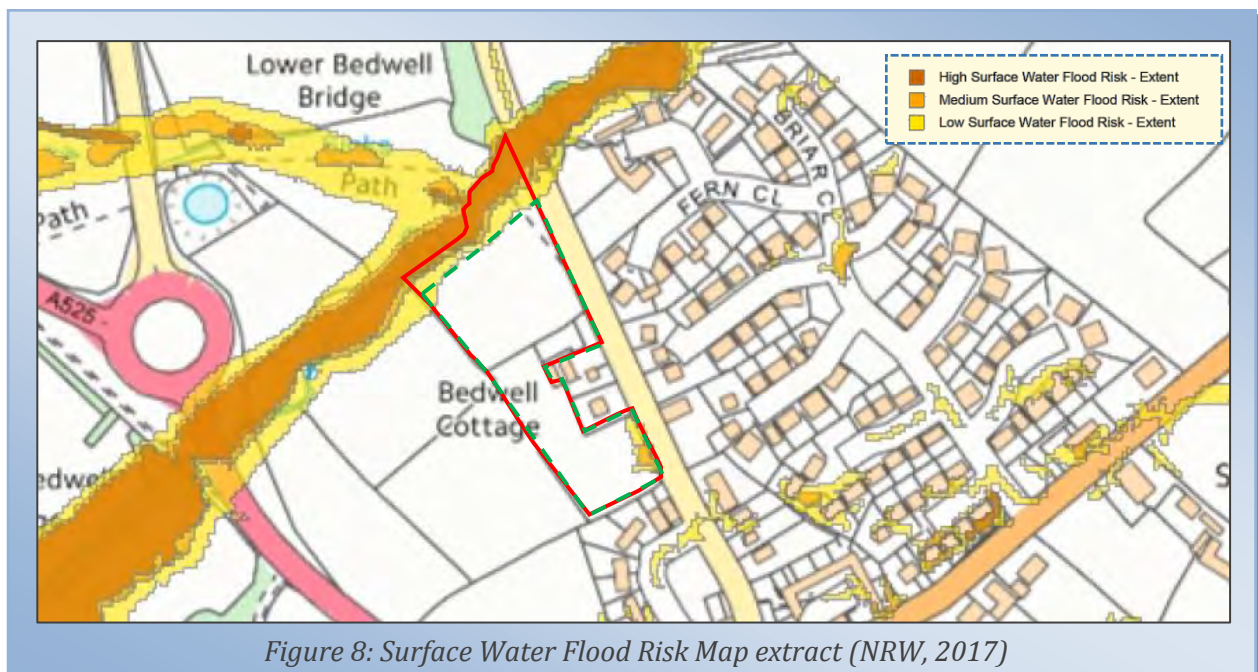
5.2 Tidal Flood Risk

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

5.3 Surface Water

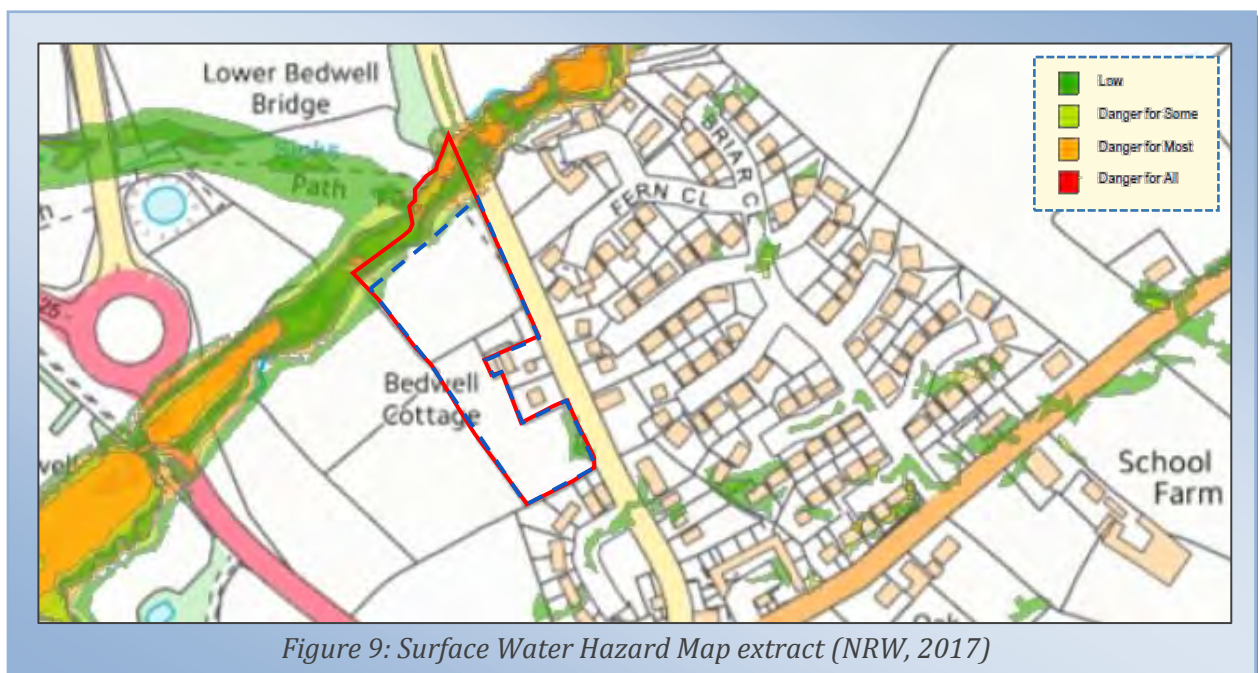
5.3.1 Surface Water flooding occurs when rainwater is unable to drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This section will consider the surface water flood risks associated with overland run-off (pluvial) and sewers.

5.3.2 An increase in impermeable areas through development can reduce percolation rates at source, therefore increasing surface water run-off. If this run-off is not controlled effectively it can increase the frequency and extent of localised flooding in neighbouring areas of the catchment. TAN15 states therefore that 'the aim should be for new development not to create additional run-off when compared with the undeveloped situation and re-development to reduce the overall run-off where possible' (Section 8.3).



5.3.3 Overall the development site is shown to be a varying risk from surface water based on the NRW online mapping (**Figure 8**). However, the proposed highly vulnerable residential development will take place within those areas of the site at lesser flood risk. The areas of site at risk of surface water flooding neighbour the existing watercourse and there is a requirement to maintain an 8m easement from this watercourse, meaning a large portion of the surface water flood risk area will be contained within this no build easement area.

- 5.3.4 An intra-site sequential approach to the management of flood risk has been adopted, the proposed development is being located within those areas at lowest flood risk. Review of the NRW surface water flood risk mapping and the indicative layout shows that development area (green dashed extent in **Figure 8**) will be located predominantly within the very low surface water flood risk areas. There is an isolated areas of surface water flood risk in the southern portion of the site, at present this area of the site is lower than the neighbouring highway and this combination increases the likelihood of pluvial/surface water overland flow and therefore susceptibility to ponding water in the extreme storm events.
- 5.3.5 NRW mapping provide additional information in terms of hazards risk and surface water, **Figure 9** is an extract of their hazard risk map which shows that although some areas of the proposed development area (blue dashed line in **Figure 9**) are considered to be at some risk from surface water the level of risk to people is predominantly low.



- 5.3.6 In order to mitigate any potential residual flood risk from surface water it is advised that (following any re-grade of the site) finished floor levels are raised a minimum of 150mm above the external levels to provide overland flood routes for excess surface water run-off. This will help protect properties from excess surface water run-off. The risk to the proposals from surface water would be further reduced post-development through the implementation of formal onsite surface water drainage infrastructure for effective surface water management (the exact management methodologies are to be confirmed during detailed design).

5.4 Pluvial Flood Risk

- 5.4.1 Intense rainfall that is unable to soak into the ground or enter drainage systems can run-off land and result in flooding. Local topography and the land use can have a strong influence on the direction and depth of flow. The surrounding areas to the east/south are developed and the risk of pluvial run-off onto site from the east and south is minimal. The neighbouring areas to the west of the site are undeveloped and have the potential to generate pluvial run-off,

however as levels generally fall north towards the watercourse the risk directly to the development would be minimal.

- 5.4.2 The volume and rate of overland flow from land can be exacerbated if development increases the percentage of impermeable area. Any overland flows generated by the proposed development must be carefully controlled; safe avenues directing overland flow away from existing and proposed buildings is advised.

5.5 Artificial Sources of Flood Risk

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

Reservoirs

- 5.5.2 NRW consider reservoirs to be bodies of water holding over 25,000cu.m of water, based on the NRW reservoir flood mapping the northern portion of the site is shown to potentially be at some risk from reservoir flooding (an extract of NRW's reservoir flood map is included in **Figure 10**).
- 5.5.3 It is understood that should a failure occur in an upstream reservoir, a large body of water would potentially escape at once and flooding could occur with little warning. It should be noted that the risk of catastrophic failure is considered to be very low, as reservoirs are often considered to be major assets and subject to strict maintenance and inspection procedures.

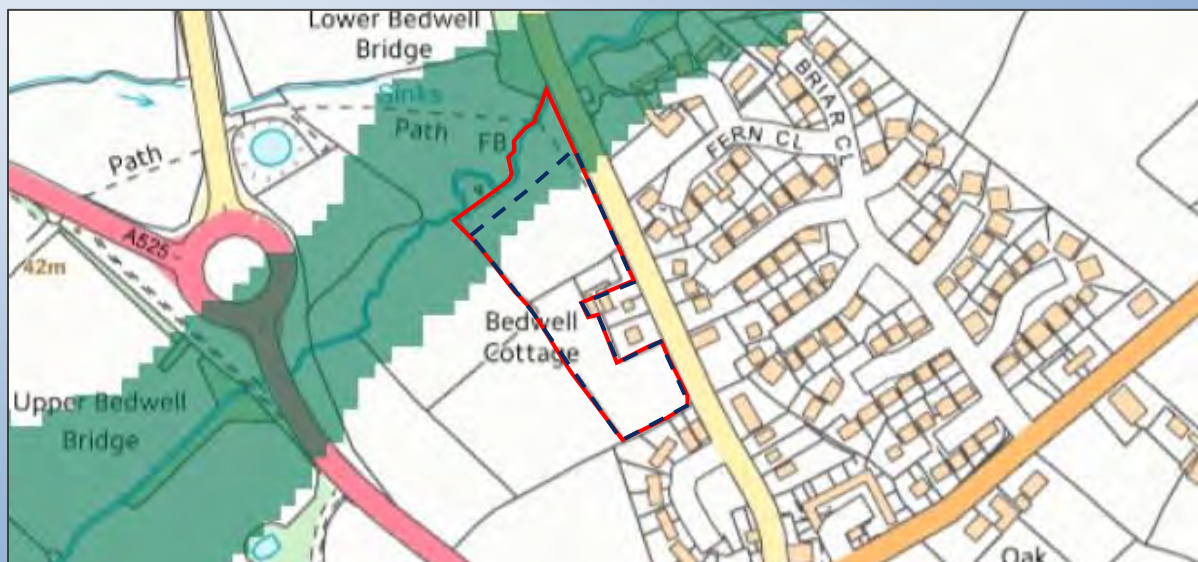


Figure 10: Reservoir Flood Map Extract (NRW 2017)

- 5.5.4 Although reservoir flooding is 'extremely unlikely', if a failure was to occur there would be little or no warning therefore preparedness is key. The government long term flood mapping provides estimates of the potential depths and speeds of flooding associated with reservoirs. In terms of the potential highest flood risk areas, these directly neighbouring the main watercourse channel and no residential development will take place within this highest risk area.

- 5.5.5 The development area (blue dashed line in **Figure 10**) is still located partly within the extents potential reservoir flood risk, however review of the long term flood mapping shows that the flood risk areas within the development area would be potentially susceptible to flood depths of less than 0.3m and flood velocities of less than 0.05m/s (see map extracts in **Appendix B**). These potential depths and velocities combined with the residual nature of flood risk mean that the risk to the development from reservoir flooding is low.

Canals

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

5.6 Groundwater Flood Risk

- 5.6.1 Groundwater flooding is caused by unusually high groundwater levels, it occurs as excess water emerges at the ground surface (or within manmade underground structures). Groundwater flooding tends to be more persistent typically lasting for weeks or months and it can result in significant damage to property.
- 5.6.2 In general terms groundwater flooding can occur from three main sources:
-  If groundwater levels are naturally close to the surface, then this can present a flood risk during times of intense rainfall. No groundwater flood risk has been identified during consultation with the various interested parties.
 -  Seepage and percolation occur where embankments above ground level hold water. In these cases water travels through the embankment material and emerges on the opposite side of the embankment. At present there are no reported problems with groundwater flooding.
 -  Groundwater recovery/rebound occurs where the water table has been artificially depressed by abstraction. When the abstraction stops the water table makes a recovery to its original level. There is the potential for groundwater flooding in low lying areas where groundwater levels have been depressed below their pre-pumping conditions, where these were at or close to ground level. As with the seepage scenario the likelihood of flooding from this source is considered to be low.
- 5.6.3 No historical flooding associated with groundwater has been identified during the preparation of this FCA and any mitigation proposed to secure the development against the primary source of flooding would be suitable to mitigate other sources of flood risk such as groundwater flooding. Furthermore, as the proposed buildings will be elevated above the external levels there would scope for overland flow routes around the properties in the event of groundwater or other source of flooding resulting in overland flow.

5.7 Sewer Flood Risk

- 5.7.1 In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and waste water known as 'combined sewers'. Foul water flooding often occurs in areas prone to overland flow and can result when the sewer is overwhelmed by heavy rainfall and will continue until the water drains away. It can also occur when the sewer becomes blocked or is of inadequate capacity, this could lead to there being a high risk of internal property flooding with contaminated water.

- 5.7.2 Review of the Welsh Water sewer records show there to be existing surface water and foul water sewer infrastructure to the east and south of the site, with an onsite combined sewer running along the western portion and parallel to the watercourse to the north. There will be a requirement to provide easements from any sewer asset within/adjacent to the site in accordance with UU standard guidance.
- 5.7.3 Consultation with various parties has not identified any existing sewer flood risk issues or historical flooding of the immediate site area. No indication of sewer related flooding has been identified within the various publications or our discussions.

5.8 Historical and Anecdotal Flooding Information

- 5.8.1 An internet based search for flooding events did not identify any historical flooding events that impacted on the proposed development area. The Preliminary Flood Risk Assessment (PFRA) does not identify any past flooding of 'local significance' in the vicinity of the proposed development, nor does it identify any past floods with 'significant harmful consequences'.
- 5.8.2 Consultation with the various interested parties also failed to highlight any recorded historical flooding in the immediate vicinity of the site.

5.9 Mitigation Measures and Residual Risks

- 5.9.1 As part of the overall site is identified to be located within Flood Zone C2 mitigation measures discussed below consider the residual risks to site from a variety of sources in compliance with TAN15. However it is noted that the proposed development area will be located solely within the extents of Flood Zone A.

Mitigation Measures

- 5.9.2 Typically it would be recommended that the residential dwellings have a minimum Finished Floor Level (FFL) set to safeguard against potential residual flood risks. Although there will be no residential dwellings located within the floodplain extents. It would still be recommended that the dwellings onsite have a minimum FFL set 600mm above the predicted TWL in the 1% AEP+CC event, based on the data the FFL should be 37.28mAOD, however the topographic survey shows that the existing ground level within the development area is 37.28mAOD, it is therefore likely that the proposed FFL will be significantly higher than the required minimum to safeguard against flooding.
- 5.9.3 The residential proposals adopted an intra-sequential approach to flood risk and as such will be situated within those areas of least flood risk (Flood Zone 1). No level raising within the floodplain to account for these proposals is anticipated, therefore there is no requirement for compensatory floodplain storage.
- 5.9.4 As with any development it is also advised that external levels fall away from the proposed buildings and any overland flows generated by the proposals are carefully controlled (safe avenues away from any existing and proposed buildings is advised).
- 5.9.5 To minimise the flood risk to the neighbouring development and conform to the guidance set out in TAN15, it is proposed that surface water run-off be managed effectively, ideally with the peak rates of run-off being restricted to the equivalent of the pre-development situation.

Opportunities should be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off.

- 5.9.6 The opportunity should also be sought to incorporate SuDS where feasible into the drainage management approach, this will be determined as part of detailed design however given the nature and scale of the proposals there will potentially be scope to incorporate SuDS measures to the north of the scheme.
- 5.9.7 The development and its drainage systems should be designed to cope with intense storm events up to and including the 100 year return period rainfall event with an allowance for Climate Change (CC); based on the design life of the proposal this allowance will be in the form of 30%.
- 5.9.8 As with any drainage system blockages within either the foul or surface water system have the potential to cause flooding or disruption. It is important that should any drainage systems not be offered for adoption to either the Water Company or the Local Authority then an appropriate maintenance regime be scheduled with a suitably qualified management company for any private drainage systems.

Residual Risks

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

6.0 SURFACE WATER MANAGEMENT

6.1 Pre-development Surface Water Run-off

- 6.1.1 For the purposes of determining the existing rate of surface water run-off the site is considered to be 100% pervious; the total site is approximately 1.247ha in size. Based on indicative planning layout only 1.025ha of the site is proposed to be developed, this figure has been used in our surface water calculations as it more accurately represents the proposed development area.
- 6.1.2 The peak rates and volumes of run-off generated by the existing development area have been calculated for the peak events and are shown in **Table 3 (Appendix K)**. The surface water run-off rates have been calculated using the Flood Estimation Handbook (FEH) and the Institute of Hydrology Report 124 (IH124) Greenfield run-off method using the rainfall characteristics from the FEH CD-ROM v3.0 details of which are included **Appendix L**.

Site Area	Run-Off Rates				Run-Off Volumes	
	1 In 1 Year	1 In 30 Year	1 In 100 Year	QBAR	1 In 1 Year	1 In 100 Year
Greenfield (1.025ha)	4.1l/s	8.2l/s	10.1l/s	4.6l/s	65.8cu.m	218.2cu.m

Table 3: Pre-Development Surface Water Run-Off Rates (Betts Hydro, 2017)

6.2 Post-development Surface Water Run-off

- 6.2.1 The residential nature of the proposals means that there will be an increase in the impermeable areas of the site, resulting in an increase in both the volume and the peak rates of run-off if flows are unrestricted. The proposed impermeable area is estimated to be 40% (0.405ha) of the development area based on the indicative layout (refer to **Appendix M**).
- 6.2.2 The unrestricted post-development run-off rates and volumes have been calculated and detailed in **Table 4**, based on the assumed impermeable area and the FEH rainfall catchment characteristics (6hr duration event).

Site Area	Run-Off Rates			Run-Off Volumes	
	1 In 1 Year	1 In 30 Year	1 In 100 Year +CC	1 In 1 Year	1 In 100 Year +CC
Brownfield Portion (0.405ha)	14.0l/s	31.4l/s	54.7l/s	48.5cu.m	296.9cu.m

Table 4: Post-Development Un-Restricted Run-Off Rates and Volumes (Betts Hydro, 2017)

- 6.2.3 The development proposals will provide significant betterment to the unrestricted rates noted in **Table 4** above, the surface water run-off generated by the development area will mimic the pre-development situation (see noted in **Table 3**), meaning betterment on the uncontrolled rates quoted above.

6.3 Sustainable Drainage Systems (SuDS)

- 6.3.1 Sustainable Drainage Systems (SuDS) have the ability to address four core objectives: water quantity, water quality, amenity and biodiversity. In accordance with national policy including the Non-Statutory Technical Standards for Sustainable Drainage Systems (March

2015) and the SuDS Manual (CIRIA 753), SuDS should be specified wherever possible to manage surface water run-off generated onsite.

- 6.3.2 Where possible, peak surface water discharge rates to watercourses and sewers should be appropriately managed and where possible reduced. Preference should always be given to SuDS over the traditional methods of buried sewers wherever possible and practical. It would be beneficial to implement wider green space or a POS area within site, where SuDS features could be implemented. Multiple benefits to using SuDS include the improvement of biodiversity, aesthetics, ecology and water quality. Furthermore there may be the potential to utilise some SuDS features for conveyance/attenuation of surface water flows, opposed to the traditional below ground storage methods.
- 6.3.3 Opportunities should be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off, furthermore there may be the scope to incorporate methods such as swales, rills and rain gardens to provide a degree of treatment before flows are carried offsite (examples seen in **Figure 11**). It would also be recommended that permeable paving and bio-filtration be considered in private (non-adopted areas) where at all feasible to assist locally with surface water management (subject to optimum ground conditions following further onsite testing). If infiltration is not feasible then the permeable paving should be lined with a positive connection into the main drainage for the site.



- 6.3.4 Should the ground conditions onsite prove favourable, infiltration measures should be considered where at all feasible, promoting SuDS to deal with surface water at the source, limiting the required attenuation and reducing the volume of surface water in the nearby sewer infrastructure.
- 6.3.5 Detailed design should confirm whether this site would be suitable for incorporation of SuDS following more detailed analysis of levels, ground conditions and attenuation requirements. The current planning proposals however do shown the potential space for SuDS within the scheme in the northern portion of the site which will remain as open/amenity space.

6.4 Methods of Surface Water Management

- 6.4.1 The total site covers 1.247ha and the development areas covers 1.025ha. At present the site is considered 100% permeable for the purposes of determining the pre-development peak

rates of surface water run-off (there may be small parcels of impermeable area). The impermeable area of the proposed development is expected to increase from 0% to 40% (covering 0.405ha).

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

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

6.5 Discharge via Infiltration

- 6.5.1 Any impermeable areas that can drain to soakaway or an alternative method of infiltration would significantly improve the sustainability of any surface water systems.

- 6.5.2 The National Soils Resource Institute (NSRI) identifies the soils in this location as; *slowly permeable, seasonally wet, acid loamy and clayey soils*. The drainage is considered to be *impeded*. The British Geology Survey (BGS) mapping data indicates that ground conditions are as follows:

- *bedrock geology description: Kinnerton Sandstone Formation - Sandstone.*
- *superficial deposits description: Till, Devensian - Diamicton. Superficial*

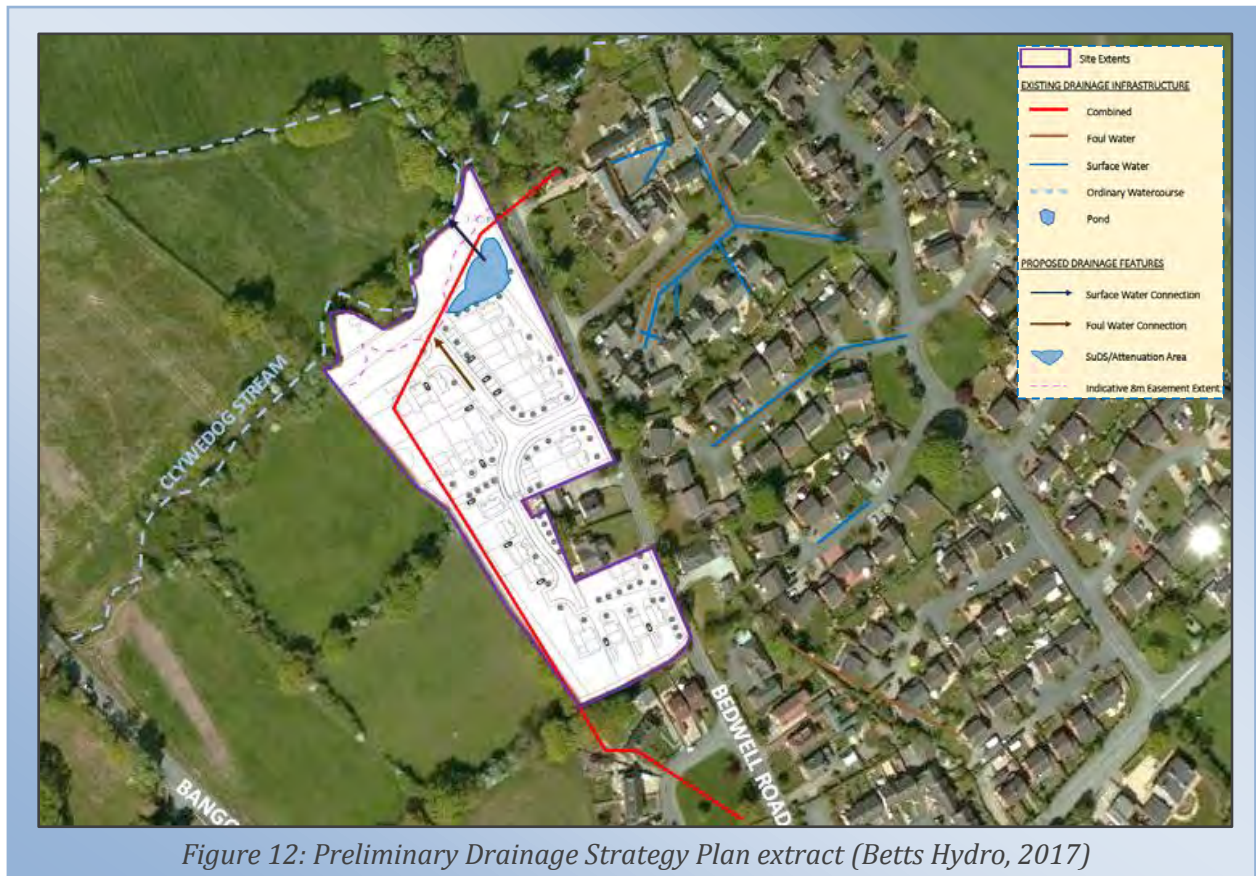
- 6.5.3 Based on the ground conditions identified by the online datasets, it can be considered that infiltration drainage is unlikely to provide a suitable means of surface water disposal for the flows generated by the whole development. In accordance with the LPA's and Welsh Water requirements however, Soakaway Testing to BRE365 will be required to be undertaken to evidence that discharge to ground will not be a viable solution, prior to exploring other options in the drainage hierarchy.

6.6 Discharge to Watercourse

- 6.6.1 Should further testing at the site identify that infiltration will not offer a feasible surface water management solution (in part or in full) then the next method in the hierarchical approach should be to discharge to watercourse. The nearest Ordinary Watercourse to the site is the Clywedog Stream running along the northern boundary of the site.

- 6.6.2 It is proposed that surface water run-off generated by the proposals discharge to the Ordinary Watercourse as illustrated in **Figure 11**. The existing ground levels onsite fall towards the northern boundary predominantly and therefore it is assumed that a gravity solution could be feasible (subject to further analysis as part of detailed design stage).

- 6.6.3 Consents from the Lead Local Flood Authority (Wrexham County Borough Council) will be required for works effecting the Ordinary Watercourse, including agreement of any outfall structures and discharge rates. The LLFA will also require a maintenance easement to be maintained from the Ordinary Watercourse banks, the exact requirements should be agreed at an early stage in the process but typically an 8m no build zone is obligatory. Discussion with Natural Resources Wales may also be needed with regards to the proposed discharge rates.



- 6.6.4 In order to comply with the guidance, the surface water run-off generated by the proposals will be required to be restricted to minimise the flood risk. In accordance with the SuDS Manual (CIRIA 753) and the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) all sites (greenfield and brownfield) should endeavour to achieve as close to pre-development greenfield rates as is viable.
- 6.6.5 When considering the development area as greenfield a pre-development greenfield rate (QBar) of 4.6l/s has been calculated using the IH124 Method (see summary in **Appendix K**). A flow restriction will be most likely in the form of a Hydrobrake® or similar approved flow control device. Given the constraints of flow control devices the minimum discharge rate from the site will be 5.0l/s this is based on the minimum flow through the orifice plate (based on standard diameter size).
- 6.6.6 The restricted flow will generate a storage requirement during the extreme storm events. The stormwater storage figures quoted in **Table 5** are estimates only and detailed design will determine with accuracy the stormwater storage requirements. Should intrusive investigation or discussion identify a different rate is required then this will be addressed during detailed design stage.

Impermeable Area (0.405ha)	1 In 1 Year	1 In 30 Year	1 In 100 Year + 40% CC
Restricted Run-Off Rate	5.0l/s	5.0l/s	5.0l/s
Estimated Stormwater Storage Volume	21cu.m-36cu.m	79cu.m-114cu.m	185cu.m-261cu.m

Table 5: Estimated Stormwater Storage Requirements (Betts Hydro, 2017)

- 6.6.7 The proposed onsite surface water drainage system will need to be sized to contain the 30yr return period event below ground with overland run-off from storm events up to and including the 1 in 100 year return period storm event (with a 40% allowance for climate change) being contained onsite.
- 6.6.8 It would be beneficial to implement a Public Open Space area(s) within the site where SuDS features could be incorporated. If designed appropriately the SuDS features could potentially aid in the attenuation and conveyance requirements for the proposals. The indicative proposals show there to be open space adjacent to the northern boundary, there may be scope to incorporate attenuation SuDS features within this area subject to further investigation during detailed design.

6.7 Discharge to Sewer

- 6.7.1 There are no proposals to discharge surface water run-off generated by the proposed development to the public sewer network given the close proximity of the watercourse.

6.8 Climate Change

- 6.8.1 There are significant indications that the UK climate is changing; the nature of this change will vary based on regional and catchment differences, consensus is that effects will become more pronounced over the coming decades. With reference to TAN15 the most likely effects to be experienced within Wales are;
-  Increases in sea levels;
 -  Greater inflow into estuaries and the sea;
 -  Significant changes in rainfall patterns seasonally;
 -  Increased evapotranspiration;
- 6.8.2 Making 'provisions' for these anticipated future changes to flood risk is considered to be an important action, ensuring future 'sustainable development' within Wales as identified within TAN15; Section 2.1. Current expert opinion indicates the likelihood of more frequent short duration and high intensity rainfall events and the addition of more frequent periods of long duration rainfall meaning future flooding events will have a greater impact on the environment and society.
- 6.8.3 Any increase in the level of flood risk to the proposed development from Climate Change is likely to be related to the increase in rainfall intensity and duration and its impact upon the surface water drainage system, along with the potential impact of sea level rise and its associated impact on flood water levels.
- 6.8.4 Climate Change should be accounted for within the design and it is recommended that an increase in peak rainfall intensity of up to 40% is allowed for in accordance with the latest changes to national and local policy guidance.

7.0 FOUL WATER MANAGEMENT

- 7.1 Review of the Welsh Water sewer records identify public sewer infrastructure within close proximity of the site (see records in **Appendix G**). The nearest assets would be the public combined sewer bisecting the site. There will be a requirement to provide easements from any sewer assets within/adjacent to the site in accordance with standard guidance, further discussion with WW will confirm the specific easement requirements.
- 7.2 The foul water flows generated by the development are proposed to connect into the public combined sewer bisecting the northern portion of the site. Detailed drainage design will be required to confirm whether a site wide gravity solution would be feasible, although as the majority of the site falls towards the northern boundary of site it is likely that this will be the case. Consents and relevant agreements will be required from WW prior to commencement of works.
- 7.3 Early consultation with WW will identify their preferred point(s) of connection and any additional constraints which need to be considered. Based on the proposals for the construction of up to 24no. residential units, the approximate peak foul water flows generated by the development are 1.1l/s. This is 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 has been prepared to support an outline planning application for a residential development on land off Bedwell Road in Cross Lanes. The total site covers 1.247ha and is predominantly permeable at this time, although the proposed development areas covers a smaller portion of the wider site (1.025ha). The whole site is shown to be located within Flood Zones A and C2 based on the Development Advice Map, however the development area is located within Flood Zone A only.

Flood Risk

- 8.2 The FCA has reviewed all sources of flood risk to both the proposed development and to the existing adjacent development as a result of the proposals. The site is shown to predominantly be located within Flood Zone 1, with the northern boundary being within in Flood Zones 2 and 3. The nearest watercourse to the site is Clywedog Stream, which runs parallel to the northern boundary of the site. The primary flood risk to the development proposals is considered to be the fluvial associated with the adjacent watercourse. Clywedog Stream is an Ordinary Watercourse and discussion with the Lead Local Flood Authority (Wrexham County Borough Council) has been undertaken to identify the potential flood risks to the site.
- 8.3 Wrexham County Borough Council has identified that hydraulic modelling of Clywedog Stream and its tributaries was undertaken in 2009 this data has been used within our assessment as its confirmed to be the most accurate up-to-date available. The hydraulic modelling provide predicted top water levels (at multiple cross-sections adjacent to site) for the various modelled flood events. The predicted flood water levels have been compared to the existing ground levels on the site to more accurately ascertain the level of fluvial flood risk to the proposals. It can be stated that the extents of the floodplain in the modelled events would encroach out of channel and partly into the wider site. However, not all of the site is proposed to be residentially developed as an intra-sequential approach to flood risk has been adopted.
- 8.4 The residential (highly) vulnerable development is proposed to be located solely within Flood Zone 1 and will remain flood free in the 1% AEP and 0.1% AEP events (based on the hydraulic modelling undertaken). The overall fluvial flood risk to the residential proposals is considered to be low. The proposed development has been justified in accordance with TAN15 and suitable mitigation measures proposed to ensure that the development is safe. It would be recommended that the proposed dwellings onsite have a minimum finished floor level set 600mm above the predicted Top Water Level in the 1% AEP+CC event. Based on the model outputs at the cross sections onsite the minimum finished floor level should be 37.28mAOD.
- 8.5 Review of the topographic survey shows that the existing ground level (within the development area) is currently 37.28mAOD, therefore the proposed finished floor level will likely be raised higher than the required minimum to safeguard against flooding due to other engineering constraints. It is advise following any re-grade onsite that the finished floor levels are raised above the external levels to provide avenues for overland flow which could result from other residual flood risk sources. No level raising within the floodplain to account for these proposals is anticipated, therefore there is no requirement for compensatory floodplain storage.

- 8.6 As part of the overall site is identified to be at risk from fluvial flooding, it would be recommended that future occupants sign up to the flood warning service provided by Natural Resources Wales in the event of a future flood incident impacting the neighbouring river catchment. The proposed residential development will be located within the lesser flood risk areas only however consideration has been given to safe emergency access and egress. As the proposed access road is located within Flood Zone 1 and the dwelling are proposed to have mitigation to cater for any residual flood risks, safe access and egress will be maintained from Bedwell Road.
- 8.7 Review of online resources and consultation with various interested parties has failed to identify any significant historical flooding events to have impacted on the site. The site is shown to be at varying risk from flooding associated with surface water and reservoirs however as the primary flood risk is fluvial the mitigation proposed to cater for these flood risks would also cater for any risk associated with the other potential sources of flood risk.

Drainage Strategy

- 8.8 A key focus should also be on the effective management of surface water run-off generated by the proposals. Based on the ground conditions identified online, it can be considered that infiltration drainage is likely to provide a suitable surface water management method disposal for the flows generated by the proposed development (Soakaway Testing to BRE365 will be required to be undertaken).
- 8.9 It is proposed that surface water run-off generated by the proposals discharge to the Clywedog Stream on the northern boundary of site (should testing evidence infiltration will not be feasible). The existing ground levels onsite predominantly fall towards the northern boundary and therefore a gravity solution could be feasible (subject to further analysis as part of detailed design stage). Consents from the Lead Local Flood Authority (Wrexham County Borough Council) will be required for works effecting the Ordinary Watercourse, including agreement of any outfall structures and discharge rates.
- 8.10 The surface water run-off generated by the proposals will be required to be restricted to minimise the flood risk. In accordance with the policy all sites (greenfield and brownfield) should endeavour to achieve as close to pre-development greenfield rates as is viable. When considering the development area a pre-development greenfield rate (Q_{Bar}) of 4.6l/s has been calculated. Given the constraints of flow control devices however, the minimum discharge rate from the site will be 5.0l/s this is based on the minimum flow through the orifice plate (based on standard diameter size).
- 8.11 The restricted flow will generate a storage requirement during the extreme storm events. It would be beneficial to implement SuDS onsite in accordance with recent policy changes, to provide water quality and attenuation benefits for the site. Detailed design should confirm which methods would be most suitable for incorporation following more detailed analysis of levels and layout.
- 8.12 This Flood Consequence Assessment is considered to be commensurate with the development proposals and in summary, the development can be considered appropriate in accordance with TAN15, providing the mitigation measures proposed are conformed to.

9.0 RECOMMENDATIONS

- 9.1 An intra-sequential approach to flood risk has been adopted and proposed residential (highly vulnerable) development has been steered to those areas of site at least risk from flooding associated with fluvial, surface water and artificial sources. It would still be recommended that the proposed dwellings onsite have a minimum finished floor level set 600mm above the predicted Top Water Level in the 1% AEP+CC event. Based on the model the minimum finished floor level should be 37.28mAOD. As with any development it is also advised that external levels fall away from property to minimise the flood risk from a variety of sources.
- 9.2 The Lead Local Flood Authority (Wrexham) will require a maintenance easement to be maintained from the Clywedog Stream flowing adjacent to the northern boundary of the site. The exact requirements should be agreed at an early stage in the process but typically an 8m no build zone is obligatory, this can be seen in the current indicative proposals.
- 9.3 It would be recommended that future occupants sign up to the flood warning service provided by Natural Resources Wales in the event of a future flood incident impacting the neighbouring river catchment. This will improve preparedness and alleviate residual flood risk and potential vulnerability.
- 9.4 Any overland flows generated by the proposed development must be controlled, safe avenues directing overland flow away from any existing and proposed buildings are advised. To minimise the flood risk to the neighbouring property and proposed dwellings it is proposed that the surface water run-off generated by the proposals be managed effectively with the peak rates of run-off being restricted.
- 9.5 Soakaway Testing to BRE365 will be required to be undertaken to evidence that discharge to ground will not be a viable solution prior to pursuing other options identified in the hierarchical approach. Detailed design will be required to confirm feasibility of the drainage strategy and early discussion with all relevant parties will identify any additional considerations/constraints.
- 9.6 Opportunities should be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off. Added benefits include biodiversity and visual enhancements. It is proposed that SuDS systems are also considered within the scheme to in part manage the surface water run-off generated, particularly attenuation.
- 9.7 The proposed onsite surface water drainage system will need to be sized to contain the 30yr return period event below ground with overland run-off from storm events up to and including the 1 in 100 year return period storm event (with a 40% allowance for climate change) being contained onsite.
- 9.8 There will be a requirement to provide easements from any sewer assets within/adjacent to the site in accordance with Welsh Water standards. It is important that should any proposed drainage systems not be offered for adoption to either the Water Company or the Local Authority then an appropriate maintenance regime be scheduled with a suitably qualified management company for any private drainage systems.

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CIRIA – <http://www.ciria.org/>

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

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

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

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

Flood London – <http://www.floodlondon.com/>

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

Google Maps – <http://maps.google.co.uk/>

London Resilience – <http://www.londonprepared.gov.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/hecras/>

United Utilities - <http://www.unitedutilities.com/default.aspx>

Watertight International – <http://www.watertightinternational.com/>

APPENDIX A: TAN15 EXTRACTS

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Figure 1

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

Figure 2

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

Summary of Policy Requirements

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

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

APPENDIX B: NRW/EA INFORMATION & CORRESPONDENCE

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Kirsty Williams

From: Thomas, Colin <Colin.Thomas@cyfoethnaturiolcymru.gov.uk>
Sent: 11 April 2017 14:45
To: Kirsty Williams
Subject: FW: ATI-12575a-Land off Bedwell Road, Cross Lanes, Wrexham, LL13 0TR

Follow Up Flag: Follow up
Flag Status: Completed

Dear Kirsty,

I have been informed that we don't hold any detailed information for this site:

Self Service and use of Open Data: You can now make the most of open data provided **free** online. You can

- create and **export an A4 or A3 PDF map** using our the [NRW Flood Risk Map](#), from the NRW Website. Here you will find many spatial risk layers, and be able to produce a map up to scale on 1:10000 (to be increased to 1:5000 in future updates). **Or**
- **download** FloodMap layers and other spatial flood datasets from "[Lle](#)" the Welsh Government Portal for [Open GIS data](#). Spatial data is free to download, view and use within your own GIS system. You will be able to find Flood Zones, Flood Defences, Recorded Flood Outline, Areas Benefiting Defences and more. More datasets will be released in the coming year.
- download the Extreme Tide level report and data from the [Coastal Flood Boundary Conditions for the Mainland UK Coasts and Islands \(SC060064\)](#), covering still water levels for the whole Welsh Coastline. Wave overtopping is **not** covered.

Please Note The Following:

** All information supplied will need to be verified by the recipient PRIOR to using in a Flood Consequences Assessment (FCA). We would expect to see a review of the hydrology, in-channel survey, and floodplain topography etc. to demonstrate the data is suitable for the purposes of producing an FCA. Please contact the Flood Risk Analysis Team for further advice.*

** As of 1st of December, 2016 you will need to apply climate change allowances carefully to ensure compliance with Welsh Government climate change clarification letter.*

Kind Regards
Colin

Colin Jason Thomas
Swyddog Cymorth Busnes/Business Support Officer
Cyfoeth Naturiol Cymru/Natural Resources Wales
Maes y Ffynnon
Penrhosgarnedd
Bangor
LL57 2DW

Ffon/Tel: 03000 655267

E bost/E-mail:

Colin.Thomas@cyfoethnaturiolcymru.gov.uk

Colin.Thomas@naturalresourcescymru.gov.uk

Gwefan/Website:

www.cyfoethnaturaolcymru.gov.uk/ www.naturalresourceswales.gov.uk

Ein pwrpas yn sicrhau fod adnoddau naturiol Cymru yn cael eu cynnal, gwella a'u defnyddio yn cynnal, gwella a'u defnyddio yn gynaliadwy, yn awr ac i'r dyfodol.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, used and enhanced, now and in the future

From: Data Distribution

Sent: 28 March 2017 10:18

To: Enquiries <enquiries@cyfoethnaturaolcymru.gov.uk>

Subject: ATI-12575a-Land off Bedwell Road, Cross Lanes, Wrexham, LL13 0TR

Hi Seren,

Thanks for this, we will log the request for historical flooding and water levels as a data request.

I think the sentence "If there are any 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 works at an early stage" is asking for our advice on the FCA. Could you therefore please also send this to Planning.

Thank you,
Rachel

From: Enquiries

Sent: 28 March 2017 10:03

To: Data Distribution <datadistribution@cyfoethnaturaolcymru.gov.uk>

Subject: NRW:02940084

Hi team,

I have forwarded this email to yourselves in the hope that you could advise Kirsty with her query.

Kind regards,

Seren Metcalfe

Ymgynghorydd Gofal Cwsmer/Customer Care Advisor

Cwsmeriaid, Cyfathrebu a Gwybodaeth/Customer, Communications and Information Directorate

Cyfoeth Naturiol Cymru/Natural Resources Wales

Siaradwraig Cymraeg

----- Original Message -----

From: kirstywilliams@betts-associates.co.uk

Received: 28/03/2017

To: Enquiries Queue; HZW-005344; HZW-006866

Cc: Lucy Stephenson; Ryan Knowles

Subject: HYD217 Bedwell Road, Cross Lanes

To whom it may concern,

Land off Bedwell Road, Cross Lanes, Wrexham, LL13 0TR

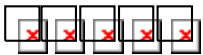
Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and any water levels; this would be greatly appreciated. If there are any 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 works 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

Kirsty Williams BSc(Hons)
Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
CHESTER OFFICE - 01244 289041



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

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



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FLOOD RISK FROM RIVERS AND SEA
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

- Main Rivers
- Flood Defences
- Risk of Flooding from Rivers & Sea
 - High
 - Medium
 - Low
 - Very Low

Graddfa / Scale 1: 4,999

Dyddiad / Date
06/04/2017



FLOOD ZONE MAP

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

- Main Rivers
- Flood Defences
- Floodmap Flood Zone 3
- Floodmap Flood Zone 2

Graddfa / Scale 1: 5,001

Dyddiad / Date
06/04/2017



FLOOD WARNING AREAS

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

- Main Rivers
- Flood Defences
- Flood Warning Area
- Flood Alert Area

Graddfa / Scale 1: 4,999

Dyddiad / Date
06/04/2017



HISTORIC FLOODING

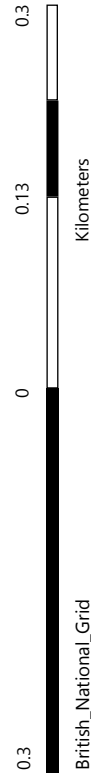
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

- Main Rivers
- Flood Defences
- Historic Flood Map

Graddfa / Scale 1: 4,999

Dyddiad / Date
06/04/2017



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SURFACE WATER FLOOD RISK

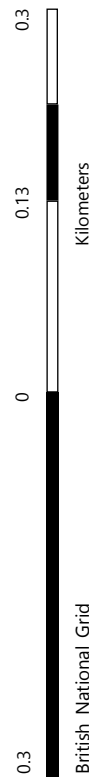
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

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

Graddfa / Scale 1: 5,001

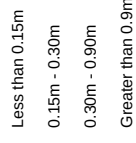
Dyddiad / Date
06/04/2017



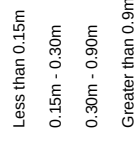
SURFACE WATER FLOOD RISK DEPTH
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

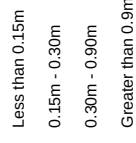
High Surface Water Flood Risk - Depth (m)



Medium Surface Water Flood Risk - Depth (m)

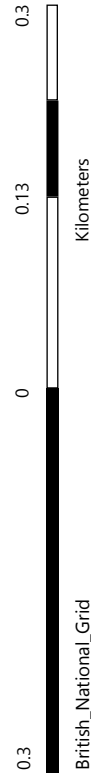
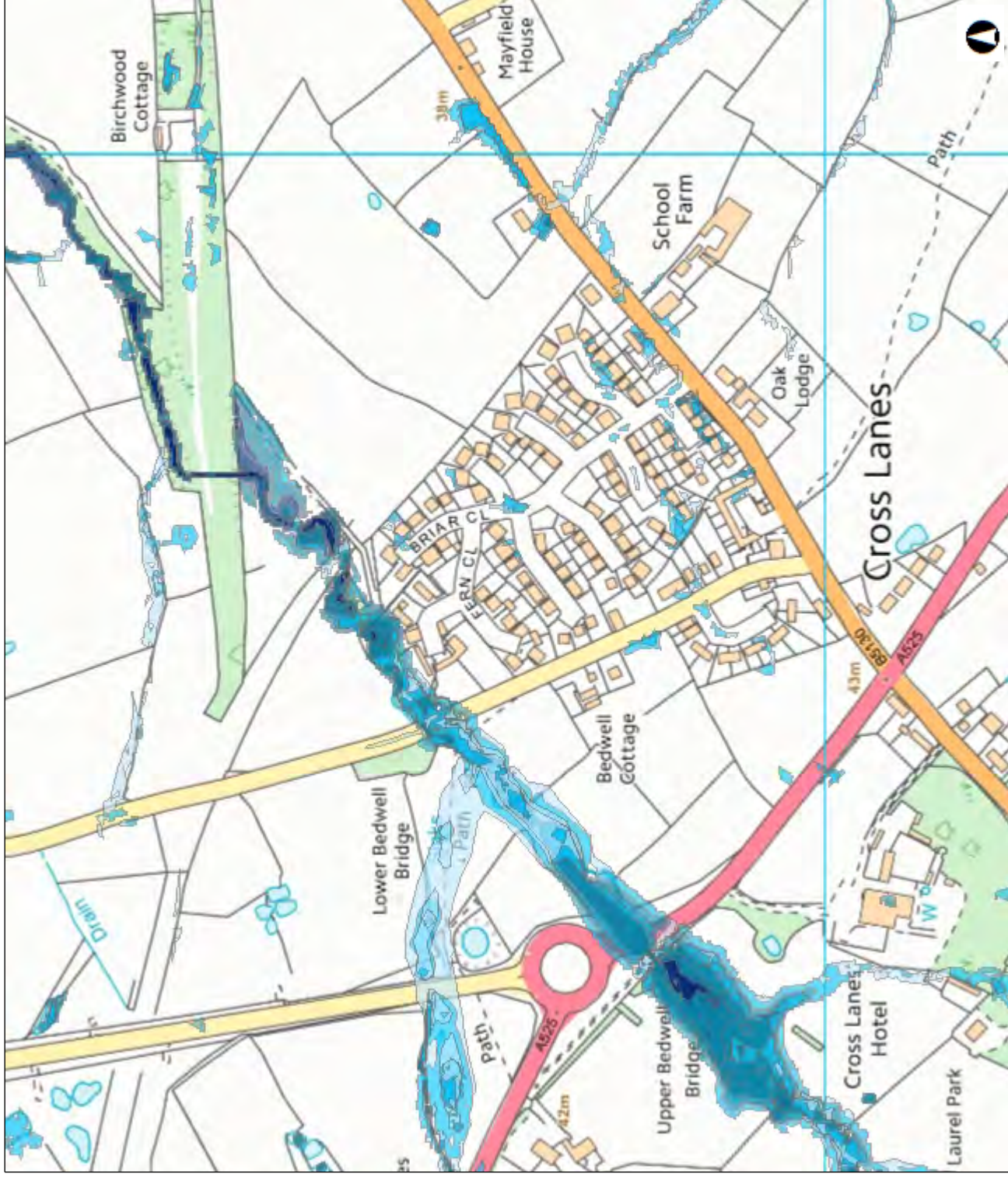


Low Surface Water Flood Risk - Depth (m)



Graddfa / Scale 1: 5,001

Dyddiad / Date
06/04/2017

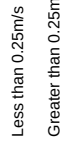


SURFACE WATER FLOOD RISK VELOCITY

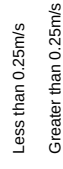
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Allwedd / Map Key

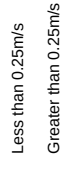
High Surface Water Flood Risk - Velocity (m/s)



Medium Surface Water Flood Risk - Velocity (m/s)



Low Surface Water Flood Risk - Velocity (m/s)



Graddfa / Scale 1: 5,001

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SURFACE WATER FLOOD RISK
DIRECTION OF FLOW
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

- ↑ Low Surface Water Flood Risk - Flow Direction
- Low Surface Water Flood Risk - Extent

Graddfa / Scale 1:5,001

Dyddiad / Date
06/04/2017



SURFACE WATER FLOOD RISK HAZARD
MAP
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

High Surface Water Flood Risk - Hazard

- Low
- Danger for Some
- Danger for Most
- Danger for All

Medium Surface Water Flood Risk - Hazard

- Low
- Danger for Some
- Danger for Most
- Danger for All

Low Surface Water Flood Risk - Hazard

- Low
- Danger for Some
- Danger for Most
- Danger for All

Graddfa / Scale 1:5,001

Dyddiad / Date
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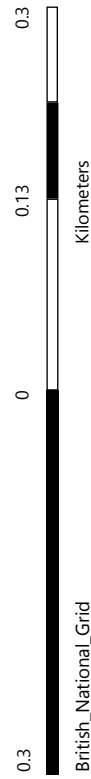
FLOODING FROM RESERVOIRS

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key
Reservoir Extents

Graddfa / Scale 1: 4,999

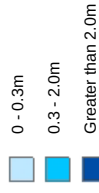
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FLOODING FROM RESERVOIRS DEPTH
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

Reservoir Depths

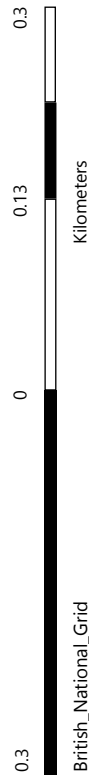


Graddfa / Scale 1: 4,999

Dyddiad / Date
06/04/2017



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FLOODING FROM RESERVOIRS

VELOCITY

Map Perygl Llifogydd / Flood Risk Map

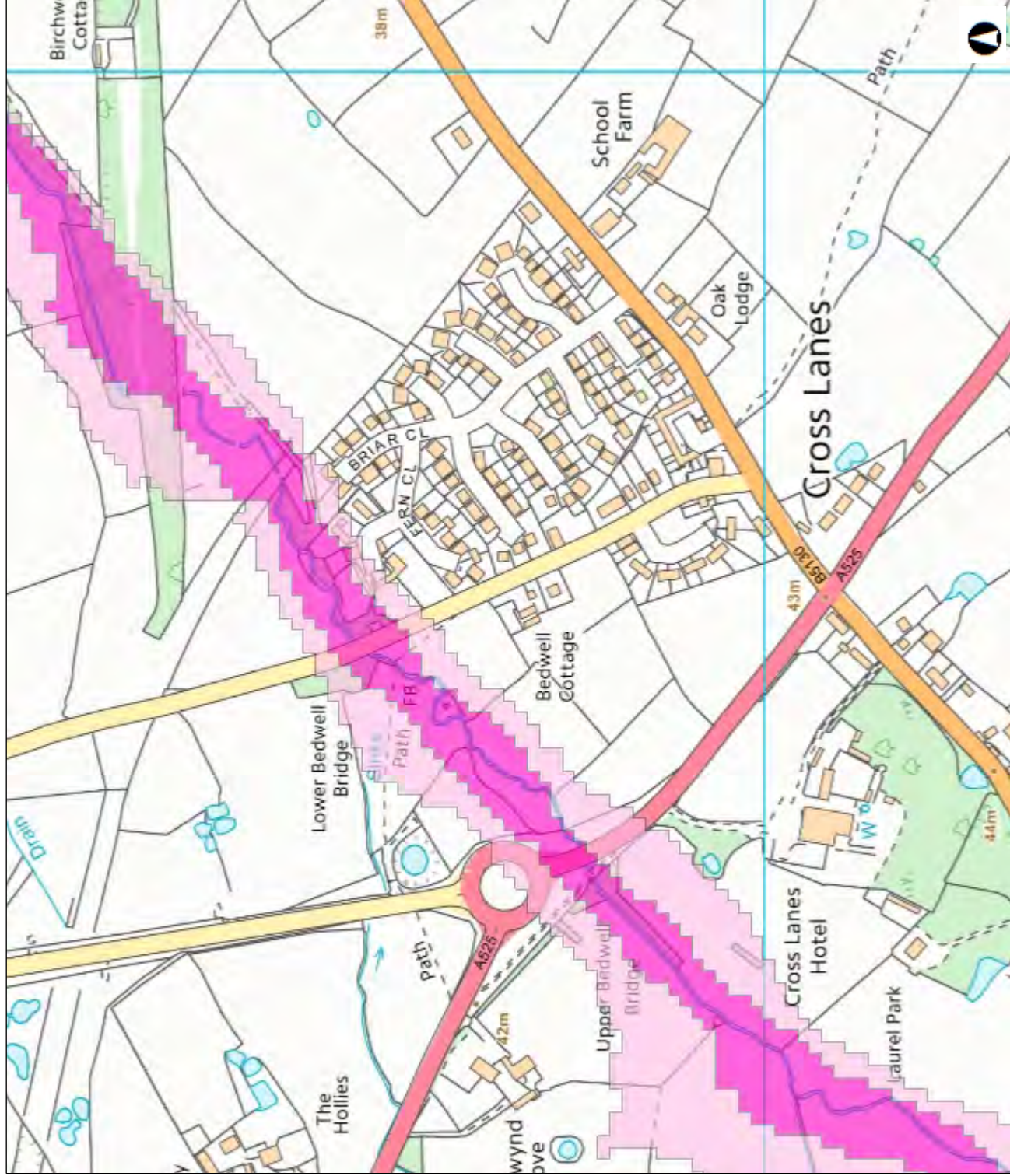
Allwedd / Map Key

Reservoir Velocities

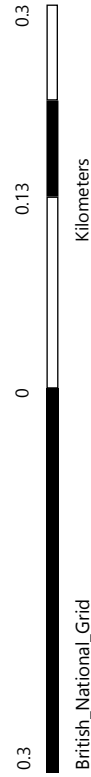
- 0 - 0.5m/s
- 0.5 - 2.0m/s
- Greater than 2.0m/s

Graddfa / Scale 1: 4,999

Dyddiad / Date
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APPENDIX C: SEWER RECORDS & CORRESPONDENCE

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Kirsty Williams

From: Kirsty Williams
Sent: 28 March 2017 09:28
To: 'Jones-Hughes Henry'
Subject: HYD217 Bedwell Road, Cross Lanes
Attachments: LOCATION PLAN.pdf

Good Morning Henry,

Land off Bedwell Road, Cross Lanes, Wrexham, LL13 0TR

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and any water levels; this would be greatly appreciated. If there are any 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 works 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

Kirsty Williams BSc(Hons)
Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
CHESTER OFFICE - 01244 289041



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

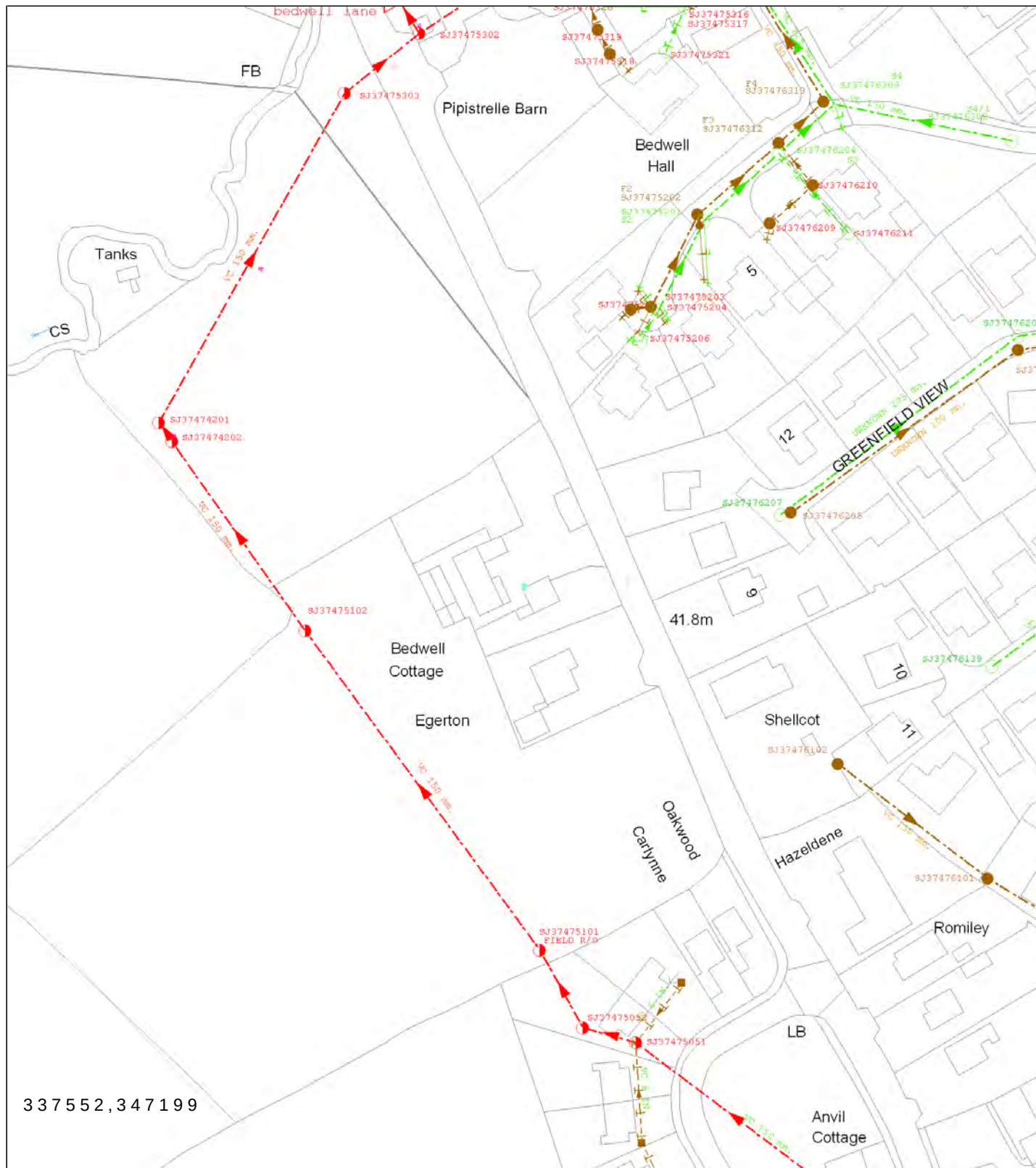
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Bedwell Road, Cross Lanes, Wrexham

Scale: 1:1250
07/04/2017

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

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 Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and 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. The information which is supplied hereby by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 based upon the best information available and in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a drain sewer or disposal main laid before 1 September 1989, or if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.

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LEGEND



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

NB: Sewer symbol colour indicates the sewer type.

RED - Combined
GREEN - Surface Water
BROWN - Foul

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APPENDIX D: LPA/LLFA CORRESPONDENCE

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Kirsty Williams

From: Carole Wright <Carole.Wright@wrexham.gov.uk>
Sent: 28 March 2017 14:26
To: Kirsty Williams
Subject: RE: HYD217 Bedwell Road, Cross Lanes

Hi Kirsty

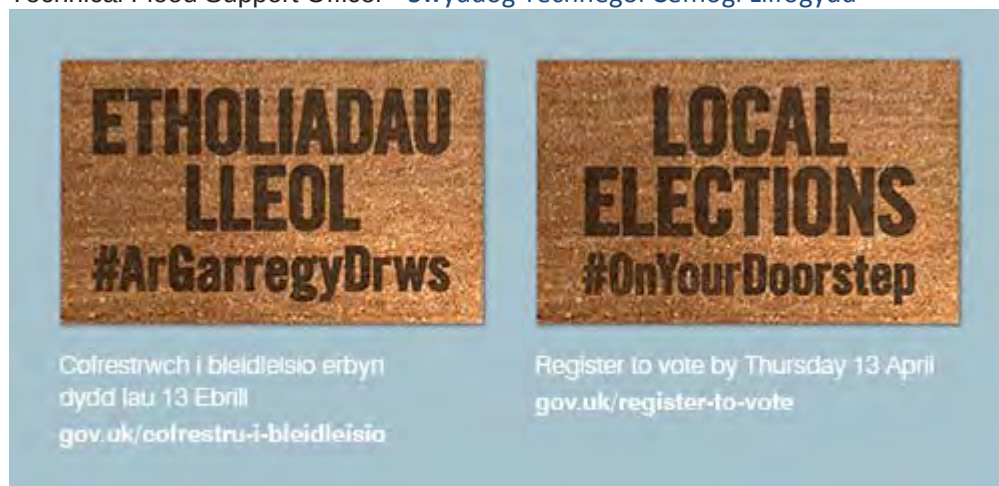
The report was submitted in 2007 to support the link road application and unfortunately we do not have the model. Our senior flood officer Neil Taunt will be happy to discuss any issues with you as your project progresses.

Kind regards

Carole Wright

Carole Wright - BA MBCS

Technical Flood Support Officer - Swyddog Technegol Cefnogi Llifogydd



01978 729735

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

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

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facebook.com/wrexhamcouncil | facebook.com/cyngorwreccsam

From: Kirsty Williams [mailto:kirstywilliams@betts-associates.co.uk]
Sent: 28 March 2017 14:19
To: Carole Wright
Cc: Neil Taunt
Subject: RE: HYD217 Bedwell Road, Cross Lanes

Many Thanks Carole for your swift and comprehensive response.

The team may be in touch again as the project progresses in terms of the hydraulic assessment you sent though as it appears there should be an existing hydraulic model that may be of use if we need to look at the more up to date climate change aspects. I don't suppose you have access to the actual model do you ? also could you find out the date of the report you sent through please so at least we have an idea of how recent the dataset is. Thank you

Kind Regards

Kirsty Williams BSc(Hons)
Flood Risk Analyst

BETTS HYDRO

Specialists in Drainage and Flood Risk

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

CHESTER OFFICE - 01244 289041



kirstywilliams@betts-associates.co.uk

www.betts-associates.co.uk

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From: Carole Wright [<mailto:Carole.Wright@wrexham.gov.uk>]

Sent: 28 March 2017 13:47

To: Kirsty Williams <kirstywilliams@betts-associates.co.uk>

Cc: Neil Taunt <Neil.Taunt@wrexham.gov.uk>

Subject: RE: HYD217 Bedwell Road, Cross Lanes

Hi again

My apologies, I omitted the surface water link.

http://www.wrexham.gov.uk/english/planning_portal/publications/surface_water.htm

kind regards

Carole Wright

Carole Wright - BA MBCS

Technical Flood Support Officer - *Swyddog Technegol Cefnogi Llifogydd*



01978 729735



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



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From: Kirsty Williams [<mailto:kirstywilliams@betts-associates.co.uk>]

Sent: 28 March 2017 11:19

To: flooding

Subject: HYD217 Bedwell Road, Cross Lanes

To Whom It May Concern,

Land off Bedwell Road, Cross Lanes, Wrexham, LL13 0TR

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and any water levels; this would be greatly appreciated. If there are any 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 works at an early stage.

Furthermore we have been advised that as the Lead Local Flood Authority you may have existing hydraulic/river models of the Ordinary Watercourse which bounds the northern portion of the development site. NRW have requested that we review the potential flood risks from this source and as it is Ordinary they cannot provide any specific modelling data. Any assistance you can provide would be greatly appreciated. Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Kirsty Williams BSc(Hons)
Flood Risk Analyst

BETTS HYDRO
Specialists in Drainage and Flood Risk

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

CHESTER OFFICE - 01244 289041



kirstywilliams@betts-associates.co.uk

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APPENDIX E: LOCATION PLAN

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LOCATION PLAN

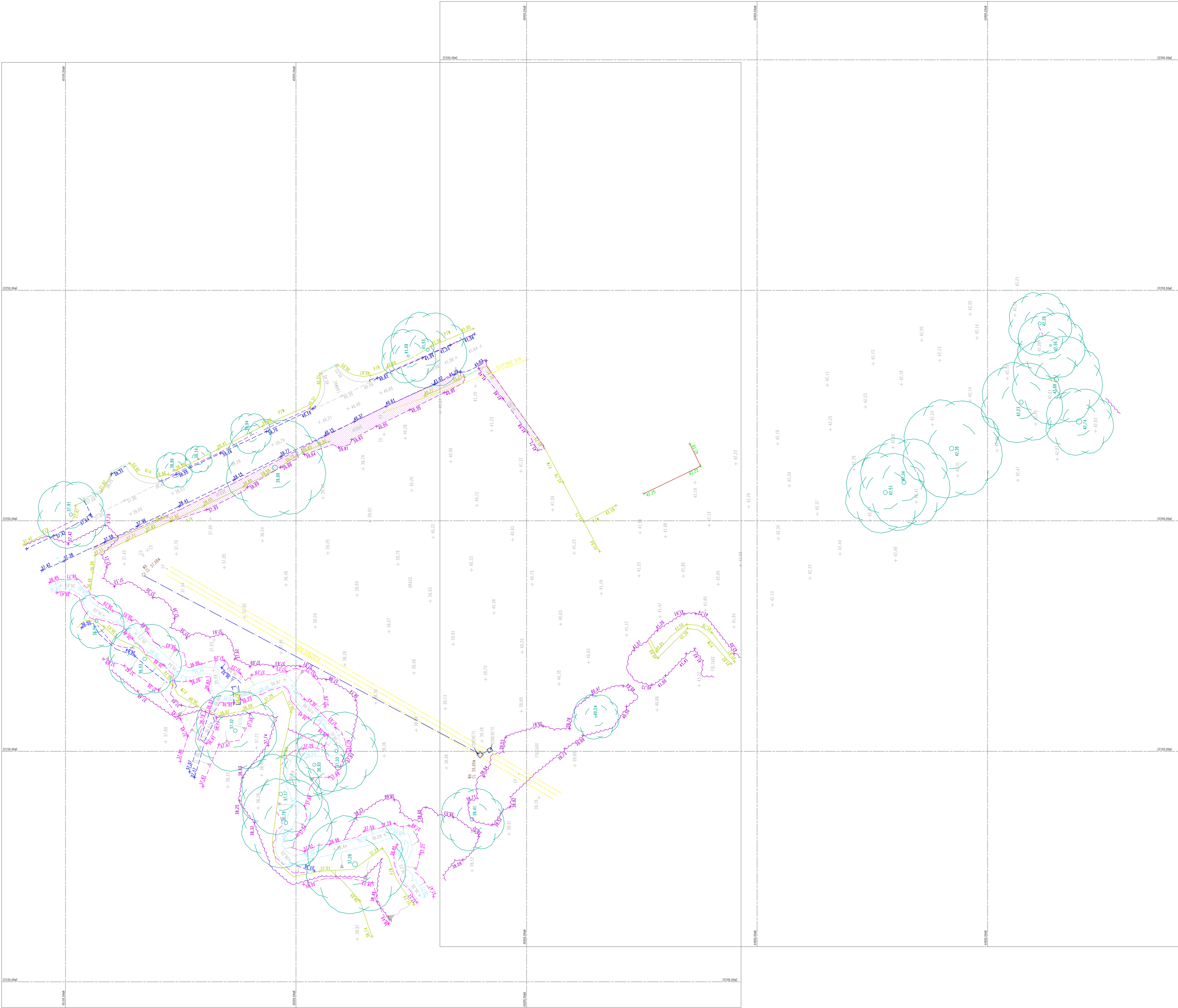
Land off Bedwell Road, Cross Lanes, Wrexham, LL13 0TR



OS X (Eastings)	337522
OS Y (Northings)	347194
Nearest Post Code	LL13 0TR
Lat (WGS84)	N53:01:06 (53.018381)
Long (WGS84)	W2:55:58 (-2.932803)
Lat, Long	53.018381, -2.932803
Nat Grid	SJ375471 / SJ3752247194

APPENDIX F: EXISTING LEVELS INFORMATION

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APPENDIX G: PROPOSED PLANNING LAYOUT

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APPENDIX H: DEVELOPMENT ADVICE MAP

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DEVELOPMENT ADVICE MAP

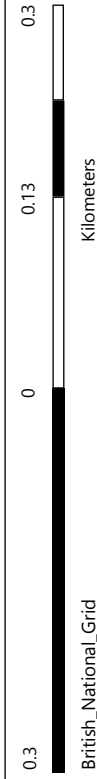
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Map Key

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

Graddfa / Scale 1: 4,999

Dyddiad / Date
06/04/2017



APPENDIX I: HYDRAULIC MODEL REPORT

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CAPITA SYMONDS

Wrexham County
Borough Council

Wrexham Industrial Estate,
Southern Road

Hydraulic Modelling
Technical Report:
Clywedog Stream and
Hollies Stream

CS/000868/39

Capita Symonds Ltd, 24-30 Holborn, LONDON, EC1N 2LX
T: 02078709300 F: 02078709399

CONTENTS

1. INTRODUCTION..... 4
1.1 Aim 4
1.2 Flood Model Selection..... 4

2. DATA COLLECTION..... 4
2.1 Ground Survey 4
2.2 Hydrology 4

3. BASELINE MODEL SETUP..... 4
3.1 Model Extents..... 4
3.2 Mannings n..... 5
3.3 Hydraulic Structures..... 5
3.4 Model Boundaries 5

4. BASELINE MODELLING RESULTS 6

5. SOUTHERN ACCESS ROUTE MODEL SETUP 6

6. SOUTHERN ACCESS ROUTE MODELLING RESULTS 7

7. CONCLUSIONS..... 8

APPENDICES

APPENDIX 1 Figures and Drawings
APPENDIX 2 Photos
APPENDIX 3 ISIS Model Results

1. INTRODUCTION

1.1 Aim

To assess the impact of the proposed Wrexham Industrial Estate Southern Access Road, including a new bridge, on flows in the Clywedog Stream and adjoining watercourse. The proposed southern access route will cross the Hollies Stream immediately north of Cross Lanes roundabout, and the Clywedog Stream immediately south of it.

The results from this modelling exercise will produce flood levels in the study area. These outlines will represent the extent of baseline flooding and expected flooding following the construction of the proposed access road.

1.2 Flood Model Selection

The hydraulic model was constructed using the one dimensional modelling program iSIS. This was decided due to the scale of the watercourses being modelled. Both streams are reasonably small, with the Clywedog Stream having a catchment area of less than 3.5km^2 at the site of the proposed access road and the Hollies Stream a catchment area of 0.5km^2 .

2. DATA COLLECTION

2.1 Ground Survey

Information on fifteen cross-sections along the study reach of the Clywedog Stream and Hollies Stream was obtained from a survey carried out by PM Surveys, Deeside in March 2007. The width of the cross-sections varies between 42m and 101m.

The information was provided to Capita Symonds as detailed drawings, for use in this hydraulic model.

The survey did not contain details of any structures on the Clywedog Stream or Hollies Stream. This information was gained from Wrexham County Borough Council and measurements taken during a site visit in March 2007.

2.2 Hydrology

A separate hydrological study was undertaken by Capita Symonds in 2007 to obtain flows in the Clywedog Stream. Estimates of peak flood flow and hydrograph shape from these analyses have been used to provide inflow to this hydraulic model.

3. BASELINE MODEL SETUP

3.1 Model Extents

The study area of the Clywedog Stream begins 80m upstream of Upper Bedwell Bridge (SJ 372471), finishing 450m downstream of this at Lower Bedwell Bridge (SJ 375473). This reach was chosen as it encompasses the flooding in the area and should produce accurate results representing the effects of the proposed southern access road.

The Clywedog Stream is a natural channel. Figure 1 shows that the river channel is fairly straight with a small area of meandering. Hollies Stream is a significant tributary of the Clywedog Stream and is also represented in Figure 1. The confluence between the Clywedog Stream and Hollies Stream is located 24m upstream of Lower Bedwell Bridge. A 480m stretch of Hollies Stream has been included within the model, which begins immediately downstream of Upper Bedwell Bridge (SJ 373471).

3.2 Mannings n

Details of the river channels were observed during the site visit conducted in March 2007. The study reaches of the Clywedog Stream and Hollies Stream are located in fields, which at the time of the site visit were overgrown with vegetation. The Clywedog Stream's channel is made up of earth and a Mannings n value of 0.02 was chosen. The Hollies Stream flows through an overgrown field and therefore its channel mainly consists of long grass, a Mannings n value of 0.05 was chosen. The Mannings n value selected for the floodplains within the model was 0.05 due to the extent of the overgrowth in the surrounding area. Sensitivity analysis has been conducted on these Mannings n values by increasing and reducing them by 10%. From the results of this analysis it was concluded that the model was not sensitive to changes in Mannings n.

3.3 Hydraulic Structures

There are six structures currently located within the vicinity of the study area. Three of these are bridges, one footbridge and two road bridges (the Upper and Lower Bedwell Bridges), and are all situated on the Clywedog Stream. The two road bridges are arched masonry bridges, and the footbridge is a flat-decked wooden bridge. The remaining three structures are culverts all located on Hollies Stream. Two of these culverts are in the field immediately upstream of the Clywedog Stream and the final culvert is at the confluence with the Clywedog Stream and Hollies Stream.

As previously stated the survey conducted by PM Surveys contained no details of any of these structures. The only dimensions of these structures are rough measurements made on a site visit in March 2007. Therefore extensive sensitivity analysis was conducted on them, which involved altering the diameter of the culverts by $\pm 25\%$ and the structure coefficients by $\pm 10\%$. These changes were analysed independently. The results of this analysis concluded that the model was not sensitive to these changes and therefore measurements taken during the site visit were used within the model.

3.4 Model Boundaries

The model contains two inflows, one at the upstream boundary of each watercourse. The inflow calculated during the hydrological assessment of the area for the Clywedog Stream, was at a point some distance downstream of the model's boundary, therefore combining the flows in the Clywedog Stream and Hollies Stream. This point was chosen to ensure that a conservative flow value was used in the model. This inflow could not easily be divided between the two streams as no level data was available in this area, and therefore catchment areas for the two streams could not easily be established. As a rough estimate, it was decided that 90% of the flow should be entered at the top of the Clywedog Stream with the remaining 10% into the Hollies Stream.

Due to the uncertainty surrounding these inflows a number of scenarios were run with varying proportions of this flow down Hollies Stream to examine the sensitivity of the model to this split in flow. The analysis showed that the model was not particularly sensitive to these varying scenarios and so the 90:10 split was retained within the model.

The downstream boundary conditions of the model were unknown in this area. Therefore the boundary was set at normal depth within the iSIS model 20m downstream of Lower Bedwell bridge. When this type of boundary is specified within iSIS, a flow-head relationship, based on normal depth, is automatically generated at this point.

4. BASELINE MODELLING RESULTS

The model has been run for 1%, 1% plus climate change and 0.1% AEP flood event for the baseline scenario and proposed scenario. The results of these runs are presented in Table 1. The locations of the cross-sections for which results are reported can be seen in Figure 1.

Location		% Annual Probability Flood Event		
Clywedog (CS)	Stream	1	1 + CC	0.1
CS0409		Predicted Flood Level (mAOD)	Predicted Flood Level (mAOD)	Predicted Flood Level (mAOD)
CS0373		39.51	39.58	39.81
CS0322		39.38	39.47	39.78
CS0313		39.32	39.45	39.76
u/s proposed bridge		39.32	39.45	39.76
d/s proposed bridge		38.91	38.98	39.10
CS0228		38.82	38.89	39.01
CS0175		38.30	38.36	38.47
CS0138		37.79	37.85	37.96
CS0014		37.56	37.61	37.73
Footbridge		36.66	36.68	36.79
CS0000		36.78	36.85	36.94
		36.75	36.81	36.91
Hollies Stream (HS)				
HS0474		41.27	41.32	41.41
HS0366		40.93	40.98	41.07
HS0243		40.26	40.31	40.39
u/s proposed culvert		39.98	40.00	40.05
d/s proposed culvert		39.73	39.75	39.79
Culvert in field 01		36.90	36.97	36.97
Culvert in field 02		36.79	36.85	36.95
Culvert in field 03		36.78	36.85	36.94
CS0007d2 (confluence of HS and CS)		36.78	36.85	36.94

Table 1 Predicted Flood Levels Prior to the Construction of the Proposed Road Bridge

During the 1% AEP plus climate change (20%) event both the Clywedog Stream and the Hollies Stream flowed slightly out of bank for the majority of the study reach. All structures modelled surcharged during this event, except the Upper Bedwell Bridge. The culverts located on Hollies Brook significantly surcharge with water spilling out at depths varying between 200 and 600mm. Water flows over the footbridge crossing the Clywedog Stream at depths reaching 300mm, with the stream also flowing around the bridge into the surrounding fields at this point. The culvert beneath the Lower Bedwell Bridge surcharges causing water to flow onto the road.

5. SOUTHERN ACCESS ROAD MODEL SETUP

The access road will cross Hollies Stream immediately north of Cross Lanes roundabout and will involve the introduction of a circular culvert with a diameter of 900mm.

The access road will cross the Clywedog Stream immediately south of Cross Lanes roundabout and will involve the introduction a rectangular culvert (Middle Bedwell Bridge) with a cross-section of 3.4m by 1.6m and length of 15m. The proposed road deck was incorporated into the model by using its elevation in the spillways for these two culverts.

6. SOUTHERN ACCESS ROAD MODELLING RESULTS

The model was run for the 1%, 1% plus climate change and 0.1% AEP events. Table 2 shows the predicted flood levels with the proposed bridge at the same cross-section locations as for the baseline case in Table 1. The locations of the cross-sections listed in the table are shown in Figure 1.

Location	Stream	% Annual Probability Flood Event		
		1	1 + CC	0.1
Clywedog (CS)		Predicted Flood Level (mAOD)	Predicted Flood Level (mAOD)	Predicted Flood Level (mAOD)
CS0409		39.55	39.73	39.90
CS0373		39.40	39.48	39.78
CS0322		39.34	39.47	39.76
CS0313		39.34	39.47	39.76
u/s proposed bridge		38.93	39.01	39.14
d/s proposed bridge		38.82	38.89	39.01
CS0228		38.30	38.36	38.47
CS0175		37.79	37.85	37.96
CS0138		37.56	37.61	37.73
CS0014		36.66	36.68	36.79
Footbridge		36.78	36.85	36.94
CS0000		36.75	36.81	36.91
Hollies Stream (HS)				
HS0474		41.25	41.30	41.39
HS0366		40.97	41.04	41.13
HS0243		40.22	40.25	40.32
u/s proposed culvert		39.98	40.04	40.15
d/s proposed culvert		39.74	39.76	39.80
Culvert in field 01		36.91	36.97	36.97
Culvert in field 02		36.79	36.85	36.95
Culvert in field 03		36.78	36.85	36.94
CS0007d2				
(confluence of HS and CS)		36.78	36.85	36.94

Table 2 Predicted water levels following the Construction of the Proposed Southern Access Road

The water level on the upstream side of the proposed Middwell Bridge will be 38.93mAOD and 39.01mAOD during the 1% and 1% plus climate change events. The soffit of the bridge is 39.57mAOD, therefore the freeboard is 0.64m and 0.56m respectively.

The difference in predicted flood levels between the baseline and proposed case have been calculated at three cross-sections upstream and one downstream of the proposed bridge (Clywedog Stream) and culvert (Hollies Stream). These values are stated in Table 3. Positive difference values indicate an increase in flood level as a result of the proposed access road and crossing.

Location	% Annual Probability Flood Event			
	1	1 + CC		0.1
Clywedog Stream (CS)	Difference (m)	Difference (m)	Difference (m)	Difference (m)
CS0373	0.02	0.01		0
CS0322	0.02	0.02		0
CS0313	0.02	0.02		0
u/s proposed bridge	0.02	0.03		0.04
d/s proposed bridge	0	0		0
Hollies Stream (HS)				
HS0474	-0.02	-0.02		-0.02
HS0366	0.04	0.06		0.06
HS0243	-0.04	-0.06		0.09
u/s proposed culvert	0			0
d/s proposed culvert	0.01	0.01		0

Table 3 Changes in water levels following the Construction of the Proposed Southern Access Road.

7. CONCLUSIONS

With the exception of the Upper Bedwell Bridge the existing structures surcharge during the 1% AEP flood event. Middle Bedwell Bridge will not surcharge and has a freeboard of 0.64m during the 1% AEP event. The proposed southern access road and associated crossings will produce a small increase in water levels approximately 6mm upstream. Table 3 shows the difference in water level between the baseline and proposed scenarios, with the maximum increase being 9mm for the 1% AEP plus climate change, upstream of the proposed culvert on the Hollies Stream.

APPENDIX 1: Figures



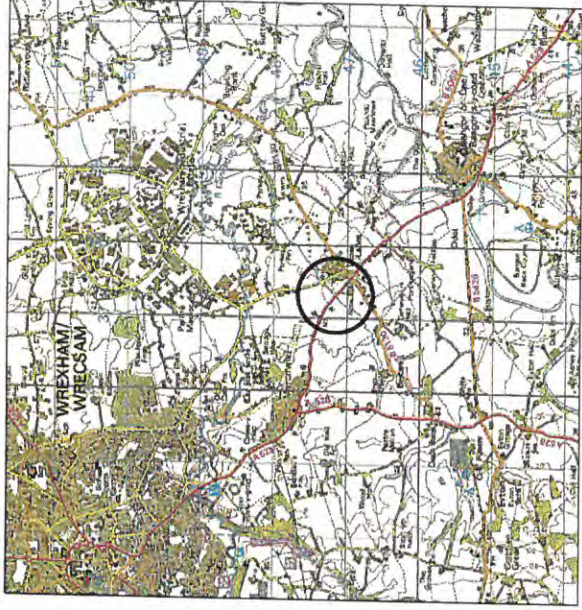
WREXHAM INDUSTRIAL ESTATE ACCESS ROAD

Access to Wrexham Industrial Estate
Clywedog Stream Hydraulic
Model Cross-section

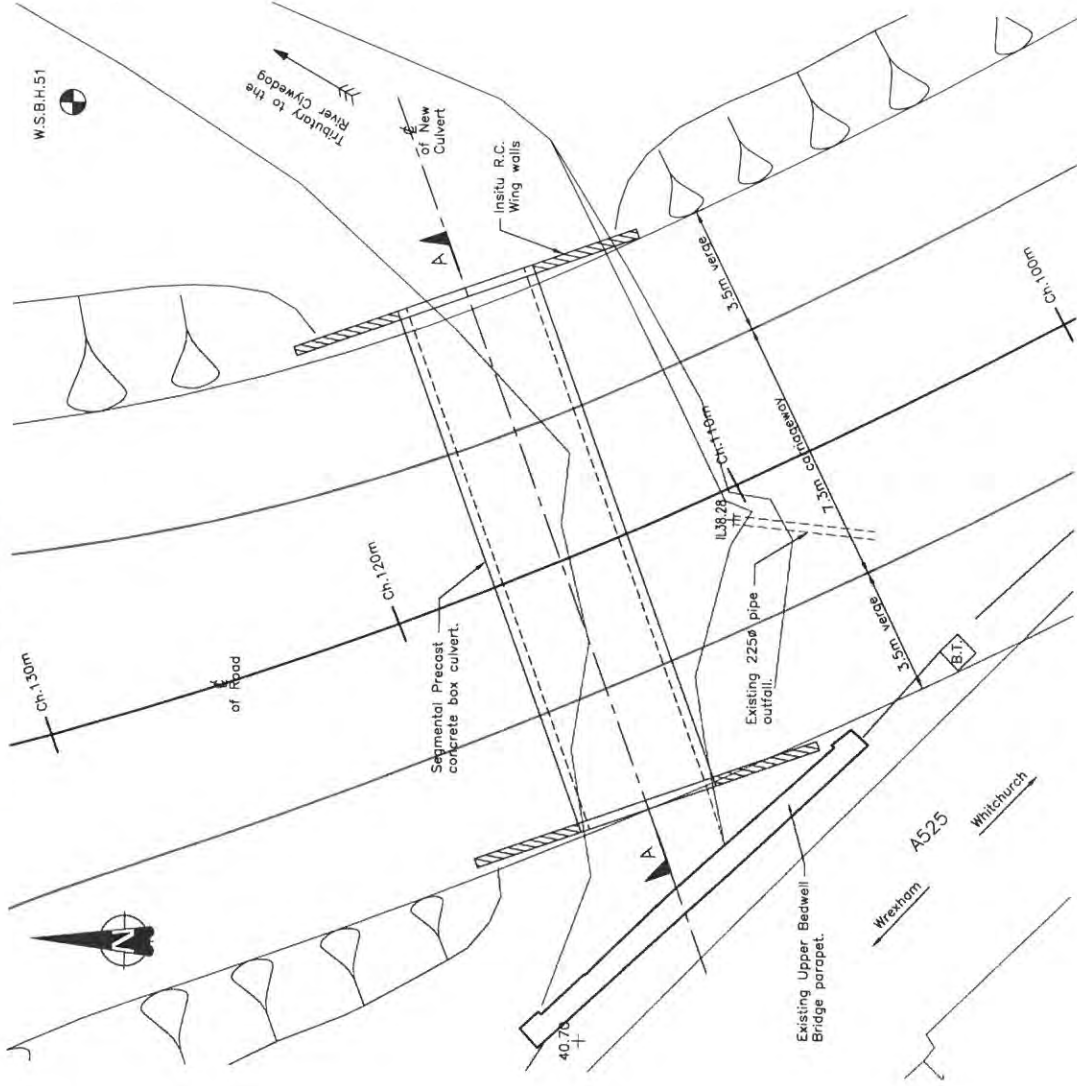
CAPITA SYMONDS
Penrhos Manor, Oak Drive, Colwyn Bay,
North Wales, LL29 7YW
Tel: 01492 539200
Fax: 01492 531333

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GAP	GJ	GJ	13/07/07	A3 1:2,000	E.Grinstead		Figure 1

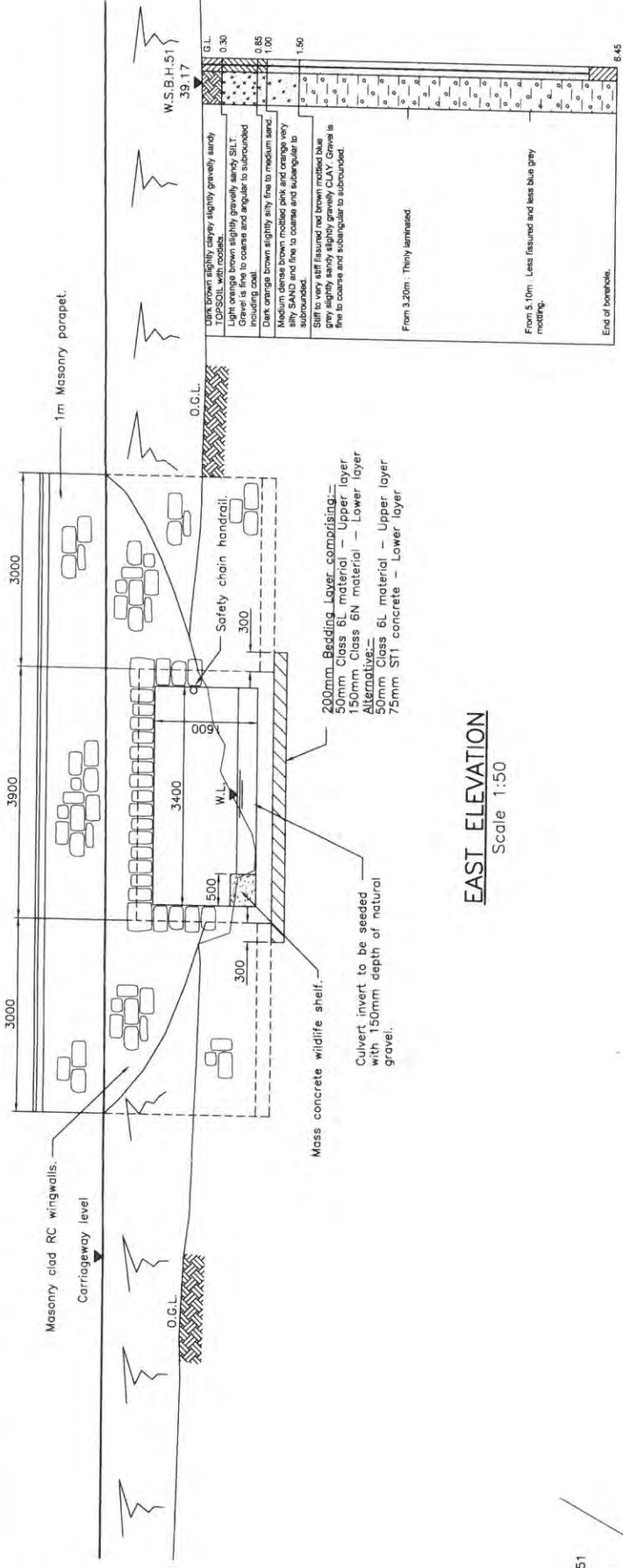
NOTE: THE PROPERTY OF THIS DRAWING AND DESIGN IS VESTED IN CAPITA SYMONDS GROUP LIMITED
AND MUST NOT BE COPIED OR REPRODUCED IN ANY WAY WITHOUT THEIR WRITTEN CONSENT



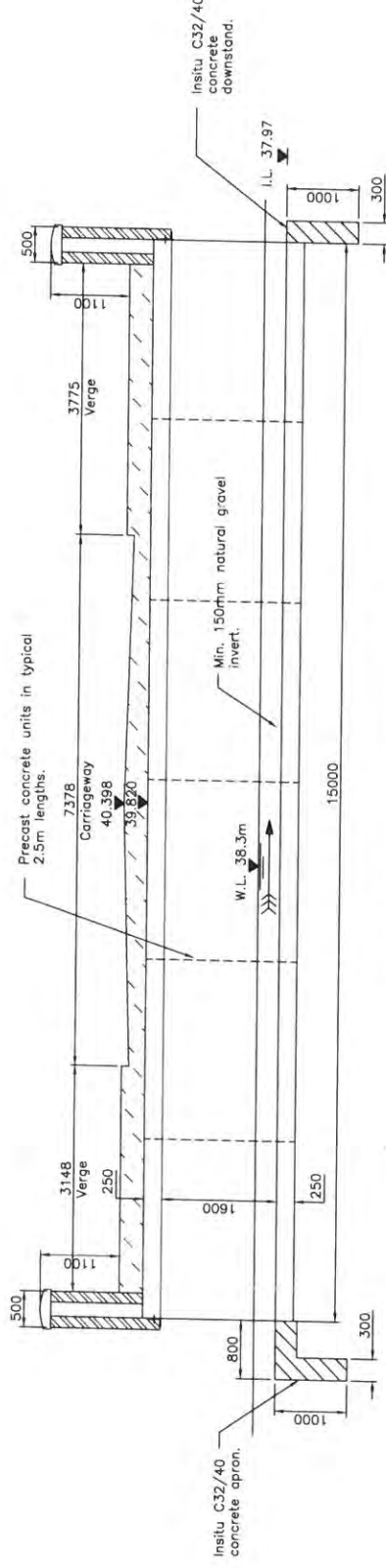
LOCATION PLAN
Scale 1:50000



PLAN
Scale 1:100



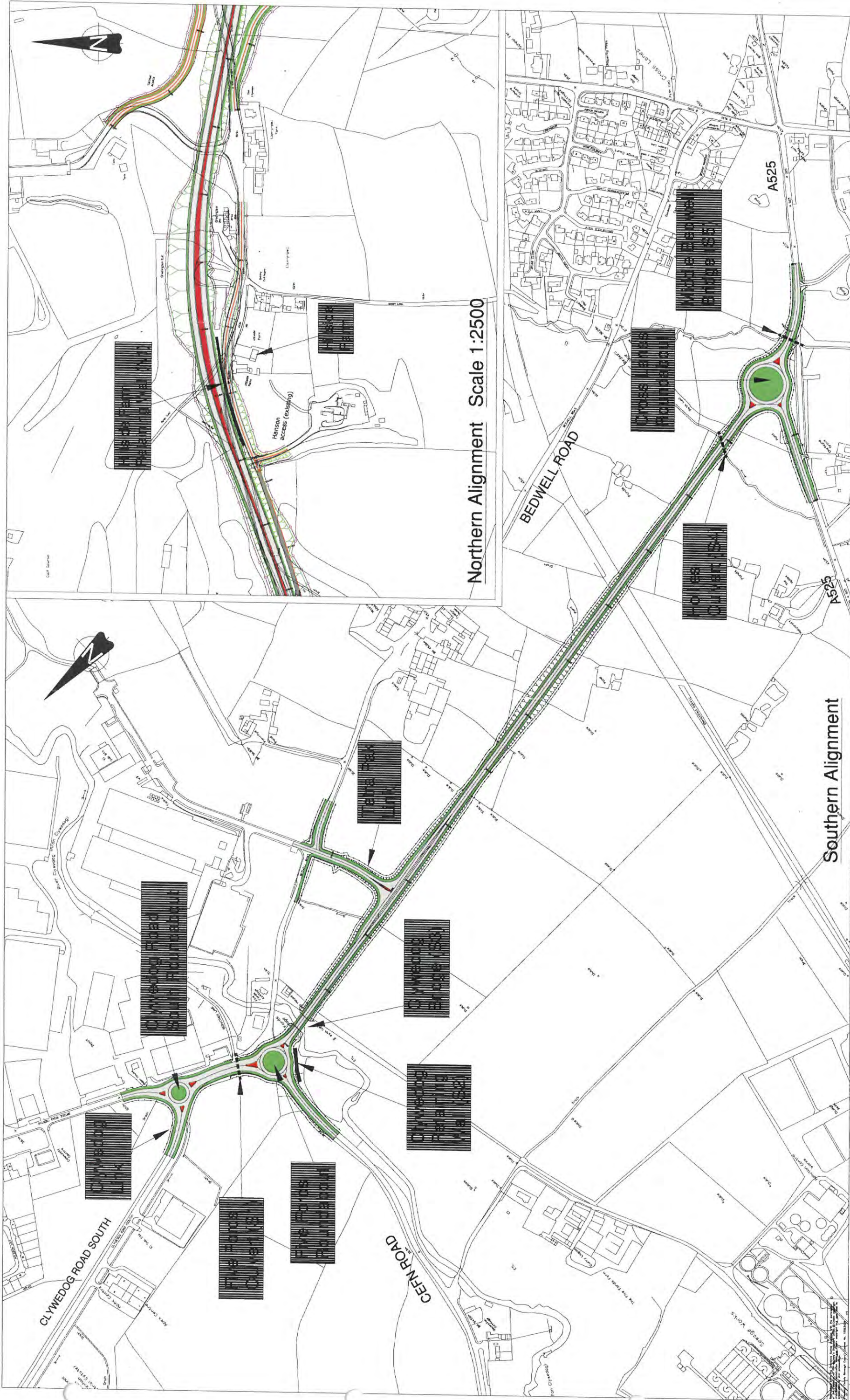
EAST ELEVATION
Scale 1:50



LONGITUDINAL SECTION A-A
Scale 1:50

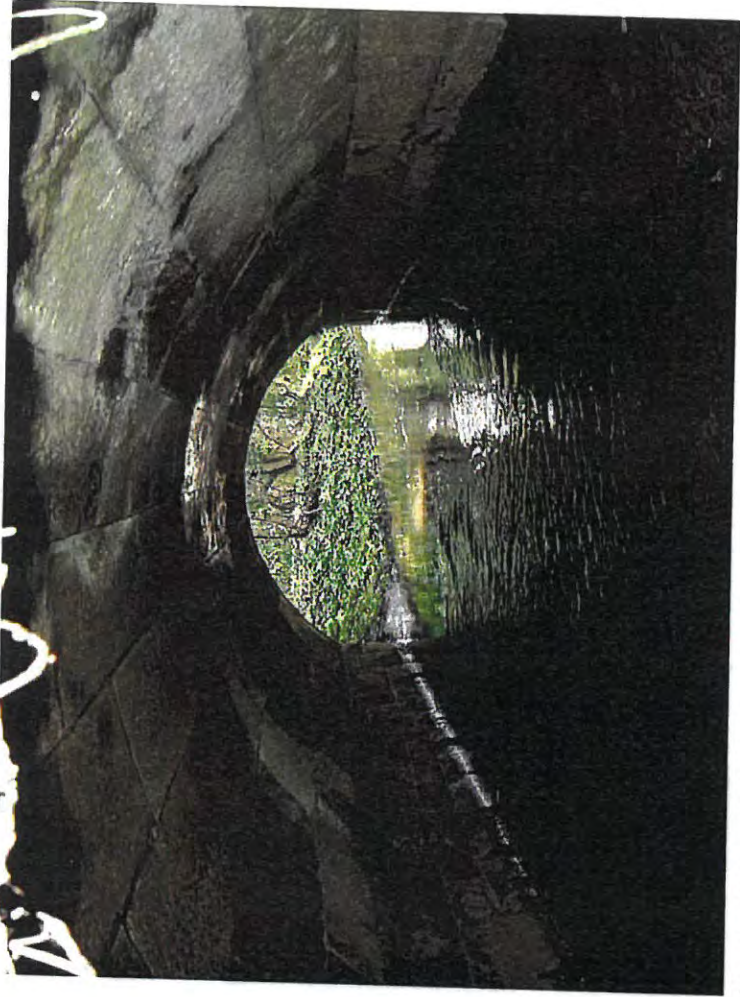
- Notes:
1. All dimensions shown are in millimetres unless stated otherwise.
 2. The chosen cement type shall be consistent for all visible elements of the structure.
 3. All fill to structures shall be Class 6N material.
 4. Precast reinforced concrete box culvert to be designed to BS41/01. The Design of Buried Concrete Box and Portal Frame Structures.
 5. The wildlife shelf is to be sited at least 150mm above the highest water level in accordance with HA81/99.
 6. Materials for construction:-
 - In situ reinforced concrete Class 32/40
 - Blinding Concrete - Standard Mix ST1
 - Reinforcement high yield bars to BS4449
 7. Finishes -
 - All formed finishes F3 except formed permanently buried finishes F1
 - All unformed surfaces U2
 - In situ reinforced concrete wingwalls and parapets to be faced with natural Sandstone and lime mortar.
 8. The available flow area of the box culvert is 4.23m². The estimated discharge rate of the culvert constructed at a gradient of 1 in 100 and an assumed roughness co-efficient of 0.3 is 7.6m³/s.
 9. H.W.L. - Maximum height in flood = To be determined.
 10. W.L. - Surveyed water level = 38.300
 11. The anticipated design flow = To be determined.

TE/06934/02A		TE/06934/02A	
DRAWING NUMBER:		DRAWING NUMBER:	
WREXHAM COUNTY BOROUGH COUNCIL		WREXHAM INDUSTRIAL ESTATE	
CROWN BUILDINGS, 31, CHESTER STREET,		ACCESS ROAD	
WREXHAM LL13 8BG.		MIDDLE BEDWELL BRIDGE	
MARTIN WRIGHT BSc(Hons) MRICS		GENERAL ARRANGEMENT	
CHIEF TRANSPORTATION AND ASSET MANAGEMENT OFFICER		DRAWING TITLE:	
Tel. (01978) 297102		DATE	
Fax. (01978) 297103		AMENDMENTS:	
		SCALES:	
		AS SHOWN	
		BRIDGES	
		NATIONAL GRID REF:	
		RKD	
		STATUS:	
		A FIRST ISSUE	
		28/03/2006	
		Preparatory	
		Scheme Title:	
		WREXHAM INDUSTRIAL ESTATE	
		ACCESS ROAD	
		MIDDLE BEDWELL BRIDGE	
		GENERAL ARRANGEMENT	
		DRAWING NUMBER:	
		TE/06934/02A	



DRAWING NUMBER: 02754/D/ 419 A		WREXHAM COUNTY BOROUGH COUNCIL CROWN BUILDINGS, WREXHAM LL13 8BG. MARTIN WRIGHT BSC(Hons) MRICS CHIEF TRANSPORTATION AND ASSET MANAGEMENT OFFICER Tel. (01978) 297102 Fax. (01978) 297103		JOB NUMBER: TE 02754 DADIV GROUP: DESIGN DRAWN BY: RT CHECKED BY: AIS APPROVED BY:		SCALES: 1:2500 AMENDMENTS:		DATE		SCHEME TITLE: Wrexham Industrial Estate Access Road	
02754/D/ 419 A		wrexham COUNTY BOROUGH BWRDISTRESSOL wrecsam		NATIONAL GRID REF:		STATUS: A Original Drawing		15/03/2007		DRAWING TITLE: Location of Structures	
02754/D/ 419 A		wrexham COUNTY BOROUGH BWRDISTRESSOL wrecsam		DESIGN		RT		AIS		Scheme	

APPENDIX 2: Photos



Upper Bedwell Bridge



Footbridge



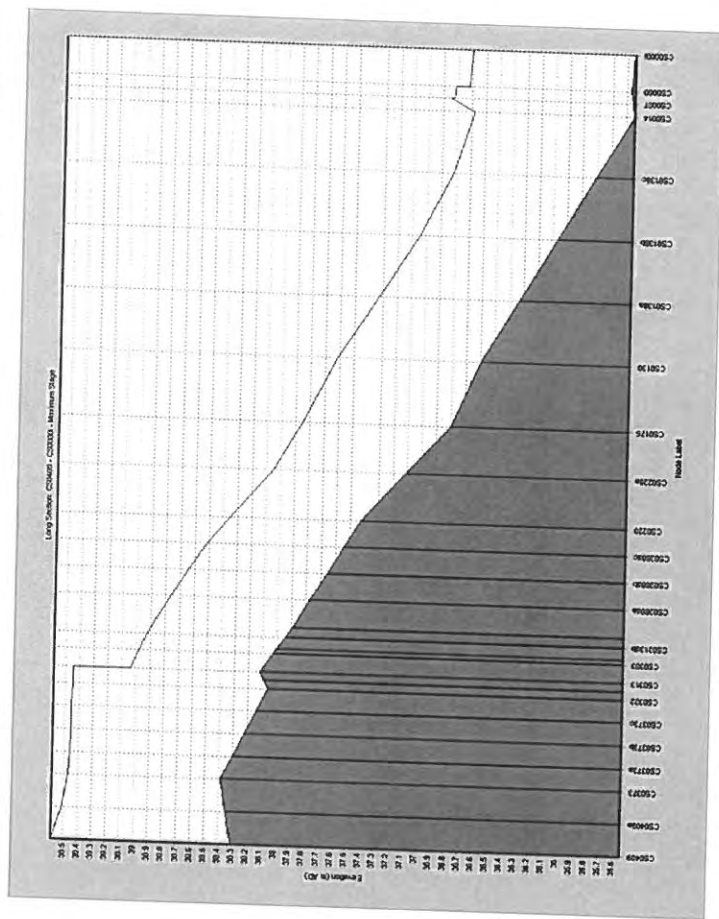
Lower Bedwell Brook



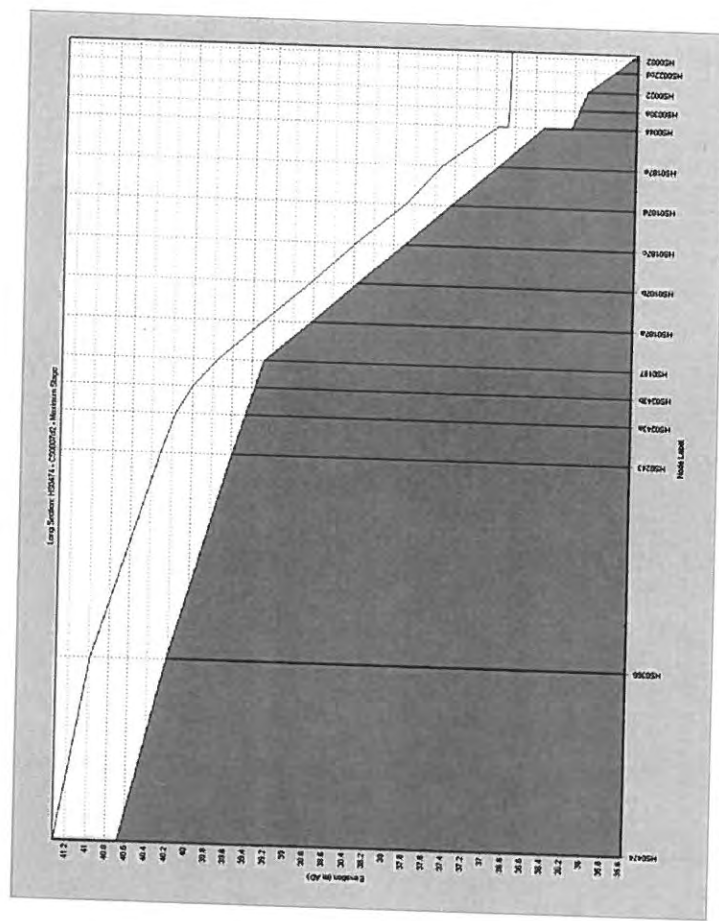
Culvert on Hollies Stream

APPENDIX 3: ISIS Model Results

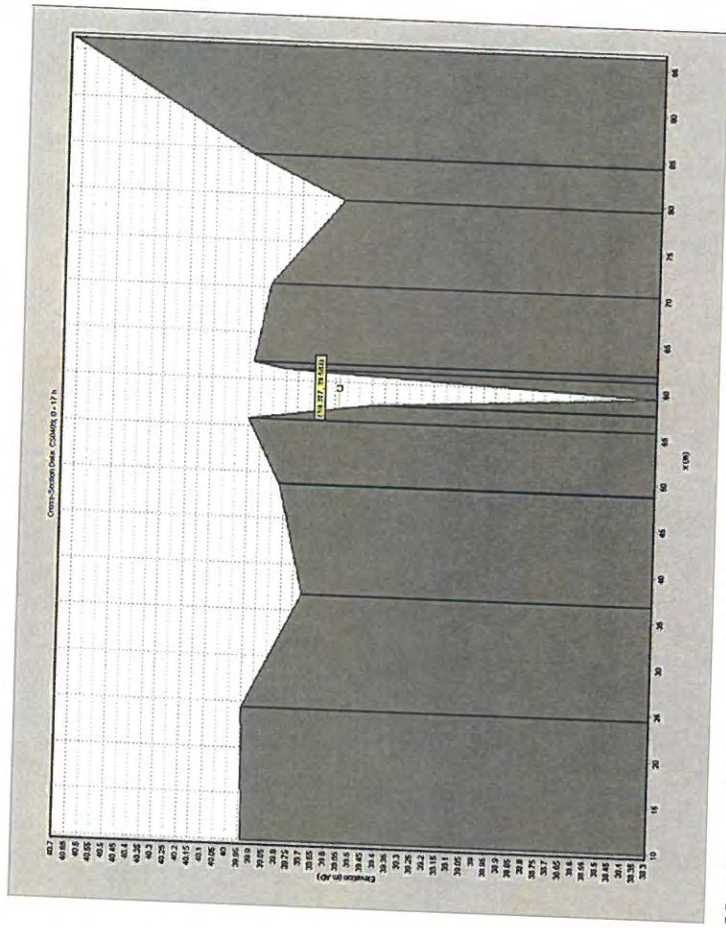
Baseline iSIS outputs representing Maximum Stage at Cross-sections



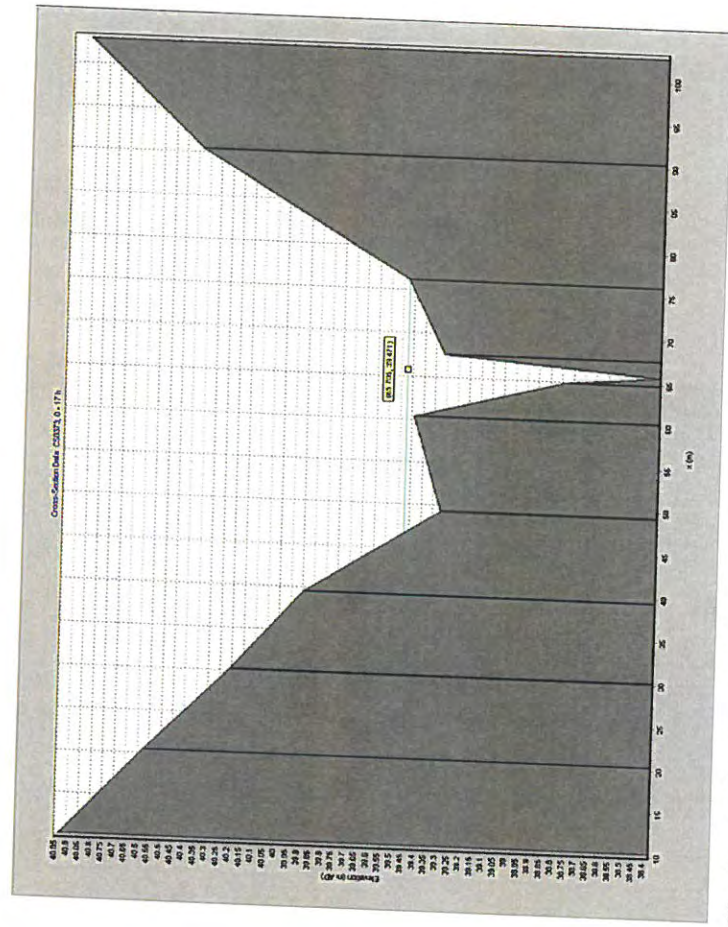
Long Section of Clywedog Stream



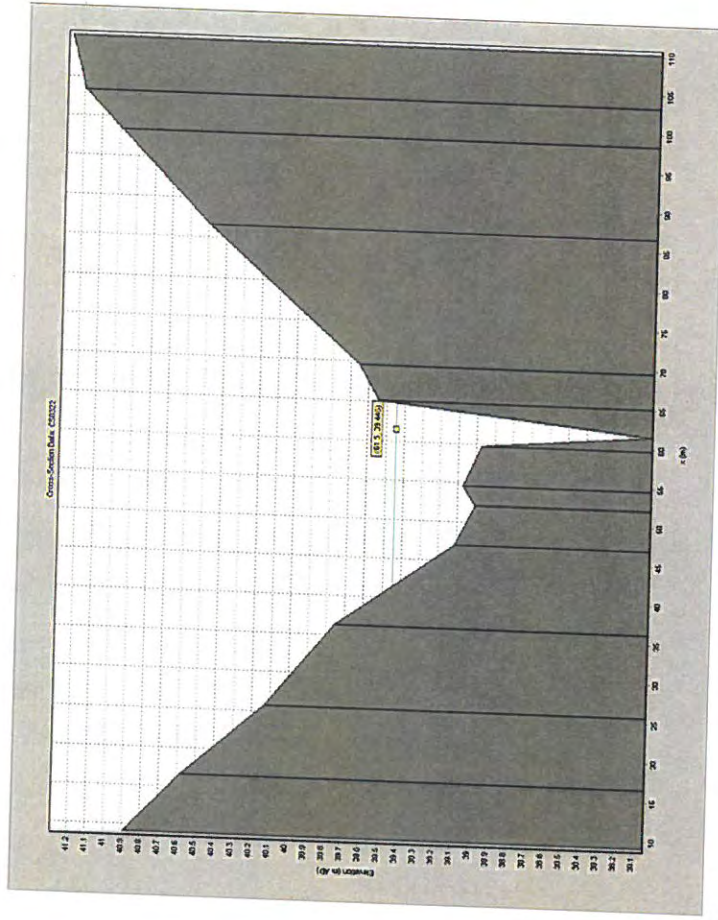
Long Section of Hollies Stream



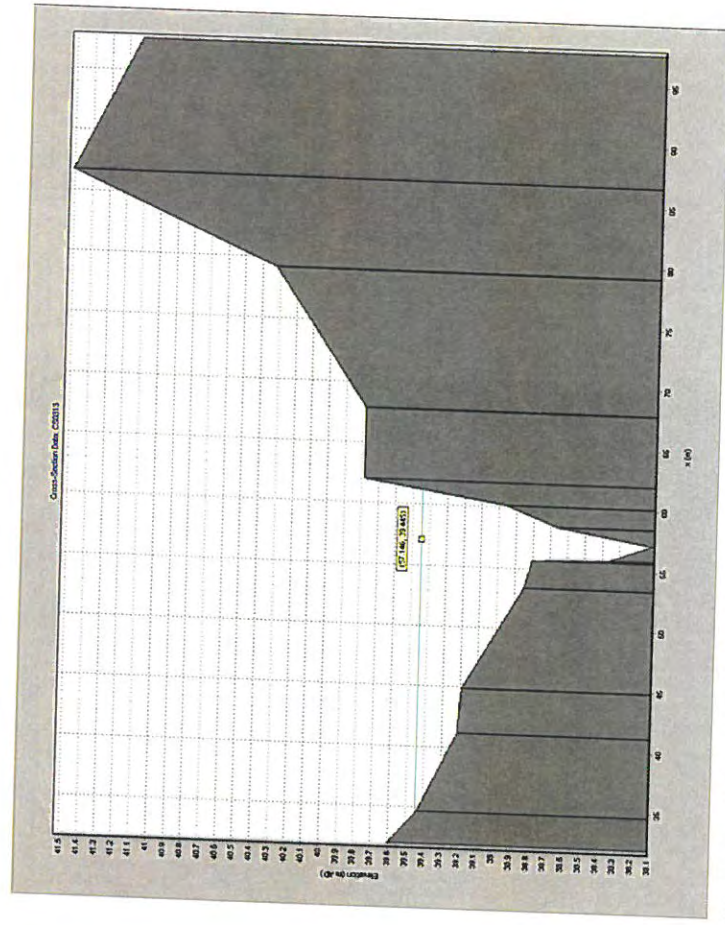
Maximum Stage at CS0409



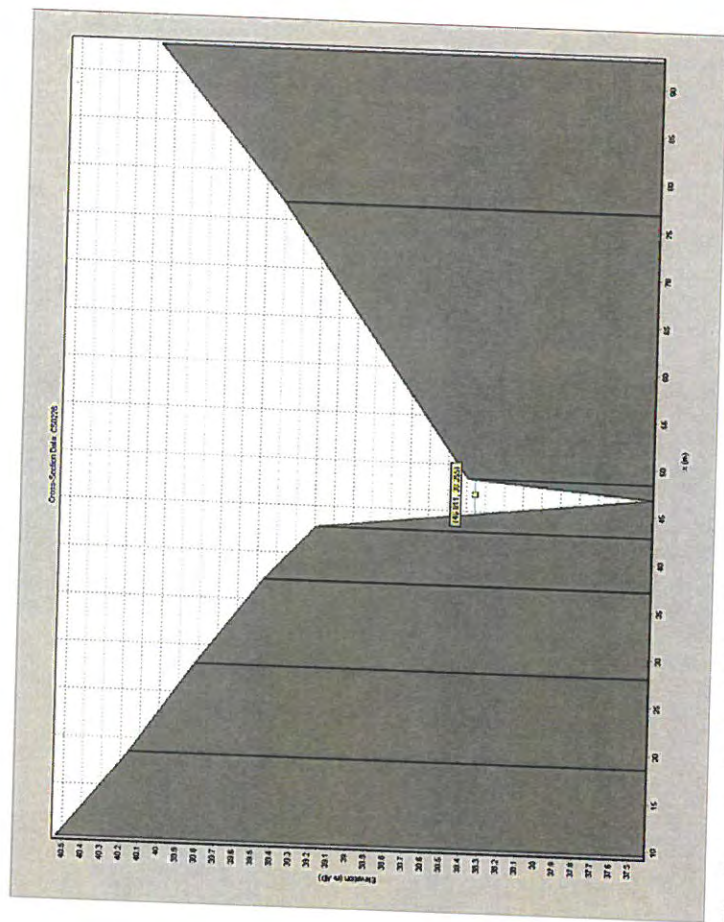
Maximum Stage at CS0373



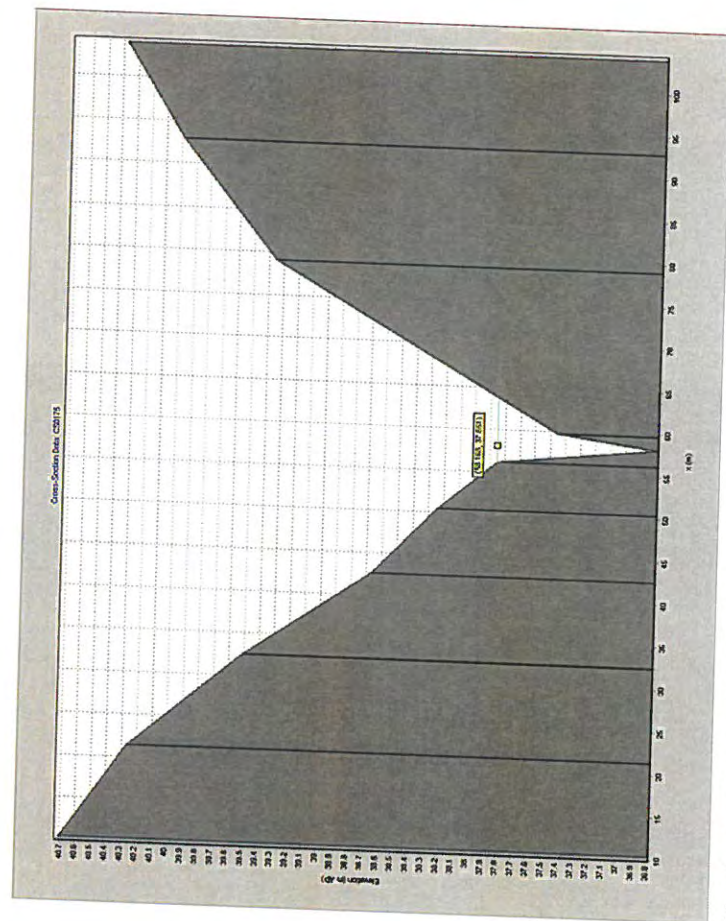
Maximum Stage at CS0322



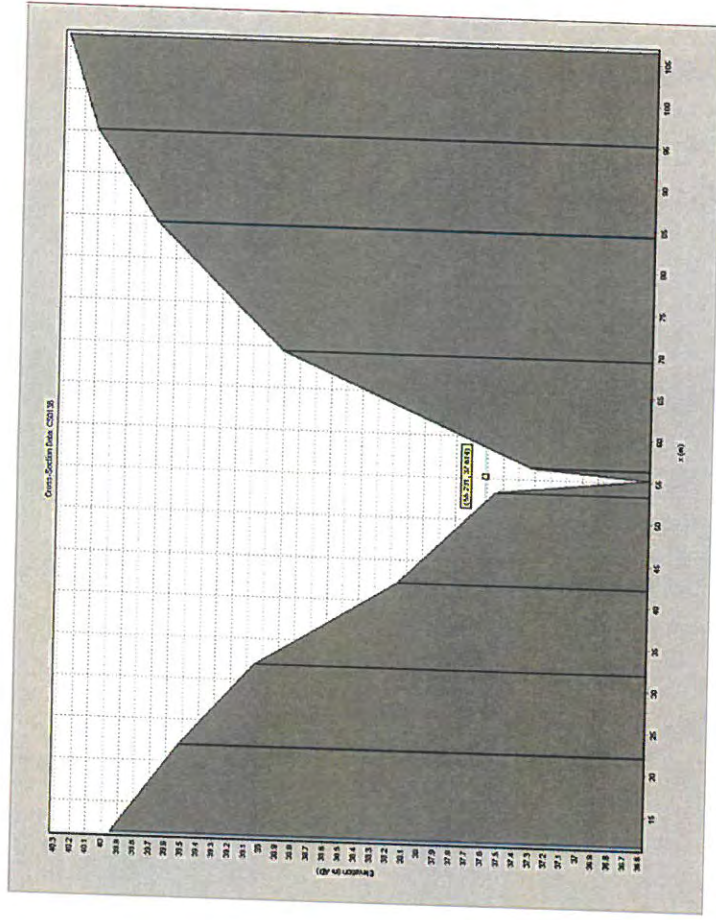
Maximum Stage at CS0313



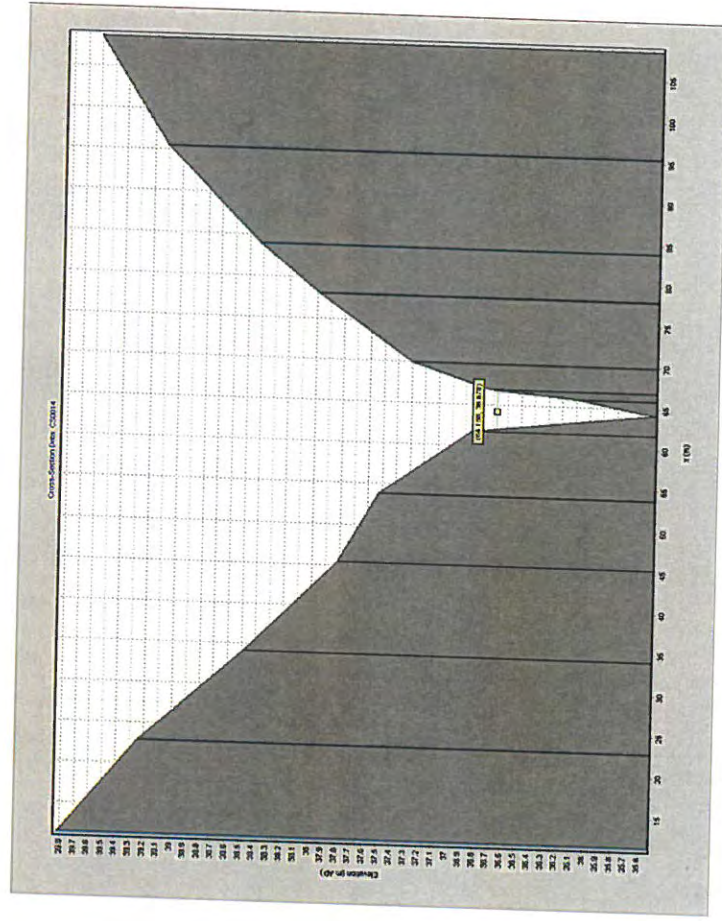
Maximum Stage at CS0228



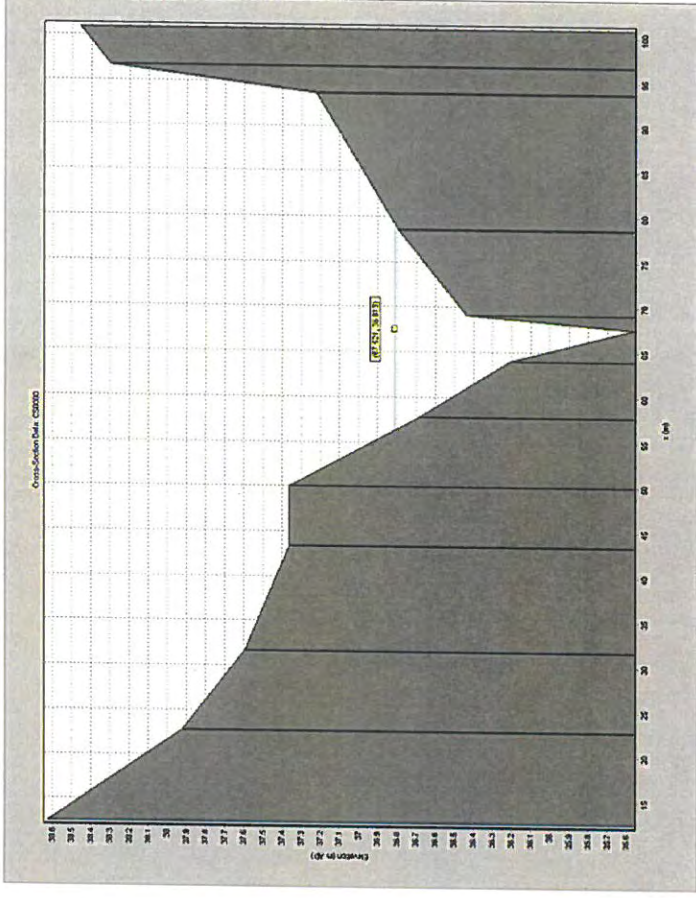
Maximum Stage at CS0175



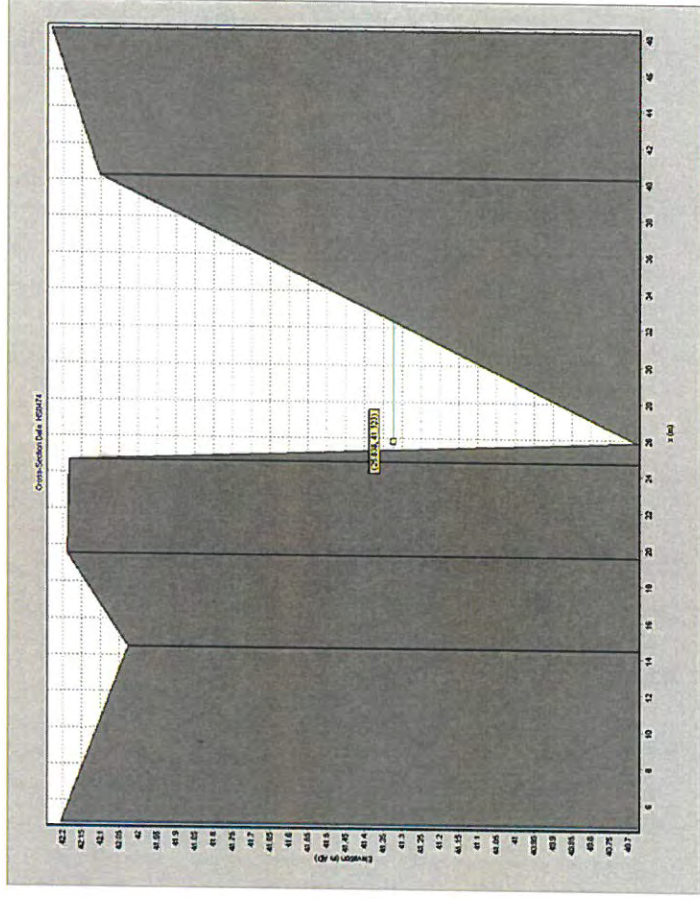
Maximum Stage at CS0138



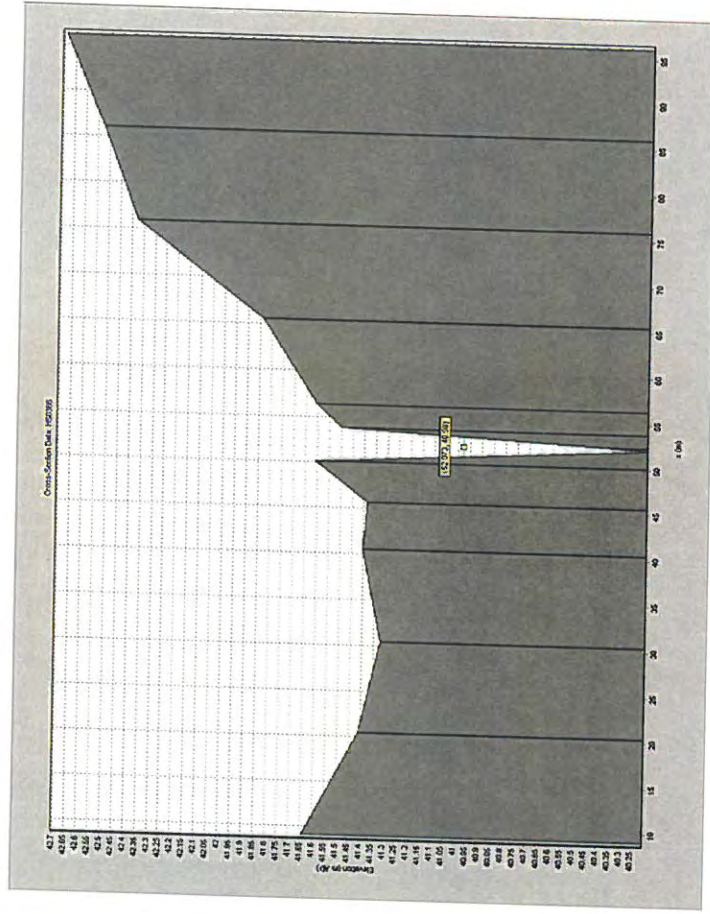
Maximum Stage at CS0014

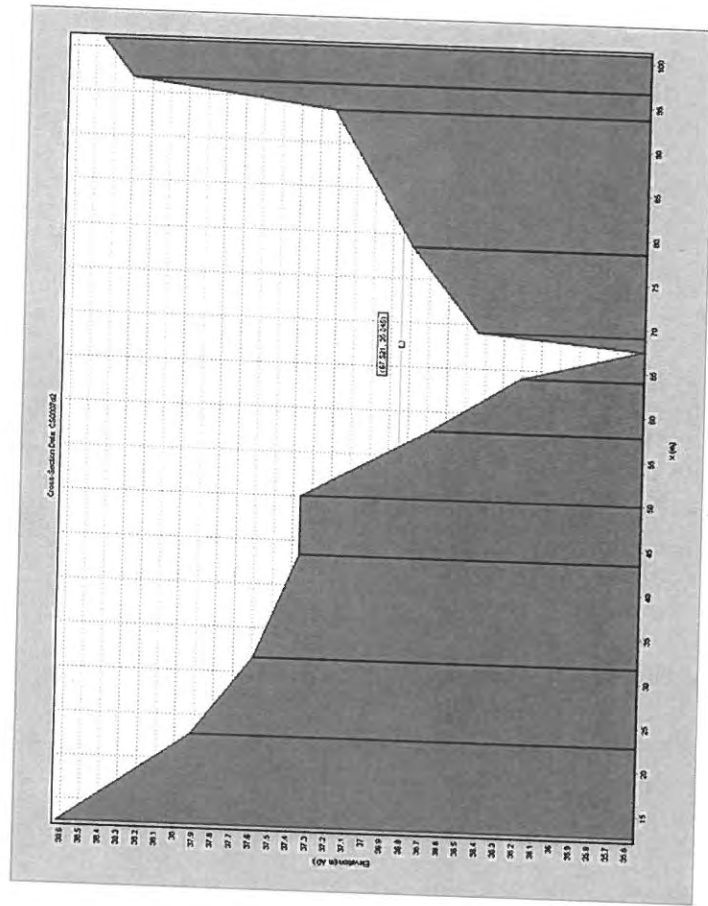


Maximum Stage at CS0000



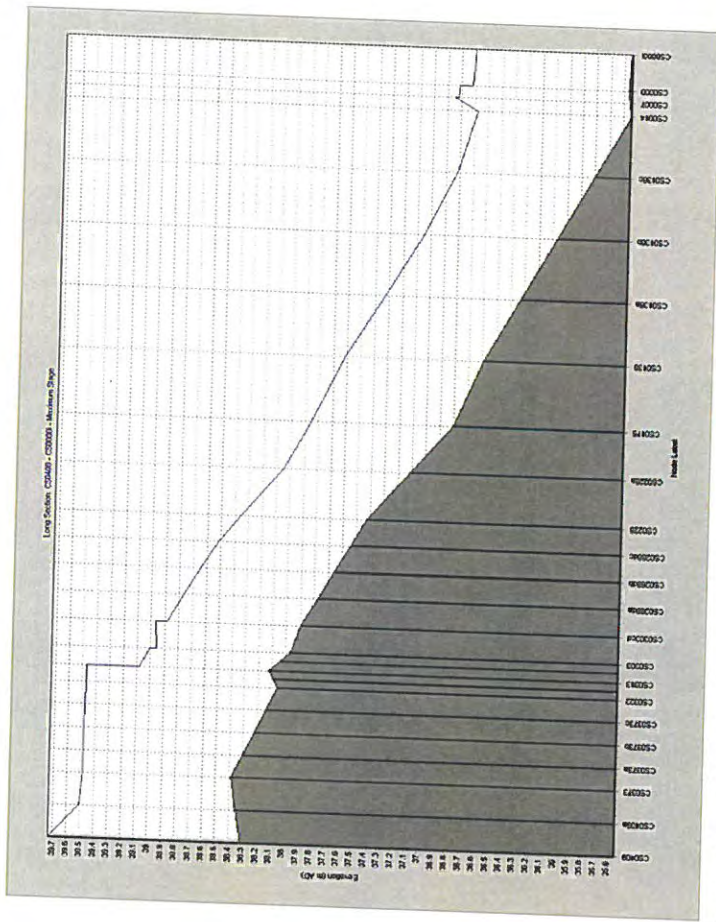
Maximum Stage at HS0474



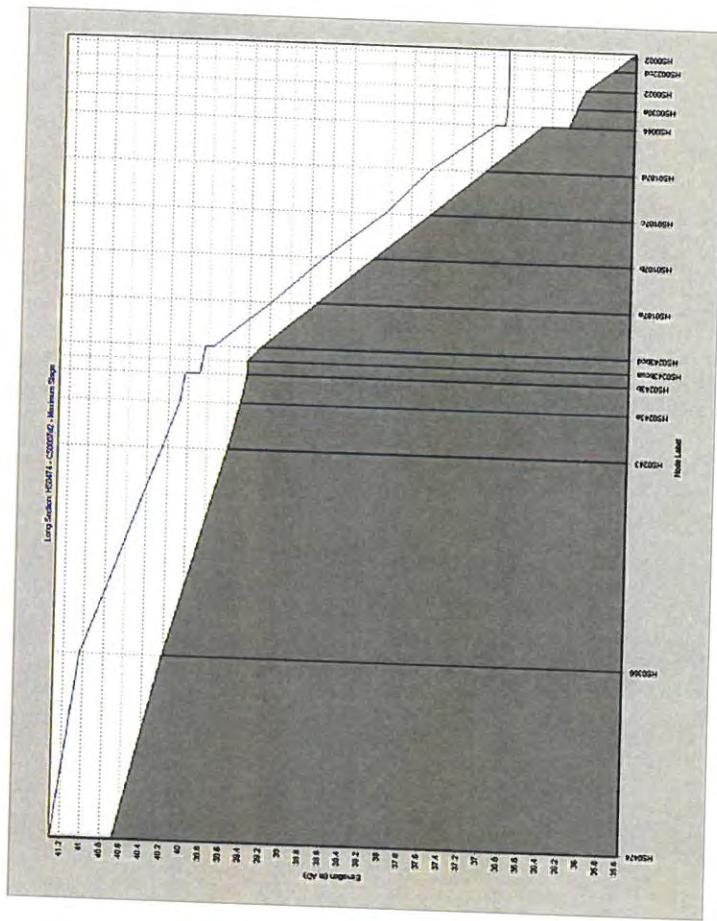


Maximum Stage at CS0007d2 (confluence of Clywedog Stream and Hollies Stream)

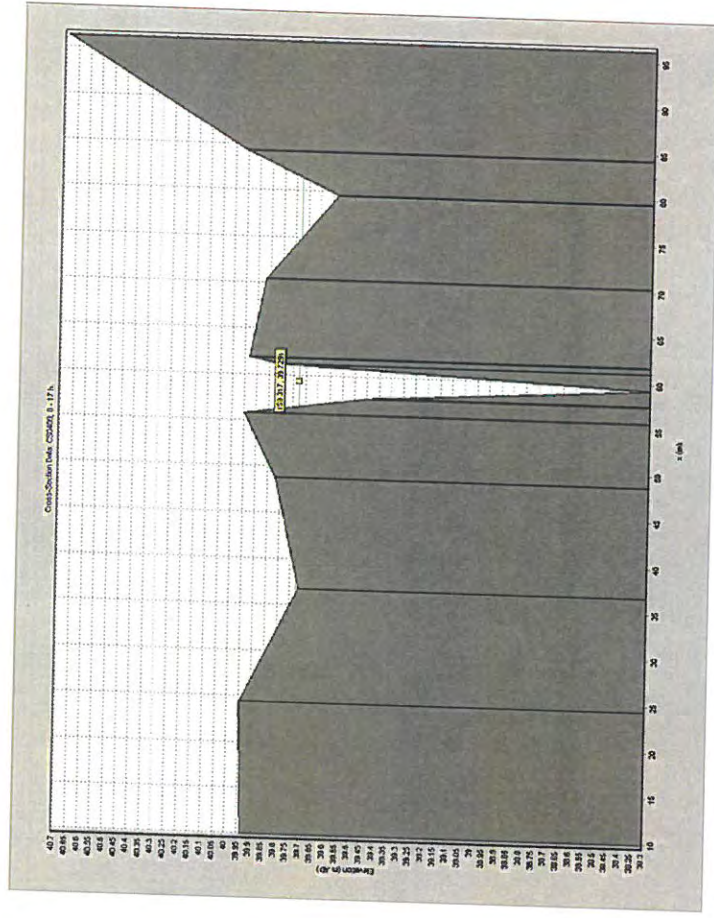
Proposed iSIS outputs representing Maximum Stage at Cross-sections



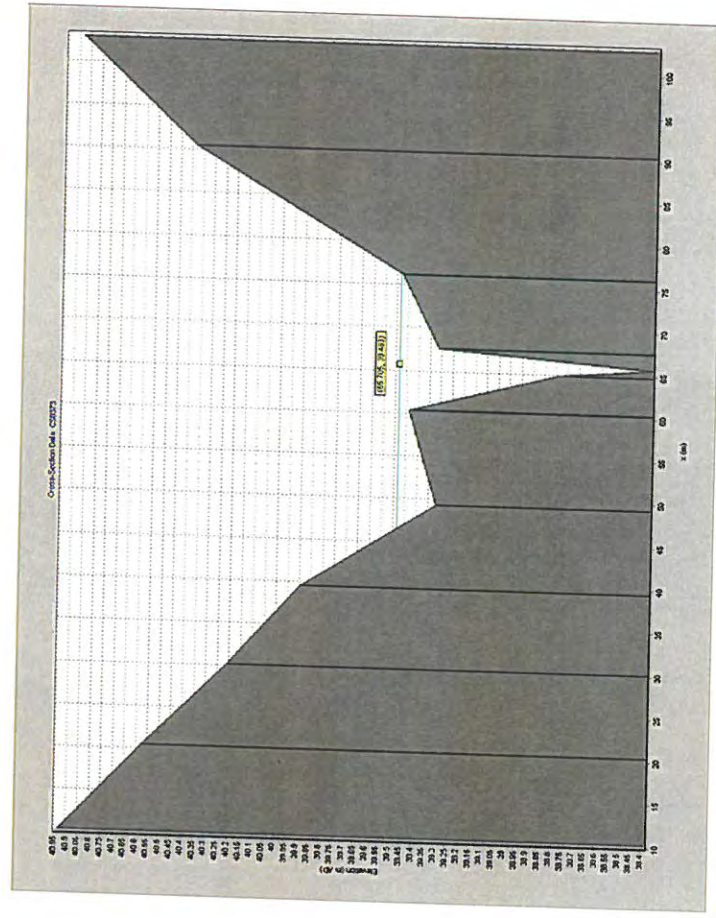
Long Section of Clywedog Stream



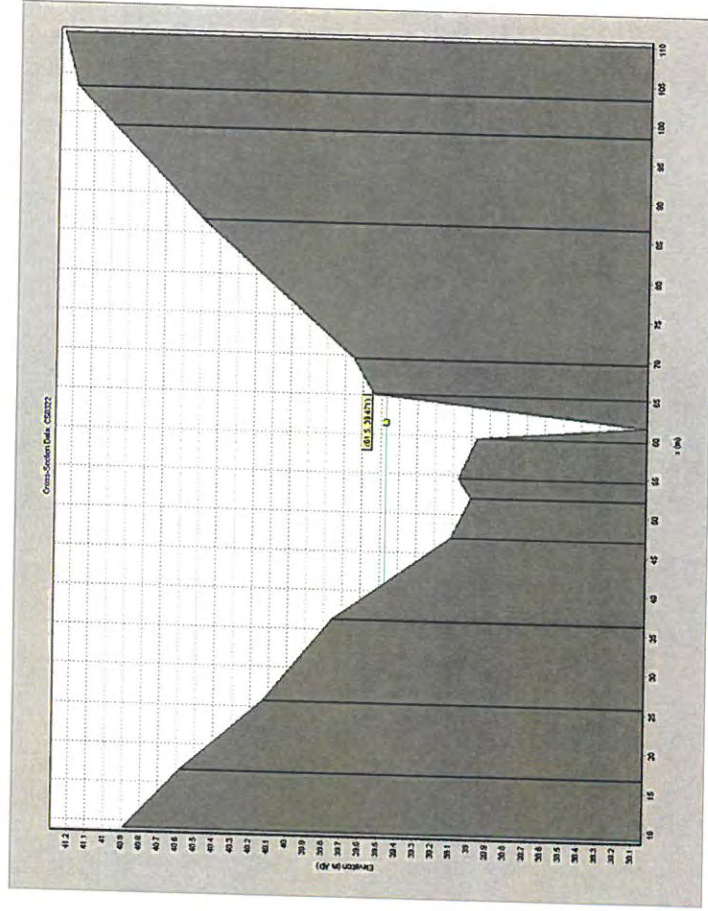
Long Section of Hollies Stream



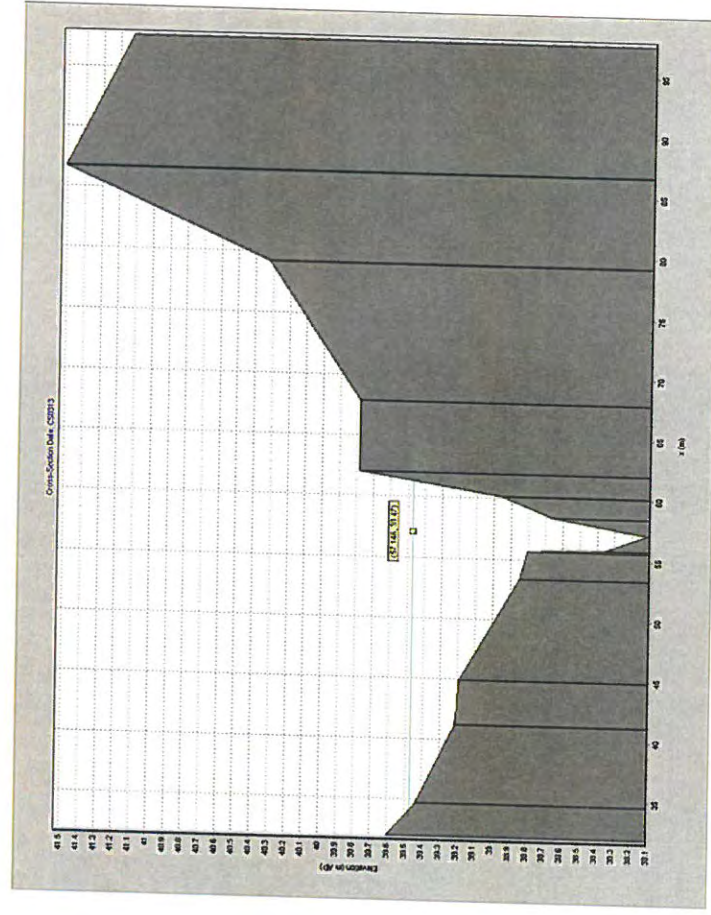
Maximum Stage at CS0409



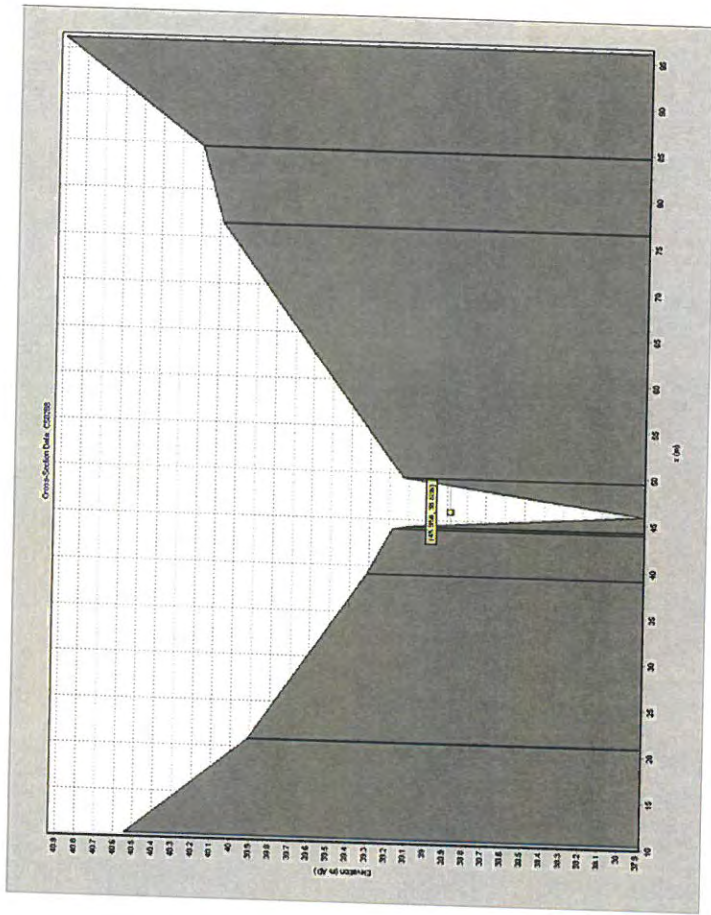
Maximum Stage at CS0373



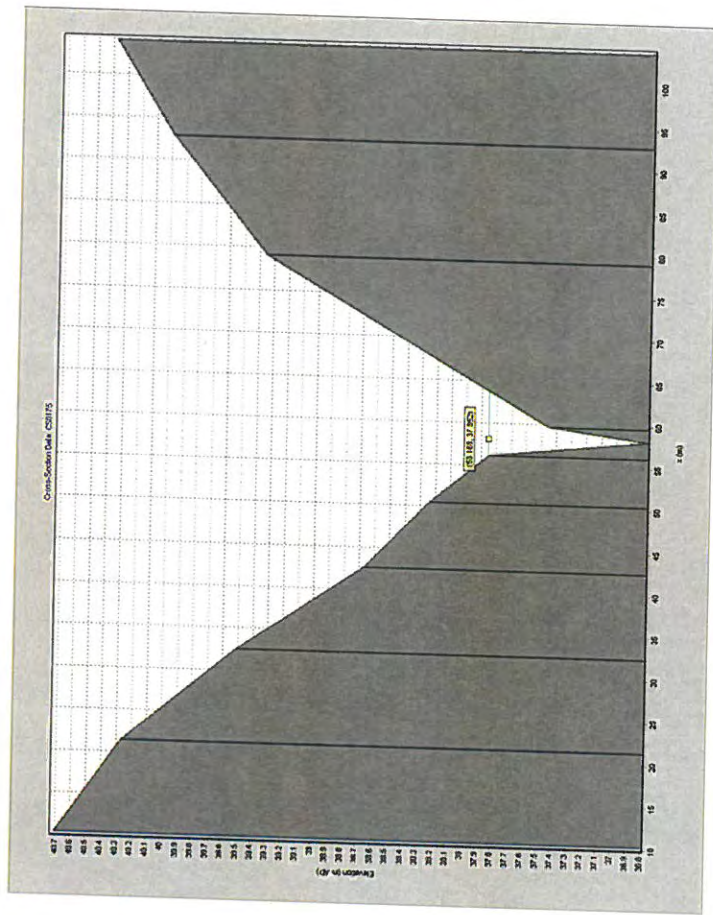
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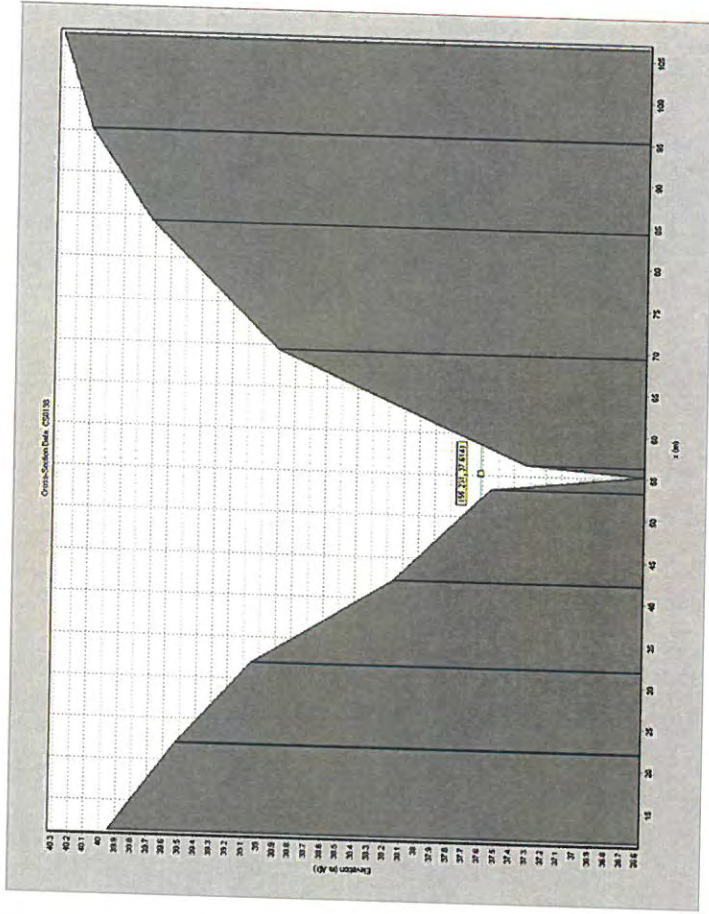
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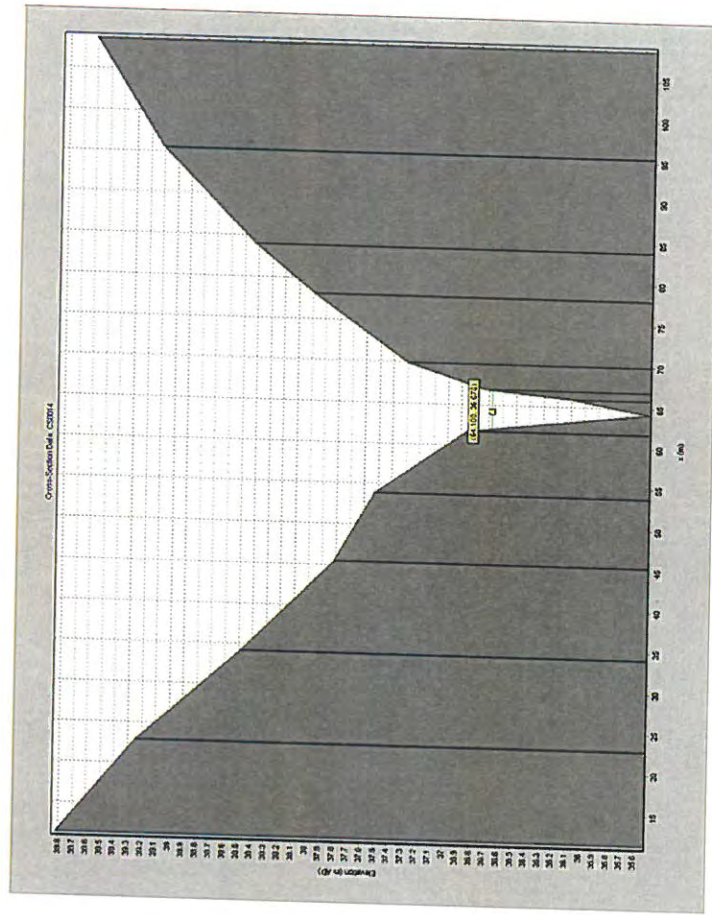
Maximum Stage at CS0228



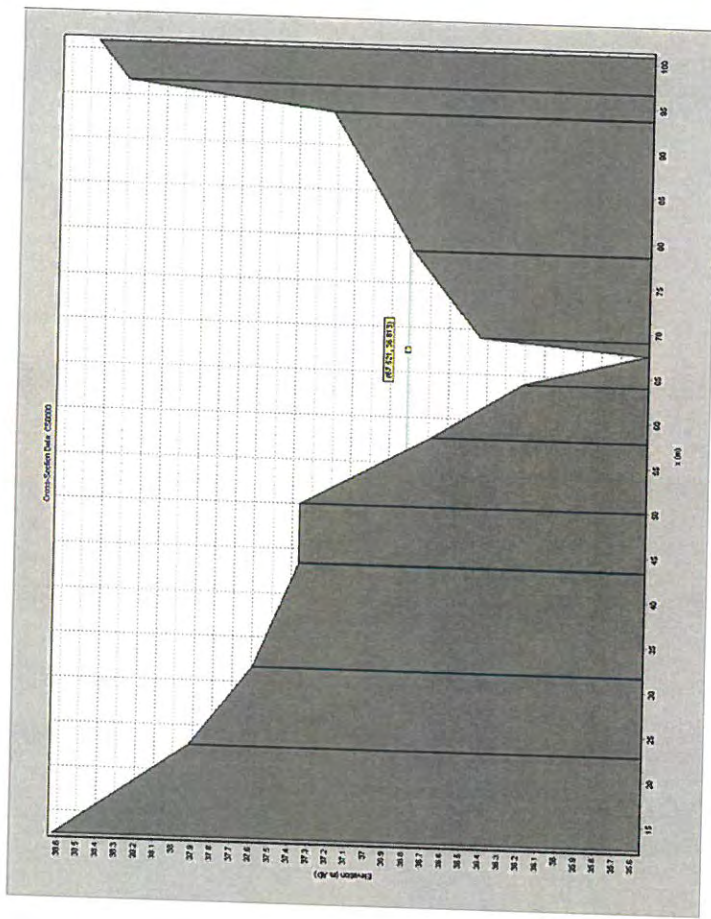
Maximum Stage at CS0175



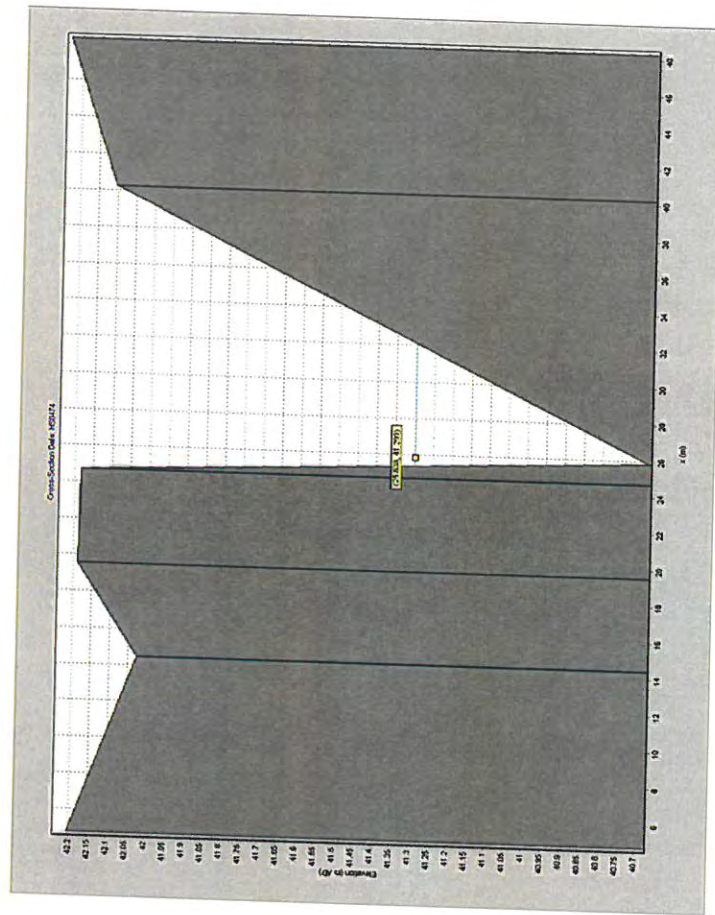
Maximum Stage at CS0138



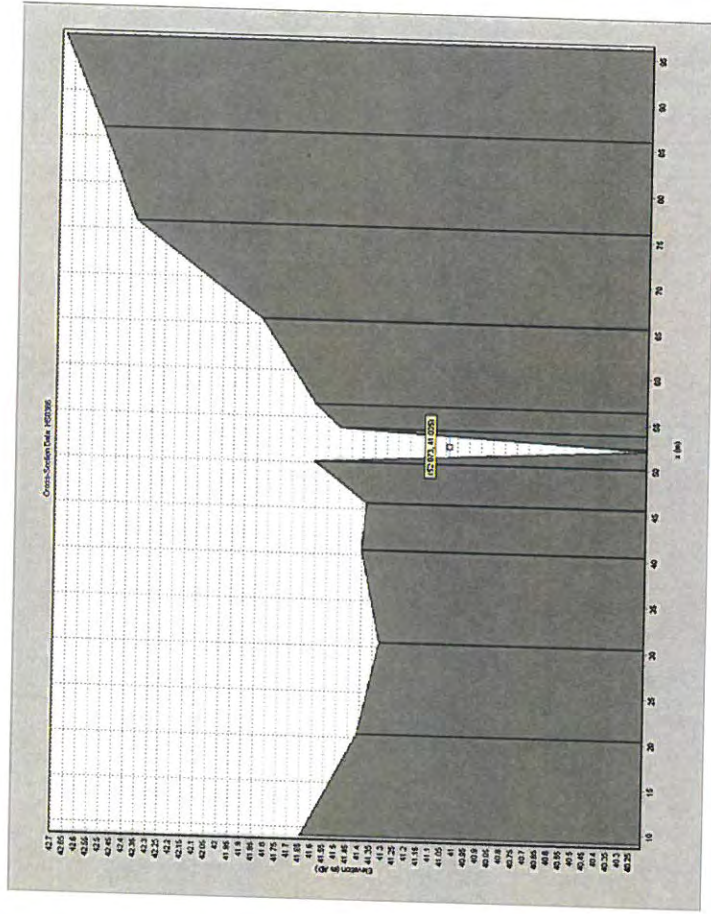
Maximum Stage at CS0014



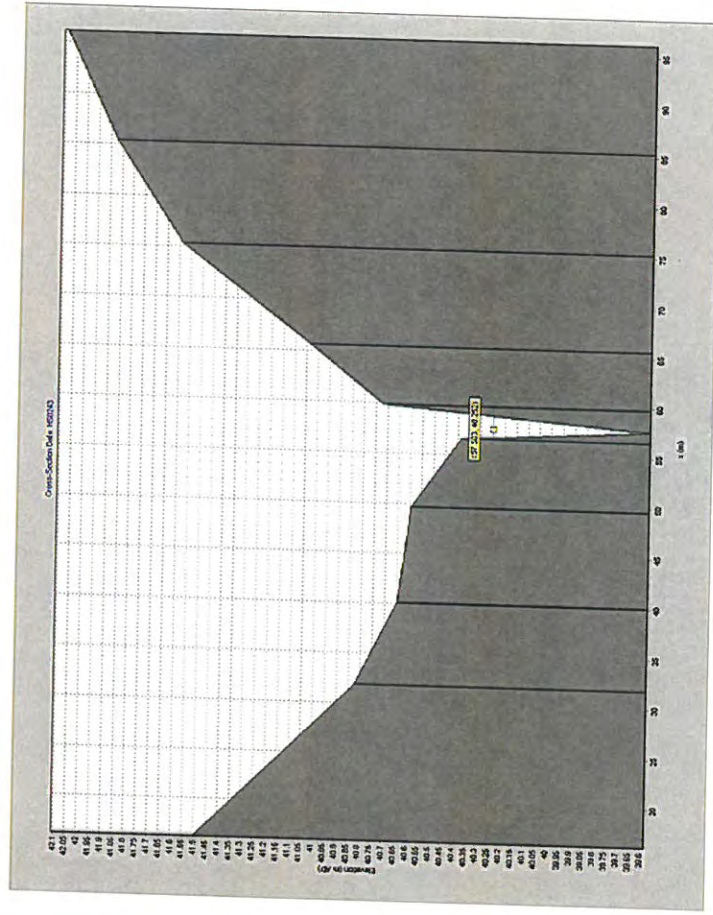
Maximum Stage at CS0000



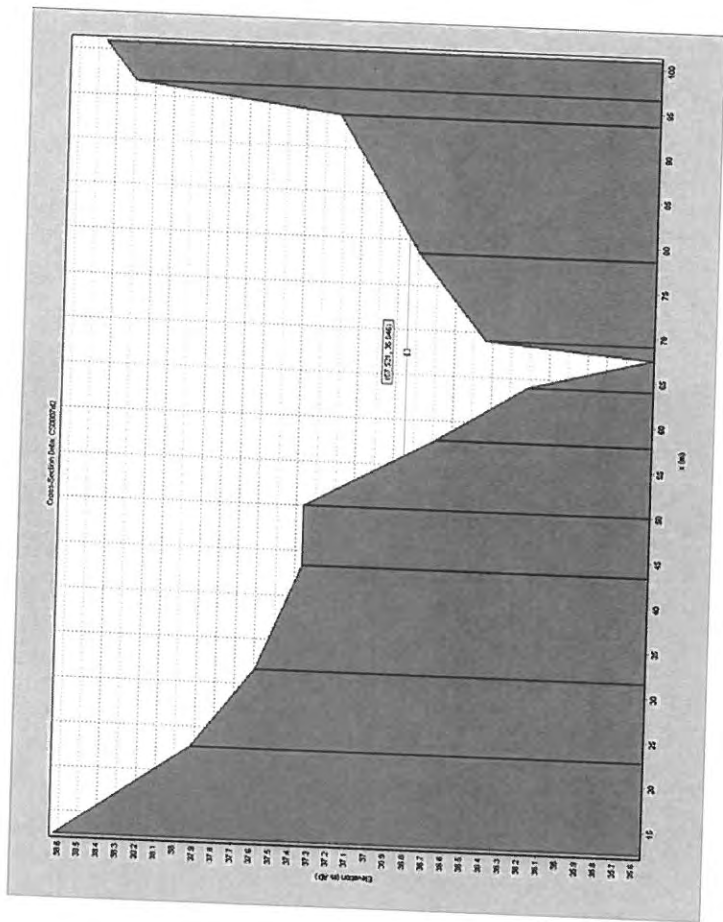
Maximum Stage at HS0474



Maximum Stage at HS0366



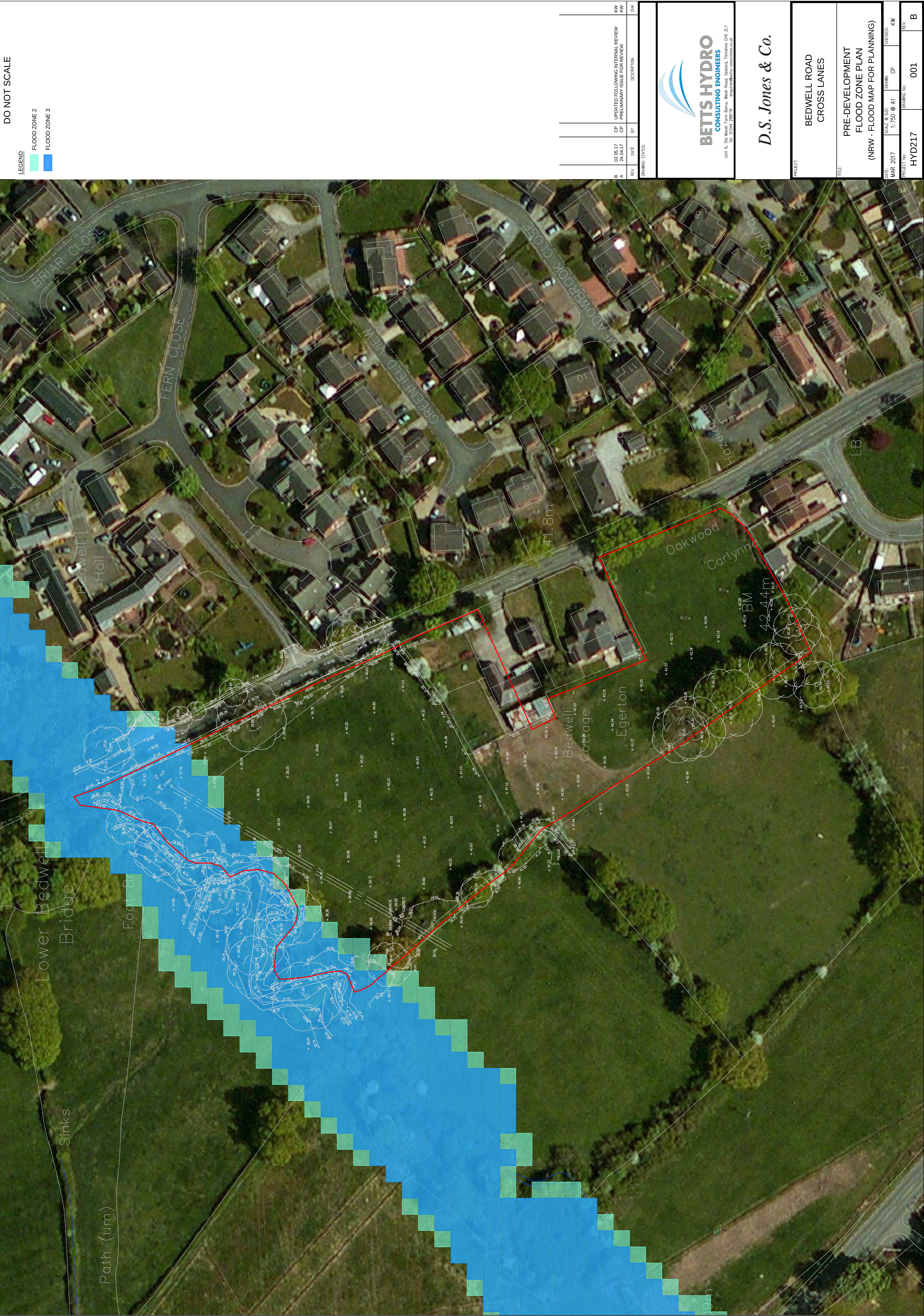
Maximum Stage at HS0243



Maximum Stage at CS0007d2 (confluence of Clywedog Stream with Hollies Stream)

APPENDIX J: FLOODPLAIN PLANS

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DO NOT SCALE

LEGEND

- FLOOD ZONE 2
- FLOOD ZONE 3

REV	DATE	BY	DESCRIPTION	DWG
B	02.05.17	CP	UPDATED FOLLOWING INTERNAL REVIEW	KW
A	24.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	KW

BETTS HYDRO
CONSULTING ENGINEERS
Unit 6, Old Morth Farm Barns, Welsh Road, Salsford, Fifehire D16 2Y
01344 220010
01344 220010

D.S. Jones & Co.

PROJECT
BEDWELL ROAD
CROSS LANES

TITLE
PRE-DEVELOPMENT
FLOOD ZONE PLAN
(NRW - FLOOD MAP FOR PLANNING)

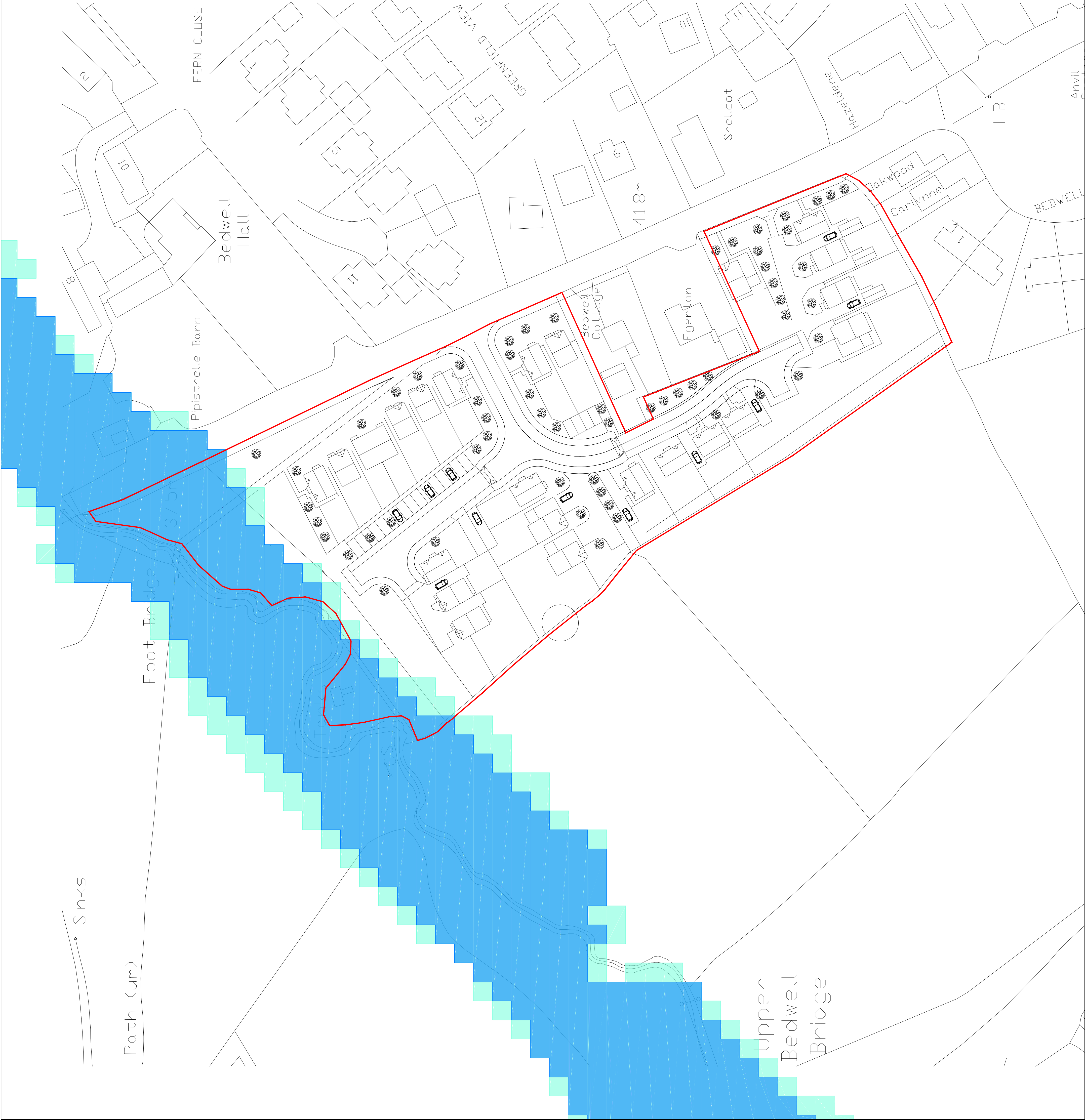
DATE	SCALE & SIZE	DRAWN	CHECKED	KW
MAR 2017	1:750 @ A1	CP		
PROJECT NO.	DRAWING NO.			
HYD217	001			B

DO NOT SCALE

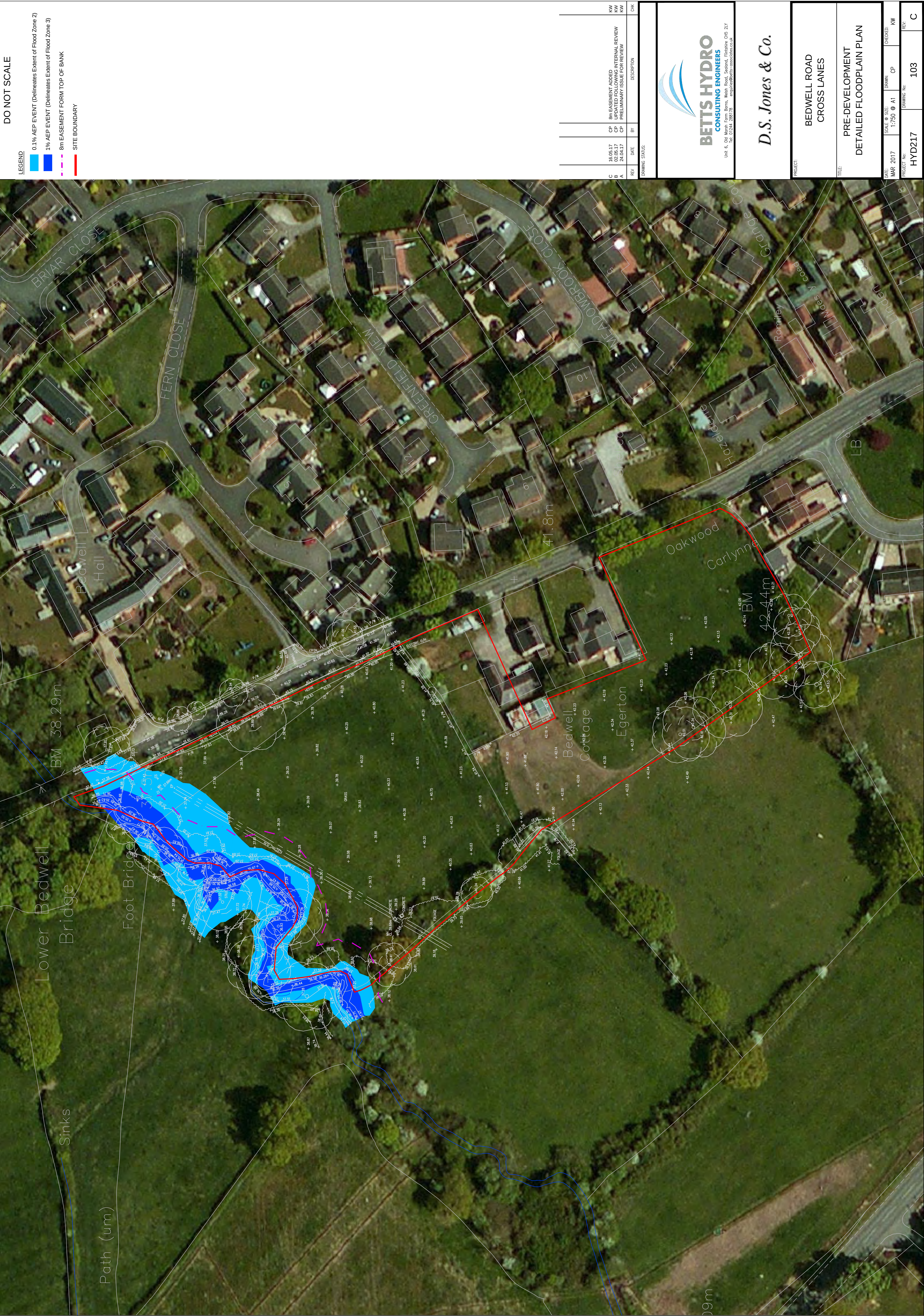
LEGEND

FLOOD ZONE 2

FLOOD ZONE 3



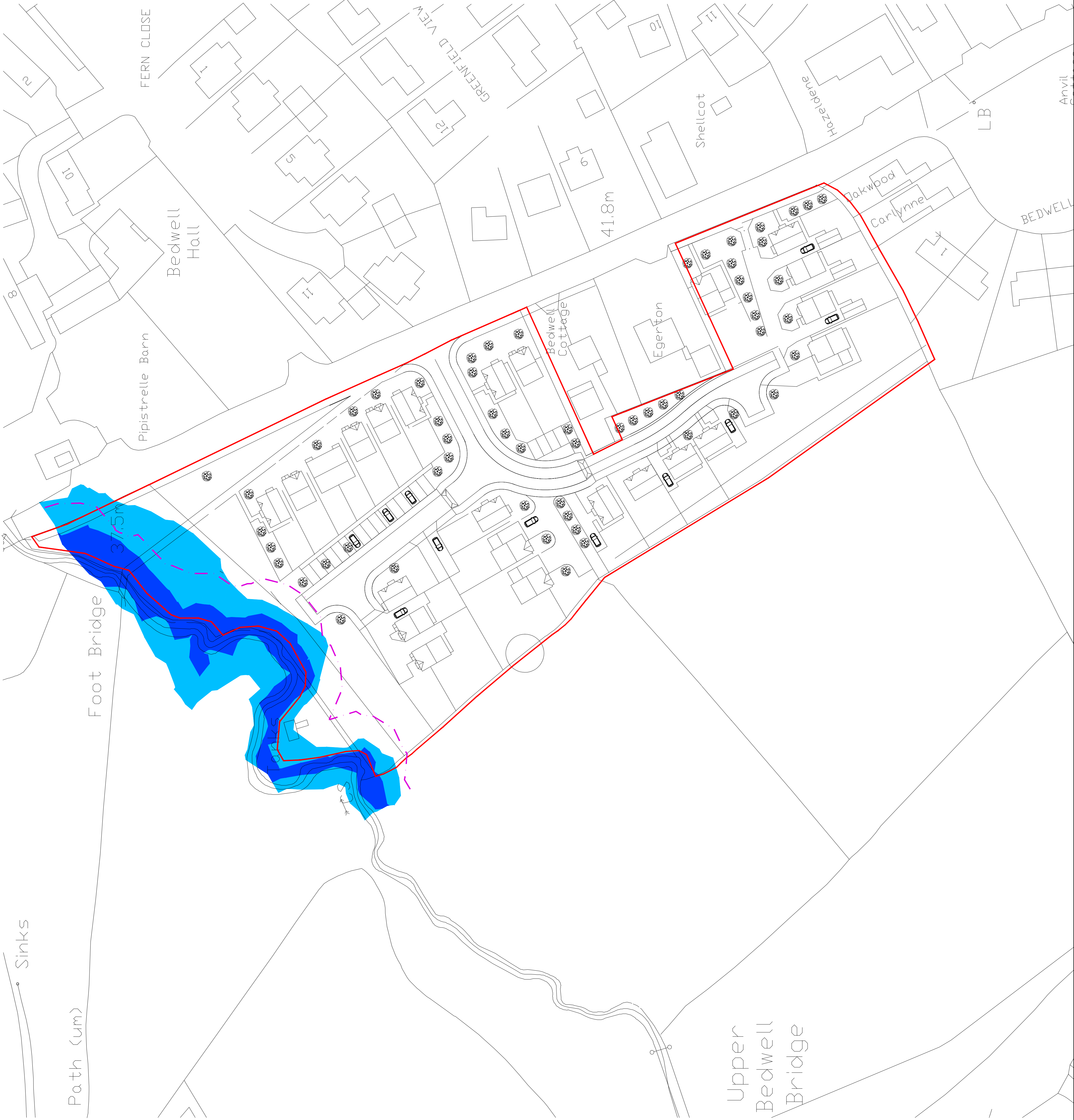
B	02.05.17	CP	UPDATED FOLLOWING INTERNAL REVIEW	KW
	24.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	KW
A		BY	DESCRIPTION	CHK
DRAWING STATUS				
Unit 6, Old Marsh Farm Barns, Welsh Road, Seabond, Porthcawl, Rhondda Cynon Taf, Wales Tel: 01443 258073 www.betts-hydro.co.uk				
<i>D.S. Jones & Co.</i>				
PROJECT: BEDWELL ROAD CROSS LANES				
TITLE: POST-DEVELOPMENT FLOOD ZONE PLAN (NRW - FLOOD MAP FOR PLANNING)				
DATE: MAR 2017	SCALE & SIZE: 1:750 @ A1	DRAWN: CP	CHECKED: KW	
PROJECT NO: HYD217	DRAWING NO: 002	REV: B		



DO NOT SCALE

LEGEND

- 0.1% AEP EVENT (Delineates Extent of Flood Zone 2)
- 1% AEP EVENT (Delineates Extent of Flood Zone 3)
- 8m EASEMENT FORM TOP OF BANK
- SITE BOUNDARY



C	16.05.17	CP	8m EASEMENT ADDED	KW	
B	02.05.17	CP	UPDATED FOLLOWING INTERNAL REVIEW	KW	
A	24.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	KW	
REV	DATE	BY	DESCRIPTION	CHK	
DRAWING STATUS					
 Unit 6, Old North Farm Barns, Wash Road, Seabold, Frinton, Ch5 2LY Tel: 01244 258173 enquiries@betts-hydro.co.uk					
<i>D.S. Jones & Co.</i>					
PROJECT					
BEDWELL ROAD CROSS LANES					
TITLE					
PRE-DEVELOPMENT DETAILED FLOODPLAIN PLAN					
DATE	SCALE @ SIZE	DRAWN	CHECKED	KW	
MAR 2017	1:750 @ A1	CP			
PROJECT No.	DRAWING No.				
HYD217	203				C

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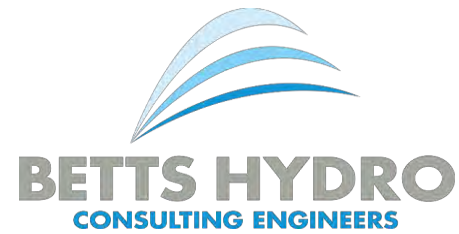
APPENDIX K: SURFACE WATER RUN-OFF CALCULATIONS AND ATTENUATION ESTIMATES

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SURFACE WATER RUN-OFF CALCULATION SHEET

Development	BEDWELL ROAD, CROSS LANES.
Project No.	HYD217

Revision	0.0	Completed by	KW
Date	23.05.17	Checked by	DK



Areas				Catchment Characteristics			
Total Site	1.247	ha		SAAR	718	mm	
Development Area (for SW Strategy)	1.025	ha		SPR	38	%	
Existing Impermeable	0.027	ha		i ₁	12.4	mm/hr	
Existing Impermeable (for SW Strategy)	0.000	ha	0%	i ₃₀	27.9	mm/hr	
Existing Pervious	1.220	ha		i ₁₀₀	37.4	mm/hr	
Existing Pervious (for SW Strategy)	1.025	ha	100%	d ₁	11.3	mm	
Proposed Impermeable (total)	0.405	ha	40%	d ₁₀₀	56.4	mm	

Run-off Rates				Volumes					
Pre-development				Pre-development					
Impermeable	1yr	0.0	l/s	Impermeable	1yr	0.0	cu.m		
	30yr	0.0	l/s		100yr	0.0	cu.m		
	100yr	0.0	l/s		Pervious	1yr	65.8	cu.m	
	50mm/hr	0.0	l/s			100yr	218.2	cu.m	
	Pervious	1yr	4.1			l/s	Total	1yr	65.8
30yr		8.2	l/s	100yr		218.2		cu.m	
100yr		10.1	l/s	Post-development	Impermeable (total)	1yr		45.8	cu.m
QBar		4.6	l/s			100yr+CC		296.9	cu.m
Total		1yr	4.1		l/s	Reduction (total)	-36%	-78.7	cu.m
	30yr	8.2	l/s						
	100yr	10.1	l/s						
Post-development									
Impermeable (total)	1yr	14.0	l/s						
	30yr	31.4	l/s						
	100yr+CC	54.7	l/s						

Quick storage Estimates		low	high	mean	Imp. Area (ha)	Max. Discharge (l/s)	Rainfall	CC
Return Period	1yr	21	36	28.5	0.405	5.0 *	FEH	0
Return Period	30yr	79	114	96.5	0.405	5.0 *	FEH	0
Return Period	100yr+CC	169	234	201.5	0.405	5.0 *	FEH	30%
Return Period	100yr+CC	185	261	223	0.405	5.0 *	FEH	40%

* Minimum Restraint Of A Flow Control Device (Based On The Standard Orifice Diameter Plate Constraints)

Old Marsh Farm Barns
Welsh Road
Sealand Flintshire CH5 2LY

Date 20/04/2017 17:18
File

Designed by patricktaylor
Checked by



Micro Drainage

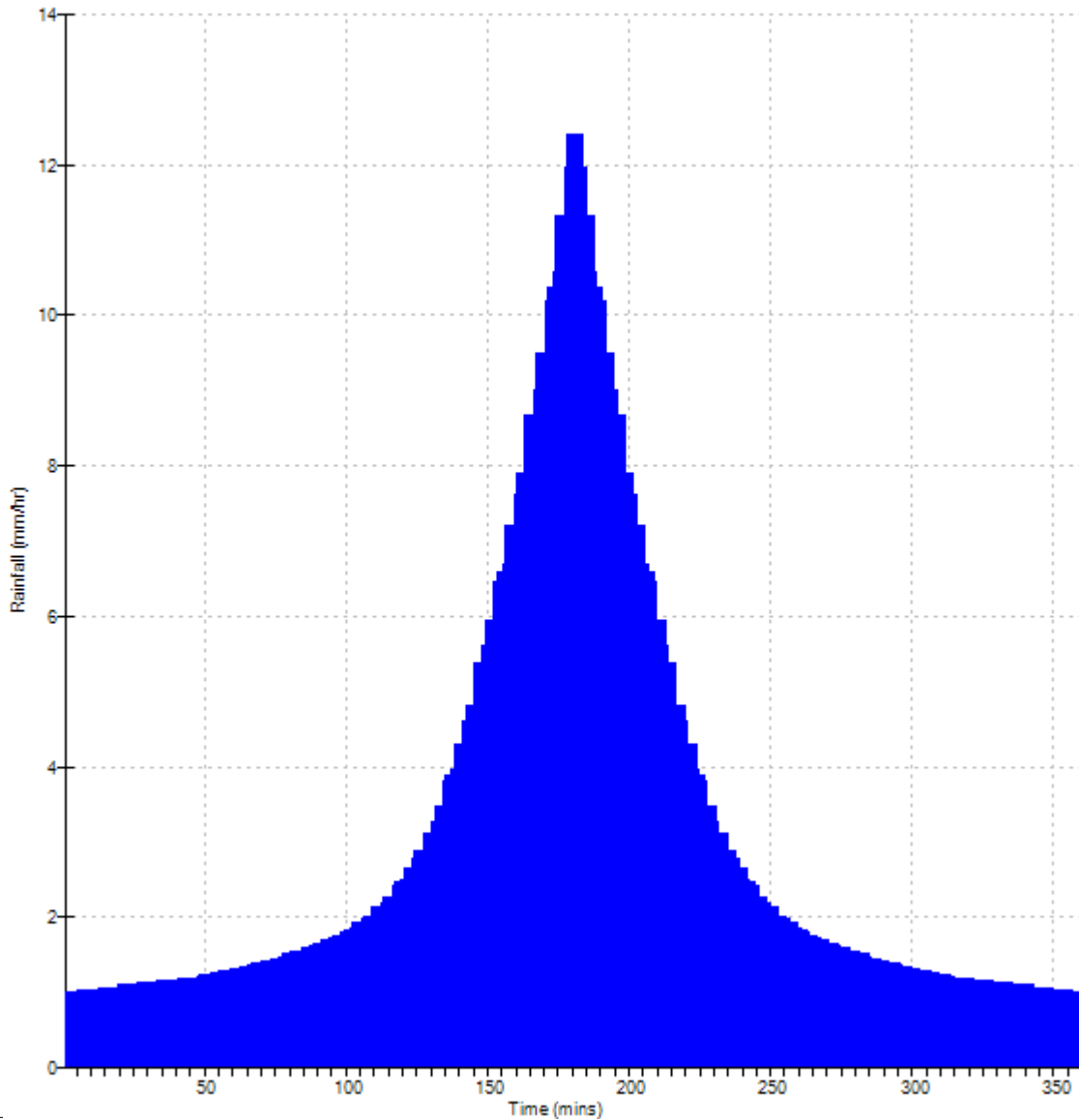
Network 2014.1.1

Rainfall profile

Storm duration (mins) 360

FEH Data

C (1km)	-0.025
D1 (1km)	0.309
D2 (1km)	0.419
D3 (1km)	0.307
E (1km)	0.285
F (1km)	2.391
Peak Intensity (mm/hr)	12.416
Ave. Intensity (mm/hr)	3.167
Return Period (years)	1



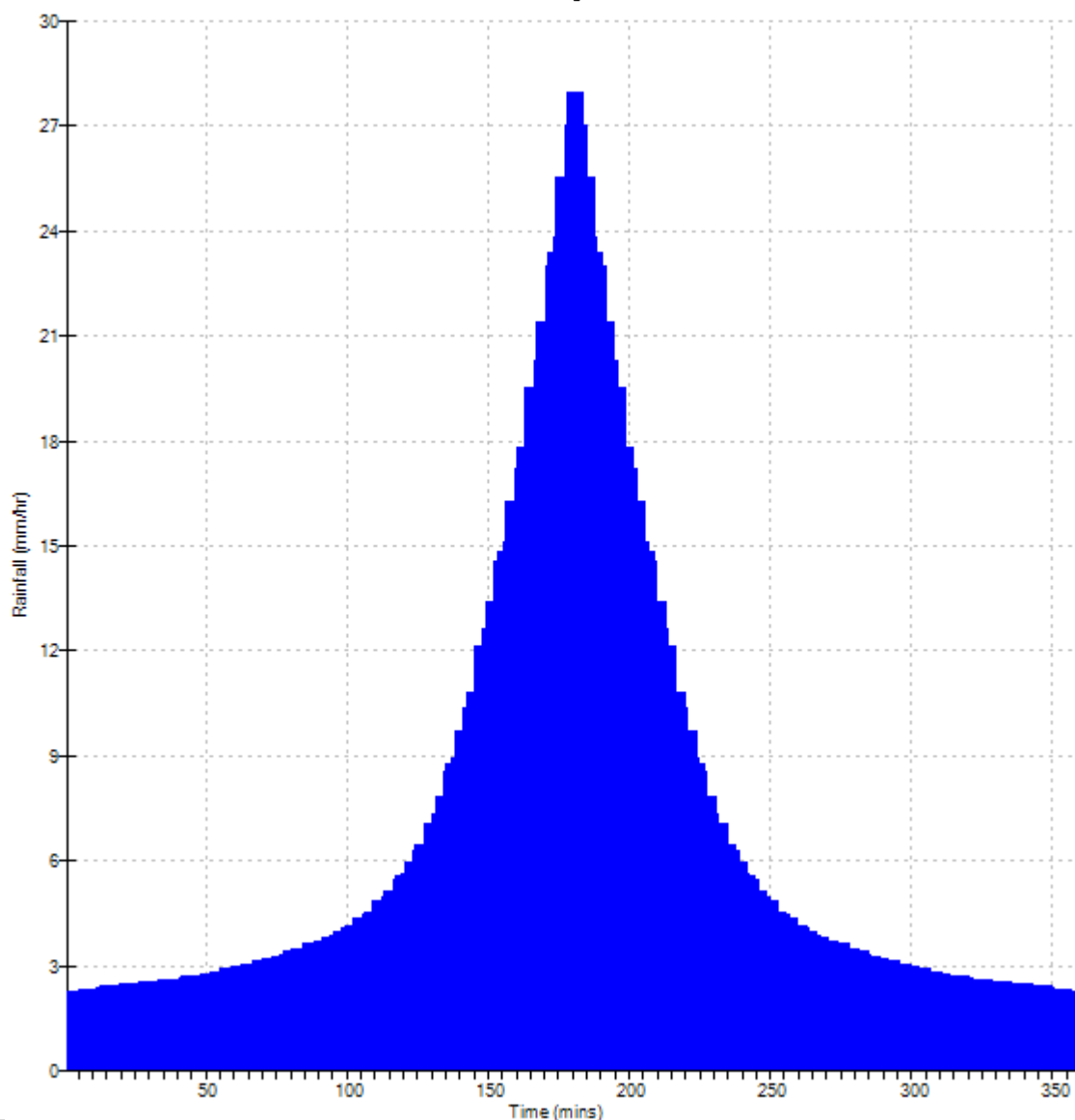
Betts Associates Ltd		Page 1
Old Marsh Farm Barns Welsh Road Sealand Flintshire CH5 2LY		
Date 20/04/2017 17:18	Designed by patricktaylor	
File	Checked by	
Micro Drainage	Network 2014.1.1	

Rainfall profile

Storm duration (mins) 360

FEH Data

C (1km)	-0.025
D1 (1km)	0.309
D2 (1km)	0.419
D3 (1km)	0.307
E (1km)	0.285
F (1km)	2.391
Peak Intensity (mm/hr)	27.992
Ave. Intensity (mm/hr)	7.141
Return Period (years)	30



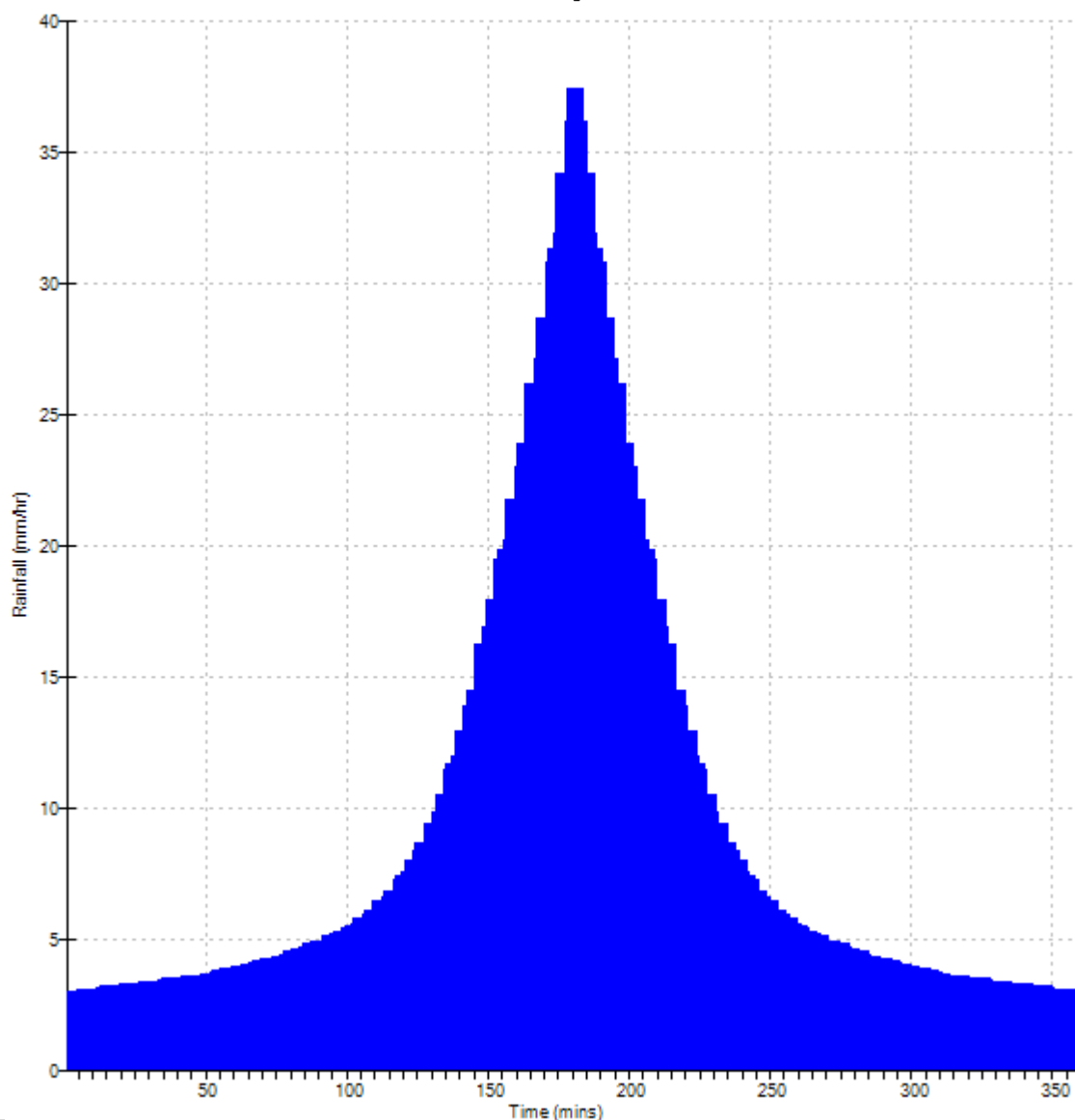
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Old Marsh Farm Barns Welsh Road Sealand Flintshire CH5 2LY		
Date 20/04/2017 17:19	Designed by patricktaylor	
File	Checked by	
Micro Drainage	Network 2014.1.1	

Rainfall profile

Storm duration (mins) 360

FEH Data

C (1km)	-0.025
D1 (1km)	0.309
D2 (1km)	0.419
D3 (1km)	0.307
E (1km)	0.285
F (1km)	2.391
Peak Intensity (mm/hr)	37.486
Ave. Intensity (mm/hr)	9.563
Return Period (years)	100



Betts Associates Ltd		Page 1
Old Marsh Farm Barns Welsh Road Sealand Flintshire CH5 2LY	BEDWELL ROAD CROSS LANES HYD217	
Date 23.05.17 File	Designed by KW Checked by DK	
Micro Drainage Source Control 2014.1.1		
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 1 Soil 0.450 Area (ha) 1.025 Urban 0.000 SAAR (mm) 718 Region Number Region 9 Results 1/s QBAR Rural 4.6 QBAR Urban 4.6 Q1 year 4.1 Q1 year 4.1 Q30 years 8.2 Q100 years 10.1		
©1982-2014 XP Solutions		

Betts Associates Ltd		Page 1																																		
Old Marsh Farm Barns	BEDWELL ROAD																																			
Welsh Road	CROSS LANES																																			
Sealand Flintshire CH5 2LY	HYD217																																			
Date 23.05.17	Designed by KW																																			
File	Checked by DK																																			
Micro Drainage		Source Control 2014.1.1																																		
<u>Greenfield Runoff Volume</u> FEH Data <table> <tr> <td>Return Period (years)</td> <td>1</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>Site Location GB 337400 347250 SJ 37400 47250</td> <td></td> </tr> <tr> <td>C (1km)</td> <td>-0.025</td> </tr> <tr> <td>D1 (1km)</td> <td>0.309</td> </tr> <tr> <td>D2 (1km)</td> <td>0.419</td> </tr> <tr> <td>D3 (1km)</td> <td>0.307</td> </tr> <tr> <td>E (1km)</td> <td>0.285</td> </tr> <tr> <td>F (1km)</td> <td>2.391</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>1.025</td> </tr> <tr> <td>SAAR (mm)</td> <td>718</td> </tr> <tr> <td>CWI</td> <td>107.323</td> </tr> <tr> <td>SPR Host</td> <td>38.090</td> </tr> <tr> <td>URBEXT (1990)</td> <td>0.0055</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>33.79</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>65.827</td> </tr> </table>			Return Period (years)	1	Storm Duration (mins)	360	Site Location GB 337400 347250 SJ 37400 47250		C (1km)	-0.025	D1 (1km)	0.309	D2 (1km)	0.419	D3 (1km)	0.307	E (1km)	0.285	F (1km)	2.391	Areal Reduction Factor	1.00	Area (ha)	1.025	SAAR (mm)	718	CWI	107.323	SPR Host	38.090	URBEXT (1990)	0.0055	Percentage Runoff (%)	33.79	Greenfield Runoff Volume (m³)	65.827
Return Period (years)	1																																			
Storm Duration (mins)	360																																			
Site Location GB 337400 347250 SJ 37400 47250																																				
C (1km)	-0.025																																			
D1 (1km)	0.309																																			
D2 (1km)	0.419																																			
D3 (1km)	0.307																																			
E (1km)	0.285																																			
F (1km)	2.391																																			
Areal Reduction Factor	1.00																																			
Area (ha)	1.025																																			
SAAR (mm)	718																																			
CWI	107.323																																			
SPR Host	38.090																																			
URBEXT (1990)	0.0055																																			
Percentage Runoff (%)	33.79																																			
Greenfield Runoff Volume (m³)	65.827																																			
©1982-2014 XP Solutions																																				

Betts Associates Ltd		Page 1																																		
Old Marsh Farm Barns	BEDWELL ROAD																																			
Welsh Road	CROSS LANES																																			
Sealand Flintshire CH5 2LY	HYD217																																			
Date 23.05.17	Designed by KW																																			
File	Checked by DK																																			
Micro Drainage		Source Control 2014.1.1																																		
<u>Greenfield Runoff Volume</u> FEH Data <table> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>Site Location GB 337400 347250 SJ 37400 47250</td> <td></td> </tr> <tr> <td>C (1km)</td> <td>-0.025</td> </tr> <tr> <td>D1 (1km)</td> <td>0.309</td> </tr> <tr> <td>D2 (1km)</td> <td>0.419</td> </tr> <tr> <td>D3 (1km)</td> <td>0.307</td> </tr> <tr> <td>E (1km)</td> <td>0.285</td> </tr> <tr> <td>F (1km)</td> <td>2.391</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>1.025</td> </tr> <tr> <td>SAAR (mm)</td> <td>718</td> </tr> <tr> <td>CWI</td> <td>107.323</td> </tr> <tr> <td>SPR Host</td> <td>38.090</td> </tr> <tr> <td>URBEXT (1990)</td> <td>0.0055</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>37.10</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>218.205</td> </tr> </table>			Return Period (years)	100	Storm Duration (mins)	360	Site Location GB 337400 347250 SJ 37400 47250		C (1km)	-0.025	D1 (1km)	0.309	D2 (1km)	0.419	D3 (1km)	0.307	E (1km)	0.285	F (1km)	2.391	Areal Reduction Factor	1.00	Area (ha)	1.025	SAAR (mm)	718	CWI	107.323	SPR Host	38.090	URBEXT (1990)	0.0055	Percentage Runoff (%)	37.10	Greenfield Runoff Volume (m ³)	218.205
Return Period (years)	100																																			
Storm Duration (mins)	360																																			
Site Location GB 337400 347250 SJ 37400 47250																																				
C (1km)	-0.025																																			
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Area (ha)	1.025																																			
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CWI	107.323																																			
SPR Host	38.090																																			
URBEXT (1990)	0.0055																																			
Percentage Runoff (%)	37.10																																			
Greenfield Runoff Volume (m ³)	218.205																																			
©1982-2014 XP Solutions																																				

STORMWATER STORAGE ESTIMATES

Micro Drainage		Variables			
Variables Results Design Overview 2D Overview 3D Vt	FEH Rainfall		Cv (Summer)	0.750	
	Return Period (years)		1	Cv (Winter)	0.840
	Site Location		Impervious Area (ha)	0.405	
	GB 337400 347250 SJ 37400 47250		Maximum Allowable Discharge (l/s)	5.0	
	C (1km)	-0.025	D3 (1km)	0.307	
	D1 (1km)	0.309	E (1km)	0.285	
	D2 (1km)	0.419	F (1km)	2.391	
			Infiltration Coefficient (m/hr)	0.00000	
			Safety Factor	2.0	
			Climate Change (%)	0	
Micro Drainage		Results			
Global Variables require approximate storage of between 21 m³ and 36 m³. These values are estimates only and should not be used for design purposes.					

Micro Drainage		Variables			
Variables Results Design Overview 2D Overview 3D Vt	FEH Rainfall		Cv (Summer)	0.750	
	Return Period (years)		30	Cv (Winter)	0.840
	Site Location		Impervious Area (ha)	0.405	
	GB 337400 347250 SJ 37400 47250		Maximum Allowable Discharge (l/s)	5.0	
	C (1km)	-0.025	D3 (1km)	0.307	
	D1 (1km)	0.309	E (1km)	0.285	
	D2 (1km)	0.419	F (1km)	2.391	
			Infiltration Coefficient (m/hr)	0.00000	
			Safety Factor	2.0	
			Climate Change (%)	0	
Micro Drainage		Results			
Global Variables require approximate storage of between 79 m³ and 114 m³. These values are estimates only and should not be used for design purposes.					

	Variables							
	FEH Rainfall		Cv (Summer)	0.750				
	Return Period (years)	100	Cv (Winter)	0.840				
	Site Location		Impervious Area (ha)	0.405				
	GB 337400 347250 SJ 37400 47250		Maximum Allowable Discharge (l/s)	5.0				
	C (1km)	-0.025	D3 (1km)	0.307				
	D1 (1km)	0.309	E (1km)	0.285				
Results	D2 (1km)		0.419	F (1km)	2.391	Infiltration Coefficient (m/hr)	0.00000	
Design					Safety Factor	2.0		
Overview 2D					Climate Change (%)	30		
Overview 3D								
Vt								

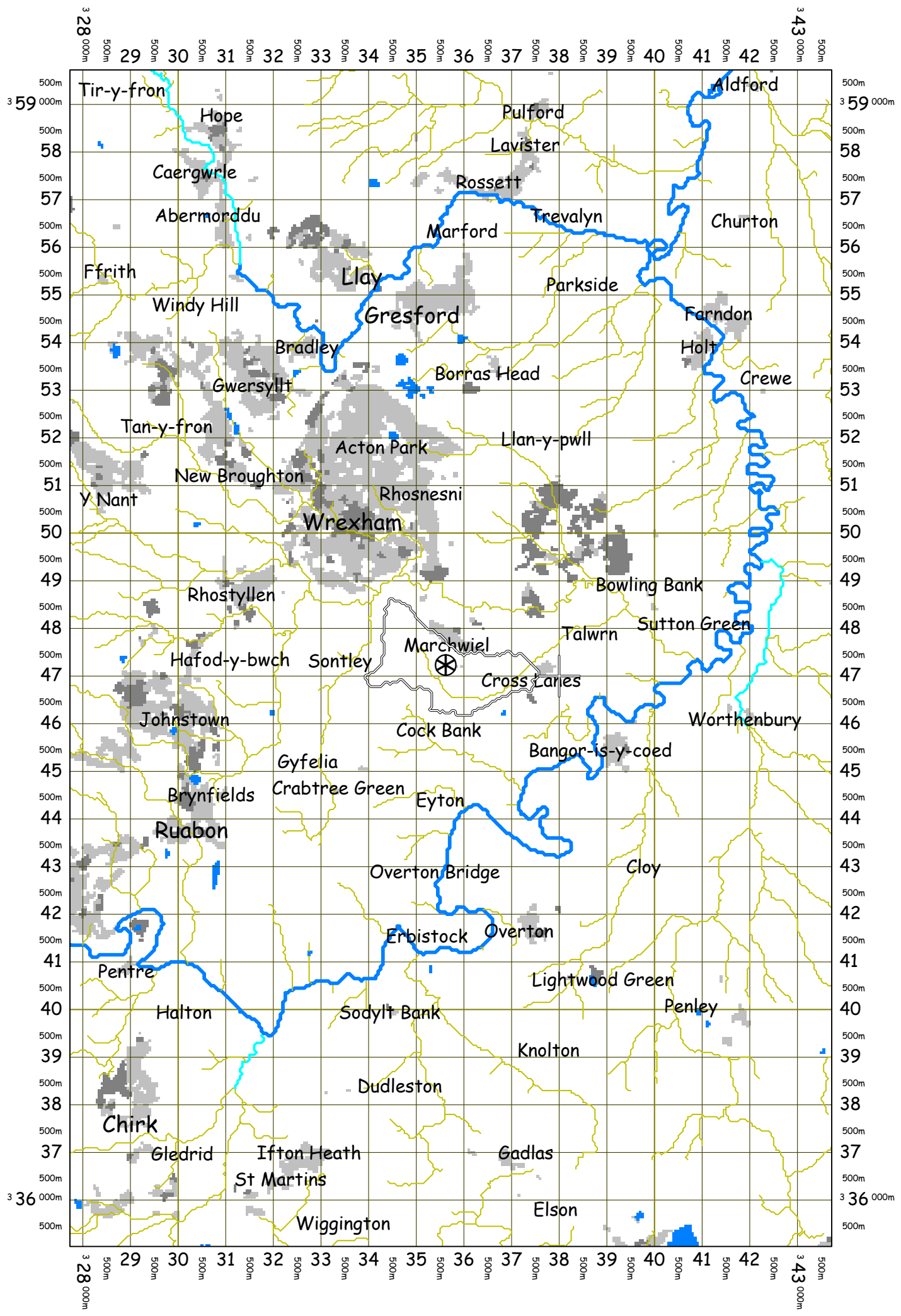
	Results
	Global Variables require approximate storage of between 169 m³ and 234 m³. These values are estimates only and should not be used for design purposes.

	Variables							
	FEH Rainfall		Cv (Summer)	0.750				
	Return Period (years)	100	Cv (Winter)	0.840				
	Site Location		Impervious Area (ha)	0.405				
	GB 337400 347250 SJ 37400 47250		Maximum Allowable Discharge (l/s)	5.0				
	C (1km)	-0.025	D3 (1km)	0.307				
	D1 (1km)	0.309	E (1km)	0.285				
Results	D2 (1km)		0.419	F (1km)	2.391	Infiltration Coefficient (m/hr)	0.00000	
Design					Safety Factor	2.0		
Overview 2D					Climate Change (%)	40		
Overview 3D								
Vt								

	Results
	Global Variables require approximate storage of between 185 m³ and 261 m³. These values are estimates only and should not be used for design purposes.

APPENDIX L: FEH CATCHMENT DATA & DESCRIPTIONS

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VERSION	FEH CD-RO Version	3 exported at	13:40:54 GMT	Thu	06-Apr-17
CATCHMENT	GB	337400	347250 SJ 37400 47250		
AREA	4.09				
ALTBAR	60				
ASPBAR	118				
ASPVAR	0.49				
BFIHOST	0.432				
DPLBAR	2.6				
DPSBAR	23.7				
FARL	1				
LDP	4.92				
PROPWET	0.51				
RMED-1H	9.2				
RMED-1D	29.3				
RMED-2D	36.9				
SAAR	718				
SAAR4170	752				
SPRHOST	38.09				
URBCONC1	0.25				
URBEXT199	0.0055				
URBLOC199	1.042				
C	-0.02482				
D1	0.32356				
D2	0.40463				
D3	0.3148				
E	0.28549				
F	2.37749				
C(1 km)	-0.025				
D1(1 km)	0.309				
D2(1 km)	0.419				
D3(1 km)	0.307				
E(1 km)	0.285				
F(1 km)	2.391				

DESIGN RAINFALL

Calculate : Design rainfall for

☒ catchment 337400 347250 [SJ 37400 47250]
☐ 1 km grid point 338000 347000 [SJ 38000 47000]
☐ Manually entered values ☐ for a point

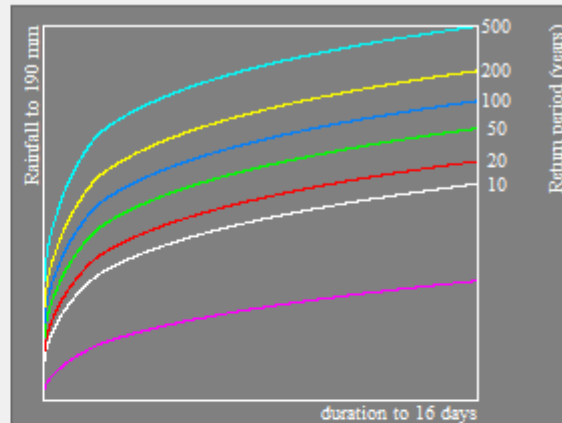
Area : km²

C : D3 :
 D1 : E :
 D2 : F :

Duration : Hours ☐ Fixed ☒ Sliding
 Return period : Years ☒ AM ☐ POT

Rainfall depth mm

 An areal reduction factor of 0.967 has been applied to a point rainfall of 11.7 mm to yield a catchment design rainfall of 11.3 mm.



Calculate : Design rainfall for

☒ catchment 337400 347250 [SJ 37400 47250]
☐ 1 km grid point 338000 347000 [SJ 38000 47000]
☐ Manually entered values ☐ for a point

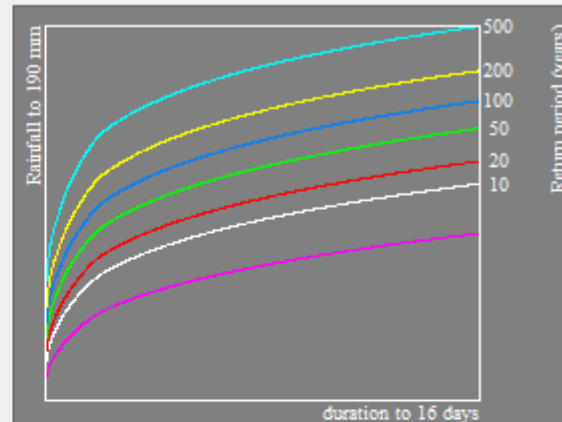
Area : km²

C : D3 :
 D1 : E :
 D2 : F :

Duration : Hours ☐ Fixed ☒ Sliding
 Return period : Years ☒ AM ☐ POT

Rainfall depth mm

 An areal reduction factor of 0.967 has been applied to a point rainfall of 21.0 mm to yield a catchment design rainfall of 20.3 mm.



Calculate : Design rainfall for

☒ catchment 337400 347250 [SJ 37400 47250]
☐ 1 km grid point 338000 347000 [SJ 38000 47000]
☐ Manually entered values ☐ for a point

Area : km²

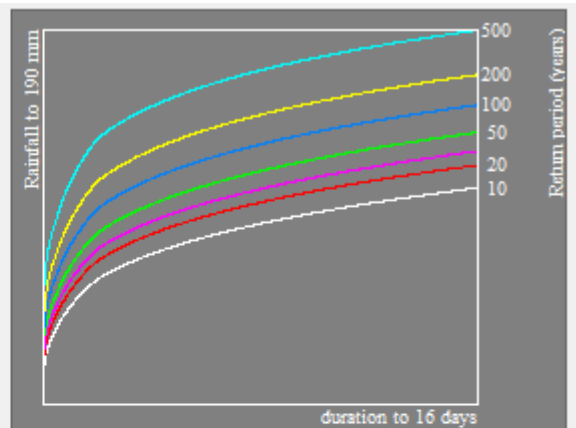
C : D3 :
 D1 : E :
 D2 : F :

Duration : Hours ☐ Fixed ☒ Sliding
 Return period : Years ☒ AM ☐ POT

Rainfall depth mm

Calculate... Export... Cancel

 An areal reduction factor of 0.967 has been applied to a point rainfall of 43.5 mm to yield a catchment design rainfall of 42.1 mm.



Calculate : Design rainfall for

☒ catchment 337400 347250 [SJ 37400 47250]
☐ 1 km grid point 338000 347000 [SJ 38000 47000]
☐ Manually entered values ☐ for a point

Area : km²

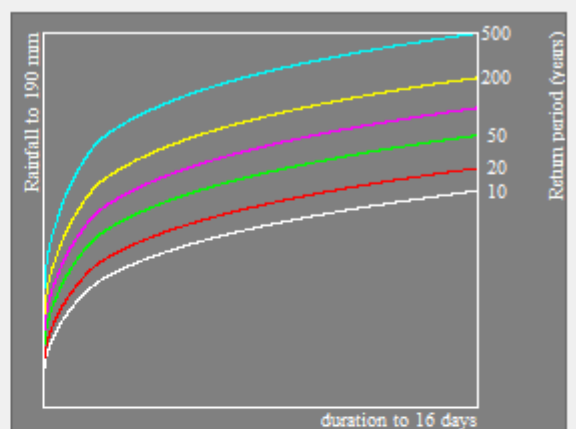
C : D3 :
 D1 : E :
 D2 : F :

Duration : Hours ☐ Fixed ☒ Sliding
 Return period : Years ☒ AM ☐ POT

Rainfall depth mm

Calculate... Export... Cancel

 An areal reduction factor of 0.967 has been applied to a point rainfall of 58.3 mm to yield a catchment design rainfall of 56.4 mm.



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APPENDIX M: IMPERMEABLE AREAS PLANS

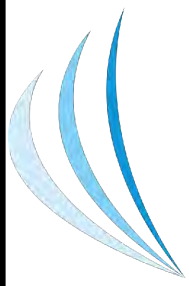
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DO NOT SCALE

- NOTES
- PRE-DEVELOPMENT PERVIOUS AREAS - 1.220ha
 - PRE-DEVELOPMENT IMPERMEABLE AREAS - 0.027ha
 - TOTAL SITE AREA - 1.247ha

REV	DATE	BY	DESCRIPTION	DWG
B	02.05.17	CP	UPDATED FOLLOWING INTERNAL REVIEW	KW
A	24.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	KW



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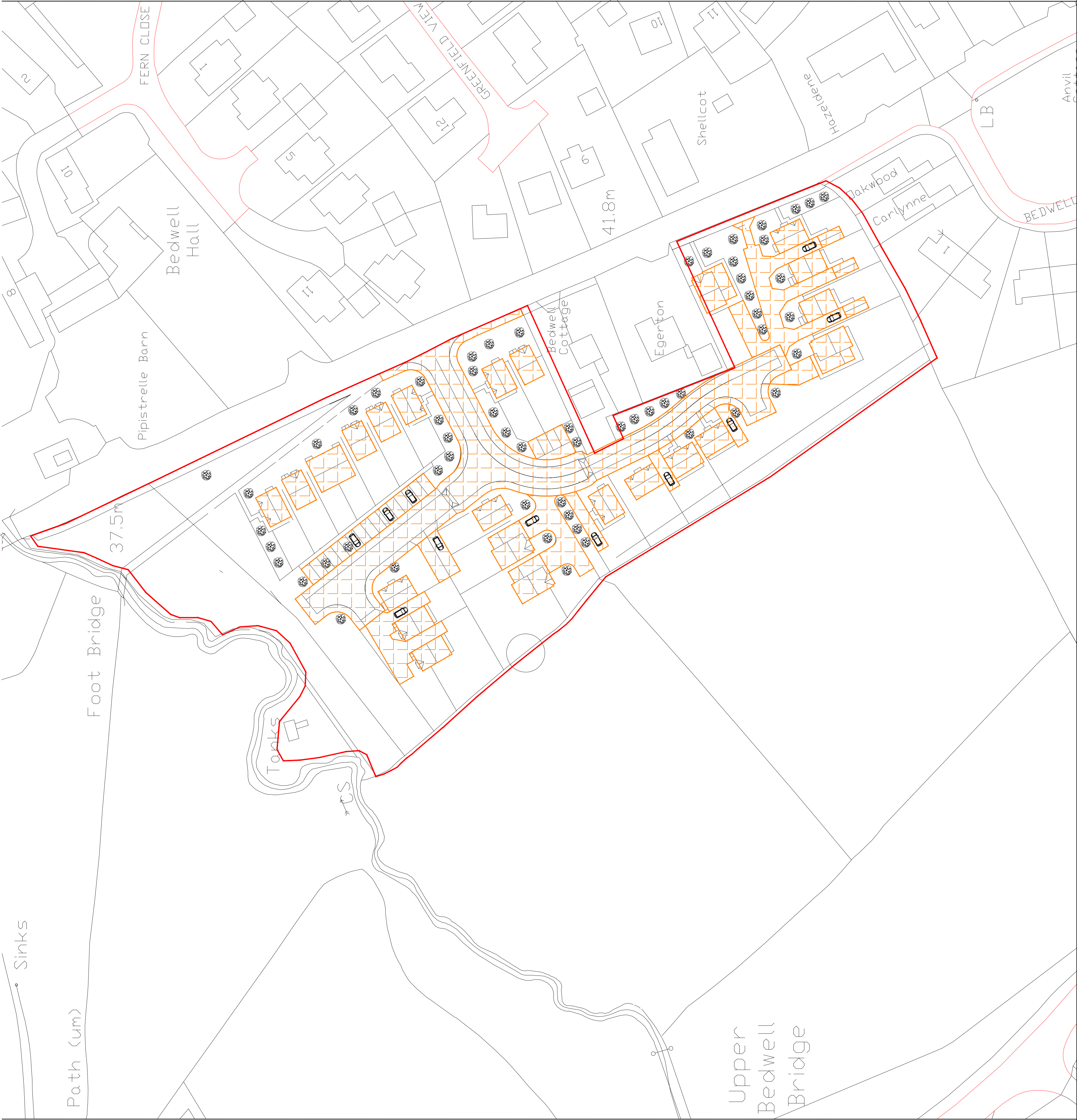
PROJECT	BEDWELL ROAD CROSS LANES		
TITLE	PRE-DEVELOPMENT IMPERMEABLE AREAS PLAN		

DATE	SCALE & SIZE	DRAWN	CHECKED
APR 2017	1:750 @ A1	CP	KW
PROJECT NO.	DRAWING NO.	101	B
HYD217			

DO NOT SCALE

NOTES

- POST-DEVELOPMENT PERVIOUS AREAS - 0.842ha
- POST-DEVELOPMENT IMPERMEABLE AREAS - 0.4051a
- TOTAL SITE AREA - 1.247ha



REV	DATE	BY	DESCRIPTION	KW	CHK
A	25.04.17	CP	PRELIMINARY ISSUE FOR REVIEW		
DRAWING STATUS					



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CONSULTING ENGINEERS

Unit 6, Old Marsh Farm Barns, Welsh Road, Seabond, Pwllheli Gt 2, Y
NW 57 44 250013
01752 850000

D.S. Jones & Co.

BEDWELL ROAD
CROSS LANES

POST-DEVELOPMENT
IMPERMEABLE AREAS PLAN

DATE: APR 2017	SCALE & SIZE: 1:750 @ A1	DRAWN: CP	CHECKED: KW
PROJECT NO: HYD217	DRAWING NO: 201	REV: A	

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APPENDIX N: PFRA/SFRA INFORMATION

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4. Historic/Past Flood Risk

All records of previous flooding incidents in WCBC were collected from the data sets listed in Chapter 3, methodology, within Table 2. These flood events came from a range of flood sources, and in many cases the source of flooding was unknown or not recorded. A summary of information specific to each source of flooding considered as part of the PFRA are included below. The locally agreed surface water information was determined by combining a number of data sets from a range of organisations as described in Table 2 Chapter 3. The figure within this Chapter show the data sets used to determine the impacts of historic flood risk.

4.1. Surface Water Flooding

Surface Water Flooding (SWF) occurs following intense rainfall which, due to the large volume of water exceeds the ability of the drainage systems to cope. Due to its sudden nature there is no lead time as is often the case with pluvial and fluvial flooding. This sudden rise in water levels can cause localised flooding, often affecting individual streets and/or properties as the drainage network is unable to cope.

Within the WCBC area this was the most prominent cause of flooding from the three sources the LLFA is required to assess. The main source of flooding was predominantly from surface water run off from paved surfaces frequently becoming an issue as the flooded property was below the level of the road surface. Insufficient drainage or blockages of the drainage system was also a major cause of this surface water runoff. Figure 3 below shows the results of both the external questionnaire, as well as the internal data collection.

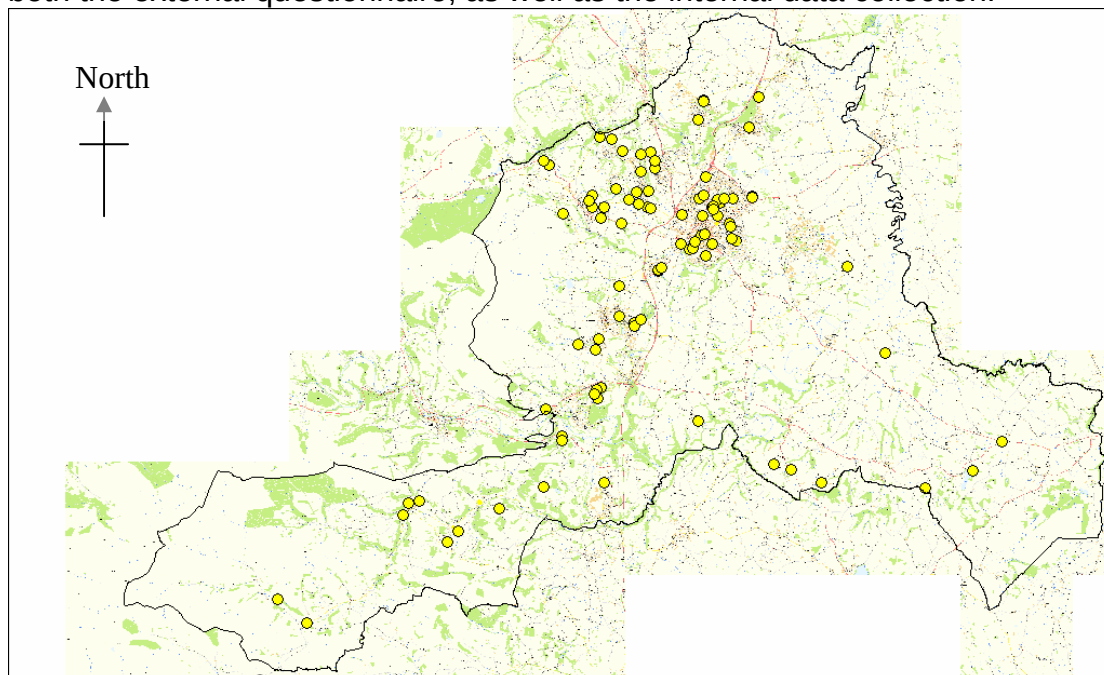


Figure 3 - Flooding Incidents within WCBC

still the case as with surface water none of the affected areas meet the requirements set by EA/WAG to be counted as an IFRA. Figure 4 below shows all sewer flooding incidents within the WCBC area over the last 10 years. This information was taken from the data set provided by WW/DC. Note that all flooding incidents in figure 4 are a combination of both internal and external flooding.

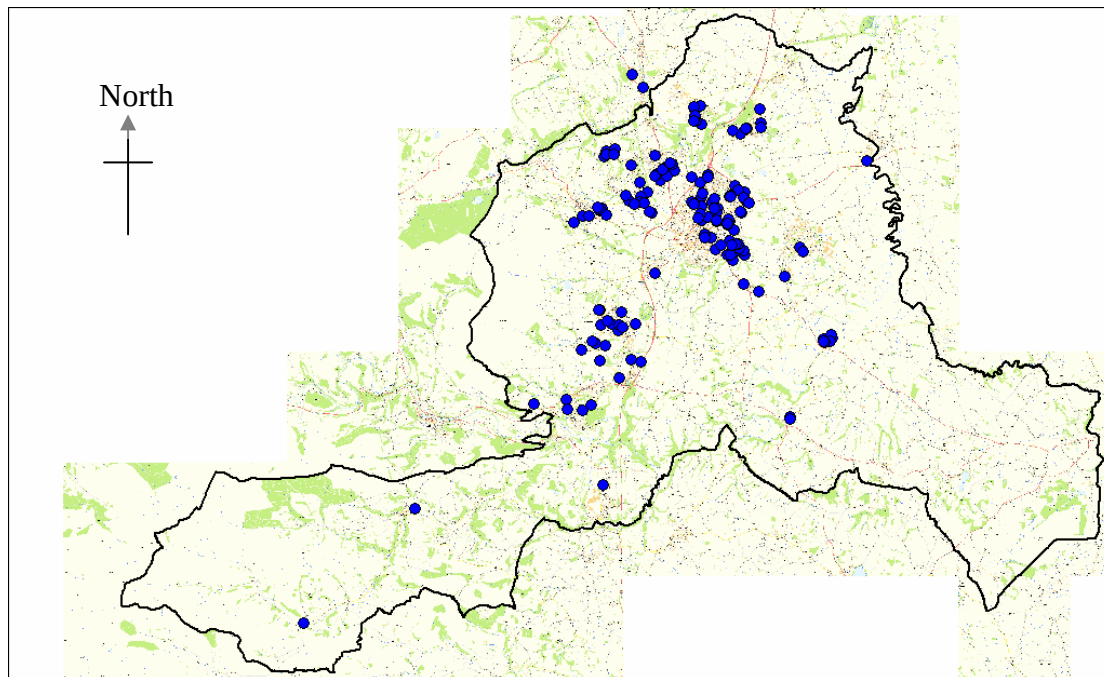


Figure 4 - Sewer Flooding Incident

4.4. Canal and Ordinary Watercourse Flooding

Information was obtained from British Waterways detailing the canal network throughout WCBC including the location of canals, weirs, sluices and locks. There are no historic records of canal overtopping or flooding issues from a canal within WCBC which meet the criteria for a significant flooding. There were a few events of canal breach/overtopping within the WCBC area which only affected rural areas and were caused by badgers burrowing under the canal in two cases. The first, in 2004, only flooded rural areas; the second in 2009 caused flooding and the evacuation of 1 property as well as causing water damage to a car. Both these incidents occurred around the village of Bettisfield. All incidents are shown on Figure 5 overleaf.

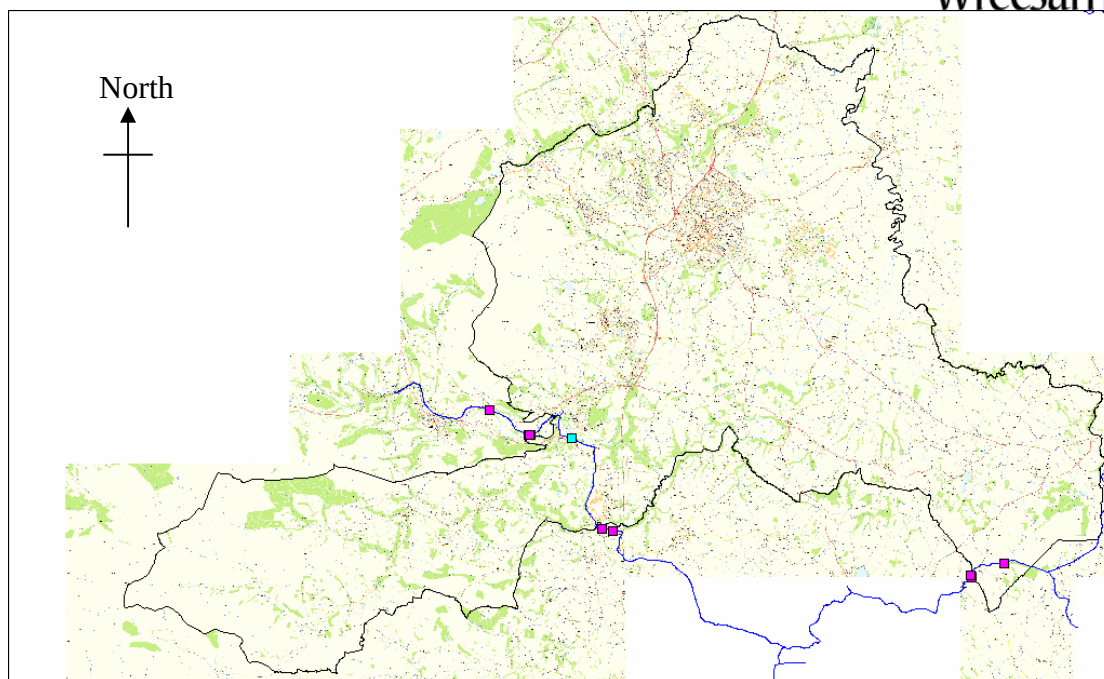


Figure 5 - Canal Flooding Incidents

4.5. Interaction with Main Rivers and the Sea

Insufficient data was available to draw definitive conclusions at this point. However, there is anecdotal evidence to suggest that surface water flooding is exacerbated in some areas, such as Bangor on Dee when the river is in flood. This occurred during the November 2000 floods when the one-way flap valves were unable to open due to the river level being above them, with the pressure of the river keeping the flap closed. As a consequence of this, High Volume Pumps (HVP's) pumps were brought in to extract the excess surface water in to the river system.

4.6. Consequence of Historic Flooding

As a result of the issues discussed in Chapter 3 methodology, insufficient data is available to draw definitive conclusions on the impacts and consequences of historic flood events on people, the economy and the environment. Due to the lack of information available, no historic flood events have been considered to have had 'significant harmful consequences' if the criteria set by the EA is used. Therefore Annex 1 of the Preliminary Assessment Report (PAR) which is the Spreadsheet containing information on past flood risk shall have a nil return. However, the information gathered and collated on past flood events shall be stored and used by WCBC in order to complete the LFRMS. Continuing to update this database at regular periods will allow a comprehensive picture of flooding in the WCBC area to be compiled, which will provide the foundations of the LFRMS.

flooding then the area is defined as an Indicative Flood Risk Area. The WCBC area has 20 locations above Flood Risk Thresholds (Signified by the red squares in figure 6 below), However the population of these squares is still below the threshold of 5000 people meaning that they are not classed as an IFRA.

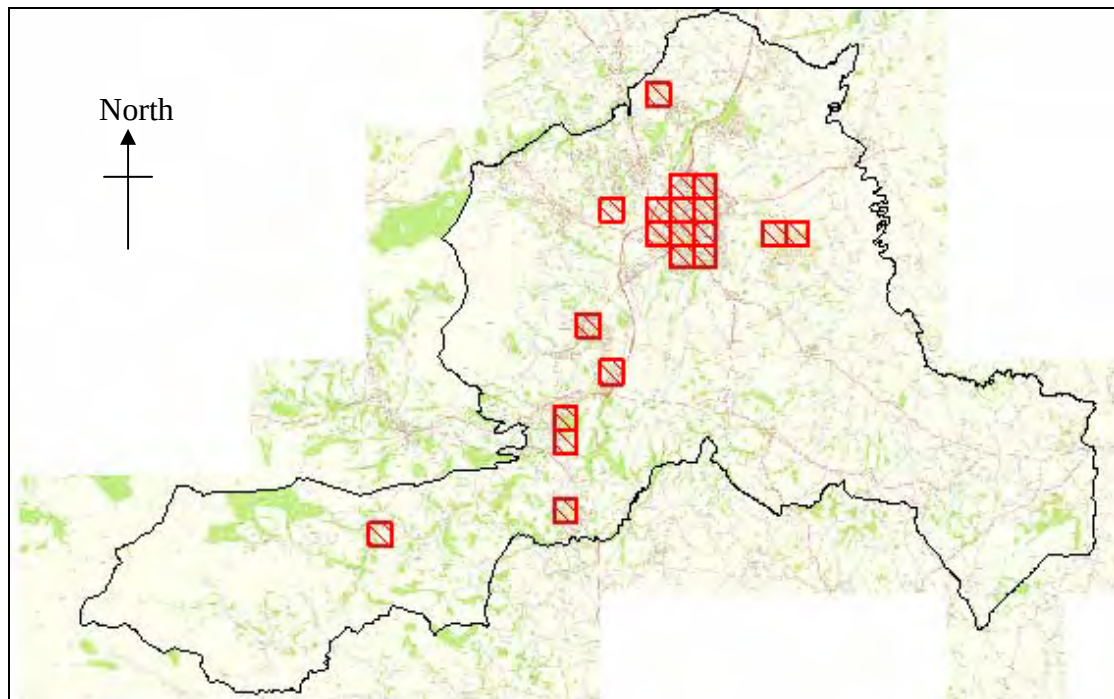


Figure 6 - Indicative Flood Risk Areas

6.3. Review of indicative Flood Risk Areas

As part of the PFRA process reviewing the areas defined by the EA as IFRA must be undertaken. Having collected, collated and assessed the numerous data sets from a range of organisations it is clear that there shall be no amendments to the IFRA as identified by the EAW, or the need to include any new ones as there are no areas that match the criteria set by DERFA/WAG. Due to this WCBC shall return a nil return for the spreadsheet for updating and reviewing of the IFRA.

For the future review of the PFRA, which shall be undertaken in 2017 there is likely to be a change to the indicative flood risk areas due to the expanding population and constraints they will place upon the local drainage infrastructure. It is predicted that the thresholds for what constitutes a flood risk area shall also be redefined for future work, which will also have an impact upon the areas defied as being at risk.

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APPENDIX O: OVERLAND FLOOD FLOW ROUTING PLANS

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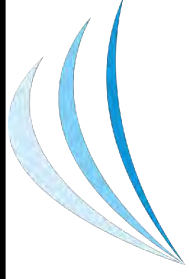
DO NOT SCALE

LEGEND

OVERLAND FLOOD FLOWS



REV	DATE	BY	DESCRIPTION	CHK
B A	02.06.17 24.04.17	CP CP	UPDATED FOLLOWING INTERNAL REVIEW PRELIMINARY ISSUE FOR REVIEW	KW KW



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BEDWELL ROAD
CROSS LANES

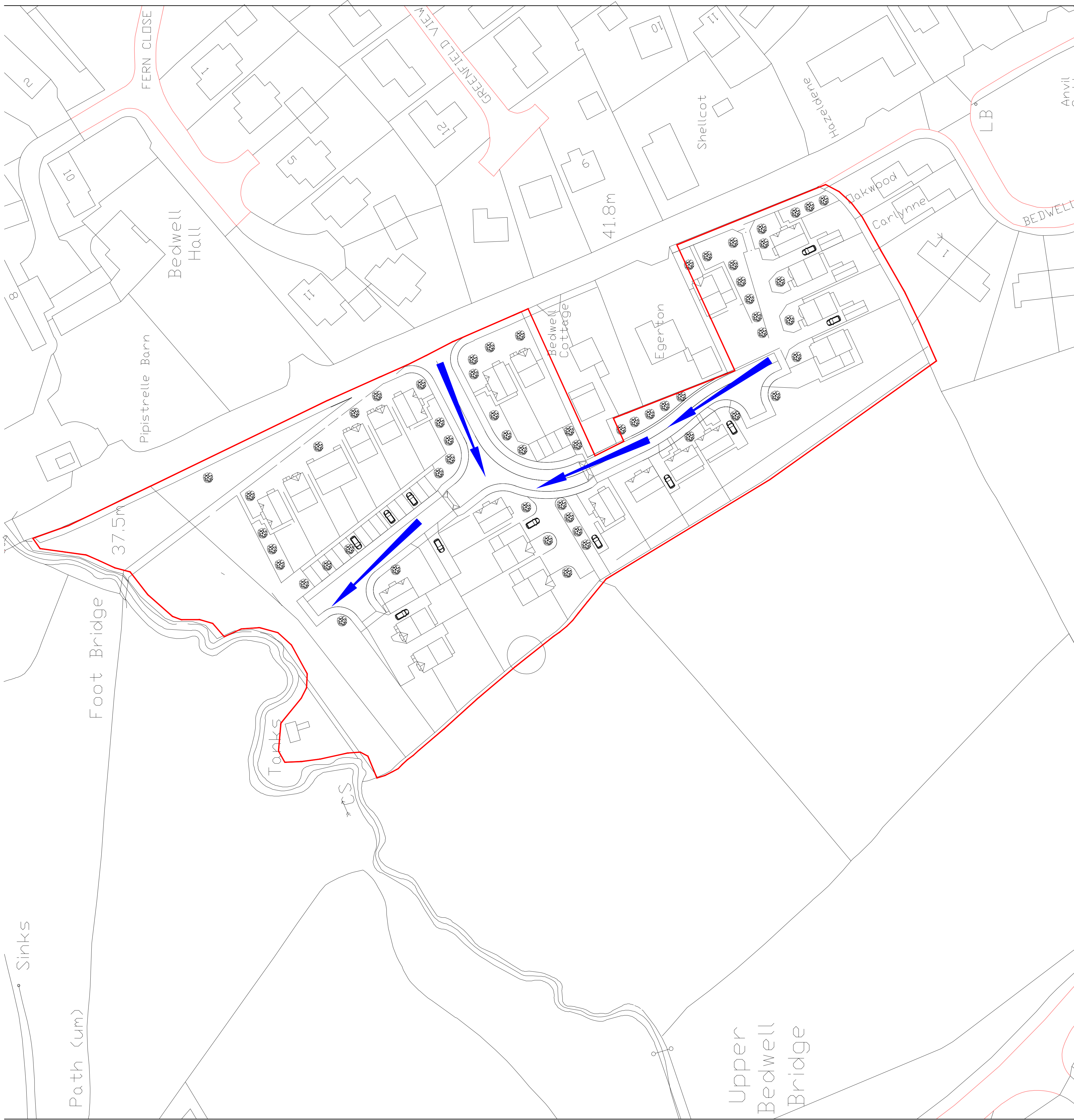
PRE-DEVELOPMENT OVERLAND FLOOD FLOW PLAN

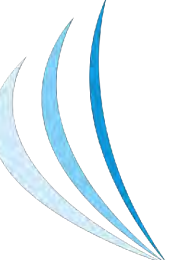
DATE:	APR 2017	SCALE & SIZE:	1:750 @ A1	DRAWN:	CP	CHECKED:	KW
PROJECT No:				DRAWING No:		REV:	
HYD217				102		B	

DO NOT SCALE

LEGEND

OVERLAND FLOOD FLOWS



A	25.04.17	CP	PRELIMINARY ISSUE FOR REVIEW	KW
REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS:				
 BETTS HYDRO CONSULTING ENGINEERS Unit 6, 641 Victoria Road, Warrington, Cheshire, CH9 2LY Tel: 01244 288010 Fax: 01244 288011 www.betts-hydro.co.uk				
<i>D.S. Jones & Co.</i>				
PROJECT:				
BEDWELL ROAD CROSS LANES				
TITLE:				
POST-DEVELOPMENT OVERLAND FLOOD FLOW PLAN				
DATE: APR 2017	SCALE 10 SIZE: 1:750 @ A1	DRAWING: CP	CHECKED: KW	
PROJECT No: HYD217		DRAWING No: 202		REV: A

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APPENDIX P: AERIAL DRAINAGE PLANS

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Surface Water Drainage

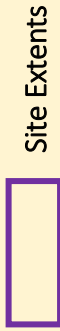
Based on ground conditions identified online, it can be considered that infiltration is unlikely to provide a full viable drainage solution for surface run-off generated by the site, (Soakaway Testing BRE365 will be required to confirm). Should infiltration not be feasible, it is proposed that surface water run-off discharge to the Ordinary Watercourse (Clywedog Stream) running adjacent to the northern boundary. A gravity connection to the watercourse is likely to be feasible and will be confirmed during detailed design following further analysis of levels. Consent for outfall to the Ordinary Watercourse will be required from the Lead Local Flood Authority. The LLFA and Natural Resource Wales will need to be in agreement with the proposed discharge rate(s), therefore early discussion would be advised.

In order to comply with the national policy, the surface water run-off will be required to be restricted, all sites should endeavour to achieve as close to pre-development greenfield rates as is viable. The proposals are to therefore restrict the rate of discharge to mimic a pre-development greenfield situation and the restricted rate will generate a storage requirement during the extreme storm events. It would be beneficial to incorporate SuDS to assist with some of the required onsite attenuation which will be continued during the next stage in the application.

Foul Water Drainage

The foul water flows generated by the development are proposed to outfall to the public combined sewer located within the site (adjacent to the northern border). Detailed drainage design will be required to confirm the most appropriate location for a point of connection (following discussion with Welsh Water), alongside determining whether a full gravity solution will be feasible.

LEGEND



Site Extents

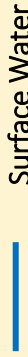
EXISTING DRAINAGE INFRASTRUCTURE



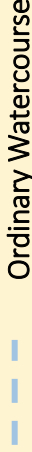
Combined



Foul Water



Surface Water

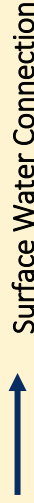


Ordinary Watercourse

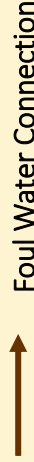


Pond

PROPOSED DRAINAGE FEATURES



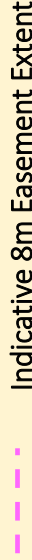
Surface Water Connection



Foul Water Connection



SuDS/Attenuation Area



Indicative 8m Easement Extent

Notes:

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

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

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

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

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APPENDIX Q: NOTES OF LIMITATIONS

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

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

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