PROPOSED RESIDENTIAL DEVELOPMENT ON LAND OFF MILL LANE, GRAMPOUND, CORNWALL

FLOOD RISK ASSESSMENT

J-1802-Rev.01

Engineering & Development Solutions

www.eadsolutions.co.uk

PROPOSED RESIDENTIAL DEVELOPMENT ON LAND OFF MILL LANE, GRAMPOUND, CORNWALL

FLOOD RISK ASSESSMENT

Report No.	Issue Detail	Originator	Date	Checked by	Date
J-1802	01	AW	03/03/2021	TPS	03/03/2021

For: Classic Builders (SW) Ltd.
Estover Close
Estover
Plymouth
PL6 7PL

Job No: J-1802
Date: March 2021
Edition: 01

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APPENDICES

1.0 INTRODUCTION

Classic Builders South West are proposing to construct a new residential dwelling on land off Mill Lane in Grampound, Cornwall. The site is located off Mill Lane, opposite the Doctor`s Surgery in Grampound as shown on the location plan and boundary plan provided as **Figures 1 & 2** below.

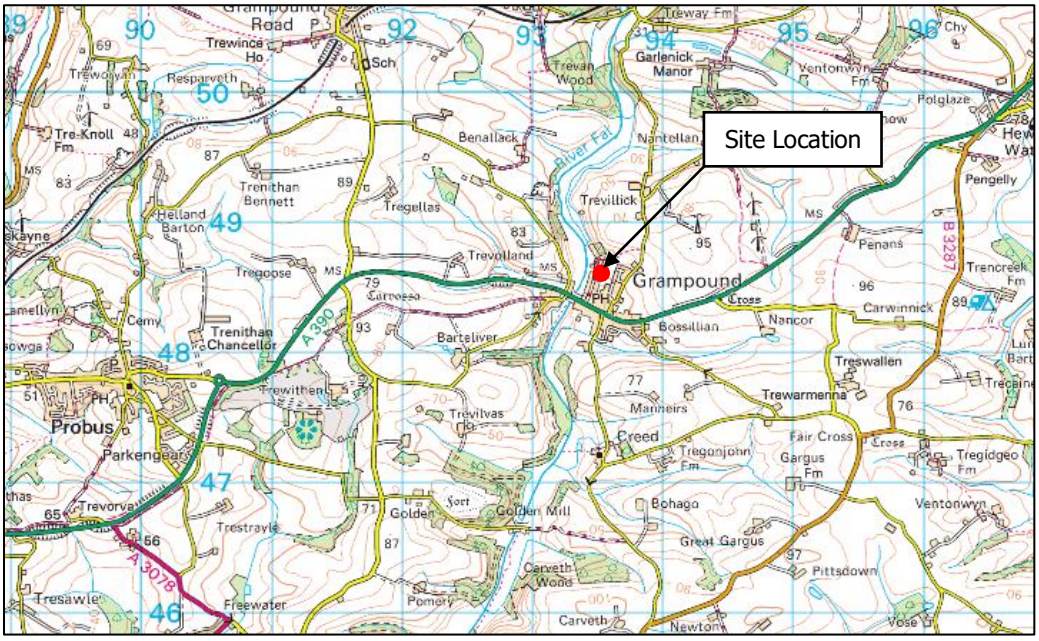

Figure 1 – Location Plan

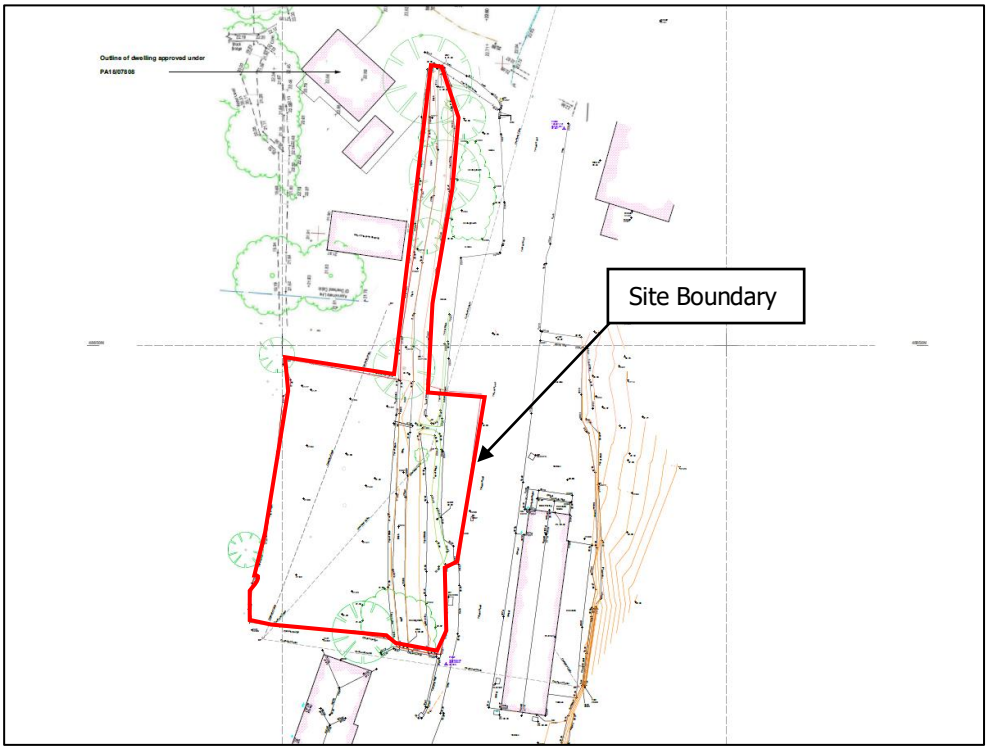

Figure 2 – Site Boundary

- **Site Description**

The site currently comprises a parcel of land located to the west of Mill Lane directly adjacent to the River Fal. The site boundary is inclusive of a ditch originating to the north of the main parcel of land as shown in **Figure 2**. The land is heavily vegetated with a number of trees located on the boundary. Access is from Mill Lane onto the site, although there is no formal vehicular entrance into the site. The approximate Ordnance Survey Grid Reference for the site is SW 93454 48631.

The site is bounded by the road to the east, vegetated areas to the north, the River Fal to the west and a residential property to the south.

A topographic survey of the site, included in **Appendix A**, indicates that the site slopes generally from the north east to south west towards the river. Levels also drop towards a local ditch located towards the east of the site. Existing levels within the site range from around 21.77m AOD in the north of the plot to 21.32m AOD in the south of the plot towards the riverbank. The ditch running through the site is located in the east of the plot running in a north to south direction with levels ranging from 22.22m AOD in the far north, off the main building plot area, to 20.99m AOD at the north of the building plot and 20.92m AOD in the south east of the plot. Mill Lane is located at a level of 22.50m AOD towards the north east of the site and 22.56m AOD towards the south east of the site boundary.

The River Fal is located to the west of the site flowing in a north to south direction with generally open agricultural land further west on the opposite riverbank.

In the wider context, the site is located off the A390 highway, approximately six miles west of St Austell and eight miles east of Truro. The site is located towards the north west extremity of the village of Grampound.

The general topography of the area is defined by the river valley flowing from the north to the south. A local highpoint is located approximately 800m to the east of the site which is at 96m AOD. The general area surrounding the site is rural in nature with some wooded areas located upstream form the site. The nearest coastline is located to the south approximately 7.7km away at East Portholland.

- **Existing Usage**

The area proposed for development comprises a vegetated area of land between Mill Lane and the River Fal. The site boundary also encompasses a local ditch which runs from the north into the site. A topographic survey is included in **Appendix A**.

- **Proposed Usage**

The proposal is to erect a new residential dwelling on the plot raised above the ground level on stilts with access from Mill Lane. Proposed plans are included in **Appendix A**.

- **Flood Risk Context**

Reference to the Environment Agency (EA) Flood Map for Planning indicates the site is located in Flood Zone 3 (**Figure 3**). This is associated with the River Fal located adjacent to the western boundary of the site. Inspection of the EA indicative Flood Map for Planning shows the flood outline to be poorly defined indicating the modelling used is likely to be JFLOW data. This is a coarse modelling tool used to inform regional studies and is not always suitable to assess flood risk on a site-by-site basis. As such, a numerical model to further assess the flood risk at the site is considered in this report.

The aims of the FRA are to investigate the potential flood extents and depths at the site and ensure that the development of the site can be carried out safely and without increasing flood risk to third parties off site.

To address this requirement, Engineering & Development Solutions (EDS) have been commissioned to prepare an FRA for the proposed development, in accordance with the best practice principles of the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG). This report details the findings of the study.

2.0 FLOOD MECHANISMS

- **Fluvial (River) Flooding**

Analysis of the EA Flood Map for Planning (**Figure 3**) indicates that the site is located within Flood Zone 3 associated with the River Fal.

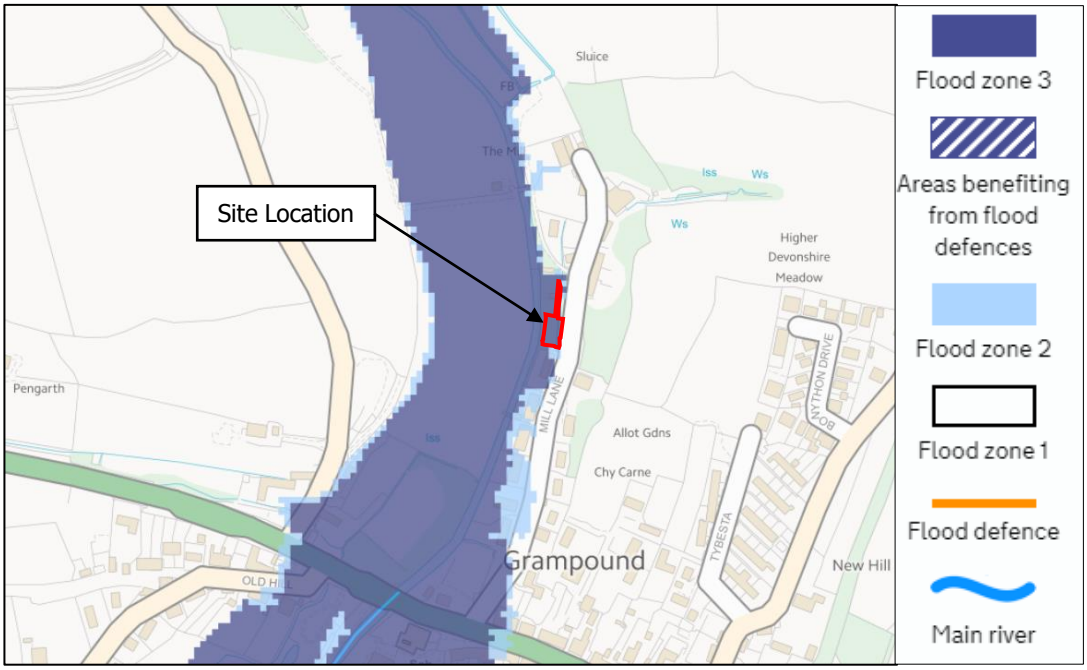

Figure 3 – Environment Agency Flood Map for Planning (Rivers and Sea) Extract

In consideration of the above, further understanding of the potential fluvial flood levels at the site at present and considering climate change has been sought though numerical modelling. As such, fluvial flooding is investigated in more detail in **Sections 3 & 4** of this report.

Several other possible flooding mechanisms have been considered at the site and are discussed below.

- **Groundwater Flooding**

Groundwater flooding is linked to the presence of aquifers and the ability of the underlying geological strata to bear water. Flooding occurs when water levels in the ground rise above surface elevations. It is considered that groundwater is not an issue on this site, furthermore the Cornwall Council Strategic Flood Risk Assessment (SFRA) highlights that the geology of Cornwall has only minor aquifers and generally does not experience much groundwater flooding. As such, groundwater flooding is not considered any further in this report.

- **Overland Sheet Flow**

The site is located on land which gently slopes in a south westerly direction towards the boundary of the site and towards the River Fal. A local ditch is located on the site in the east where local levels fall towards this feature.

The EA risk of surface water flooding map, **Figure 4** below, indicates the potential surface water flood risk to the site. It shows the site is at low to high risk of surface water flooding. The high-risk areas are generally associated with the ditch on the site.

As the site is also at risk of fluvial flooding associated with the nearby River Fal, mitigation measures for fluvial flooding will also be applicable to surface water flooding. Mitigation measures have been detailed later in the report.

Figure 4 – EA Flood Risk from Surface Water Map Extract

- **Tidal Flooding**

The site is situated at levels above 20m AOD and inland from the tidal influence of the sea at Tresillian. The risk of tidal flooding will not be considered further in this report.

- **Historic Flooding**

Inspection of the EA Historical Flood Map online at Gov.uk indicates there have been no historical flood events registered at the site. A flood outline is located to the south west of the site on the agricultural land located to the west of the River Fal.

- **Flooding as a Result of Development**

Development and paving of permeable areas have the potential to increase flood risk to properties downslope of the proposed development. This proposal is the construction of a new dwelling to be located on stilts. As such, a suitable Sustainable Drainage System (SuDS) should be designed in accordance with best practice principles to manage runoff created by the impermeable areas of the building.

3.0 FLUVIAL FLOOD RISK

Analysis of the EA Flood Map for Planning (**Figure 3**) indicates that the site is located in Flood Zone 3 according to the coarse JFlow modelling output. As this modelling is not always suitable for site specific flood risk assessments, fluvial flooding from the watercourse in the vicinity of the site has been investigated in more detail below.

- **Method Statement**

An overview of the method used to assess the extent and depth of potential fluvial flooding at the site is outlined below:

1. Estimation of peak flows for the watercourse for the 20-year, 100-year, 100-year including climate change allowances, and 1,000-year return periods.
2. Build a HEC-RAS model of the site and surrounding area using topographic survey data.
3. Run HEC-RAS model for variety of return periods.
4. Compare model outputs against site information and discuss implications.

Flood flow estimates were derived for a variety of return period events. The catchment descriptors for the site were obtained from the FEH web service.

- **Flood Flow Estimation**

To understand the potential flood depths on site resulting from an extreme fluvial flow within the watercourse passing the site, it is necessary to estimate the fluvial flow for a range of return period events. This section describes how the flow estimates were determined for various return period events at present and with an allowance for future climate change.

- **Catchments**

The catchment descriptors for the site were obtained from the Flood Estimation Handbook (FEH) web service. The site falls within the catchment for the River Fal which is 77.28km^2 in size. An extract of the catchment area is shown below in **Figure 5**.

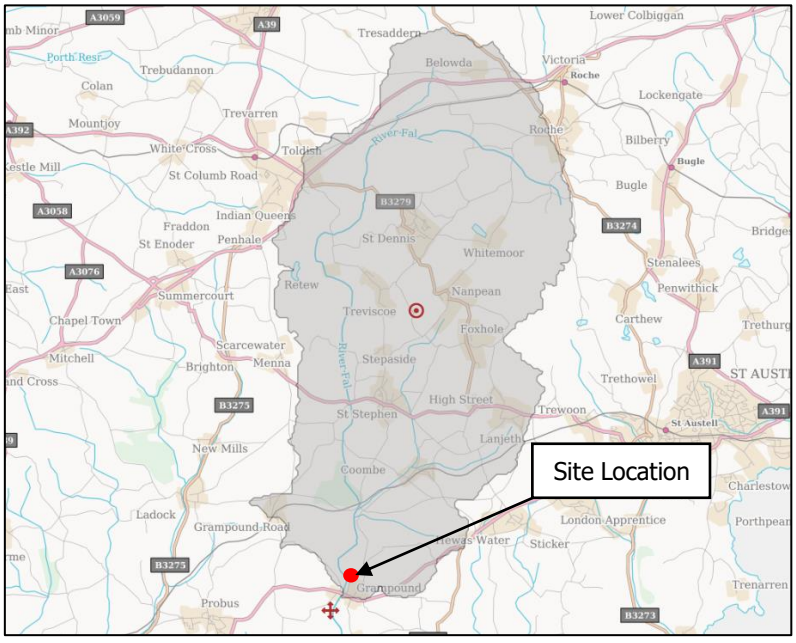

Figure 5 – FEH Catchment Boundary Extracts

- **Flood Flow Methods**

In accordance with best practice, fluvial flood flows in the River Fal were derived from the Flood Estimation Handbook (FEH) web service. The EA gauging stations at both Tregony (48003) and Trenowth (48012) provide a significant amount of historic flow data with a continuous record of Annual Maximum Flows (AMAX) spanning over 55 and 21 years respectively. In view of this good length of flow data, the Statistical Method of analysis would be the preferred method for calculating flood flows.

QMED Adjustment

The gauging stations at Tregony and Trenowth, both located on the Fal, along with 4 other similar gauging stations were used to provide QMED adjustment.

QMED for the River Fal was calculated using both AMAX data and catchment descriptors to yield an adjustment factor which was applied to QMED at the subject site, within the software WINFAP 4.

Pooling Group

In applying the statistical method, a pooling group was generated for the catchment at the site. Each of the pooled gauging stations were reviewed manually, particularly considering the quality of the data at each station and their geographical proximity to the site. Where data quality was flagged as discordant, the gauging stations were removed from the pooling group and replaced with other station to ensure a cumulative record of more than 500 years of data for hydraulically similar gauged catchments. The record of pooling groups is included in **Appendix B**.

The final pooling group was then further analysed in WINFAP and used to produce fluvial flood flows for a series of return periods, incorporating the QMED adjustment as outlined above.

Climate Change

An allowance for climate change over the lifetime of the site (taken as 100 years for residential use) should be undertaken. Information on climate change allowances has been outlined by the Environment Agency in the guidance entitled 'Flood risk assessments: climate change allowances.' This document states that the higher central and upper end allowances should be used for residential developments over the next 100 years. Table 1 of the guidance shows the anticipated changes to peak river flow for the South West district to be 40% (higher central) and 85% (upper end).

In accordance with the Environment Agency guidance, the 40% climate change allowance has been considered within the modelling exercise; values for an 85% climate change scenario are included in **Appendix B**.

Flow Summary

The predicted flows have been calculated using the FEH Statistical Method using QMED donor adjustment. The resulting flow estimates are shown in **Table 1** below.

Return Period (Year)	River Fal Flow (m^3/s)
20	19.21
100	25.28
100 + CC*	35.39
1,000	36.90

Table 1 – FEH Statistical Method Flow Estimates

***** CC denotes climate change allowance – 100-year peak flow increased by 40%

4.0 HEC-RAS HYDRAULIC MODELLING

Steady state flood modelling of the watercourses was carried out to assess the extent of the flood zones on the site, using HEC-RAS Version 5.0.7 released in March 2019 developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Centre. The modelling was carried out to assess the likely extents, depths and velocities of flood water within the site.

- **HEC-RAS Data Inputs**

The model was created using information from a topographic survey provided for the site, in particular within the site boundary. Additional topographic information contained on file was used to define the model upstream and downstream from the site. LiDAR data taken from the National Lidar Program DTM 2020 model at 1m resolution was used where topographic data was not available.

A total of 8 cross sections were entered into the model. An additional 8 cross sections were created in the software using the HEC-RAS interpolation method.

The flood flow estimates defined in **Section 3** of this report for the incoming flow of the stream entered the model at the uppermost Cross Section 10.

Flow Boundary Conditions

Upstream: Normal Depth, Gradient of Channel 0.002
Downstream: Normal Depth, Gradient of Channel 0.002

Geometric Data

Manning's n values were taken from the HEC-RAS manual and varied across the model as the landscape changed. These were varied horizontally within each cross section to accurately model the floodplain landscapes. A summary of values used is as follows:

- Channel – Clean, straight, full, no rifts or deep pools – 0.030
- Left bank – Floodplains - 0.04 to 0.07
- Right bank – Floodplains – 0.033 to 0.07

Culvert

The A390 road crosses the river approximately 250m downstream from the site. This feature was modelled as a box culvert with a 9.7m span and 2.13m rise and entered into the model at Cross Section number 5.5.

Figure 6 below, shows a schematic overview of the model including a background LiDAR terrain model.

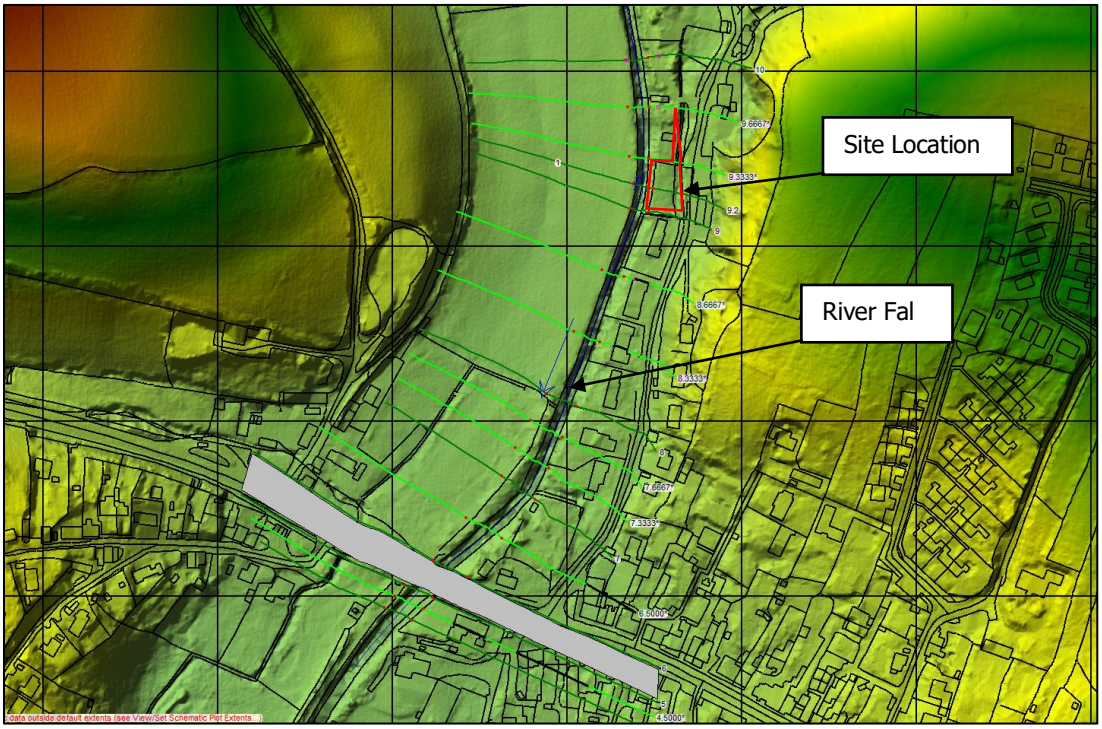

Figure 6 – HEC-RAS Geometry Extract Including LiDAR Background Elevation

Figure 7 below shows a schematic of the model looking upstream as shown in HEC-RAS. The site is located between Cross Sections 9.3 and 9.0.

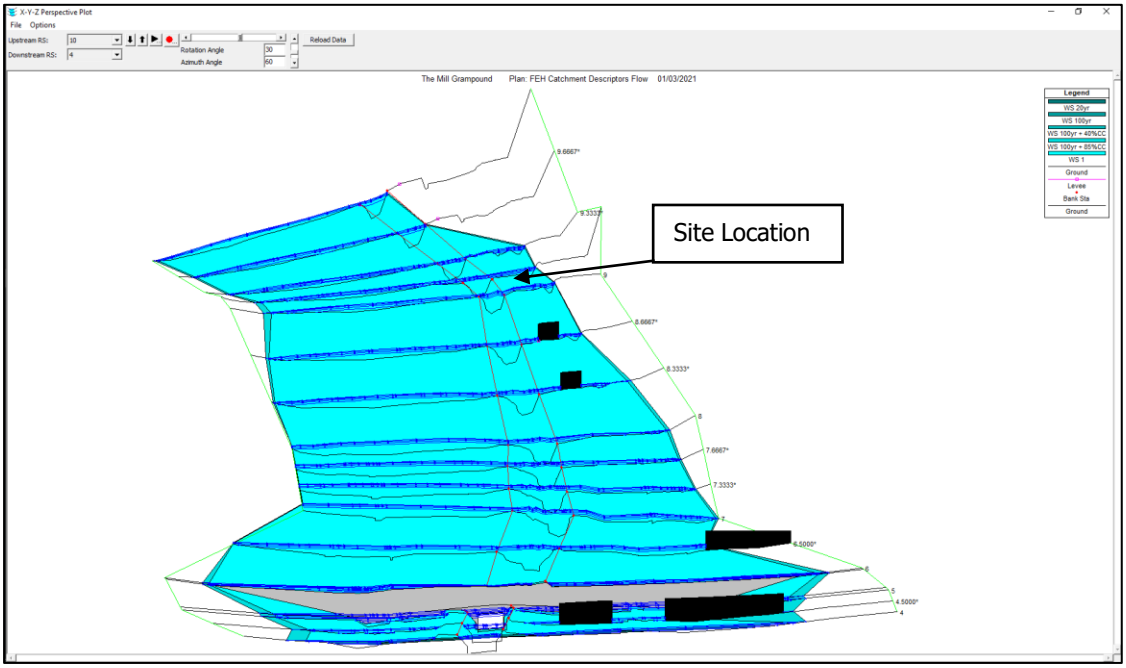

Figure 7 – Schematic View of the Cross-Sections from the HEC-RAS Model

The HEC-RAS files for this project are available upon request to EDS.

- **Modelling Assumptions & Methodology**

The aim of this modelling study was to seek a quantifiable demonstration of the flood risk at the subject site. Rather than providing outputs for all return periods this modelling study focused principally upon the 1 in 20-year, 1 in 100-year, 1 in 100-year fluvial flood event including a 40% allowance for climate change and the 1 in 1,000-year flood event. Therefore, flood zone extents are indicative of Flood Zones 2 & 3 as defined in the Planning Practice Guidance (PPG). Values for an 85% climate change scenario are included in **Appendix B**.

For the 1 in 20-year, 1 in 100 year, 1 in 100-year + 40% climate change and 1 in 1,000-year flood events the fluvial floodplain extent was exported and plotted onto the topographic survey. Some manual adjustments were made where the existing ditch is located on site.

- **Modelling Results**

Results from the HEC-RAS model are summarised below in **Table 2** for the 1 in 20-year, 1 in 100-year, 1 in 100-year + climate change and the 1 in 1,000-year flows at Cross-Section 9.2 which passes through the middle of the site. The full tabulated HEC-RAS results are included in **Appendix B**.

Cross Section	Fluvial Event (Year)	Water Level (m)	Channel Velocity (m/s)
9.2	20	20.91	2.17
9.2	100	21.14	2.30
9.2	100 + CC (40%)	21.49	2.30
9.2	1,000	21.58	2.09

Table 2 – Summary Of HEC-RAS Results at Cross Section 9.2 Passing Through the Site

A plan showing the modelled floodplain extent is included as drawing J-1802 5001A in **Appendix C.**

The results indicate that the footprint of the building straddles a number of flood risk designations with part of the site being in Flood Zone 3, part being in Flood Zone 2 and part being in Flood Zone 1. However, the footprint of the proposed dwelling is located above ground which is within Flood Zone 2 and Flood Zone 1.

- **Sensitivity Analysis**

Manning's n

A sensitivity analysis was undertaken for the site, the Manning 'n' values were increased globally across the model by 0.01. This resulted in an increase in water surface elevations at Cross Section 9.2 of between 0.07m and 0.23m.

FEH Catchment Descriptors Flows

The best practice flow estimation method is to adjust QMED based on appropriate donor catchments as described in Section 3.0. QMED estimated on catchment descriptors only was estimated to be 2.4 times higher than QMED when using the donor adjusted values. For completeness, a sensitivity analysis was undertaken using the unadjusted flows based on FEH catchment descriptors only. This results in an increase in flood levels of between 0.58m and 0.84m at Cross Section 2.

Blocked Culvert Analysis

The culvert passing underneath the A390 road was modelled as 75% blocked to represent a blocked culvert scenario. This resulted in an increase in flood levels of between 0.26m and 0.9m at the site.

- **Fluvial Flooding Summary**

The flood model indicates that part of the site is located in Flood Zone 3 where ground levels are below the 1 in 100-year flood level of 21.14m AOD (as modelled at Cross Section 9.2). When considering the 1 in 100 year plus 40% allowance for climate change event, parts of the site are located below the modelled flood level of 21.49m AOD (at modelled Cross Section 9.2). Again, parts of the site are located within Flood Zone 2, levels below the 1 in 1,000-year flood level of 21.58m AOD (as modelled at Cross Section 9.2). A section of the site is located in Flood Zone 1 where levels are elevated above the modelled flood levels.

Sensitivity analyses were undertaken for Manning's n; a culvert blockage scenario; and for flows generated using the FEH Catchment Descriptors only method of flow estimation. These resulted in elevated flood levels across the site ranging from 0.07 to 0.9m.

A drawing showing the modelled floodplain extents is included as J-1802 5001A in **Appendix C**.

5.0 ACCESS AND EGRESS

The proposed access and egress route for the development is via a raised footbridge and driveway located at the same level as Mill Lane. This level is a minimum of 22.50m AOD at the north of the building plot. As such, the proposed access/egress route will be above the extreme modelled flood level at the site of 21.58m AOD.

The proposed access will also be located above the modelled flood levels when considering the three sensitivity analyses undertaken. The most extreme flood level in these analyses was 22.1m AOD when considering the 1 in 1,000-year flood event for the FEH Catchment Descriptors only method of flow estimation.

6.0 MITIGATION MEASURES

The following mitigation measures are recommended to minimise flood risks to the proposed development:

1. Usually, the minimum finished flood level (FFL) of the proposed dwelling should be located at a level 600mm above the 1 in 100-year flood event plus 40% allowance for climate change which is a level of 22.09m AOD. In this case, considering the sensitivity analysis undertaken based on various scenarios, the maximum flood level modelled based on the 1 in 1,000 year event is 22.1m AOD. As such, to ensure the proposed development is above any possible flood level modelled, it is recommended the FFL is set at 600mm above this extreme flood level. It is recommended the minimum FFL is set at **22.70m AOD**.

2. The proposal should not infill the floodplain. As this proposal is for construction of a dwelling on stilts, it is recommended any volume of permanent construction materials installed below a level of 21.58m AOD on the site should be offset by allowing for the same volume of flood storage on the site. This could be achieved by lowering the existing ground levels slightly to offset the filling.

3. Construction methods should be flood resistant to a level of at least 22.7m AOD for any new construction. Electrical circuitry and apparatus should be installed at or above a level of 22.7m AOD. Alternatively, electrical installations should be designed to withstand flooding. Further advice on flood resilient construction is available from Improving Flood Resilience of New Buildings which is available at:

   www.planningportal.gov.uk/uploads/br/flood_performance.pdf

4. A flood warning and evacuation plan should be prepared for the development in the case of a Flood Warning. This should be linked with the EA flood warning systems.

   The following actions are typically recommended for residents at each stage of flood notification:

Flooding is possible.
Be prepared.
- Monitor flood warnings and advice issued by the Environment Agency, Cornwall council, the emergency services and News channels.
- Prepare to implement Emergency Plan

Flooding is expected.
Immediate action required.
- Continue to monitor flood warnings and advice
- Move family, pets, and valuables to a safe place
- Put flood protection equipment in place

Severe flooding.
Danger to life.
- Stay in a safe place with a means of escape
- Be ready to evacuate from building if needed
- Call 999 if in immediate danger

5. Residents of the site should sign up to the Environment Agency flood alert system for this area. The Environment Agency operate a countrywide flood warning system that covers both river and tidal flooding. The system will provide an alert of an extreme flood event which may present a risk to the area. The flood warning system is free, and the site owner should sign up to the system as soon as the dwelling is occupied. Flood warnings can be issued by phone, text, or email. Registration to receive warnings can be either by phone on 0345 988 1188 or online at www.gov.uk/sign-up-for-flood-warnings.

7.0 FLOOD RISK POLICY

Based on the findings of this study, the site proposed for development is located partially within Flood Zone 1, partially within Flood Zone 2 (between 1 in 100 and 1 in 1,000 annual probability of flooding) and partially within Flood Zone 3 (1 in 100-year annual probability of flooding).

The proposed development is for construction of a new dwelling to be raised off the existing ground level on stilts. As such, the proposal can be described as being located in Flood Zone 2 as the extent of Flood Zone 3 on the site is within the lower areas of the site where an existing ditch is located. The proposal would seek to bridge this ditch for access which would be at a level above the modelled flood levels.

In accordance with Planning Practice Guidance (PPG) Table 2, the proposed development '*Buildings used for dwelling houses*' are classified as 'More Vulnerable'. Referring to Table 3 of PPG shown in **Figure 9** below, the development would be acceptable.

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

Figure 9 – Extract from PPG - Flood risk vulnerability and flood zone 'compatibility'

8.0 SUMMARY

The proposed development is to construct a dwelling on stilts on land off Mill Lane, Grampound, Cornwall. The EA`s indicative Flood Map for Planning shows the footprint of the proposed building to be located within Flood Zone 3, however, more detailed hydraulic analysis indicates that the ground beneath the footprint of the proposed building is actually located with Flood Zone 2.

The River Fal flows in a generally north to south direction past the site to the west. The flood risk to the site is associated with this river. The EA indicative Flood Map for Planning appeared to be derived from JFlow data which is a coarse national level modelling tool to inform regional development planning. As such, a HEC-RAS model was constructed with a view to quantifying the risk of fluvial flooding to the site.

Flood flow estimates were undertaken for the 1 in 20-year, 100-year, 100-year + 40% CC, 100-year + 85% CC and 1,000-year events using the FEH Statistical Method with QMED adjusted using donor catchments as outlined in **Section 3**.

The HEC-RAS model was constructed using a topographic survey of the proposed development site included in **Appendix A**, existing topographical data held on file and LiDAR data available for the area.

The modelling showed that the majority of the development site is located at a level above the 1 in 100-year fluvial flood level of 21.14m AOD for modelled Cross Section 9.2 which passes through the middle of the site. Lower elevations along an existing ditch are located at a level below this flood level and therefore located in Flood Zone 3. When considering the 1 in 100 year plus 40% climate change event, parts of the site are below the flood level of 21.49m AOD. Parts of the site are located at a level below the 1 in 1,000-year flood level of 21.58m AOD and is therefore located in Flood Zone 2.

Three sensitivity analyses were undertaken for the site based on increased Manning's n number; a culvert blockage scenario of the A390 road bridge downstream from the site; and using FEH Catchment Descriptors only estimation of flows. These resulted in increased flood levels of between 0.07 to 0.9m at the site.

The modelled floodplain extents were transposed into a drawing included as J-1802 5001A in **Appendix C**.

Mitigation measures have been proposed in **Section 6.0**. The modelling was undertaken using flow estimation based on the FEH Statistical method with QMED donor gauging station adjustment. This is the best practice method to adjust estimation of QMED based on observed flow data from existing gauging stations. In this case, the gauging station upstream at Trenowth and downstream from the site at Tregony. Due to the sensitivity analysis undertaken and variability of flood levels at the site, it is recommended that the FFL's of the development site are located at a minimum level of 22.70m AOD to ensure the proposed dwelling is safe and above all modelled flood levels.

The access/egress route for the proposed development is off Mill Lane where the existing levels are a minimum of 22.50m AOD and remains free from flooding for all modelled flood events.

Considering the findings of this study, the site has been shown to be located mainly in Flood Zone 2 with some lower lying areas located in Flood Zone 3. NPPF states that 'More Vulnerable' uses of land such as dwelling houses are appropriate in Flood Zone 2.

APPENDIX A SITE SURVEY & PROPOSAL DRAWINGS

notes

amendments. | checked.

N

DesignStudiosw

client.
Mr. C. Wells & Mr N. Hewitt-Boorman

project.
Proposed new dwelling @ Mill Lane Grampound. TR2 4RU

drg.
Existing Site survey

scale. 1/200, @ A1

date. February 2021

drawn. CNW | checked

proj. no. | drg. no. | rev.
2020 / 96 / SS.

For Planning Application Use Only

DENSITY OF DEVELOPMENT (Plot ratio)

Total site area	745sq.m
footprint of proposal	122 sq.m
percentage of plot area being built on	16.33%

Percentage of plot area built on adjacent properties

Mead House	17%
Town Mill Development	23%
The Leat	26%
No.5 Mill Lane	29%
The Old Quarry	31%
Mill Lane Cottages	35%

DENSITY OF DEVELOPMENT (Bedspaces per hectare)

Total site area	745 sq.m
Proposed no bedspaces	8
Number of Bedspaces per hectare	107

Bedspaces per hectare built on adjacent properties

No.5 Mill Lane	123
The Old Quarry	150
Town Mill Development	153
The Leat	227
Mill Lane Cottages	261

notes

N

amendments. checked.

27/02/21. Rev A
Car parking amended

DesignStudiosw
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client.
Mr. C. Wells & Mr. N. Hewitt-Boorman

project.
Proposed new dwelling @ Mill Lane
Grampound. TR2 4RU

drg.
Proposed Site Plan

scale. 1/200, @ A1
date. March 2021
drawn. CNW checked

proj. no. drg. no. rev.
2020 / 96 / SP rev A

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APPENDIX B CALCULATIONS

J-1802 River Fal Flows FEH Catchment Descriptors with QMED Adjustment

Catchment	77.28 km2

Flows		
Year	ReFH2	FEH
20	43.99	19.205
100	68.58	25.28
100 + CC 40%	102.94	35.39
100 + CC 85%	147.27	46.77
1000	128.53	36.90

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
48003 (Fal @ Tregony)	0.202	55	11.045	0.162	0.273	0.89
48012 (Fal @ Trenowth)	0.245	21	10.21	0.152	0.253	1.887
78004 (Kinnel Water @ Redhall)	0.37	40	78.224	0.118	0.011	1.006
25006 (Greta @ Rutherford Bridge)	0.39	58	73.356	0.186	0.197	0.067
205008 (Lagan @ Drumiller)	0.392	43	27.176	0.139	-0.047	0.882
203033 (Upper Bann @ Bannfield)	0.437	24	64.73	0.122	-0.085	1.379
203043 (Oonawater @ Shanmoy)	0.446	32	31.326	0.166	0.084	0.123
203028 (Agivey @ Whitehill)	0.476	46	64.858	0.145	0.205	1.704
76019 (Roe Beck @ Stockdalewath)	0.54	19	39.9	0.231	0.337	1.245
73011 (Mint @ Mint Bridge)	0.566	49	54.835	0.217	0.291	0.466
46013 (Bovey @ Bovey Parke)	0.585	14	24.8	0.219	0.245	1.207
67009 (Alyn @ Rhydymwyn)	0.611	62	8.681	0.264	0.309	1.714
47020 (Inny @ Bealsmill)	0.617	34	34.476	0.196	0.144	0.244
76014 (Eden @ Kirkby Stephen)	0.618	47	88.271	0.168	-0.034	1.185
Total		544				
Weighted means				0.175	0.156	

With donor adjustment

Return Periods	GL
2	11.588
5	14.742
10	16.929
20	19.205
50	22.499
100	25.28
200	28.359
1000	36.901
QMED	11.588

Catchment descriptors

Return Periods	GL
2	28.229
5	35.911
10	41.238
20	46.782
50	54.806
100	61.58
200	69.081
1000	89.889
QMED	28.229

HEC-RAS Plan: Baseline River: Fal Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	10	20yr	19.21	19.77	21.25	21.00	21.50	0.004978	2.24	8.57	8.43	0.71
1	10	100yr	25.28	19.77	21.47	21.20	21.76	0.004921	2.41	10.50	9.14	0.72
1	10	100yr + 40%CC	35.39	19.77	21.71	21.47	22.10	0.005661	2.77	12.77	9.95	0.78
1	10	100yr + 85%CC	46.77	19.77	21.74	21.74	22.39	0.009251	3.56	13.14	10.17	1.00
1	10	1000yr	36.90	19.77	21.71	21.51	22.13	0.006150	2.89	12.78	9.95	0.81
1	9.6667*	20yr	19.21	19.63	21.12	20.87	21.37	0.004861	2.23	8.63	8.44	0.70
1	9.6667*	100yr	25.28	19.63	21.34	21.06	21.63	0.004755	2.39	10.56	9.03	0.71
1	9.6667*	100yr + 40%CC	35.39	19.63	21.71	21.33	21.93	0.003351	2.20	22.85	61.00	0.61
1	9.6667*	100yr + 85%CC	46.77	19.63	21.66	21.85	22.12	0.006956	3.14	19.89	52.18	0.87
1	9.6667*	1000yr	36.90	19.63	21.72	21.62	21.95	0.003501	2.26	23.57	63.10	0.62
1	9.3333*	20yr	19.21	19.50	20.97		21.23	0.004859	2.24	8.58	8.25	0.70
1	9.3333*	100yr	25.28	19.50	21.19		21.49	0.004764	2.41	10.47	8.75	0.70
1	9.3333*	100yr + 40%CC	35.39	19.50	21.53	21.18	21.82	0.004103	2.44	18.12	46.06	0.67
1	9.3333*	100yr + 85%CC	46.77	19.50	21.77	21.74	21.96	0.003069	2.22	33.22	80.07	0.58
1	9.3333*	1000yr	36.90	19.50	21.61	21.22	21.85	0.003512	2.29	21.94	57.45	0.62
1	9.2	20yr	19.21	19.44	20.91		21.15	0.004418	2.17	8.92	9.32	0.67
1	9.2	100yr	25.28	19.44	21.14		21.41	0.004449	2.30	11.32	11.27	0.68
1	9.2	100yr + 40%CC	35.39	19.44	21.49	21.12	21.75	0.003956	2.30	18.94	49.24	0.66
1	9.2	100yr + 85%CC	46.77	19.44	21.75	21.65	21.91	0.002396	2.02	36.57	87.74	0.53
1	9.2	1000yr	36.90	19.44	21.58	21.16	21.78	0.003002	2.09	24.20	64.11	0.58
1	9	20yr	19.21	19.36	20.81		21.08	0.005074	2.29	8.40	7.93	0.71
1	9	100yr	25.28	19.36	21.01		21.33	0.005250	2.51	10.15	9.66	0.73
1	9	100yr + 40%CC	35.39	19.36	21.23	21.05	21.66	0.006190	2.91	12.79	18.47	0.80
1	9	100yr + 85%CC	46.77	19.36	21.59	21.59	21.86	0.003951	2.51	25.88	60.70	0.65
1	9	1000yr	36.90	19.36	21.26	21.10	21.70	0.006353	2.97	13.29	20.65	0.81
1	8.6667*	20yr	19.21	19.08	20.71	20.32	20.89	0.003251	1.90	10.09	9.18	0.58
1	8.6667*	100yr	25.28	19.08	20.92	20.50	21.14	0.003403	2.09	12.34	16.87	0.60
1	8.6667*	100yr + 40%CC	35.39	19.08	21.25	20.76	21.44	0.002617	2.01	23.64	52.30	0.54
1	8.6667*	100yr + 85%CC	46.77	19.08	21.62	21.30	21.70	0.001224	1.46	49.67	89.54	0.37
1	8.6667*	1000yr	36.90	19.08	21.31	20.80	21.47	0.002354	1.92	26.85	57.85	0.51
1	8.3333*	20yr	19.21	18.80	20.65		20.78	0.001998	1.57	12.94	21.62	0.46
1	8.3333*	100yr	25.28	18.80	20.91		21.01	0.001658	1.53	22.20	51.33	0.42
1	8.3333*	100yr + 40%CC	35.39	18.80	21.30		21.34	0.000794	1.14	49.16	81.85	0.30
1	8.3333*	100yr + 85%CC	46.77	18.80	21.63		21.66	0.000454	0.89	79.79	106.43	0.23
1	8.3333*	1000yr	36.90	18.80	21.35		21.39	0.000719	1.09	53.46	83.75	0.29
1	8	20yr	19.21	18.52	20.66		20.71	0.000737	1.08	26.87	61.52	0.28
1	8	100yr	25.28	18.52	20.93		20.96	0.000524	0.92	45.46	78.18	0.24
1	8	100yr + 40%CC	35.39	18.52	21.30		21.32	0.000301	0.72	77.01	89.91	0.19
1	8	100yr + 85%CC	46.77	18.52	21.63		21.64	0.000212	0.61	110.22	110.66	0.16
1	8	1000yr	36.90	18.52	21.35		21.37	0.000286	0.69	81.58	93.10	0.18
1	7.6667*	20yr	19.21	18.47	20.63		20.70	0.000981	1.16	23.23	57.37	0.32
1	7.6667*	100yr	25.28	18.47	20.92		20.95	0.000645	0.94	42.80	79.58	0.26
1	7.6667*	100yr + 40%CC	35.39	18.47	21.30		21.31	0.000322	0.70	75.89	92.45	0.19
1	7.6667*	100yr + 85%CC	46.77	18.47	21.63		21.64	0.000217	0.59	110.80	134.30	0.16
1	7.6667*	1000yr	36.90	18.47	21.35		21.36	0.000297	0.69	80.57	95.22	0.18
1	7.3333*	20yr	19.21	18.43	20.61		20.67	0.001214	1.21	20.66	45.86	0.35
1	7.3333*	100yr	25.28	18.43	20.90		20.94	0.000785	0.96	40.37	81.15	0.29
1	7.3333*	100yr + 40%CC	35.39	18.43	21.29		21.31	0.000339	0.70	75.28	96.33	0.19
1	7.3333*	100yr + 85%CC	46.77	18.43	21.62		21.64	0.000213	0.58	117.30	150.36	0.16
1	7.3333*	1000yr	36.90	18.43	21.34		21.36	0.000311	0.68	80.22	99.80	0.19
1	7	20yr	19.21	18.38	20.58		20.65	0.001432	1.20	19.38	40.78	0.37
1	7	100yr	25.28	18.38	20.88		20.92	0.000847	0.97	38.60	82.81	0.29
1	7	100yr + 40%CC	35.39	18.38	21.29		21.30	0.000334	0.69	78.08	120.54	0.19
1	7	100yr + 85%CC	46.77	18.38	21.62		21.63	0.000192	0.55	127.88	158.06	0.15
1	7	1000yr	36.90	18.38	21.34		21.35	0.000302	0.67	84.56	133.64	0.18
1	6.5000*	20yr	19.21	18.68	20.56		20.61	0.000987	1.04	18.73	21.97	0.32
1	6.5000*	100yr	25.28	18.68	20.85		20.90	0.000717	1.00	30.63	52.96	0.28
1	6.5000*	100yr + 40%CC	35.39	18.68	21.26		21.29	0.000385	0.82	68.85	133.75	0.21
1	6.5000*	100yr + 85%CC	46.77	18.68	21.61		21.62	0.000204	0.66	123.77	170.08	0.16
1	6.5000*	1000yr	36.90	18.68	21.32		21.34	0.000349	0.79	76.39	145.85	0.20
1	6	20yr	19.21	18.98	20.50	19.76	20.57	0.001210	1.24	16.02	13.02	0.35
1	6	100yr	25.28	18.98	20.78	19.91	20.86	0.001173	1.31	21.05	28.60	0.35
1	6	100yr + 40%CC	35.39	18.98	21.22	20.13	21.27	0.000660	1.10	52.73	129.78	0.27
1	6	100yr + 85%CC	46.77	18.98	21.60	20.34	21.62	0.000291	0.81	114.67	187.26	0.19
1	6	1000yr	36.90	18.98	21.28	20.15	21.32	0.000612	1.08	60.77	148.77	0.26
1	5.5		Culvert									
1	5	20yr	19.21	19.06	20.31		20.41	0.001833	1.41	13.61	11.60	0.42
1	5	100yr	25.28	19.06	20.54		20.66	0.001863	1.55	16.38	13.52	0.43
1	5	100yr + 40%CC	35.39	19.06	20.85		21.00	0.001917	1.71	22.81	33.45	0.44
1	5	100yr + 85%CC	46.77	19.06	21.08	20.32	21.23	0.001912	1.80	35.03	89.34	0.45
1	5	1000yr	36.90	19.06	20.89		21.03	0.001925	1.73	24.07	36.99	0.44
1	4.5000*	20yr	19.21	19.04	20.29		20.39	0.001918	1.43	13.42	11.59	0.42
1	4.5000*	100yr	25.28	19.04	20.52		20.64	0.001936	1.57	16.14	12.12	0.43
1	4.5000*	100yr + 40%CC	35.39	19.04	20.81		20.98	0.002121	1.78	19.88	13.28	0.46
1	4.5000*	100yr + 85%CC	46.77	19.04	20.98		21.20	0.002742	2.11	23.10	29.60	0.53
1	4.5000*	1000yr	36.90	19.04	20.84		21.01	0.002182	1.82	20.28	13.40	0.47
1	4	20yr	19.21	19.02	20.27	19.75	20.38	0.002003	1.45	13.23	11.60	0.43
1	4	100yr	25.28	19.02	20.50	19.89	20.63	0.002004	1.58	16.02	14.12	0.44
1	4	100yr + 40%CC	35.39	19.02	20.81	20.10	20.96	0.002003	1.73	23.50	43.33	0.45
1	4	100yr + 85%CC	46.77	19.02	21.01	20.31	21.16	0.002002	1.82	36.74	93.18	0.46
1	4	1000yr	36.90	19.02	20.84	20.13	20.99	0.002003	1.74	25.06	48.45	0.45

HEC-RAS Plan: Mannings River: Fal Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	10	20yr	19.21	19.77	21.48	21.00	21.64	0.004954	1.82	10.57	9.16	0.54
1	10	100yr	25.28	19.77	21.70	21.20	21.90	0.005236	2.00	12.67	9.89	0.56
1	10	100yr + 40%CC	35.39	19.77	21.84	21.47	22.16	0.007951	2.51	14.11	10.73	0.70
1	10	100yr + 85%CC	46.77	19.77	21.81	21.74	22.39	0.014422	3.37	13.89	10.60	0.94
1	10	1000yr	36.90	19.77	21.84	21.51	22.19	0.008542	2.60	14.18	10.77	0.72
1	9.6667*	20yr	19.21	19.63	21.34	20.87	21.51	0.004812	1.81	10.61	9.04	0.53
1	9.6667*	100yr	25.28	19.63	21.59	21.06	21.76	0.004341	1.84	16.93	41.13	0.51
1	9.6667*	100yr + 40%CC	35.39	19.63	21.83	21.33	21.96	0.003657	1.77	31.36	75.23	0.48
1	9.6667*	100yr + 85%CC	46.77	19.63	21.97	21.85	22.08	0.003586	1.79	42.49	87.31	0.48
1	9.6667*	1000yr	36.90	19.63	21.86	21.62	21.98	0.003590	1.76	33.21	77.38	0.47
1	9.3333*	20yr	19.21	19.50	21.20		21.37	0.004816	1.83	10.52	8.76	0.53
1	9.3333*	100yr	25.28	19.50	21.42	20.91	21.62	0.005043	1.99	13.92	28.08	0.55
1	9.3333*	100yr + 40%CC	35.39	19.50	21.69	21.18	21.85	0.004189	1.91	27.41	70.32	0.51
1	9.3333*	100yr + 85%CC	46.77	19.50	21.88		21.99	0.003397	1.79	42.38	91.03	0.46
1	9.3333*	1000yr	36.90	19.50	21.72	21.21	21.87	0.004047	1.89	29.61	74.51	0.50
1	9.2	20yr	19.21	19.44	21.14		21.29	0.004630	1.75	11.25	11.21	0.52
1	9.2	100yr	25.28	19.44	21.36		21.54	0.004880	1.90	14.34	26.22	0.54
1	9.2	100yr + 40%CC	35.39	19.44	21.64	21.12	21.78	0.003899	1.83	27.70	69.95	0.50
1	9.2	100yr + 85%CC	46.77	19.44	21.82		21.94	0.003055	1.77	43.19	94.05	0.45
1	9.2	1000yr	36.90	19.44	21.67	21.16	21.81	0.003759	1.83	29.81	74.18	0.49
1	9	20yr	19.21	19.36	21.04		21.22	0.004980	1.86	10.46	9.83	0.53
1	9	100yr	25.28	19.36	21.24		21.46	0.005503	2.06	12.96	19.24	0.57
1	9	100yr + 40%CC	35.39	19.36	21.48	21.06	21.71	0.005654	2.20	20.47	45.15	0.58
1	9	100yr + 85%CC	46.77	19.36	21.75		21.89	0.003767	1.92	38.21	88.80	0.48
1	9	1000yr	36.90	19.36	21.52	21.10	21.74	0.005515	2.19	22.10	50.00	0.58
1	8.6667*	20yr	19.21	19.08	20.91	20.32	21.04	0.003516	1.60	12.29	16.63	0.46
1	8.6667*	100yr	25.28	19.08	21.13	20.50	21.27	0.003462	1.69	17.88	37.83	0.46
1	8.6667*	100yr + 40%CC	35.39	19.08	21.44	20.76	21.53	0.002458	1.50	35.11	70.50	0.39
1	8.6667*	100yr + 85%CC	46.77	19.08	21.73	21.30	21.78	0.001389	1.19	61.24	102.55	0.30
1	8.6667*	1000yr	36.90	19.08	21.49	20.80	21.57	0.002264	1.45	38.28	74.33	0.38
1	8.3333*	20yr	19.21	18.80	20.85		20.92	0.002046	1.26	19.37	45.58	0.35
1	8.3333*	100yr	25.28	18.80	21.11		21.16	0.001455	1.13	34.14	71.68	0.30
1	8.3333*	100yr + 40%CC	35.39	18.80	21.44		21.46	0.000842	0.89	60.65	88.37	0.23
1	8.3333*	100yr + 85%CC	46.77	18.80	21.72		21.74	0.000576	0.77	89.32	111.14	0.20
1	8.3333*	1000yr	36.90	18.80	21.48		21.50	0.000792	0.86	64.45	91.38	0.23
1	8	20yr	19.21	18.52	20.84		20.87	0.000691	0.79	38.98	72.76	0.21
1	8	100yr	25.28	18.52	21.10		21.12	0.000485	0.67	59.53	84.04	0.17
1	8	100yr + 40%CC	35.39	18.52	21.43		21.44	0.000355	0.57	88.61	98.47	0.15
1	8	100yr + 85%CC	46.77	18.52	21.71		21.72	0.000276	0.54	119.36	113.65	0.14
1	8	1000yr	36.90	18.52	21.47		21.48	0.000343	0.56	92.84	101.78	0.15
1	7.6667*	20yr	19.21	18.47	20.83		20.85	0.000895	0.83	35.82	73.69	0.23
1	7.6667*	100yr	25.28	18.47	21.09		21.11	0.000560	0.67	57.50	86.49	0.19
1	7.6667*	100yr + 40%CC	35.39	18.47	21.42		21.43	0.000367	0.57	87.69	102.05	0.15
1	7.6667*	100yr + 85%CC	46.77	18.47	21.71		21.72	0.000280	0.52	121.87	142.44	0.14
1	7.6667*	1000yr	36.90	18.47	21.46		21.47	0.000353	0.56	92.10	105.50	0.15
1	7.3333*	20yr	19.21	18.43	20.80		20.83	0.001164	0.87	32.69	74.36	0.26
1	7.3333*	100yr	25.28	18.43	21.08		21.10	0.000636	0.67	55.83	89.13	0.20
1	7.3333*	100yr + 40%CC	35.39	18.43	21.41		21.42	0.000380	0.57	88.10	118.91	0.15
1	7.3333*	100yr + 85%CC	46.77	18.43	21.70		21.71	0.000274	0.51	129.34	151.98	0.13
1	7.3333*	1000yr	36.90	18.43	21.46		21.47	0.000362	0.56	93.40	128.33	0.15
1	7	20yr	19.21	18.38	20.78		20.81	0.001344	0.89	30.13	73.51	0.27
1	7	100yr	25.28	18.38	21.07		21.09	0.000657	0.68	54.99	93.79	0.20
1	7	100yr + 40%CC	35.39	18.38	21.41		21.42	0.000367	0.55	94.77	150.96	0.15
1	7	100yr + 85%CC	46.77	18.38	21.70		21.71	0.000248	0.47	140.39	160.66	0.13
1	7	1000yr	36.90	18.38	21.45		21.46	0.000344	0.54	101.35	152.39	0.15
1	6.5000*	20yr	19.21	18.68	20.74		20.77	0.001026	0.86	25.20	45.76	0.25
1	6.5000*	100yr	25.28	18.68	21.03		21.06	0.000746	0.81	42.50	86.63	0.22
1	6.5000*	100yr + 40%CC	35.39	18.68	21.39		21.41	0.000425	0.67	87.30	157.37	0.17
1	6.5000*	100yr + 85%CC	46.77	18.68	21.69		21.70	0.000270	0.57	137.25	173.36	0.14
1	6.5000*	1000yr	36.90	18.68	21.43		21.45	0.000391	0.65	94.43	160.61	0.16
1	6	20yr	19.21	18.98	20.67	19.76	20.73	0.001493	1.08	18.58	18.75	0.30
1	6	100yr	25.28	18.98	20.97	19.91	21.03	0.001295	1.08	30.05	65.14	0.28
1	6	100yr + 40%CC	35.39	18.98	21.36	20.13	21.39	0.000703	0.89	73.07	159.61	0.21
1	6	100yr + 85%CC	46.77	18.98	21.68	20.34	21.69	0.000366	0.69	129.78	195.81	0.16
1	6	1000yr	36.90	18.98	21.41	20.15	21.43	0.000629	0.85	81.05	166.26	0.20
1	5.5		Culvert									
1	5	20yr	19.21	19.06	20.55		20.62	0.001874	1.17	16.50	13.75	0.32
1	5	100yr	25.28	19.06	20.80		20.88	0.001924	1.27	21.32	28.72	0.33
1	5	100yr + 40%CC	35.39	19.06	21.06		21.15	0.002020	1.38	33.57	76.64	0.35
1	5	100yr + 85%CC	46.77	19.06	21.24		21.32	0.001966	1.42	51.80	114.71	0.34
1	5	1000yr	36.90	19.06	21.09		21.18	0.002046	1.40	35.93	93.47	0.35
1	4.5000*	20yr	19.21	19.04	20.53		20.60	0.001942	1.18	16.26	12.14	0.33
1	4.5000*	100yr	25.28	19.04	20.78		20.86	0.002059	1.30	19.40	13.13	0.34
1	4.5000*	100yr + 40%CC	35.39	19.04	21.00		21.13	0.002652	1.56	23.89	33.01	0.39
1	4.5000*	100yr + 85%CC	46.77	19.04	21.12		21.29	0.003613	1.88	29.43	62.77	0.46
1	4.5000*	1000yr	36.90	19.04	21.02		21.15	0.002757	1.60	24.65	36.05	0.40
1	4	20yr	19.21	19.02	20.51	19.75	20.58	0.002003	1.19	16.18	14.53	0.33
1	4	100yr	25.28	19.02	20.77	19.89	20.85	0.002003	1.28	21.79	36.93	0.34
1	4	100yr + 40%CC	35.39	19.02	21.01	20.09	21.10	0.002003	1.36	36.79	93.42	0.34
1	4	100yr + 85%CC	46.77	19.02	21.16	20.31	21.24	0.002001	1.41	55.01	131.75	0.35
1	4	1000yr	36.90	19.02	21.04	20.13	21.12	0.002002	1.37	39.40	109.91	0.34

HEC-RAS Plan: Culv Block 75% River: Fal Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	10	20yr	19.21	19.77	21.80	21.00	21.90	0.001394	1.39	13.78	10.54	0.39
1	10	100yr	25.28	19.77	21.84	21.20	22.00	0.002264	1.79	14.16	10.76	0.50
1	10	100yr + 40%CC	35.39	19.77	21.84	21.47	22.16	0.004398	2.49	14.21	10.79	0.69
1	10	100yr + 85%CC	46.77	19.77	21.74	21.74	22.39	0.009251	3.56	13.14	10.17	1.00
1	10	1000yr	36.90	19.77	21.84	21.51	22.19	0.004835	2.61	14.15	10.75	0.73
1	9.6667*	20yr	19.21	19.63	21.82	20.87	21.86	0.000650	0.99	30.43	74.10	0.27
1	9.6667*	100yr	25.28	19.63	21.88	21.06	21.93	0.000879	1.16	35.07	79.47	0.31
1	9.6667*	100yr + 40%CC	35.39	19.63	21.96	21.33	22.03	0.001243	1.40	41.62	86.42	0.37
1	9.6667*	100yr + 85%CC	46.77	19.63	22.03	21.85	22.12	0.001610	1.62	48.15	92.34	0.43
1	9.6667*	1000yr	36.90	19.63	21.97	21.62	22.04	0.001298	1.44	42.49	87.30	0.38
1	9.3333*	20yr	19.21	19.50	21.82		21.84	0.000423	0.83	37.17	85.50	0.22
1	9.3333*	100yr	25.28	19.50	21.87		21.91	0.000570	0.98	42.34	90.99	0.25
1	9.3333*	100yr + 40%CC	35.39	19.50	21.95		22.00	0.000814	1.19	49.43	98.31	0.30
1	9.3333*	100yr + 85%CC	46.77	19.50	22.02		22.08	0.001082	1.40	56.32	107.24	0.35
1	9.3333*	1000yr	36.90	19.50	21.96		22.01	0.000852	1.22	50.34	99.65	0.31
1	9.2	20yr	19.21	19.44	21.81		21.84	0.000303	0.74	42.39	92.21	0.19
1	9.2	100yr	25.28	19.44	21.87		21.90	0.000414	0.88	47.80	96.36	0.22
1	9.2	100yr + 40%CC	35.39	19.44	21.94		21.98	0.000594	1.09	54.98	100.66	0.27
1	9.2	100yr + 85%CC	46.77	19.44	22.01		22.06	0.000792	1.29	61.57	103.24	0.31
1	9.2	1000yr	36.90	19.44	21.95		22.00	0.000622	1.12	55.88	100.97	0.27
1	9	20yr	19.21	19.36	21.81		21.83	0.000273	0.70	44.04	95.53	0.17
1	9	100yr	25.28	19.36	21.87		21.89	0.000372	0.83	49.61	100.78	0.20
1	9	100yr + 40%CC	35.39	19.36	21.94		21.97	0.000541	1.02	57.07	105.76	0.25
1	9	100yr + 85%CC	46.77	19.36	22.00		22.05	0.000730	1.22	63.79	107.58	0.29
1	9	1000yr	36.90	19.36	21.95		21.99	0.000567	1.05	57.99	106.01	0.25
1	8.6667*	20yr	19.21	19.08	21.82	20.32	21.82	0.000099	0.43	69.95	108.23	0.11
1	8.6667*	100yr	25.28	19.08	21.87	20.50	21.88	0.000139	0.53	76.13	109.46	0.13
1	8.6667*	100yr + 40%CC	35.39	19.08	21.94	20.76	21.96	0.000212	0.67	84.00	110.41	0.16
1	8.6667*	100yr + 85%CC	46.77	19.08	22.01	21.30	22.03	0.000300	0.81	90.95	111.26	0.19
1	8.6667*	1000yr	36.90	19.08	21.95	20.80	21.97	0.000224	0.69	84.96	110.53	0.16
1	8.3333*	20yr	19.21	18.80	21.82		21.82	0.000043	0.29	100.04	115.93	0.07
1	8.3333*	100yr	25.28	18.80	21.87		21.88	0.000063	0.36	106.66	117.48	0.09
1	8.3333*	100yr + 40%CC	35.39	18.80	21.94		21.95	0.000100	0.47	115.06	118.28	0.11
1	8.3333*	100yr + 85%CC	46.77	18.80	22.01		22.02	0.000148	0.58	122.45	118.98	0.14
1	8.3333*	1000yr	36.90	18.80	21.95		21.96	0.000107	0.48	116.08	118.38	0.11
1	8	20yr	19.21	18.52	21.81		21.82	0.000022	0.21	131.29	122.52	0.05
1	8	100yr	25.28	18.52	21.87		21.87	0.000033	0.26	138.41	129.85	0.06
1	8	100yr + 40%CC	35.39	18.52	21.94		21.95	0.000054	0.35	148.01	140.71	0.08
1	8	100yr + 85%CC	46.77	18.52	22.00		22.01	0.000081	0.44	156.76	141.74	0.10
1	8	1000yr	36.90	18.52	21.95		21.95	0.000058	0.36	149.21	140.85	0.08
1	7.6667*	20yr	19.21	18.47	21.81		21.82	0.000021	0.20	137.17	145.52	0.05
1	7.6667*	100yr	25.28	18.47	21.87		21.87	0.000032	0.25	145.44	147.28	0.06
1	7.6667*	100yr + 40%CC	35.39	18.47	21.94		21.94	0.000052	0.33	155.88	147.67	0.08
1	7.6667*	100yr + 85%CC	46.77	18.47	22.00		22.01	0.000078	0.42	164.99	148.01	0.10
1	7.6667*	1000yr	36.90	18.47	21.95		21.95	0.000055	0.34	157.14	147.72	0.08
1	7.3333*	20yr	19.21	18.43	21.81		21.82	0.000020	0.19	146.19	153.52	0.05
1	7.3333*	100yr	25.28	18.43	21.87		21.87	0.000030	0.24	154.84	154.02	0.06
1	7.3333*	100yr + 40%CC	35.39	18.43	21.94		21.94	0.000049	0.31	165.71	154.40	0.08
1	7.3333*	100yr + 85%CC	46.77	18.43	22.00		22.01	0.000073	0.39	175.20	154.73	0.09
1	7.3333*	1000yr	36.90	18.43	21.95		21.95	0.000052	0.33	167.02	154.45	0.08
1	7	20yr	19.21	18.38	21.81		21.82	0.000018	0.18	158.75	161.88	0.05
1	7	100yr	25.28	18.38	21.87		21.87	0.000027	0.22	167.85	162.35	0.06
1	7	100yr + 40%CC	35.39	18.38	21.94		21.94	0.000043	0.29	179.29	162.96	0.07
1	7	100yr + 85%CC	46.77	18.38	22.00		22.01	0.000064	0.36	189.27	163.48	0.09
1	7	1000yr	36.90	18.38	21.95		21.95	0.000046	0.30	180.67	163.03	0.07
1	6.5000*	20yr	19.21	18.68	21.81		21.81	0.000019	0.21	159.04	178.52	0.05
1	6.5000*	100yr	25.28	18.68	21.87		21.87	0.000029	0.26	169.05	180.50	0.06
1	6.5000*	100yr + 40%CC	35.39	18.68	21.94		21.94	0.000046	0.33	181.68	182.00	0.08
1	6.5000*	100yr + 85%CC	46.77	18.68	22.00		22.00	0.000069	0.41	192.65	182.00	0.09
1	6.5000*	1000yr	36.90	18.68	21.95		21.95	0.000049	0.35	183.20	182.00	0.08
1	6	20yr	19.21	18.98	21.81	19.76	21.81	0.000024	0.24	157.31	206.91	0.05
1	6	100yr	25.28	18.98	21.87	19.91	21.87	0.000035	0.30	168.88	210.95	0.07
1	6	100yr + 40%CC	35.39	18.98	21.94	20.13	21.94	0.000055	0.38	183.60	215.88	0.08
1	6	100yr + 85%CC	46.77	18.98	22.00	20.34	22.00	0.000080	0.46	196.58	220.13	0.10
1	6	1000yr	36.90	18.98	21.94	20.15	21.95	0.000058	0.39	185.38	216.47	0.08
1	5.5		Culvert									
1	5	20yr	19.21	19.06	20.31		20.41	0.001833	1.41	13.61	11.60	0.42
1	5	100yr	25.28	19.06	20.54		20.66	0.001863	1.55	16.38	13.52	0.43
1	5	100yr + 40%CC	35.39	19.06	20.85		21.00	0.001917	1.71	22.81	33.45	0.44
1	5	100yr + 85%CC	46.77	19.06	21.08	20.32	21.23	0.001912	1.80	35.03	89.34	0.45
1	5	1000yr	36.90	19.06	20.89		21.03	0.001925	1.73	24.07	36.99	0.44
1	4.5000*	20yr	19.21	19.04	20.29		20.39	0.001918	1.43	13.42	11.59	0.42
1	4.5000*	100yr	25.28	19.04	20.52		20.64	0.001935	1.57	16.14	12.12	0.43
1	4.5000*	100yr + 40%CC	35.39	19.04	20.81		20.98	0.002121	1.78	19.88	13.28	0.46
1	4.5000*	100yr + 85%CC	46.77	19.04	20.98		21.20	0.002742	2.11	23.10	29.60	0.53
1	4.5000*	1000yr	36.90	19.04	20.84		21.01	0.002182	1.82	20.28	13.40	0.47
1	4	20yr	19.21	19.02	20.27	19.75	20.38	0.002003	1.45	13.23	11.60	0.43
1	4	100yr	25.28	19.02	20.50	19.89	20.63	0.002004	1.58	16.01	14.12	0.44
1	4	100yr + 40%CC	35.39	19.02	20.81	20.09	20.96	0.002003	1.73	23.50	43.33	0.45
1	4	100yr + 85%CC	46.77	19.02	21.01	20.31	21.16	0.002002	1.82	36.74	93.18	0.46
1	4	1000yr	36.90	19.02	20.84	20.13	20.99	0.002003	1.74	25.06	48.45	0.45

HEC-RAS Plan: FEH Catch Flows River: Fal Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	10	20yr	46.78	19.77	21.74	21.74	22.39	0.009261	3.56	13.14	10.17	1.00
1	10	100yr	61.58	19.77	22.14	22.11	22.26	0.002510	1.97	54.36	98.01	0.53
1	10	100yr + 40%CC	86.21	19.77	22.28	22.15	22.42	0.002710	2.15	68.93	100.97	0.56
1	10	100yr + 85%CC	113.92	19.77	22.42	22.25	22.57	0.002850	2.32	83.25	103.07	0.58
1	10	1	89.89	19.77	22.30	22.16	22.44	0.002725	2.17	71.00	101.29	0.56
1	9.6667*	20yr	46.78	19.63	21.66	21.85	22.12	0.006953	3.14	19.90	52.22	0.87
1	9.6667*	100yr	61.58	19.63	21.98	21.96	22.18	0.003485	2.36	43.28	88.14	0.63
1	9.6667*	100yr + 40%CC	86.21	19.63	22.16	22.08	22.34	0.003281	2.40	60.07	96.80	0.61
1	9.6667*	100yr + 85%CC	113.92	19.63	22.29	22.20	22.49	0.003424	2.58	73.37	98.56	0.63
1	9.6667*	1	89.89	19.63	22.18	22.10	22.36	0.003261	2.42	62.26	97.08	0.61
1	9.3333*	20yr	46.78	19.50	21.77	21.74	21.96	0.003069	2.22	33.23	80.08	0.58
1	9.3333*	100yr	61.58	19.50	21.91		22.08	0.002864	2.21	45.98	94.50	0.57
1	9.3333*	100yr + 40%CC	86.21	19.50	22.10		22.25	0.002617	2.25	65.65	117.63	0.55
1	9.3333*	100yr + 85%CC	113.92	19.50	22.24		22.40	0.002607	2.37	82.70	120.26	0.56
1	9.3333*	1	89.89	19.50	22.12		22.28	0.002576	2.25	68.56	118.37	0.55
1	9.2	20yr	46.78	19.44	21.75	21.65	21.91	0.002396	2.02	36.58	87.74	0.53
1	9.2	100yr	61.58	19.44	21.88		22.04	0.002367	2.12	48.60	96.67	0.53
1	9.2	100yr + 40%CC	86.21	19.44	22.07		22.22	0.002089	2.15	68.28	106.13	0.51
1	9.2	100yr + 85%CC	113.92	19.44	22.21		22.37	0.002157	2.29	83.41	109.83	0.52
1	9.2	1	89.89	19.44	22.10		22.24	0.002062	2.15	70.92	106.99	0.50
1	9	20yr	46.78	19.36	21.59	21.59	21.86	0.003950	2.51	25.90	60.74	0.65
1	9	100yr	61.58	19.36	21.86		22.00	0.002333	2.08	48.29	99.64	0.51
1	9	100yr + 40%CC	86.21	19.36	22.06		22.18	0.002034	2.07	69.30	109.05	0.49
1	9	100yr + 85%CC	113.92	19.36	22.19		22.33	0.002170	2.24	84.41	112.99	0.51
1	9	1	89.89	19.36	22.08		22.21	0.002013	2.08	72.01	109.77	0.49
1	8.6667*	20yr	46.78	19.08	21.62	21.30	21.70	0.001224	1.46	49.69	89.57	0.37
1	8.6667*	100yr	61.58	19.08	21.88	21.47	21.93	0.000815	1.27	76.50	109.51	0.31
1	8.6667*	100yr + 40%CC	86.21	19.08	22.06	21.65	22.12	0.000867	1.40	96.66	111.95	0.33
1	8.6667*	100yr + 85%CC	113.92	19.08	22.19	21.75	22.26	0.001035	1.60	111.11	113.68	0.36
1	8.6667*	1	89.89	19.08	22.08	21.65	22.14	0.000877	1.42	99.28	112.27	0.33
1	8.3333*	20yr	46.78	18.80	21.63		21.66	0.000454	0.89	79.81	106.44	0.23
1	8.3333*	100yr	61.58	18.80	21.87		21.90	0.000370	0.87	106.96	117.51	0.21
1	8.3333*	100yr + 40%CC	86.21	18.80	22.05		22.08	0.000442	1.02	128.27	119.52	0.24
1	8.3333*	100yr + 85%CC	113.92	18.80	22.18		22.22	0.000566	1.20	143.78	129.34	0.27
1	8.3333*	1	89.89	18.80	22.08		22.11	0.000453	1.04	131.03	120.14	0.24
1	8	20yr	46.78	18.52	21.63		21.64	0.000212	0.61	110.24	110.67	0.16
1	8	100yr	61.58	18.52	21.87		21.88	0.000194	0.64	138.50	129.94	0.15
1	8	100yr + 40%CC	86.21	18.52	22.05		22.07	0.000248	0.77	163.40	142.52	0.18
1	8	100yr + 85%CC	113.92	18.52	22.18		22.20	0.000328	0.93	181.34	144.13	0.21
1	8	1	89.89	18.52	22.07		22.09	0.000256	0.79	166.68	142.90	0.18
1	7.6667*	20yr	46.78	18.47	21.63		21.64	0.000217	0.59	110.83	134.30	0.16
1	7.6667*	100yr	61.58	18.47	21.87		21.88	0.000190	0.62	145.20	147.27	0.15
1	7.6667*	100yr + 40%CC	86.21	18.47	22.05		22.06	0.000237	0.74	171.60	148.26	0.17
1	7.6667*	100yr + 85%CC	113.92	18.47	22.17		22.20	0.000311	0.88	190.07	148.96	0.20
1	7.6667*	1	89.89	18.47	22.07		22.09	0.000244	0.75	175.01	148.38	0.18
1	7.3333*	20yr	46.78	18.43	21.62		21.64	0.000213	0.58	117.33	150.37	0.16
1	7.3333*	100yr	61.58	18.43	21.87		21.88	0.000181	0.59	154.27	154.00	0.15
1	7.3333*	100yr + 40%CC	86.21	18.43	22.05		22.06	0.000223	0.70	181.81	154.97	0.17
1	7.3333*	100yr + 85%CC	113.92	18.43	22.17		22.19	0.000291	0.84	201.00	155.72	0.19
1	7.3333*	1	89.89	18.43	22.07		22.08	0.000229	0.72	185.36	155.11	0.17
1	7	20yr	46.78	18.38	21.62		21.63	0.000192	0.55	127.92	158.07	0.15
1	7	100yr	61.58	18.38	21.86		21.87	0.000161	0.54	167.01	162.31	0.14
1	7	100yr + 40%CC	86.21	18.38	22.04		22.06	0.000197	0.65	196.05	163.83	0.16
1	7	100yr + 85%CC	113.92	18.38	22.17		22.18	0.000257	0.77	216.27	164.88	0.18
1	7	1	89.89	18.38	22.07		22.08	0.000203	0.66	199.79	164.03	0.16
1	6.5000*	20yr	46.78	18.68	21.61		21.62	0.000204	0.66	123.81	170.09	0.16
1	6.5000*	100yr	61.58	18.68	21.86		21.87	0.000177	0.63	166.92	180.18	0.15
1	6.5000*	100yr + 40%CC	86.21	18.68	22.03		22.05	0.000212	0.74	199.09	182.00	0.17
1	6.5000*	100yr + 85%CC	113.92	18.68	22.16		22.18	0.000272	0.87	221.11	182.00	0.19
1	6.5000*	1	89.89	18.68	22.06		22.07	0.000217	0.75	203.22	182.00	0.17
1	6	20yr	46.78	18.98	21.60	20.34	21.62	0.000291	0.81	114.71	187.29	0.19
1	6	100yr	61.58	18.98	21.85	20.59	21.86	0.000219	0.74	164.81	209.57	0.16
1	6	100yr + 40%CC	86.21	18.98	22.03	21.14	22.04	0.000250	0.82	203.18	222.26	0.18
1	6	100yr + 85%CC	113.92	18.98	22.15	21.42	22.17	0.000314	0.93	230.47	230.99	0.20
1	6	1	89.89	18.98	22.05	21.31	22.07	0.000255	0.83	208.27	223.88	0.18
1	5.5		Culvert									
1	5	20yr	46.78	19.06	21.08	20.32	21.23	0.001911	1.80	35.05	89.56	0.45
1	5	100yr	61.58	19.06	21.32	20.59	21.44	0.001543	1.71	61.77	130.09	0.41
1	5	100yr + 40%CC	86.21	19.06	21.63		21.70	0.001046	1.50	108.85	179.64	0.34
1	5	100yr + 85%CC	113.92	19.06	21.82		21.88	0.000986	1.51	143.44	199.00	0.34
1	5	1	89.89	19.06	21.66		21.73	0.001033	1.50	113.82	182.50	0.34
1	4.5000*	20yr	46.78	19.04	20.98		21.20	0.002743	2.11	23.10	29.62	0.53
1	4.5000*	100yr	61.58	19.04	21.04	20.57	21.39	0.004189	2.64	25.24	38.77	0.66
1	4.5000*	100yr + 40%CC	86.21	19.04	21.34	21.34	21.66	0.003830	2.70	47.17	91.43	0.65
1	4.5000*	100yr + 85%CC	113.92	19.04	21.52	21.52	21.84	0.003978	2.86	64.63	108.55	0.67
1	4.5000*	1	89.89	19.04	21.37	21.37	21.69	0.003829	2.72	49.77	93.24	0.65
1	4	20yr	46.78	19.02	21.01	20.31	21.16	0.002002	1.82	36.76	93.25	0.46
1	4	100yr	61.58	19.02	21.17	20.63	21.31	0.002003	1.88	55.19	131.93	0.46
1	4	100yr + 40%CC	86.21	19.02	21.35	21.18	21.48	0.002001	1.96	82.75	163.76	0.47
1	4	100yr + 85%CC	113.92	19.02	21.50	21.35	21.62	0.002001	2.02	108.16	181.13	0.47
1	4	1	89.89	19.02	21.37	21.21	21.50	0.002001	1.97	86.30	166.37	0.47

APPENDIX C – HEC-RAS FLUVIAL FLOOD EXTENTS DRAWING

KEY

- SITE BOUNDARY
- CROSS SECTION XX — MODEL CROSS SECTION AND REFERENCE
- 1 IN 20 YEAR FLOOD
- 1 IN 100 YEAR FLOOD (FLOOD ZONE 3)
- 1 IN 100 YEAR FLOOD + 40% CLIMATE CHANGE
- 1 IN 1000 YEAR FLOOD (FLOOD ZONE 2)

NOTES

1. This drawing is copyright. Refer to details above.
2. This drawing is only to be used for the purposes described in the status box below.
   Work to figured dimensions only, do not scale.
3. This drawing is to be read in conjunction with all other drawings, details and specifications pertaining to the work described. It should only be used for the purpose marked in the status box below, and shall not be used for construction unless clearly marked CONSTRUCTION.
4. Materials and workmanship shall comply to the appropriate British Standards and Codes of Practice unless otherwise stated.
5. The activities required to construct the work, shown on drawings clearly marked CONSTRUCTION, may be subject to the provisions of the Construction (Design & Management) Regulations 2015. The Contractor and Client must ensure that they are adequately conversant with these regulations and that the appropriate procedures required under the regulations are observed at all times.
6. Design Risk Assessment

   A risk assessment relating to potential hazards associated with the works described within this drawing, in so far as they have been designed by EDS Ltd, has been undertaken. Risks identified have been eliminated by design wherever practicable. The status with regard to residual risks is as follows:

   The work is at an early planning stage and is not sufficiently advanced to allow a meaningful assessment of risks to be undertaken at this time.

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PROJECT MANAGER:-	JAN CLARK
PROJECT ENGINEER:-	ANDY WOOLLEY
DRAWN DATE:-	MARCH 2021
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REPORT

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CLIENT
CLASSIC BUILDERS SW LIMITED

PROJECT
PROPOSED DEVELOPMENT ON LAND OFF MILL LANE, GRAMPOUND, CORNWALL

DRAWING TITLE
HEC-RAS MODELLED FLOOD EXTENTS

PROJECT No.	DRAWING No.	REV.
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