

LAND OFF BANGOR ROAD, JOHNSTOWN

ABERDERFYN MODELLING STUDY

Final Report v1.0

June 2014

**Weetwood Services Ltd
Park House
Broncoed Business Park
Wrexham Road
Mold
CH7 1HP**

t: 01352 700045
e: info@weetwood.net
w: www.weetwood.net

Report Title: **Land off Bangor Road, Johnstown**
Aberderfyn Modelling Study
Final Report v1.0

Client: Gladman Developments Ltd

Date of Issue: 19 June 2014

Prepared by: Adam Edgerley BSc (Hons)
Senior Technical Engineer

Checked by: Rebecca Ellis BSc (Hons)
Associate Director

Approved by: Andrew Grime BEng MBA CEng C.WEM MICE FCIWEM
Managing Director

This document has been prepared solely as a Modelling Study report of Aberderfyn for Gladman Developments Ltd. Weetwood Services Ltd accepts no responsibility or liability for any use that is made of this document other than by Gladman Developments Ltd for the purposes for which it was originally commissioned and prepared.

Contents

Signature Sheet	Page
Contents	i
List of Tables, Figures & Appendices	ii
1 INTRODUCTION	4
1.1 Site Location & Description	5
1.2 Fluvial Flood Risk – Aberderfyn	5
2 HYDROLOGY.....	7
2.1 feh rainfall runoff METHOD: Aberderfyn	7
2.2 Hydrology results.....	8
3 HYDRAULIC MODEL DEVELOPMENT	10
3.1 Existing Models.....	10
3.2 Modelling Approach	10
3.3 Model Extent	10
3.4 Topographic DevelopmentT	11
3.5 Model Coefficients.....	13
3.6 Boundary Conditions	14
3.7 Model Version and Simulation Information	14
4 MODEL RUNS AND RESULTS	15
4.1 Model Runs	15
4.2 Model Results.....	15
5 MODEL SENSITIVITY	16
5.1 Manning’s n	16
5.2 Structure Blockage.....	16
6 PROPOSED SCENARIO	18
6.1 Development Proposals	18
6.2 Hydraulic modelling.....	18
6.3 Model Results.....	19
6.4 Flood Risk Mitigation	20
6.5 Flood Risk Elsewhere.....	21
7 SUMMARY	22

List of Tables

Table 1:	Summary of Peak Flows	9
Table 2:	Mannings n Values	14
Table 3:	Description of Model Runs - Baseline	15
Table 4:	Aberderfyn Modelled Baseline Flood Levels	15
Table 5:	Description of Model Runs - Proposed	19
Table 6:	Aberderfyn Modelled Baseline and Proposed Flood Levels	20

List of Figures

Figure 1:	Site Location	5
Figure 2:	Development Advice Map	6
Figure 3:	Environment Agency Flood Map for Planning (Rivers & Sea)	6
Figure 4:	FEH Catchment Descriptors –Aberderfyn	8
Figure 5:	Inflow Hydrographs	9
Figure 6:	Model Extent and Cross-Section Locations	10
Figure 7:	Cross-section Underestimating Water Levels	11
Figure 8:	Floodplain Storage Area Location	12
Figure 9:	Photographs of Channel Structures within Study Area	13
Figure 10:	Partial Long Profile Plot (Culvert 3 Blockage Scenario)	17
Figure 11:	Amendments to Model (Proposed Scenario)	19

List of Appendices

Appendix A:	Topographic Survey & Channel Survey
Appendix B:	Digital Model Files (Baseline)
Appendix C:	Aberderfyn 1D Model Results Plots (Baseline)
Appendix D:	Model Sensitivity Results (Baseline)
Appendix E:	Development Proposals
Appendix F:	Digital Model Files (Proposed)
Appendix G:	Aberderfyn 1D Model Results Plots (Proposed)
Appendix H:	Comparison of Flood Risk

1 INTRODUCTION

Weetwood Services Ltd (“Weetwood”) was instructed by Gladmans Development Ltd to undertake a study to examine the potential flood risk from Aberderfyn in connection with the proposed redevelopment of a site located off Bangor Road, Johnstown, Wrexham.

A 1D HEC-RAS baseline model of Aberderfyn was previously developed by Lees Roxburgh Ltd in 2013 which was utilised as part of a Flood Consequences Assessment (FCA) undertaken by Johnson Poole and Bloomer (JPB). The FCA was submitted to the local planning authority in support of a planning application and the modelled information was subsequently reviewed by Natural Resources Wales (NRW). NRW stated within their consultation response letter¹:

“...while the 1-dimensional [HEC-RAS] model provides flood levels, it does not provide sufficiently detailed information on flood extents...we would recommend that a more detailed 1D-2D model is produced to give greater confidence in the flood extents, and hence the overall design and layout of the housing development.”

“The [FCA] report suggests some land-raising in both the commercial and residential areas. We recommend that the developer use the more detailed model to investigate the effect of this land-raising on the flood extents.”

“Paragraph 5.2.13 [of the FCA] indicates that the main access road to the site will be raised to ensure it remains flood free at all times. The road crosses the floodplain at right-angles and we would like more information as to how the developer would ensure continuity of the floodplain. Again, a more detailed model would show the effect of raising the road and allow various options to be investigated.”

“Paragraph 5.2.13 [of the FCA] indicates that the main access road to the site will be raised to ensure it remains flood free at all times. The road crosses the floodplain at right-angles and we would like more information as to how the developer would ensure continuity of the floodplain. Again, a more detailed model would show the effect of raising the road and allow various options to be investigated.”

Following subsequent discussions with NRW² it was agreed that a 1D ISIS model may be sufficient to address the underlying concerns. In bringing the site forward for redevelopment Weetwood has therefore been consulted to develop a new 1D ISIS model to map the flood extents in more detail.

This report details the model development process and the resulting baseline flood conditions along with exploring potential flood risk following development of the site. In light of NRW’s comments, this report also explores the impacts of the redeveloped scenario including the proposed access route and the impact of land raising on flood risk elsewhere. Furthermore, advice is provided with respect to the location of the proposed surface water balancing pond for the development.

¹ Letter from NRW to Wrexham County Borough Council, 21 August 2013 (Ref: NT/2013/114864/01-L01)

² Telecom between Lucy Stephenson (NRW) and C Cornmell (Weetwood), 21 January 2014

1.1 SITE LOCATION & DESCRIPTION

The site is located at Ordnance Survey National Grid Reference SJ 309 460, as shown in **Figure 1**.

A topographic survey of the site has been undertaken by JLP Surveys Ltd and is provided in **Appendix A**. Site levels vary from approximately 104.80 metres above Ordnance Datum (m AOD) in the north / northwest to 101.00 m AOD in the south.

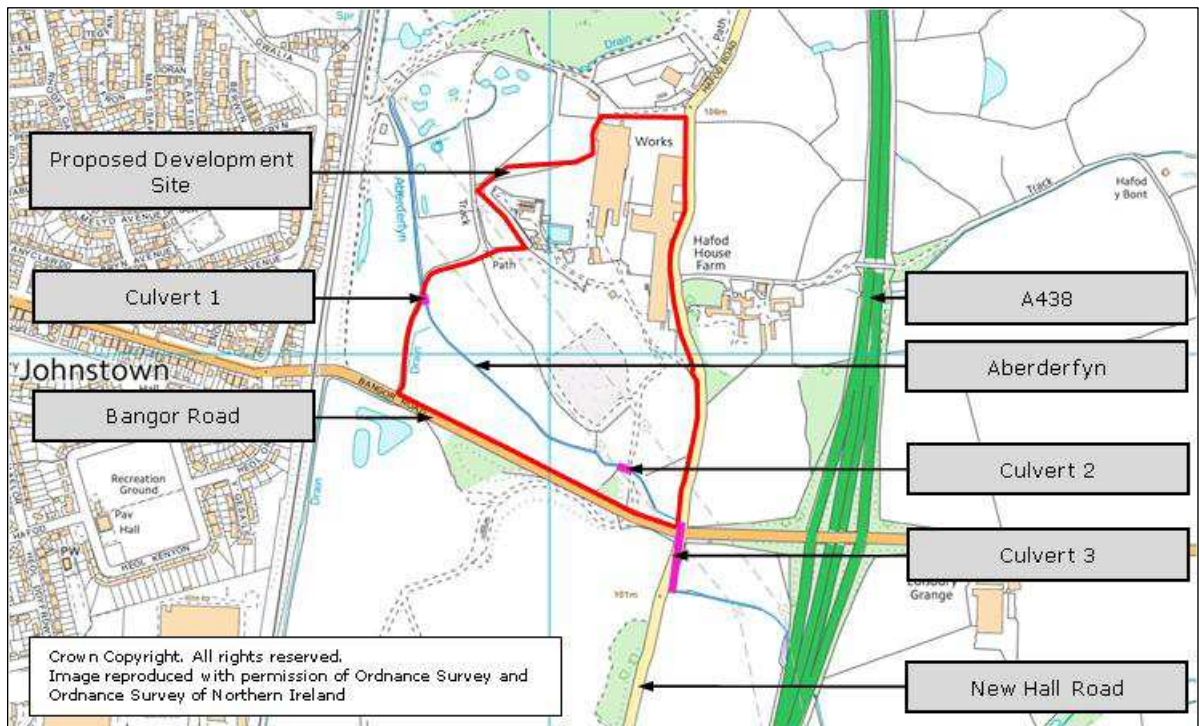


Figure 1: Site Location

1.2 FLUVIAL FLOOD RISK – ABERDERFYN

The Aberderfyn flows in a predominately south-easterly direction before its confluence with the Black Brook, which proceeds to flow in a predominately north-easterly direction. The catchment headwaters are relatively urbanised but the watercourse is largely unaltered; however, several structures cross the watercourse including several culverts.

The Aberderfyn flows through the southern extent of the site, passing through 3 culverts as illustrated in **Figure 1**. At the point where the Aberderfyn flows underneath the A483, the watercourse has a catchment area in the region of 2.52 km².

According to the Development Advice Map (**Figure 2**) the site is located within Zone A (i.e. considered to be at little or no risk of fluvial flooding), which is also supported by the NRW Flood Map³ (**Figure 3**); however, given the size of the watercourse, it is likely that this watercourse has not been accounted for within the flood maps.

³ Sourced from the Environment Agency website

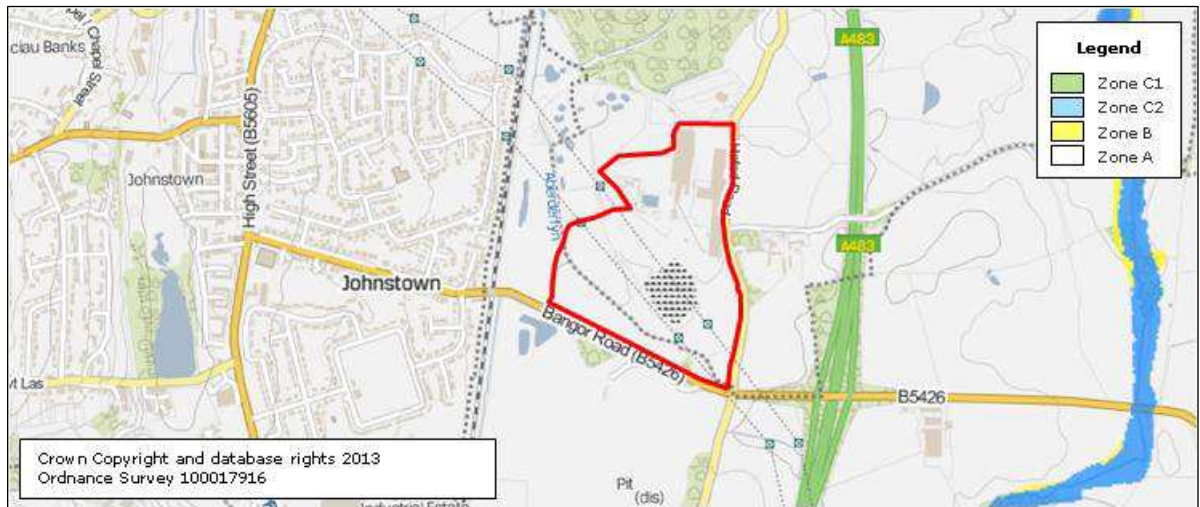


Figure 2: Development Advice Map

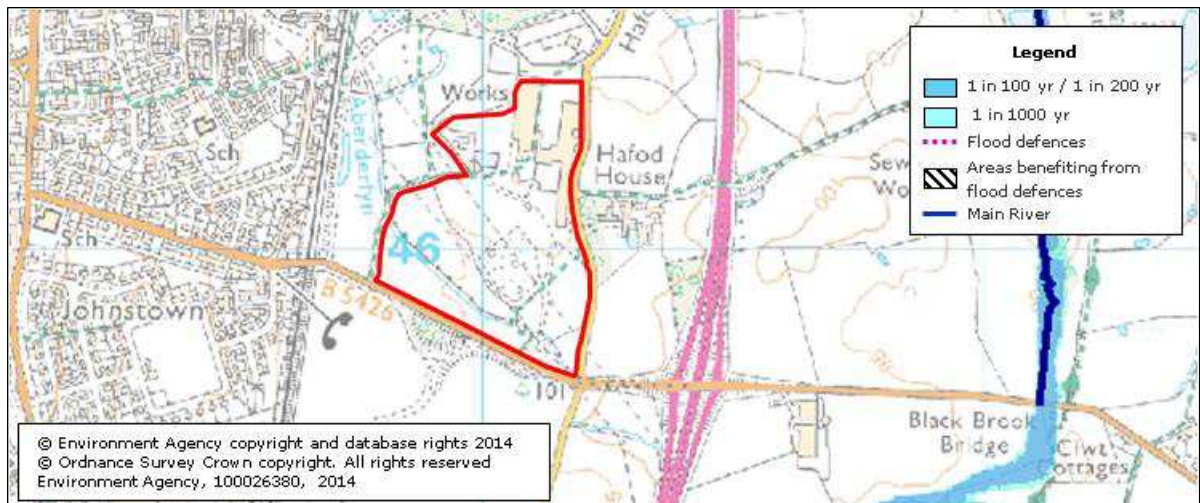


Figure 3: Natural Resources Wales Flood Map

(Source: Environment Agency website)

In order to identify and assess the level of flood risk from Aberderfyn a 1D ISIS model has been produced by Weetwood. The model development and outputs are discussed further in the following sections of this report.

2 HYDROLOGY

The following section describes the derivation of flows for the modelled reach of Aberderfyn.

In order to not underestimate flows, the catchment area for the Aberderfyn has been taken at the downstream extent of the model from where the watercourse flows underneath the A438.

The 'Revitalised FSR/FEH Rainfall Runoff Method'⁴ (ReFH) has been used to derive peak flows for specified return periods applicable to the site, as the catchment is ungauged and too small to derive a robust pooling group using the FEH Statistical Method.

2.1 FEH RAINFALL RUNOFF METHOD: ABERDERFYN

The ReFH provides good definition of runoff contributions from small catchments and involves using 'catchment descriptors' to define:

- a) The duration of the critical rain storm for the catchment⁵.
- b) The rainfall for the critical storm duration with the required return period.
- c) The profile of the critical storm to apportion storm rainfall total.
- d) The shape of the unit hydrograph.

Finally, the unit hydrograph and the profile storm are combined to produce the time against flow storm hydrograph. From the hydrograph a peak runoff rate can then be determined.

The catchment descriptors are taken from the FEH CD v3 and are shown in **Figure 4**.

⁴ <http://www.ceh.ac.uk/sections/hrr/RevitalisationofFSRFEHrainfall-runoffmodel.html>

⁵ In small, steep and urbanised catchments the duration will be shorter than in large, flat and undeveloped catchments

Revitalised FSR/FEH rainfall runoff method
Spreadsheet application version 1.3
Catchment sheet

Catchment name:

Catchment Descriptors (Descriptors in bold are used within model)

File name:

FEH CD ROM version:

Easting: Northing:
Area:

FARL	0.989	RMED-1H	9.6
PROPWET	0.51	RMED-1D	34.1
ALTBAR	133	RMED-2D	42.7
ASPBAR	97	SAAR	841
ASPVAR	0.73	SAAR4170	863
BFIHOST	0.542	SPRHOST	34.52
DPLBAR	1.95	URBCONC	0.892
DPSBAR	43.9	URBEXT2000	0.3482 very heavily urbanised
LDP	3.65	URBLOC	1.124

C	-0.02564	C(1km)	-0.026
D1	0.38182	D1(1km)	0.367
D2	0.40438	D2(1km)	0.4
D3	0.32118	D3(1km)	0.318
E	0.28744	E(1km)	0.287
F	2.36569	F(1km)	2.361

Catchment Comment:

Catchment Comment list:

Figure 4: FEH Catchment Descriptors –Aberderfyn

2.2 HYDROLOGY RESULTS

The duration of the critical storm (Dcrit) for the Aberderfyn catchment was calculated using the catchment descriptors as approximately 2.1 hours. This duration was used with the catchment descriptors to calculate the flood flows. The 1% annual exceedance probability (AEP) flood event peak flow was calculated as **5.23 m³/s**, with peak flow rates for other AEP events recorded in **Table 1**.

TAN15 requires an allowance for climate change to be made. Using the sensitivity ranges provided in Table 2 of DEFRA's note on climate change impacts⁶ and based on a development lifetime of 100 years, flows should be increased by 20% when undertaking modelling associated with developments whose lifespan is expected to last beyond 2025. **Therefore taking climate change into account would increase the 1% AEP flood event peak flow to 6.28 m³/s.**

The hydrographs for key return periods are presented in **Figure 5**.

⁶ DEFRA, Supplementary Note to Operating Authorities – Climate Change Impacts, October 2006

Table 1: Summary of Peak Flows

Watercourse	Peak Flows for AEP event (m ³ /s)		
	1%	1% cc	0.1%
Aberderfyn	5.23	6.28	9.31

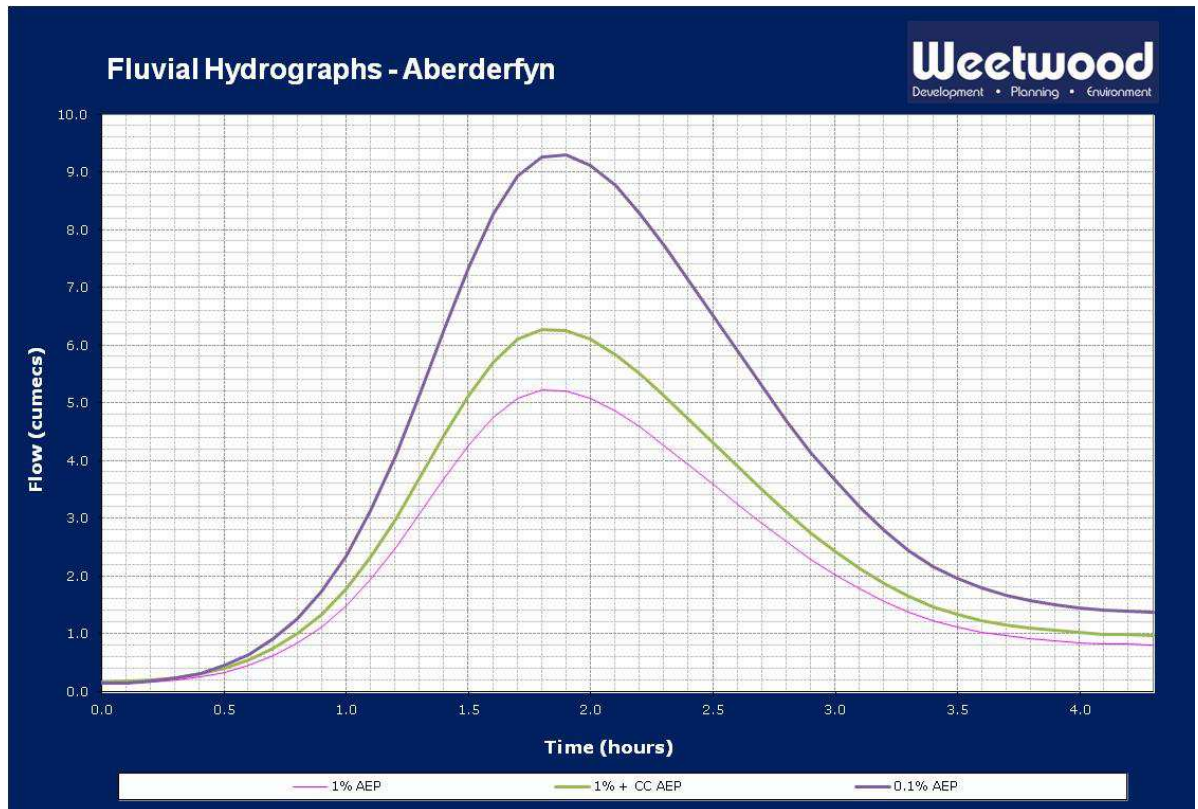


Figure 5: Inflow Hydrographs

3 HYDRAULIC MODEL DEVELOPMENT

3.1 EXISTING MODELS

As detailed previously a 1D HEC-RAS model of Aberderfyn has been developed by Lees Roxburgh Ltd.

3.2 MODELLING APPROACH

In order to more accurately define the level of fluvial flood risk to the site posed by Aberderfyn, Weetwood has developed a new 1D ISIS model.

A new channel survey of Aberderfyn was undertaken by JLP Surveys Ltd (**Appendix A**) and the corresponding data has been represented appropriately within ISIS as discussed in the following section of this report.

3.3 MODEL EXTENT

As illustrated in **Figure 6** the upstream extent of the model is located approximately 100 m to the north-west of the proposed development site (node label Ab_1008) with the downstream extent being located at the point where the Aberderfyn flows beneath the A438 (node label Ab_0000).

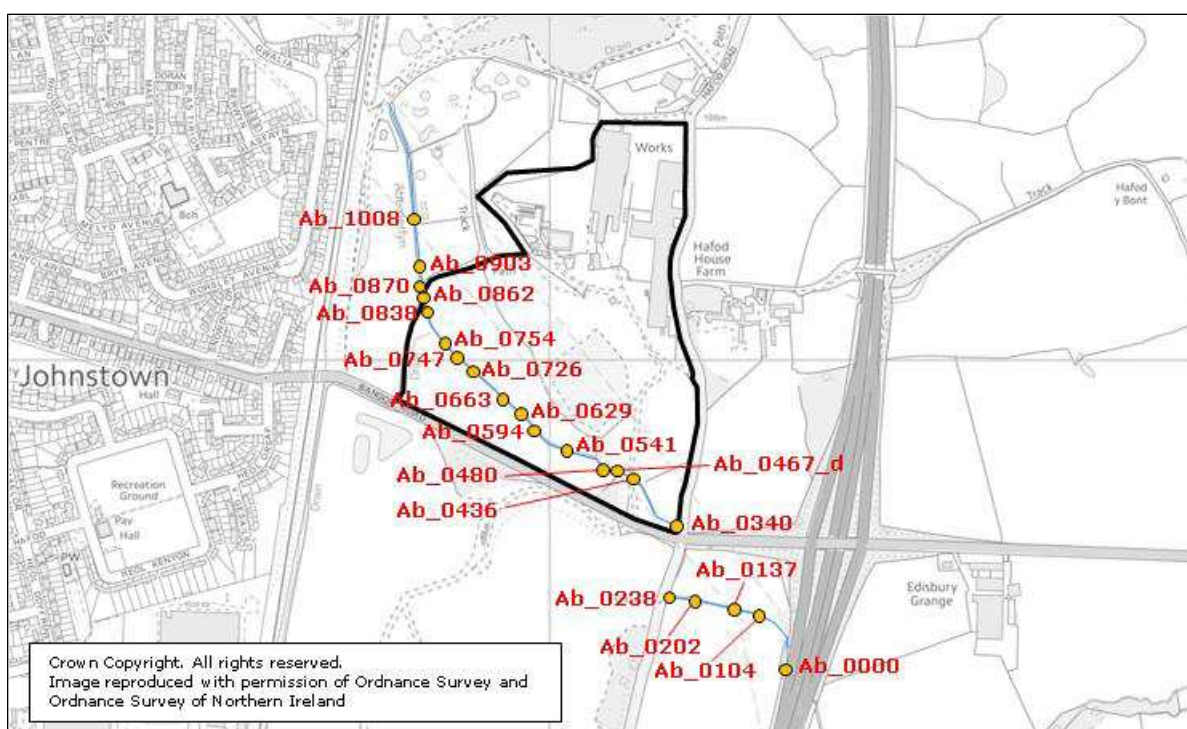


Figure 6: Model Extent and Cross-Section Locations

3.4 TOPOGRAPHIC DEVELOPMENT

The channel topography is defined by cross-sections. The data collected during the topographic survey (**Appendix A**) has been used to define these channel cross-sections. The cross-sections are spaced at regular intervals with more detailed information collected around the structures (**Section 3.4.1**). The cross-section locations are illustrated in **Figure 6**.

For most part, the floodplain on both the left and right bank of the watercourse has little or no obstruction to flow, and so has therefore been represented as extended cross-sections. The extended cross-sections were defined using data from the channel survey and topographic survey (**Appendix A**).

Some ground levels representing the left-bank floodplain within the extended cross-sections between nodes Ab_1008 and Ab_0754 are lower than top of bank levels. As such, when running the ISIS model, water was shown to appear in the floodplain which ordinarily may have been prevented by top of bank levels. Subsequently this caused instabilities within the model and also underestimated water levels within the channel. An example of this is shown in **Figure 7**.

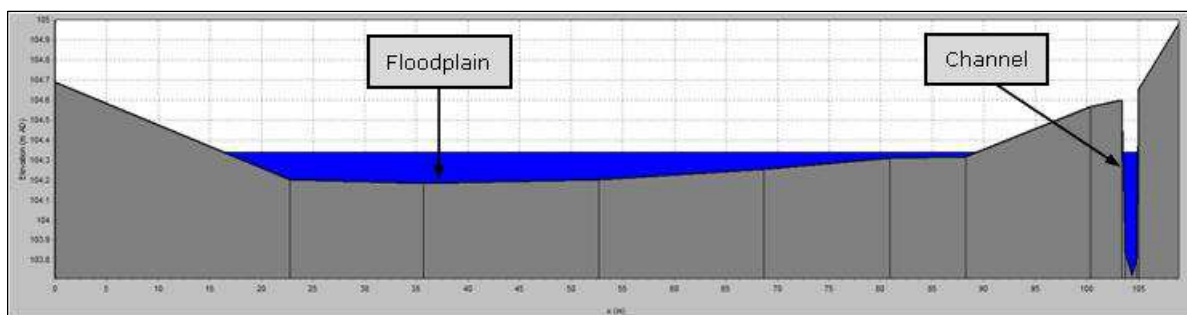


Figure 7: Cross-section Underestimating Water Levels

The channel cross-sections between these nodes were therefore truncated accordingly; however, this caused more water to appear within the channel and subsequently 'glass walling' occurred which would have overestimated water levels within the channel. In light of this, a series of spill units were incorporated between these node points which connected into a reservoir unit to more accurately represent the floodplain. The geometry of the reservoir unit and spill units were defined using the channel survey and topographic survey (**Appendix A**). The location of the storage area and associated lateral structure connections are shown in **Figure 8**.

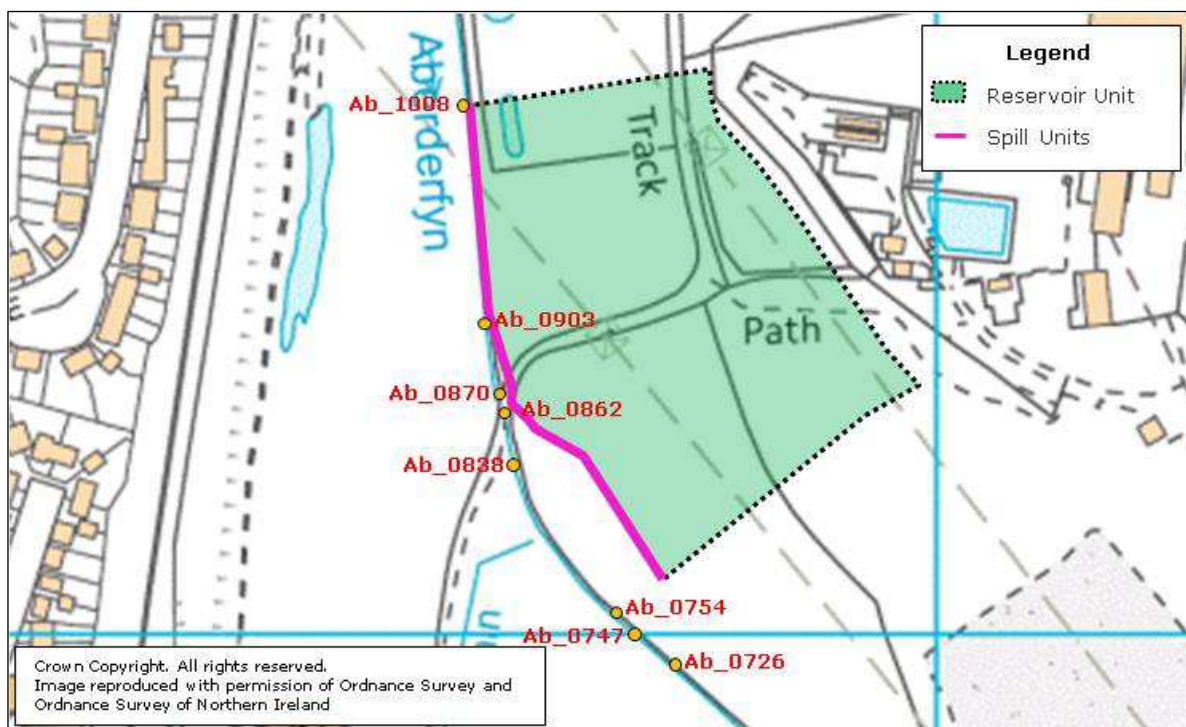


Figure 8: Floodplain Storage Area Location

3.4.1 Structures – Channel

There are three hydraulic structures within the modelled reach of Aberderfyn. The locations of these structures are shown in **Figure 1** with photographs of each structure and the ISIS unit type provided in **Figure 9**. Culvert 1 is a short 750 mm diameter culvert located towards to north-west of the site to allow for a footpath crossing. Another relatively short culvert is located towards the south-west of the site which has a diameter of 650 mm and allows for a track crossing. At the south-west corner of the site, the watercourse enters a longer culvert which runs south underneath New Hall Road before re-entering an open channel via a 350 mm outfall and flows east towards the A483.



Culvert 1 Inlet (0870C)
Culvert Inlet + Circular Conduit



Culvert 1 Outlet (0862C)
Circular Conduit + Culvert Outlet



Culvert 2 Inlet (0467C) – inaccessible
Culvert Inlet + Circular Conduit



Culvert 2 Outlet (0436C)
Circular Conduit + Culvert Outlet



Culvert 3 Inlet (0340_C)
Culvert Inlet + Circular Conduit



Culvert 3 Outlet (0238_C)
Circular Conduit + Culvert Outlet

Figure 9: Photographs of Channel Structures within Study Area

3.5 MODEL COEFFICIENTS

3.5.1 Mannings n

The Mannings n values represent the 'roughness', or resistance to water flow due to friction, in both the river channel and the floodplain. Mapping data, aerial photography and several site visits were used to define the channel and land use types, which were then assigned Mannings n values.

The Mannings n values used in the model are shown in **Table 2**.

Table 2: Mannings n Values

Land Use		Mannings n Value
Channel	Clean, straight channel with stones and weeds	0.035
	Clean windy channel with shoals and pools	0.040
Structures	Brick with Cement Mortar	0.015
	Corrugated Steel	0.021
	Float Finished Concrete	0.013 – 0.017
	Slimed Concrete	0.030
	Silted-up, Concrete	0.015 – 0.030
Floodplain	Long Grass	0.040
	Dense Trees and Shrubs	0.080
	Shrubs	0.050
	Gardens in built up areas	0.1
	Roads	0.025
	Footpaths/Paved Areas	0.025
	Car Parks/Work Yards	0.025
	Water Bodies	0.015
	Buildings	0.500
	Railway	0.060

3.6 BOUNDARY CONDITIONS

3.6.1 Input Boundaries

The input flow hydrographs are those outlined within **Section 2**. These have been input into the upstream extent of the 1D model at node 'Ab_1008' (see **Figure 6**).

3.6.2 Downstream Boundaries

At the downstream extent of the 1D model a 'Normal/Critical Depth Boundary' (NCDBDY) is applied to node Ab_0000.

3.7 MODEL VERSION AND SIMULATION INFORMATION

The model was developed using version 3.7 Professional of ISIS.

Simulations for all design events were run with a 2 second timestep. Information on timesteps and other variables can be seen in the '*.ief' files for each run, and is recorded in the modelling logbook spreadsheet ('2585 Modelling Logbook.xls') accompanying this report (**Appendix B**).

4 MODEL RUNS AND RESULTS - BASELINE

4.1 MODEL RUNS

Table 3 details the model runs that have been undertaken in order to assess the flood risk at the existing site under the baseline scenario. Full details are provided in the '2585 Modelling Logbook.xls' included within **Appendix B** of this report.

Table 3: Description of Model Runs - Baseline

Run Name	Flood Event (AEP)
2585_014_Baseline_1% Rev A	1%
2585_014_Baseline_1%CC Rev A	1% climate change
2585_014_Baseline_0.1% Rev A	0.1%

4.2 MODEL RESULTS

The results of the baseline modelling study are summarised in **Table 4** and displayed in **Appendix C**.

Table 4: Aberderfyn Modelled Baseline Flood Levels

Node	Modelled Water Levels (m AOD)		
	1% AEP	1% +CC AEP	0.1% AEP
Ab_1008	105.28	105.29	105.34
Ab_0903	104.80	104.81	104.86
Ab_0870	104.81	104.83	104.86
Ab_0862	104.37	104.40	104.44
Ab_0838	104.22	104.24	104.28
Ab_0754	103.92	103.95	104.02
Reservoir Unit	104.12	104.15	104.22
Ab_0747	103.62	103.64	103.69
Ab_0726	103.51	103.54	103.59
Ab_0663	103.29	103.32	103.40
Ab_0629	103.27	103.30	103.37
Ab_0594	103.26	103.29	103.35
Ab_0541	103.26	103.29	103.35
Ab_0480	103.25	103.28	103.34
Ab_0467_d	103.25	103.28	103.34
Ab_0436	102.35	102.45	102.68
Ab_0340	101.11	101.13	101.17
Ab_0238	99.96	100.01	100.15
Ab_0202	98.98	99.01	99.07
Ab_0137	98.54	98.56	98.62
Ab_0104	98.24	98.26	98.34
Ab_0000	97.06	97.15	97.35

5 MODEL SENSITIVITY

5.1 MANNING'S N

Sensitivity testing has been carried out for the 1% AEP climate change and the 0.1% AEP flood event on the Manning's n coefficients by varying them by +/- 20%.

A summary of the results is available in **Appendix D**. These results indicate that for the 1% AEP climate change flood event the model is not sensitive to either a 20% increase or decrease in the Manning's n coefficient with maximum stage increasing by 0.02 m or decreasing by 0.03 m on average respectively.

For the 0.1% AEP flood event the model is also not shown to be sensitive to either a 20% increase or decrease in the Manning's n coefficient with maximum stage at the site increasing or decreasing by 0.03 m on average.

The Manning's n coefficients within the baseline model are therefore deemed to be reasonable in terms of determining flood risk.

5.2 STRUCTURE BLOCKAGE

Sensitivity testing has been carried out on the model to investigate the impact of a partial structure blockage of Culvert 3 (see **Figure 1**) for the 1% AEP plus climate change flood event.

The diameter of Culvert 3 has been reduced from 350 mm to 123 mm in order to decrease the pipe's cross-sectional area by 50%. A comparison of the long-section profiles for the Culvert 3 blockage scenario with the baseline scenario is presented in **Figure 10**. The results indicate that negligible changes would be expected in terms of maximum stage upstream, adjacent to and downstream of the structure.

Culverts 1 and 2 are relatively short culverts which currently accommodate footpaths over the watercourse and water would be expected to spill over and back into the channel. Blockage of these culverts is therefore not considered to pose a risk of flooding to the site and as such has not been assessed further.

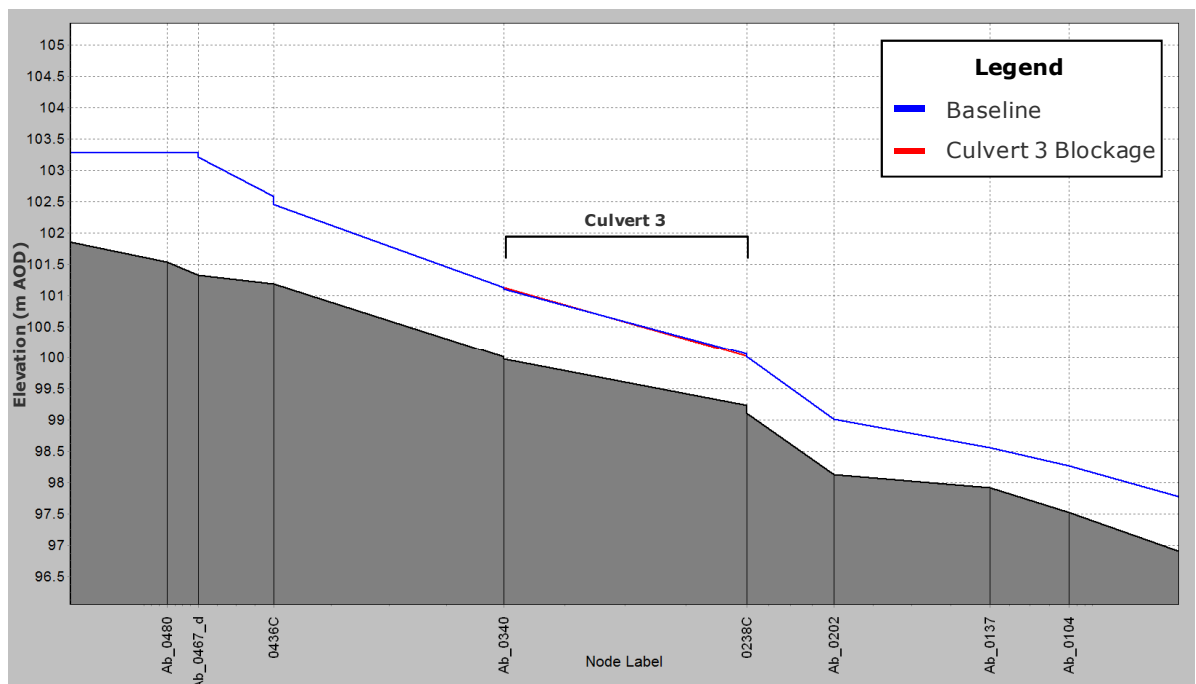


Figure 10: Partial Long Profile Plot (Culvert 3 Blockage Scenario)

6 PROPOSED SCENARIO

In light of NRW's comments as stated in **Section 1**, further consideration has been given to:

- Potential land raising of the commercial and residential areas and how this may impact flood extents
- The main access road to the site (which is to remain flood free at all times) should ensure continuity of the floodplain and impact of raising the road should be explored
- The location of the balancing pond which should be located outside of the 1% AEP flood extent

In light of NRW's comments, this section explores the impacts of the redeveloped scenario including the proposed access route and the impact of land raising on flood risk elsewhere. In addition, the location of the surface water balancing pond has been assessed.

6.1 DEVELOPMENT PROPOSALS

An indicative masterplan for the site is shown in **Appendix E**.

6.1.1 Development Platform

The indicative masterplan shows that the residential development platform will be located between 85 and 190 m to the north-east of the Aberderfyn. The intervening land will comprise areas of open space and several ponds. The commercial development platform will be located within close proximity to the south-west of the Aberderfyn adjacent to the access road.

6.1.2 Access

The proposed access road will be provided via Bangor Road approximately mid-way along the south-western boundary of the site. Thereafter the access road will cross the Aberderfyn towards the residential development platform. As stated within Section 5.2.13 of the JPB FCA, the access road to the site will be raised to ensure it remains flood free at all times.

As detailed previously, NRW has stated that the continuity of the floodplain should be ensured. Generally, NRW will seek for flows to be unimpeded during the 1% climate change AEP flood event. Given the baseline modelled output for this event (**Appendix C**) this would require a bridge with a span width of approximately 75 m, which would be unfeasible given the scale of the watercourse and proposed development. As such, water will be allowed to back up behind the access road; however, any increased flood levels will be contained within the landscaped area of the site so as not to increase flood risk elsewhere. This is discussed further in **Section 6.5.2**.

6.2 HYDRAULIC MODELLING

The baseline 1D ISIS model has been updated to account for the proposed scenario following redevelopment of the site.

In accordance with the development proposals, the culvert between nodes Culvert 2 has been removed. In addition, a new box culvert (rectangular conduit) has been appropriately incorporated into the model in the vicinity where the proposed access road may cross the watercourse (see **Figure 11**). In order to achieve this, a dummy node (Ab_0606_d) was created by duplicating node Ab_0629 and adjusting the levels within the cross-section appropriately according to the slope of the channel within the model. The proposed access crossing has been modelled without a spill unit to prevent water overtopping given that the access road is to remain dry (**Section 6.1.2**).

The box culvert has been modelled with an invert level of 102.37 m AOD which is the existing bed level of the channel. The height of the box culvert has been modelled at 1.8 m (i.e. soffit level of 104.17 m AOD) which was determined by allowing an appropriate freeboard above the maximum in-channel water level for the 1% climate change AEP flood event (see **Table 6**). The width of the box culvert has been modelled at 2.1 m which was determined by the size of the watercourse as this should stretch beyond the top of bank levels so as not to impede flows under normal conditions.



Figure 11: Amendments to Model (Proposed Scenario)

6.3 MODEL RESULTS

Table 5 details the model runs that have been undertaken in order to assess the flood risk at the site under the proposed scenario. Full details are provided in the '2585 Modelling Logbook.xls' included within **Appendix F** of this report.

Table 5: Description of Model Runs - Proposed

Run Name	Flood Event (AEP)
2585_003_Proposed_1% Rev A	1%
2585_003_Proposed_1%CC Rev A	1% climate change
2585_003_Proposed_0.1% Rev A	0.1%

The results of the modelling study are summarised in **Table 6** and displayed in **Appendix G**.

Table 6: Aberderfyn Modelled Baseline and Proposed Flood Levels

Node	Modelled Water Levels (m AOD)					
	1% AEP		1% +CC AEP		0.1% AEP	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Ab_1008	105.28	105.28	105.29	105.29	105.34	105.34
Ab_0903	104.80	104.80	104.81	104.82	104.86	104.86
Ab_0870	104.81	104.81	104.83	104.83	104.86	104.86
Ab_0862	104.37	104.37	104.40	104.40	104.44	104.44
Ab_0838	104.22	104.22	104.24	104.24	104.28	104.28
Ab_0754	103.92	103.92	103.95	103.95	104.02	104.04
Reservoir Unit	104.12	104.12	104.15	104.15	104.22	104.22
Ab_0747	103.62	103.64	103.64	103.72	103.69	104.03
Ab_0726	103.51	103.62	103.54	103.72	103.59	104.03
Ab_0663	103.29	103.59	103.32	103.71	103.40	104.03
Ab_0629	103.27	103.59	103.30	103.70	103.37	104.03
Ab_0606_d	n/a	103.58	n/a	103.70	n/a	104.03
Ab_0594	103.26	102.94	103.29	102.96	103.35	103.05
Ab_0541	103.26	102.79	103.29	102.84	103.35	102.99
Ab_0480	103.25	102.71	103.28	102.78	103.34	102.96
Ab_0467_d	103.25	102.70	103.28	102.77	103.34	102.96
Ab_0436	102.35	102.30	102.45	102.36	102.68	102.51
Ab_0340	101.11	101.11	101.13	101.11	101.17	101.14
Ab_0238	99.96	99.92	100.01	99.96	100.15	100.05
Ab_0202	98.98	98.96	99.01	98.98	99.07	99.02
Ab_0137	98.54	98.53	98.56	98.54	98.62	98.57
Ab_0104	98.24	98.23	98.26	98.24	98.34	98.28
Ab_0000	97.06	97.01	97.15	97.06	97.35	97.19

6.4 FLOOD RISK MITIGATION

6.4.1 Access Road

In order to ensure that the access road will remain dry it is recommended that the road level should be set 104.03 m AOD (i.e. the maximum in-channel flood level at node Ab_0629 during the 0.1% AEP fluvial flood event. This will afford a 603 mm freeboard above maximum water level expected at node Ab_0629 during the 1% climate change AEP fluvial flood event.

Given that a soffit level of 104.17 m AOD has been suggested for the box culvert within the proposed access road, levels along the road within the vicinity of the Aberderfyn should be raised accordingly.

6.4.2 Development Platforms

In accordance with A1.14 of TAN15, the development should remain dry during the 1% AEP flood event. **Appendix G** indicates that both the residential and commercial development platforms will remain dry during all modelled events up to a 0.1% AEP.

In order to ensure that the development platforms will remain dry it is recommended that the development platforms are raised to the 0.1% AEP fluvial flood level from the adjacent modelled node. Finished floor levels of the buildings should be set at a minimum of 150 mm above adjacent ground levels which will provide a significant freeboard above the in-channel water level expected during a 1% climate change AEP fluvial flood event.

This will also enable any potential overland flows to be conveyed safely across the site without affecting property in accordance with the approach promoted within DEFRA's Making Space for Water document.

6.4.3 Surface Water Drainage

As shown in **Appendix G**, the balancing pond will be located at the extremity of the 1% AEP flood extent. As such, it is recommended that the balancing pond should be slightly relocated to the north-east of its existing location in order to satisfy NRW's concerns with respect to this.

6.5 FLOOD RISK ELSEWHERE

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

Developers must ensure there will be no loss of flood storage capacity for floods up to the 1% AEP event as a result of their development through the provision of compensatory flood storage. Whilst not specified within Technical Advice Note 15 (TAN15), NRW generally recommend that this should be the case over the lifetime of development (i.e. should take into account climate change).

6.5.1 Development Platforms

The modelled outputs in **Appendix G** indicate that the proposed development platforms will be located outside the extreme 0.1% AEP flood extent of the Aberderfyn. As such, raising the development platforms should not impact on the flood storage capacity of the watercourse which should satisfy NRW's concerns with respect to this.

6.5.2 Access Road

Table 6 indicates that flood levels would be expected to increase by 0.08 to 0.40 m between nodes Ab_0747 and Ab_0606_d respectively (i.e. upstream of the proposed access road) during the 1% AEP climate change event. This is caused by water backing up behind the new box culvert. Consequently flood levels are shown to decrease downstream of the structure by between 0.09 to 0.51 m. Flood levels off-site upstream of node Ab_0747 are shown to remain the same as within the baseline scenario.

A flood risk comparison plot has been produced to show changes in flood levels within the floodplain compared to the baseline scenario for the 1% AEP climate change event as a result of the proposed access (**Appendix H**). This indicates that there should be no increased flood risk off-site following development given that all increased flood depths are shown to be located within the site boundary. Moreover, betterment would be expected downstream of the site during the 1% climate change AEP event.

In light of the above, this should satisfy NRW's concerns with respect to the proposed access road.

7 SUMMARY

Weetwood was instructed by Gladmans Development Ltd to undertake a study to examine the potential flood risk from Aberderfyn in connection with the proposed redevelopment of a site located off Bangor Road, Johnstown, Wrexham. NRW had raised several concerns within their consultation response letter following review of a FCA undertaken by another consultancy.

A 1D ISIS model was produced to more accurately outline the baseline flood conditions within the vicinity of the site. The baseline 1D ISIS model was modified to account for the proposed scenario following redevelopment of the site which accounted for a new access road and the removal of a culvert within the site.

Modelled outputs indicate that all development platforms should be dry in up to the 0.1% AEP fluvial flood event. As such, raising the development platforms should not result in loss of floodplain storage which should address NRW's concerns with respect to this.

Comparison of the baseline and proposed modelled outputs for the 1% climate change AEP fluvial flood event indicate that water backing up behind the new access road would only increase flood levels within the site boundary. As such, there should be no increased flood risk elsewhere resulting from the development proposals which should address NRW's concerns with respect to this.

The proposed balancing pond was shown to be located at the extremity of the 1% AEP fluvial flood outline. It is recommended that the balancing pond is slightly relocated to the north-east of its existing location which should address NRW's concerns with respect to this.

APPENDIX A:

Topographic Survey & Channel Survey



REVISIONS

- A) SURVEY WORK INFORMATION TO DITCHES
- B) BROAD SECTION SURVEYED OCT 2012 AS REQUESTED
- C) CLIGHT OPENINGS ADDED TO SURVEY NOVEMBER 2012
- D) ADDITIONAL SURVEY WORK CARRIED OUT

LEGEND

AV	AIR VALVE	MP	SERVICE MARKER POST
BL	BOLLARD	MP	MONITOR POINT
BL	BED LEVEL	NP	NAME PLATE
BS	BUS STOP	PS	POST
BT	BT INSPECTION COVER	PYL	ELECTRICITY PYLON
CL	COVER LEVEL	RE	ROOFTOP EYE
CP	CATCH PIT	RL	RAILWAY LINE
EP	ELECTRICITY POLE	RH	ROAD SIGN
EB	ELECTRIC CONTROL BOX	RH	ROOF HEIGHT
FL	FLOOR LEVEL	ST	STOP TAP
FH	FIRE HYDRANT	SFL	SOFFIT LEVEL
GH	GREENHOUSE	SP	SKIN POST
GP	GATE POST	SV	STOP VALVE
GV	GAS VALVE	TS	TOP OF PIPE/CULVERT
IC	INSPECTION CHAMBER	TS	TRAFFIC SIGNAL
IL	INVERT LEVEL	TP	TELEGRAPH POLE
LP	LAMP POST	WL	WATER LEVEL
MH	MANHOLE	WM	WATER METER
SURVEY STATION			



CL F	CHAIN LINK FENCE	TS	TOP OF PIPE/CULVERT
CPK F	CONCRETE POST/TIMBER PANEL FENCE	TS	TRAFFIC SIGNAL
CPK T P	CONCRETE POST/TIMBER PANEL FENCE	TP	TELEGRAPH POLE
FW F	FIRE WALL	WL	WATER LEVEL
SEC F	SECURITY FENCE	WM	WATER METER
T F	TIMBER FENCE		
BN F	BARE WIRE FENCE		
RS F	RANCH STYLE FENCE		
K F	KNEE RAIL FENCE		
B WALL	BROCK WALL		
C WALL	CONCRETE WALL		
R WALL	RETAINING WALL		
S WALL	STONE WALL		

NOTES:
POLY MARKERS NOT SERVICES VISIBLE AT
THE OF SURVEY SHOWN
DRAWING INFORMATION MUST BE CHECKED AND
VERIFIED WITH LOCAL AUTHORITY RECORDS
PRIOR TO WORK COMMENCEMENT
TREE SPREADS ARE SHOWN ONLY AND ARE REPRESENTATIVE OF THE
AVERAGE SPREAD, THE SHIP LINE INDICATES THE TREES EXTENT

BENCH MARK INFORMATION

project
BANGOR ROAD, WREXHAM
SHEET 3 OF 3
title
TOPOGRAPHICAL LAND SURVEY
scale
1:500
date
MAR 2012
drawn
PSH
drawing number
S12-136-3
revision
G

JLP Surveys Limited
SUITE 25, RODNEY HOUSE
KING STREET,
WIGAN WN1 1BT
Contact Peter Houston
Tel (01942 843113)
Fax (01942 492230)
Mobile (07710 428498)
Email jlp@jlp-surveys.co.uk



SURVEY ORIENTATED TO REAL TIME GPS

REVISIONS
A) SURVEY WORK SUPPLEMENTED TO 27/07/15
B) BRUSH CUTTING SURVIVAL SET 2012 AS REQUESTED
C) CLUMPY OPENING ADDED TO SURVEY NOVEMBER 2012
D) SECTIONS SURVEYED MARCH 2014
E) ADDITIONAL SURVEY WORK COMPLETED OUT

LEGEND

AV	AIR VALVE	MK	SERVICE MARKER POST
BL	BOLLARD	MP	MONITOR POINT
RL	RED LEVEL	NP	NAME PLATE
BS	BUS STOP	PS	POST
BT	BT INSPECTION COVER	PYL	ELECTRICITY PYLON
CL	COVER LEVEL	RE	REDDING EYE
CP	CATCH PIT	RL	RAILWAY LINE
EP	ELECTRICITY POLE	RH	ROAD SIGN
EB	ELECTRIC CONTROL BOX	RH	RODGE HEIGHT
FL	FLOOR LEVEL	ST	STOP TAP
FH	FIRE HYDRANT	SFL	SOFFIT LEVEL
G	GULLY	SP	SKIN POST
GH	GREENHOUSE	SV	STOP VALVE
GP	GATE POST	TOP	TOP OF PIPE/CULVERT
GV	GAS VALVE	TS	TRAFFIC SIGNALS
IC	INSPECTION CHAMBER	TP	TELEGRAPH POLE
IL	INVERT LEVEL	WL	WATER LEVEL
LP	LAMP POST	WM	WATER METER
MH	MANHOLE		
SURVEY STATION		TREE	
CL F	CHAIN LINK FENCE		
CPH F	CONCRETE POST/TIMBER FENCE		
CPH T P	CONCRETE POST/TIMBER PANEL FENCE		
FW F	POST & WIRE FENCE		
SEC F	PALLISADE/SECURITY FENCE		
T F	TIMBER FENCE		
BN F	BARE WIRE FENCE		
RS F	RANCH STYLE FENCE		
K F	KNEE RAIL FENCE		
B WALL	BRICK WALL		
C WALL	CONCRETE WALL		
R WALL	RETAINING WALL		
S WALL	STONE WALL		

NOTES:
ONLY MANHOLES AND DEPRESSIONS VISIBLE AT THE TIME OF SURVEY SHOWN.
DRAINAGE INFORMATION MUST BE OBTAINED AND VERIFIED WITH LOCAL AUTHORITY RECORDS PRIOR TO WORK COMMENCING.
TREE SPREADS ARE SHOWN ONLY AND ARE REPRESENTATIVE OF THE AVERAGE SPREAD. THE SHIP LINE LAYER QUOTES THE TREES EXTREMITY

BENCH MARK INFORMATION
All bench marks are shown in the DATUM GENERATED BY VIRS GPS

project
BANGER ROAD, WREXHAM
SHEET 2 OF 3

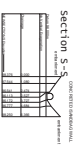
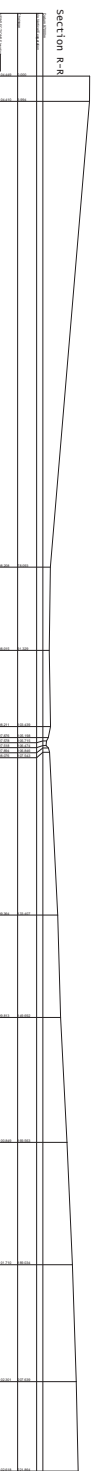
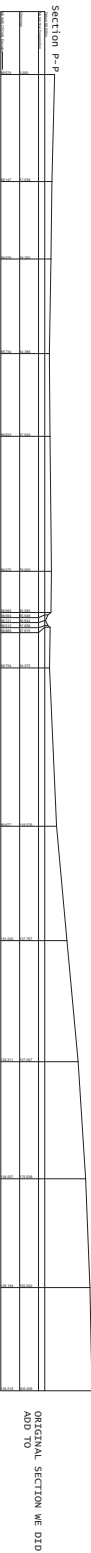
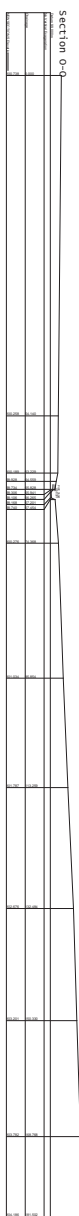
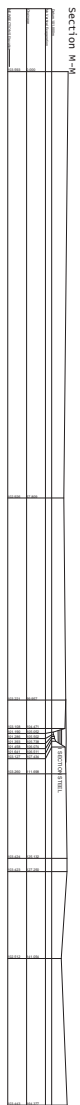
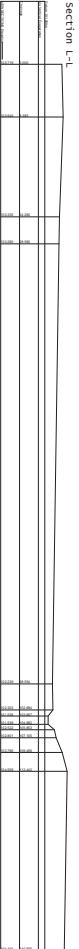
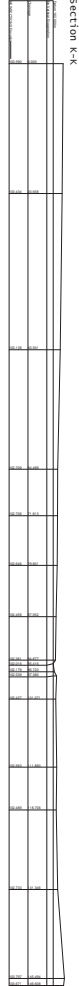
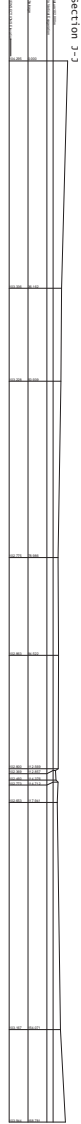
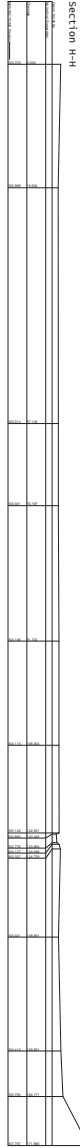
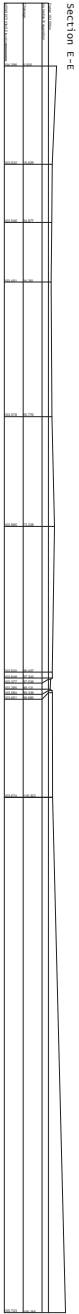
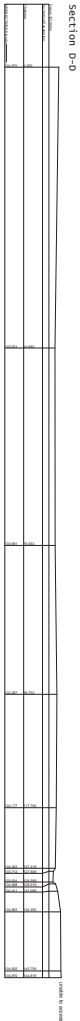
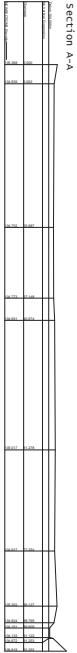
title
TOPOGRAPHICAL LAND SURVEY

scale	date	drawn	drawing number	revision
1:500	MAR 2012	PSH	S12-136-2	G

JLP Surveys Limited

SUITE 25, RODNEY HOUSE
KING STREET,
WIGAN WN1 1BT

Contact Peter Houston
Tel (01942 243313)
Fax (01942 492230)
Mobile (07710 425498)
Email jlp@jlp-surveys.co.uk



APPENDIX B:

Digital Model Files (Baseline)

APPENDIX C:

Aberderfyn 1D Model Results Plots - Baseline

Notes:

1. Do not scale from this drawing.

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

3. Flood extents derived through application of ISIS Mapper

KEY:

— Site Location

Depth (metres)

0.0 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.6

0.6 to 0.7

0.7 to 0.8

0.8 to 0.9

0.9 to 1.0

> 1.0

Weetwood

Development • Planning • Environment

Suite 1 Park House
Broncoed Business Park
Wrexham Road
Mold
CH7 1HP

T: 01352 700045
E: info@weetwood.net
W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

1% Fluvial Flood Outline
Baseline Scenario

Map Orientation:

Scale: 0 25 50 metres

N

E

S

W

Drawn:

AE

Checked:

CC

Date:

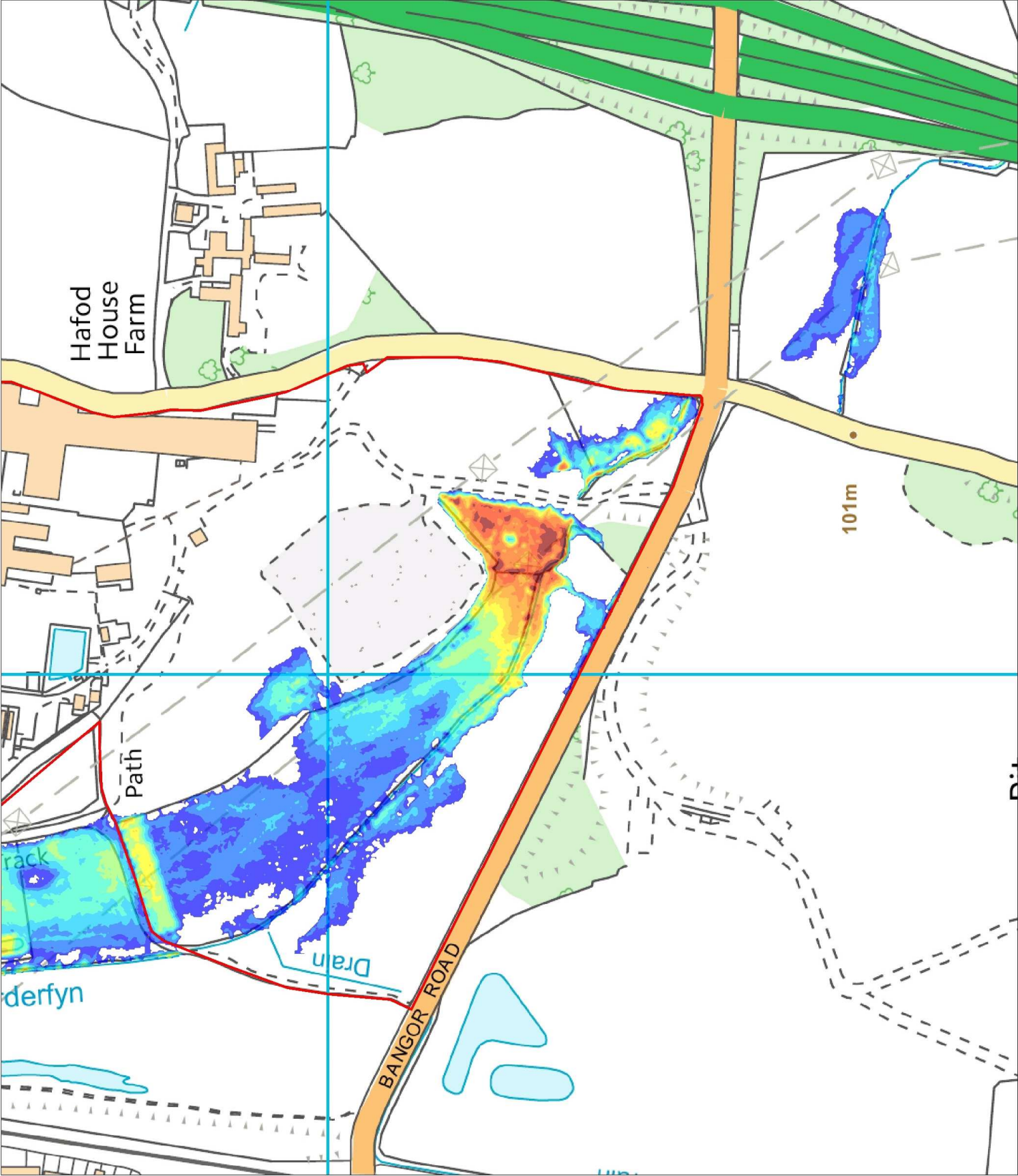
12 June 2014

Drawing No:

2585_014_Baseline_1%

Rev:

A



Notes:

1. Do not scale from this drawing.

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

3. Flood extents derived through application of ISIS Mapper

KEY:

— Site Location

Depth (metres)

0.0 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.6

0.6 to 0.7

0.7 to 0.8

0.8 to 0.9

0.9 to 1.0

> 1.0

Weetwood

Development • Planning • Environment

Suite 1 Park House
Broncoed Business Park
Wrexham Road
Mold
CH7 1HP

T: 01352 700045
E: info@weetwood.net
W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

1% CC Fluvial Flood Outline
Baseline Scenario

Map Orientation:

Scale: 0 25 50 metres

Drawn:

AE

Checked:

CC

Date:

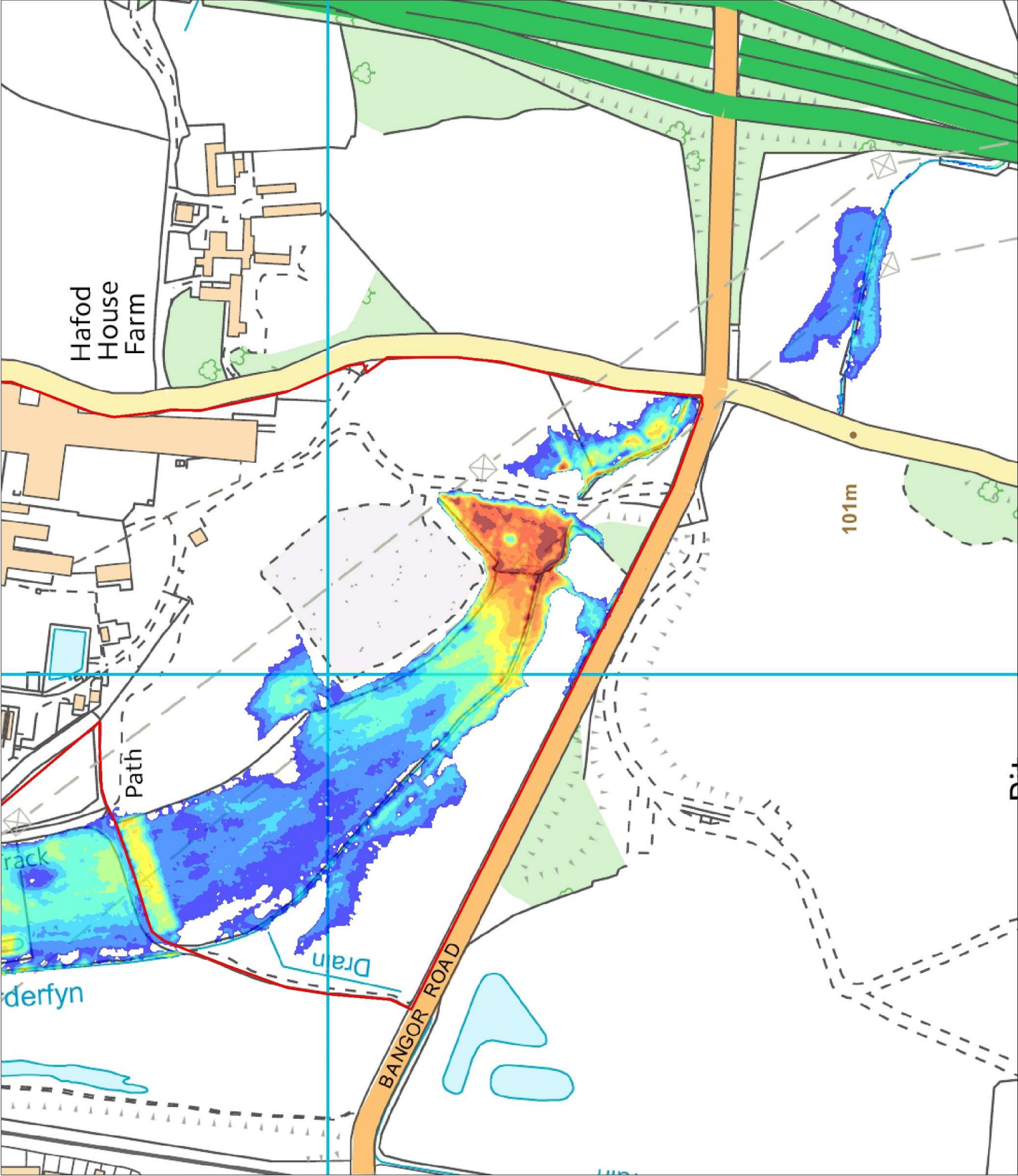
12 June 2014

Drawing No:

2585_014_Baseline_1%CC

Rev:

A



Notes:

1. Do not scale from this drawing.

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

3. Flood extents derived through application of ISIS Mapper

KEY:

Site Location

Depth (metres)

0.0 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.6

0.6 to 0.7

0.7 to 0.8

0.8 to 0.9

0.9 to 1.0

> 1.0

Weetwood

Development • Planning • Environment

Suite 1 Park House
Broncoed Business Park
Wrexham Road
Mold
CH7 1HP

T: 01352 700045
E: info@weetwood.net
W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

0.1% Fluvial Flood Outline
Baseline Scenario

Map Orientation:

Scale:

0 25 50 metres

Drawn:

AE

Checked:

CC

Date:

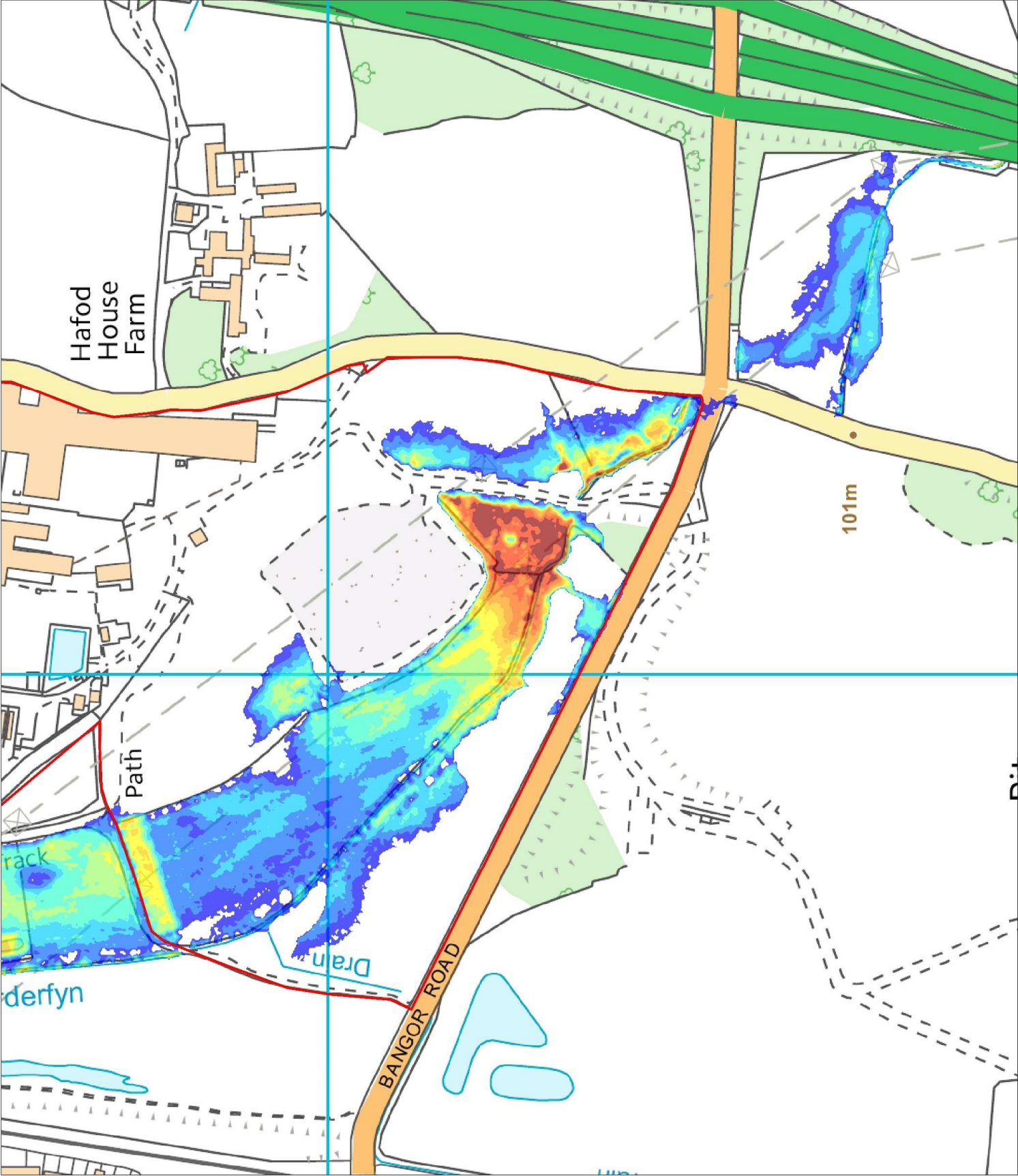
12 June 2014

Drawing No:

2585_014_Baseline_0.1%

Rev:

A



APPENDIX D:

Model Sensitivity Results (Baseline)

Model Sensitivity; Mannings n (1% AEP climate change event)					
Model Node	Maximum Stage (m AOD)				
	Baseline	20% Decrease Mannings n		20% Increase Mannings n	
Ab_1008	105.29	105.21	-0.08	105.36	0.07
Ab_0903	104.81	104.83	0.02	104.80	-0.01
Ab_0870	104.83	104.87	0.04	104.77	-0.06
Ab_0862	104.40	104.40	0	104.37	-0.03
Ab_0838	104.24	104.21	-0.03	104.27	0.03
Ab_0754	103.95	103.95	0	103.94	-0.01
Reservoir Unit	104.15	104.13	-0.02	104.17	0.02
Ab_0747	103.64	103.62	-0.02	103.66	0.02
Ab_0726	103.54	103.51	-0.03	103.56	0.02
Ab_0663	103.32	103.31	-0.01	103.34	0.02
Ab_0629	103.30	103.29	-0.01	103.31	0.01
Ab_0594	103.29	103.28	-0.01	103.29	0
Ab_0541	103.29	103.28	-0.01	103.28	-0.01
Ab_0480	103.28	103.28	0	103.28	0
Ab_0467_d	103.28	103.28	0	103.28	0
Ab_0463	102.45	102.34	-0.11	102.55	0.1
Ab_0340	101.13	101.13	0	101.13	0
Ab_0238	100.01	99.94	-0.07	100.07	0.06
Ab_0202	99.01	98.97	-0.04	99.06	0.05
Ab_0137	98.56	98.54	-0.02	98.57	0.01
Ab_0104	98.26	98.23	-0.03	98.33	0.07
Ab_0000	97.15	97.05	-0.1	97.23	0.08

Model Sensitivity; Mannings n (0.1% AEP event)					
Model Node	Maximum Stage (m AOD)				
	Baseline	20% Decrease Mannings n		20% Increase Mannings n	
Ab_1008	105.34	105.22	-0.12	105.40	0.06
Ab_0903	104.86	104.89	0.03	104.84	-0.02
Ab_0870	104.86	104.89	0.03	104.81	-0.05
Ab_0862	104.44	104.42	-0.02	104.42	-0.02
Ab_0838	104.28	104.25	-0.03	104.32	0.04
Ab_0754	104.02	104.02	0	104.02	0
Reservoir Unit	104.22	104.21	-0.01	104.25	0.03
Ab_0747	103.69	103.66	-0.03	103.72	0.03
Ab_0726	103.59	103.56	-0.03	103.61	0.02
Ab_0663	103.4	103.38	-0.02	103.42	0.02
Ab_0629	103.37	103.36	-0.01	103.38	0.01
Ab_0594	103.35	103.35	0	103.36	0.01
Ab_0541	103.35	103.34	-0.01	103.35	0
Ab_0480	103.34	103.34	0	103.34	0
Ab_0467_d	103.34	103.34	0	103.34	0
Ab_0463	102.68	102.55	-0.13	102.80	0.12
Ab_0340	101.17	101.17	0	101.17	0
Ab_0238	100.15	100.07	-0.08	100.21	0.06
Ab_0202	99.07	99.03	-0.04	99.13	0.06
Ab_0137	98.62	98.58	-0.04	98.65	0.03
Ab_0104	98.34	98.29	-0.05	98.46	0.12
Ab_0000	97.35	97.23	-0.12	97.45	0.1

APPENDIX E:

Development Proposals



Application Site (Area 17.34ha)



Proposed residential (7.0ha)
Up to 300 dwellings



Proposed Employment (0.29ha)



Local Store (0.11ha)



Proposed Vehicular Route



Proposed GCN Reserve (5.78ha)



Proposed Amenity Space (3.87ha)



Proposed Informal Play



Indicative location of equipped
children's play area



Proposed vehicular access



Indicative location of proposed
emergency access from Hafod
Road



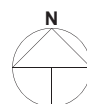
Power lines



Proposed Structure Planting



Proposed Attenuation Pond



J:\4355\LANDS\design\masterplan_d.indd

Gladman Developments Ltd
Dennis Ruabon, Hafod Tileries
Johnstown, Wrexham

Illustrative Masterplan

4355-P-05 F

masterplanning
environmental assessment
landscape design
urban design
ecology
architecture
interior design
NTS
May 2012
FPCOR Environment and Design Ltd
Lockington Hall
Lockington
Derby DE74 2BN
t: 01509 872772
e: mail@fpcor.co.uk
www.fpcor.co.uk

APPENDIX F:

Digital Model Files (Proposed)

APPENDIX G:

Aberderfyn 1D Model Results Plots - Proposed

Notes:

1. Do not scale from this drawing.

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

3. Flood extents have been derived through application of ISIS Mapper.

KEY:

Site Location

Depth (metres)

0.0 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.6

0.6 to 0.7

0.7 to 0.8

0.8 to 0.9

0.9 to 1.0

> 1.0

Weetwood

Development • Planning • Environment

Suite 1 Park House

Broncoed Business Park

Wrexham Road

Mold

CH7 1HP

T: 01352 700045

E: info@weetwood.net

W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

1% Fluvial Flood Outline
Proposed Scenario

Map Orientation:

Scale:

0 25 50 metres

Drawn:

AE

Checked:

CC

Date:

12 June 2014

Drawing No:

2585_003_Proposed_1%

Rev:

A

This figure is a map titled "1% Fluvial Flood Outline Proposed Scenario". It shows the proposed flood extents for a 1% fluvial flood event. The map includes the following elements:

- Map Orientation:** A compass rose indicating North (N), South (S), East (E), and West (W).
- Scale:** A scale bar showing 0, 25, and 50 metres.
- Drawn:** AE
- Checked:** CC
- Date:** 12 June 2014
- Drawing No:** 2585_003_Proposed_1%
- Rev:** A

The map shows the flood extents around Hafod House Farm and Bangor Road. The flood extents are color-coded according to the depth (metres) of the flood, as indicated in the KEY:

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- 0.5 to 0.6
- 0.6 to 0.7
- 0.7 to 0.8
- 0.8 to 0.9
- 0.9 to 1.0
- > 1.0

The map shows the flood extents around Hafod House Farm and Bangor Road. The flood extents are color-coded according to the depth (metres) of the flood, as indicated in the KEY:

Notes:

1. Do not scale from this drawing.

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

3. Flood extents have been derived through application of ISIS Mapper.

KEY:

Site Location

Depth (metres)

0.0 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.6

0.6 to 0.7

0.7 to 0.8

0.8 to 0.9

0.9 to 1.0

> 1.0

Weetwood

Development • Planning • Environment

Suite 1 Park House
Broncoed Business Park
Wrexham Road
Mold
CH7 1HP

T: 01352 700045
E: info@weetwood.net
W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

1% CC Fluvial Flood Outline
Proposed Scenario

Map Orientation:

Scale:

0 25 50 metres

Drawn:

AE

Checked:

CC

Date:

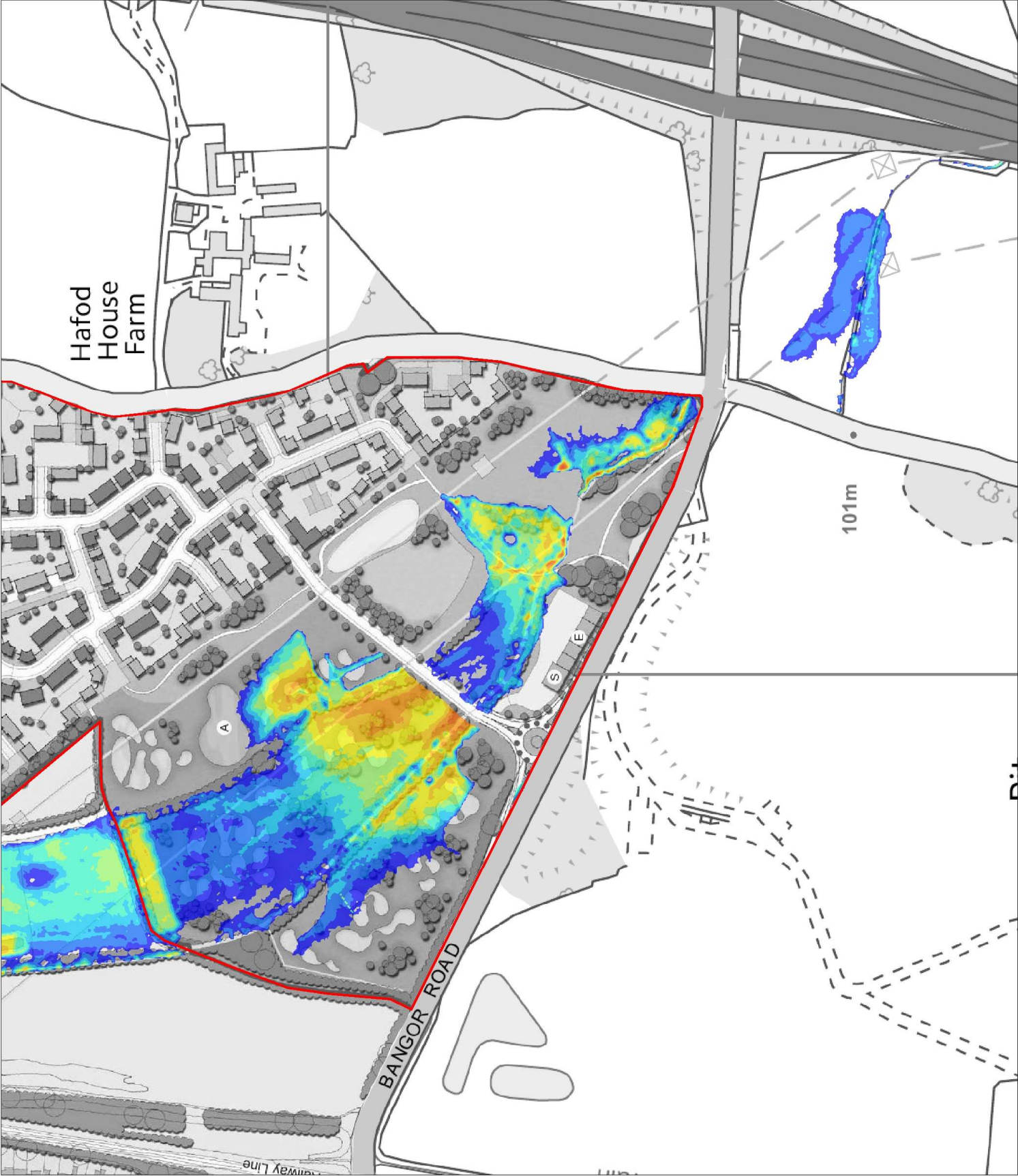
12 June 2014

Drawing No:

2585_003_Proposed_1%CC

Rev:

A



Notes:

1. Do not scale from this drawing.

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

3. Flood extents have been derived through application of ISIS Mapper.

KEY:

Site Location

Depth (metres)

0.0 to 0.1

0.1 to 0.2

0.2 to 0.3

0.3 to 0.4

0.4 to 0.5

0.5 to 0.6

0.6 to 0.7

0.7 to 0.8

0.8 to 0.9

0.9 to 1.0

> 1.0

Weetwood

Development • Planning • Environment

Suite 1 Park House

Broncoed Business Park

Wrexham Road

Mold

CH7 1HP

T: 01352 700045

E: info@weetwood.net

W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

0.1% Fluvial Flood Outline
Proposed Scenario

Map Orientation:

Scale:

0 25 50 metres

Drawn:

AE

Checked:

CC

Date:

12 June 2014

Drawing No:

2585_003_Proposed_0.1%

Rev:

A

This figure is a map titled "0.1% Fluvial Flood Outline Proposed Scenario". It displays the flood extent and depth contours for a proposed development area. The map includes the following elements:

- Flood Extent:** A red line outlines the boundary of the proposed development area.
- Flood Depth Contours:** The flood area is color-coded to represent depth in metres, ranging from 0.0 to 1.0+ metres. The colors transition from blue (0.0 to 0.1m) to yellow (0.4 to 0.5m) and then to red (0.9 to 1.0m and > 1.0m).
- Geographic Context:** The map shows the development area situated between "Hafod House Farm" to the north and "BANGOR ROAD" to the south. A "101m" contour line is also visible.
- Infrastructure:** A "Footway Line" is indicated at the bottom left, and a "S E" marker is present near the center of the development area.
- Map Orientation and Scale:** A north arrow and a scale bar (0 to 50 metres) are located in the top right corner.

APPENDIX H:

Comparison of Flood Risk

Notes:

1. Do not scale from this drawing.

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

3. Tolerance Levels of +/- 10 mm have been utilised to determine 'no change' in flood depth

KEY:

Decreased Flood Depth

'No Change'

Increased Flood Depth

Development

Planning

Environment

Weetwood

Suite 1 Park House

Broncoed Business Park

Wrexham Road

Mold

CH7 1HP

T: 01352 700045

E: info@weetwood.net

W: www.weetwood.net

Client:

Gladman Developments Ltd

Project Title:

Land off Bangor Rd,
Johnstown, Wrexham

Drawing Title:

Comparison of Flood Risk 1% CC -
Proposed minus baseline

Map Orientation:

Scale:

0 25 50 metres

Drawn:

AE

Checked:

CC

Date:

12 June 2014

Drawing No:

2585_Prop_minus_Baseline_1%CC

Rev:

A

The figure is a flood risk map comparing a proposed development's flood risk against a baseline. The map uses three colors to indicate changes in flood depth: green for 'Decreased Flood Depth', grey for 'No Change', and red for 'Increased Flood Depth'. A large red area is visible in the lower-left quadrant, indicating a significant increase in flood risk. Green areas are scattered throughout, particularly along the top and right edges, indicating a decrease in flood risk. The map also shows existing features like Hafod House Farm, Bangor Road, and a 101m elevation marker. A blue line labeled 'Drain' runs through the lower-left area. The map is overlaid with a grid of blue lines.