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RIVER WINDRUSH FLOOD ANALYSIS - DELIVERY REPORT

Land at Witney, Oxfordshire

Client: Meridian Strategic Land Ltd, Gleeson Strategic Land Ltd and Taylor Wimpey

March 2015

Project No: 43163






CONSULTING CIVIL, STRUCTURAL AND GEOTECHNICAL ENGINEERS

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FIGURES / DRAWINGS

APPENDIX

1. INTRODUCTION

1.1. Richard Jackson Limited have been instructed by Meridian Strategic Land Ltd, Gleeson Strategic Land Ltd & Taylor Wimpey to consider the deliverability of the West End Link (WEL) bridge across the River Windrush, for the purposes of improving the local transportation network, in terms of flood risk. The construction of the WEL will bring benefits in the form of reduced highway congestion for local existing traffic and also for the proposed development traffic of approximately 1400 dwellings at Land North of Witney, Oxfordshire, see **Figure 100**. The site extends to some 55 Ha and this report is to indicate the potential impact of the WEL on the river flood levels.

1.2. This report will review the potential impact of WEL and the bridge link may have on the River Windrush floodplain. The report assesses the WEL in a form that has been considered in relation to local highway benefit and is incorporated in the Transportation Delivery Report for the same project / development. The WEL in the Transportation Report is the same as is modelled in this document.

1.3. The floodplain will need to be assessed to ensure the WEL does not produce any unwanted effects on the flow and conveyance characteristics of the river throughout a 1 in 100 year plus climate change flood event. We have liaised with the Environment Agency (EA) early in the process to obtain the river model. The model has then been used to establish if there is a detrimental effect on the local environment and floodplain with the bridge in place.

1.4. To address the impact of the bridge structure on the floodplain various scenarios need to be considered to understand the benefits or dis-benefits of placing the structure in the floodplain. The current bridge structure as indicated on **Figure 101** and Drawing **43163/S/011,** is a multi-span bridge with 10 spans. The analysis will consider the multi-span bridge as indicated on the drawings. The modelling of the floodplain of the initial WEL design will take the form of various scenarios, for example, if some of the spans were not available for water to flow under the bridge. These scenarios will help establish the direct impact that different bridge forms may have on the floodplain. One benefit of analysing the WEL with a reduced number of openings, would be to replicate the existing bridge (some 400m) downstream of the WEL on Bridge Street, to understand if there could be some reduced flood levels by retaining water upstream of the WEL.

2. RIVER MODELLING REPORT SCOPE

2.1. The proposed development site lies to the north of Witney and immediately abuts the existing urban fringe. The proposed WEL is shown on **Figure 101** and **Drawing 43163/S/011** and this will be the basis upon which a River Flood Model Assessment is to be conducted.

2.2. Richard Jackson Ltd were instructed to carry out a flood modelling assessment for a proposed road bridge, WEL, across the River Windrush, Witney, Oxfordshire. We have used professional advice from Evans Rivers and Coastal Ltd to help interpret and model the River Windrush, for the purposes of establishing the effect of the WEL on the existing floodplain.

2.3. The principle methodology for assessing the impact across the floodplain was to evaluate whether the multi-span bridge was an appropriate bridge form, or whether some of the orifices created by the bridge could be removed or blocked, ie made into an embankment form of structure. If the analysis were to show that the floodplain could still function with a reduced number of spans, then the purpose of the report would be to see how constricted could the structure become before the effects on the floodplain would be unacceptable in flood risk terms.

2.4. The scope for this assessment was based on the scope parameters above the following tasks were completed:

- Determine the baseline scenario (i.e. existing conditions without proposed bridge) by re-running the existing model to ensure that the results correspond with the existing set of results provided by the Environment Agency;
- Determine the impacts on flood levels and flood extent by modelling the proposed bridge design and only utilising the spans which allow the existing watercourses to flow through the WEL, ie spans number 1,3 and 5 starting at the southern span nearest to Burford Road, this is Scenario A;
- Determine any reduction in flood level which might provide betterment to residents downstream of the WEL bridge by reducing the cross sectional area of the proposed WEL bridge openings in the model, to match those as the existing Bridge Street bridge, some 400m downstream of the proposed WEL, this is Scenario B;

2.5. For all the modelling tasks only the 1 in 100 year plus climate change design event was utilised, which was agreed with the consultants completing the Witney Strategic Flood Risk Assessment, on behalf of the West Oxfordshire District Council.

2.6. It is understood that this assessment will be submitted to the Planning Authority and Environment Agency (EA). The modelling was undertaken using the existing 1dimensional/2-dimensional hydrodynamic model, referred to as the 'Windrush Model' hereafter. The Windrush Model is a linked ISIS/TUFLOW model with a grid resolution of 5m x 5m and was supplied to Evans Rivers and Coastal Ltd in January 2015 by the Environment Agency as part of a Product 5, 6 and 7 data request.

2.7. The modelling completed is contained in the **Appendix A**, which includes the report completed by Evans Rivers and Coastal Ltd. The report findings are included Chapter 3, Conclusions.

3. CONCLUSIONS

3.1. It is proposed to construct a new development of 1400 houses to the north of Witney in Oxfordshire and in conjunction with this development, the WEL is proposed to function as a new transportation benefit.

3.2. The base river model created from the data provided from the EA has proven to be representative of the EA's model and can be relied upon to complete the analysis of the further scenarios.

3.3. The initial modelling assessment, Scenario A, (multi-spans 1, 3 and 5 open only) has determined that there is negligible impact on flood levels during the 1 in 100 year event plus climate change as a result of a WEL proposed bridge crossing over the River Windrush and its floodplain.

3.4. In fact the minor increases in water level vary between 0 and 39mm on the River Windrush Floodplain, See **Appendix A, Table 4.**

3.5. The river modelling has also tested another case, Scenario B, and in this assessment an investigation has been completed to establish the possibility of alleviating properties of flooding downstream of the proposed WEL bridge location by reducing the proposed WEL bridge openings, to those similar to that of the existing bridge on Bridge Street.

3.6. The results have shown that there is negligible impact on water levels downstream of the proposed WEL bridge in Scenario B, during the 1 in 100 year event plus climate change, however, water levels upstream of the proposed bridge increase significantly which, in turn, could result in an increased flood risk to properties along Crawley Road. The flood water levels rise between 2 and 296mm, see **Appendix A, Table 4**. Therefore, it is recommended that Bridge Scenario B is not pursued further.

3.7. When considering Scenario A, despite three openings being modelled, it is considered that the original scheme as provided to the Client and shown on Drawing **43163-S-11**, (which includes additional openings), would have even less of an impact on water levels in comparison to the model results in Scenario A, so was not considered further.

3.8. Therefore, it is concluded that the WEL as shown on Drawing **43163/S/011** is satisfactory in its approach to provide a suitable river crossing, limited to just three openings (spans 1, 3 and 5) for the watercourses that exist and to have very little impact on the water levels for a 1 in 100 year event plus climate change, upstream of the structure. In summary, a WEL or similar structure with limited orifices, similar to those of spans 1, 3 and 5, as reference above, would be an acceptable structure across the floodplain without causing a significant detrimental effect on water flood levels.

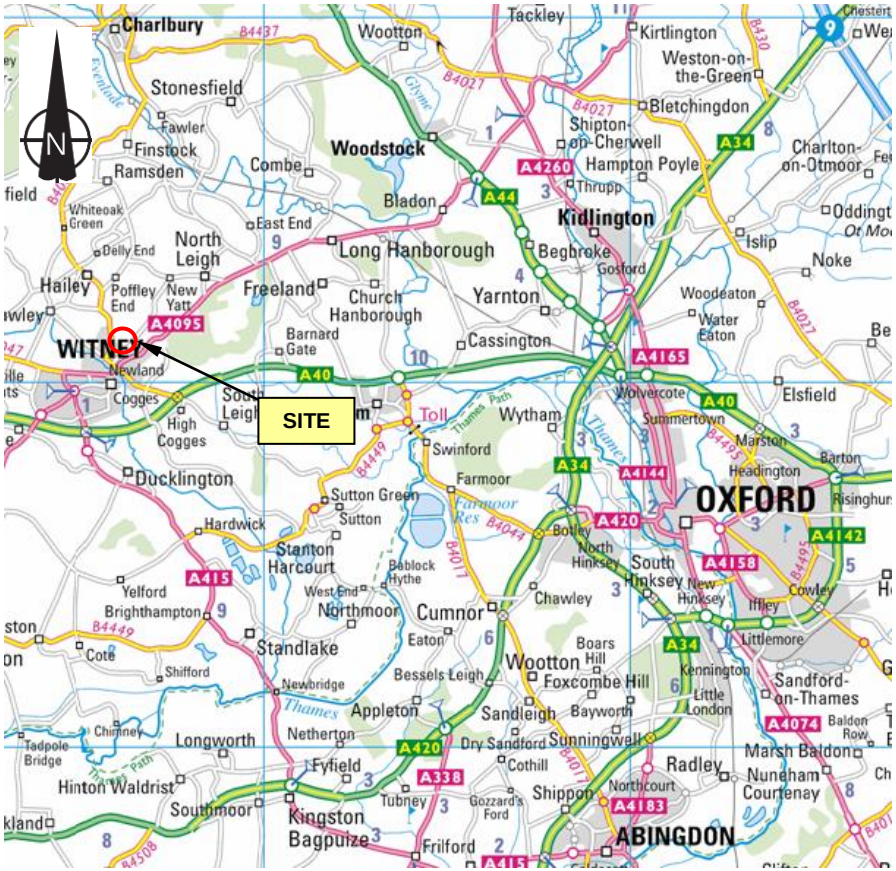
4. LIMITATIONS

4.1. This report has been produced for the sole use of Meridian Strategic Land Ltd, Gleeson Strategic Land Ltd and Taylor Wimpey in conjunction with the development of Land North of Witney for residential development. Its contents should not be relied upon by others without the written authority of Richard Jackson Limited. If any unauthorised third party makes use of this report, they do so at their own risk and Richard Jackson Limited owes them no duty of care or skill.

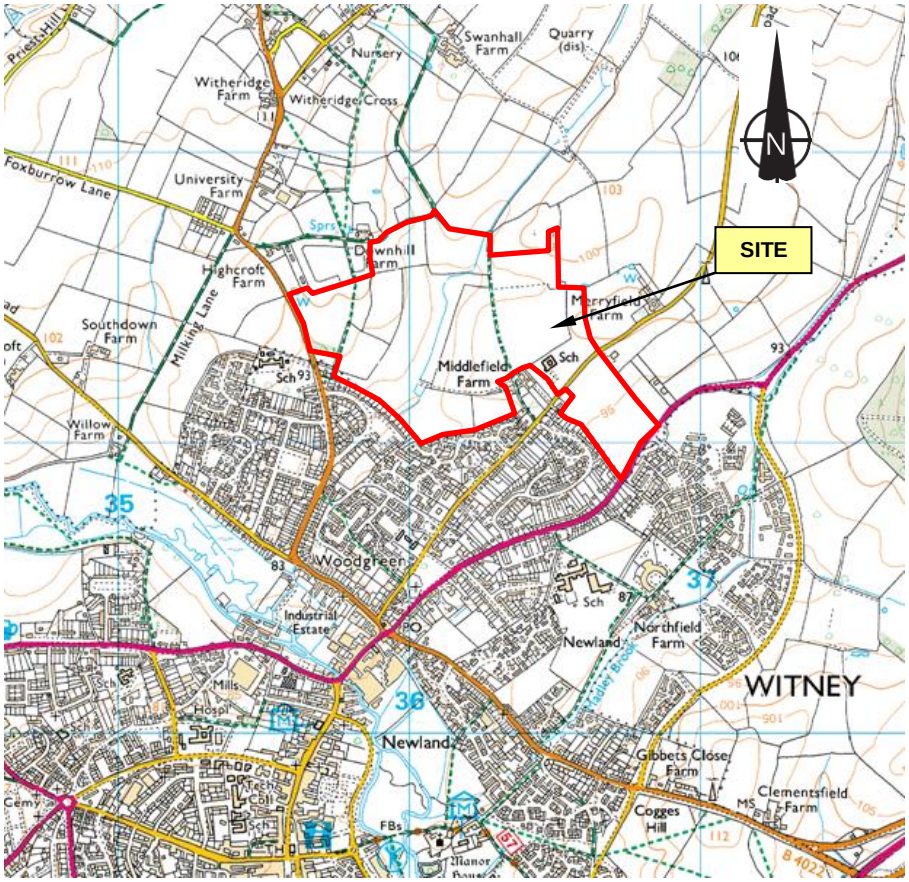
4.2. All information provided by others is taken in good faith as being accurate, but Richard Jackson Limited cannot, and does not, accept any liability for the detailed accuracy, errors or omissions in such information.

4.3. All data has been collated for the purposes of the proposed development of approximately 1400 dwellings and the WEL as shown on Drawing **43163/S/011**. Any amendment to this proposal or changes in the future will require reassessment to confirm the conclusions are still valid.

FIGURES AND DRAWINGS



Site Location



Location Plan

Client:	Drawing Title:		
Meridian Strategic Land Ltd	**Site Location Plan**		
Job Title:	Date:	Job No:	Dwg No:
Land at North Witney, Oxfordshire	**11 Aug 11**	**43163**	**Fig. 100 (NTS)**

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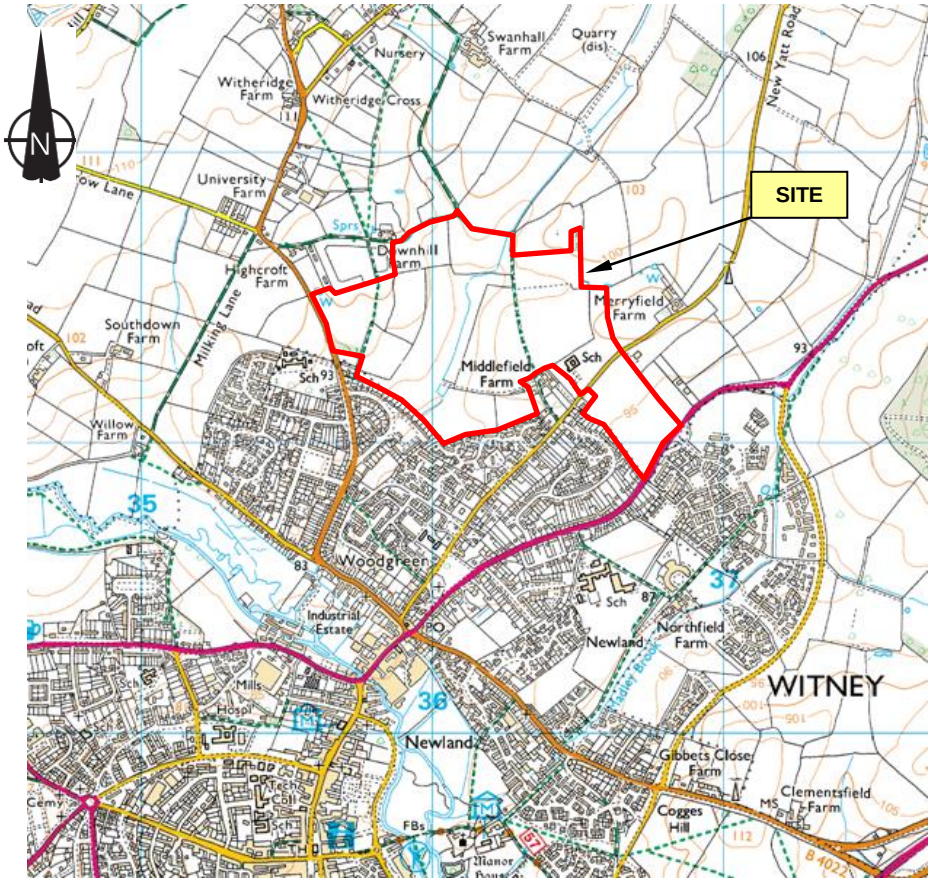
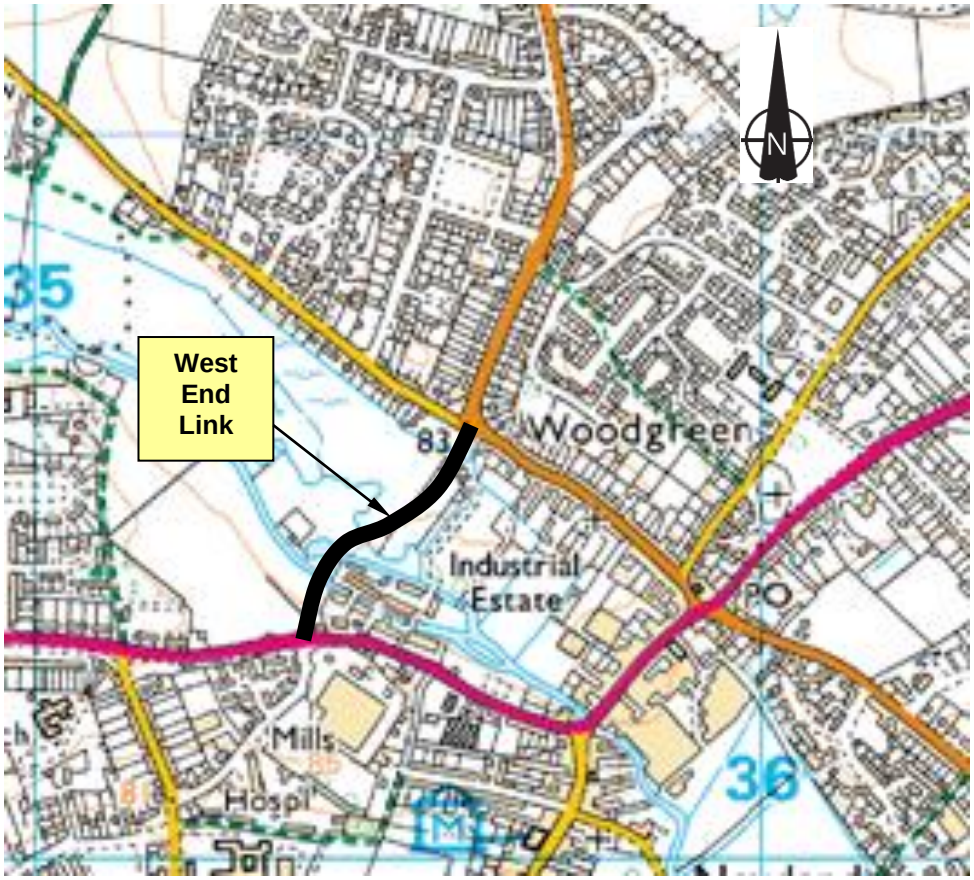


Location Plan



West End Link Location

Client:	Drawing Title:		
Meridian Strategic Land Ltd	**Location of West End Link**		
Job Title:	Date:	Job No:	Dwg No:
Land at North Witney, Oxfordshire	**9 March 15**	**43163**	**Fig. 101 (NTS)**

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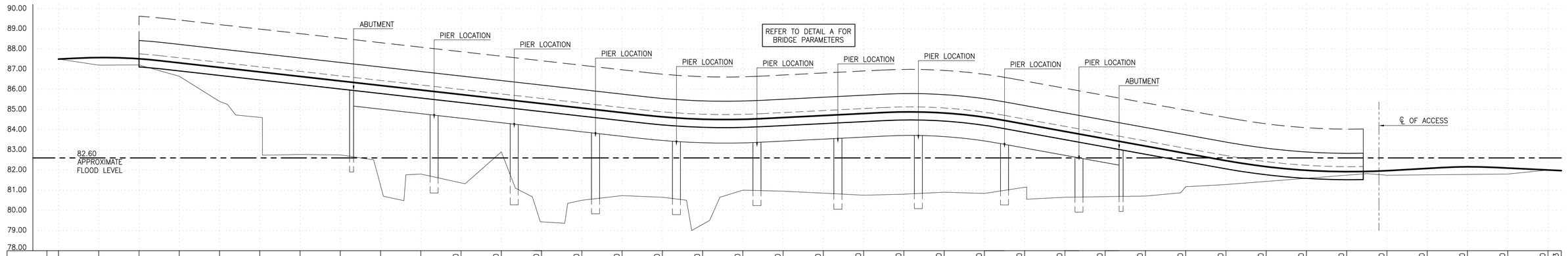
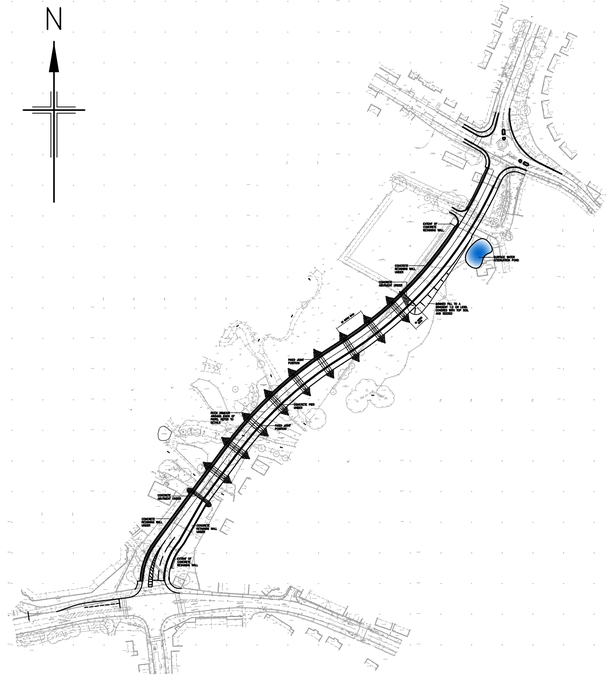
DO NOT SCALE



CHAINAGE	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0	320.0	330.0	340.0	350.0	360.0	370.0	373.3
EXISTING GROUND	87.50	87.20	87.21	86.65	85.40	84.61	82.77	82.75	81.20	81.80	81.36	82.90	79.43	80.50	80.73	80.65	79.30	81.00	80.95	80.85	80.75	80.80	80.90	80.84	81.14	80.65	80.68	80.71	81.17	81.28				81.74			81.80	82.00	81.96
℄ ROAD	87.50																																					81.96	

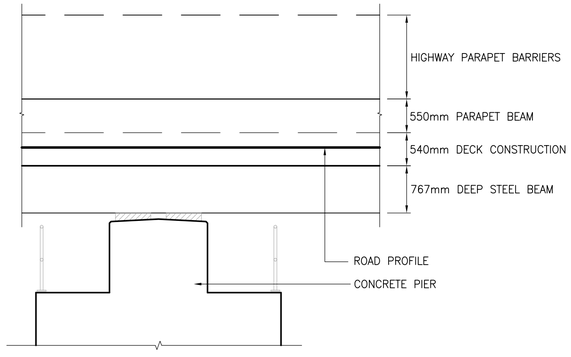
LONG SECTION ALONG CENTRE LINE OF BRIDGE

SCALE 1:500H
SCALE 1:100V



OVERVIEW PLAN OF BRIDGE

SCALE 1:2000



DETAIL A OF BRIDGE MAKE-UP

SCALE 1:50

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. ALL LEVELS ARE IN METRES AND RELATE TO ORDNANCE SURVEY DATUM.
3. ROAD DESIGN TO 50KPH DESIGN SPEED IN ACCORDANCE WITH DMRB TD9/93.
4. BRIDGE LENGTH 190M WITH 2 FIXED JOINT LOCATIONS AND 9 MOVEMENT JOINT LOCATIONS.
5. BRIDGE DESIGN IS PRELIMINARY AND SUBJECT TO TECHNICAL APPROVAL.
6. TO BE READ IN CONJUNCTION WITH DRAWINGS 43163-S-10/11/12/13

REV	DATE	DESCRIPTION	DRAWN	CHKD

REVISIONS

Project: LAND AT NORTH WITNEY	Title: LONG SECTION & CROSS SECTION OF BRIDGE ALIGNMENT	Client: MERIDIAN STRATEGIC LAND LTD	Drawn: M. HOUSE; Date: 28.09.11; Job Manager: M DOUGHTY; Checked: ; Approved: ; Scale: VARIES

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.

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Drawing No. 43163-S-11 | Revision -

Drawing Status
☒ INFORMATION ☐ APPROVAL ☐ COSTING
☐ TENDER ☐ CONSTRUCTION ☐ AS CONSTRUCTED

A1

APPENDIX A

PROPOSED ROAD BRIDGE ACROSS THE RIVER WINDRUSH, WITNEY, OXFORDSHIRE

FLOOD MODELLING ASSESSMENT

FEBRUARY 2015

REF: 1363/RE/02-15/01 REVISION A

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CONTRACT

Evans Rivers and Coastal Ltd has been commissioned by Richard Jackson Ltd, to carry out a flood modelling assessment for a proposed road bridge (also known as the West End Link Road) across the River Windrush, Witney, Oxfordshire.

QUALITY ASSURANCE, ENVIRONMENT AND HEALTH AND SAFETY

Evans Rivers and Coastal Ltd operates a Quality Assurance, Environmental, and Health and Safety Policy.

This project comprises various stages including data collection; depth analysis; and reporting. Quality will be maintained throughout the project by producing specific methodologies for each work stage. Quality will also be maintained by providing specifications to third parties such as surveyors; initiating internal quality procedures including the validation of third party deliverables; creation of an audit trail to record any changes made; and document control using a database and correspondence log file system.

To adhere to the Environmental Policy, data will be obtained and issued in electronic format and alternatively by post. Paper use will also be minimised by communicating via email or telephone where possible. Documents and drawings will be transferred in electronic format where possible and all waste paper will be recycled. Meetings away from the office of Evans Rivers and Coastal Ltd will be minimised to prevent unnecessary travel, however for those meetings deemed essential, public transport will be used in preference to car journeys.

The project will follow the commitment and objectives outlined in the Health and Safety Policy operated by Evans Rivers and Coastal Ltd. All employees will be equipped with suitable personal protective equipment prior to any site visits and a risk assessment will be completed and checked before any site visit. Other factors which have been taken into consideration are the wider safety of the public whilst operating on site, and the importance of safety when working close to a water source and highway. Any designs resulting from this project and directly created by Evans Rivers and Coastal Ltd will also take into account safety measures within a “designers risk assessment”.

Report carried out by:

…….
Rupert Evans, BSc (Hons), MSc, CEnv, C.WEM, MCIWEM, AIEMA

DISCLAIMER

This report has been written and produced for Richard Jackson Ltd. No responsibility is accepted to other parties for all or any part of this report. Any other parties relying upon this report without the written authorisation of Evans Rivers and Coastal Ltd do so at their own risk.

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Ltd. The Client shall have licence to copy and use drawings, reports and other documents for the purposes for which they were provided.

CONTENTS

1. INTRODUCTION

1.1 Project Scope

1.1.1 Evans Rivers and Coastal Ltd has been commissioned by Richard Jackson Ltd, to carry out a flood modelling assessment for a proposed road bridge (also known as the West End Link Road) across the River Windrush, Witney, Oxfordshire.

1.1.2 It is understood that this assessment will be submitted to the Planning Authority and Environment Agency. The modelling was undertaken on the basis of an existing 1-dimensional/2-dimensional hydrodynamic model, referred to as the 'Windrush Model' hereafter.

1.1.3 The Windrush Model is a linked ISIS/TUFLOW model with a grid resolution of 5m x 5m and was supplied to Evans Rivers and Coastal Ltd on the 22nd January 2015 by the Environment Agency as part of a Product 5, 6 and 7 data request.

1.1.4 The scope for this assessment was agreed with the Client and required the following tasks to be completed:

1. Determine the baseline scenario (i.e. existing conditions without proposed bridge) by re-running the existing model to ensure that the results correspond with the existing set of results provided by the Environment Agency;

2. Determine the impacts on flood levels and flood extent by modelling the proposed bridge design;

3. Determine any reduction in flood level which might provide betterment to residents downstream of the bridge by reducing the cross sectional area of the proposed bridge openings in the model;

4. For tasks 1-3 consider only the 1 in 100 year plus climate change design event;

5. Report findings.

1.1.5 This report highlights the data provided for the Witney bridge modelling, outlines the modelling approach taken and presents its findings.

2. DATA COLLECTION

2.1 The key datasets which were reviewed for the Witney bridge modelling are listed in Table 1.

Table 1: Key datasets

Data set	Source	Description
Windrush (Worsham to A40) 2014 Product 5 • _Post2007SummaryReport • Windrush_Witney_Modelling_ Report • ZA01_Witney_Model Review_v02a.	Environment Agency	Modelling report and supporting documentation.
Windrush (Worsham to A40) 2014 Product 6 • ISIS/TUFLOW Model Results	Environment Agency	ISIS and TUFLOW result files
Windrush (Worsham to A40) 2014 Product 7 • Witney Model files	Environment Agency	ISIS and TUFLOW model files
AutoCAD Drawing 43163-S-11.dwg.	Richard Jackson Ltd	Proposed bridge design

2.2 A review of the model results log files and input files provided by the Environment Agency revealed that the 1-dimensional ISIS results provided with the Product 6 data request were created using ISIS model file 'WITNEY_ONLY_002.dat' and were produced on 23rd May 2013. Additionally, the ISIS model file named 'Witney_v3.dat' was provided with the Product 7 data request and it was considered more suitable to take forward in this study. However, it remains unclear from the modelling reports provided by the Environment Agency what the differences are between these two model versions.

2.3 It was confirmed that the dates of the 2-dimensional TUFLOW run file 'W_100yrCC_v4.tcf' and the other results files provided by the Environment Agency corresponded well and were both dated 9th September 2013.

2.4 All third party data used in this study has been checked and verified prior to use in accordance with Evans Rivers and Coastal Ltd Quality Assurance procedures.

3. LOCATION AND BRIDGE ALIGNMENT

3.1 The River Windrush is a fluvial watercourse designated a Main River by the Environment Agency. The model provided by the Environment Agency extends from Worsham gauging station to the A40 downstream of Witney. It flows in a south easterly direction through the urban area of Witney.

3.2 Drawing Number 43163-S-11 shows the location and scale of the proposed bridge as provided by the Client. It should be noted that the long section shown on the drawing represents the elevation of the bridge looking upstream (i.e. north west elevation).

3.3 The bridge design shown on Drawing Number 43163-S-11 considers ten possible openings separated by bridge piers and supported at either end by abutments. The bridge alignment extends a total distance of approximately 345m and crosses the River Windrush floodplain and associated tributaries. Figure 1 shows the location of the proposed bridge in relation to the OS map.

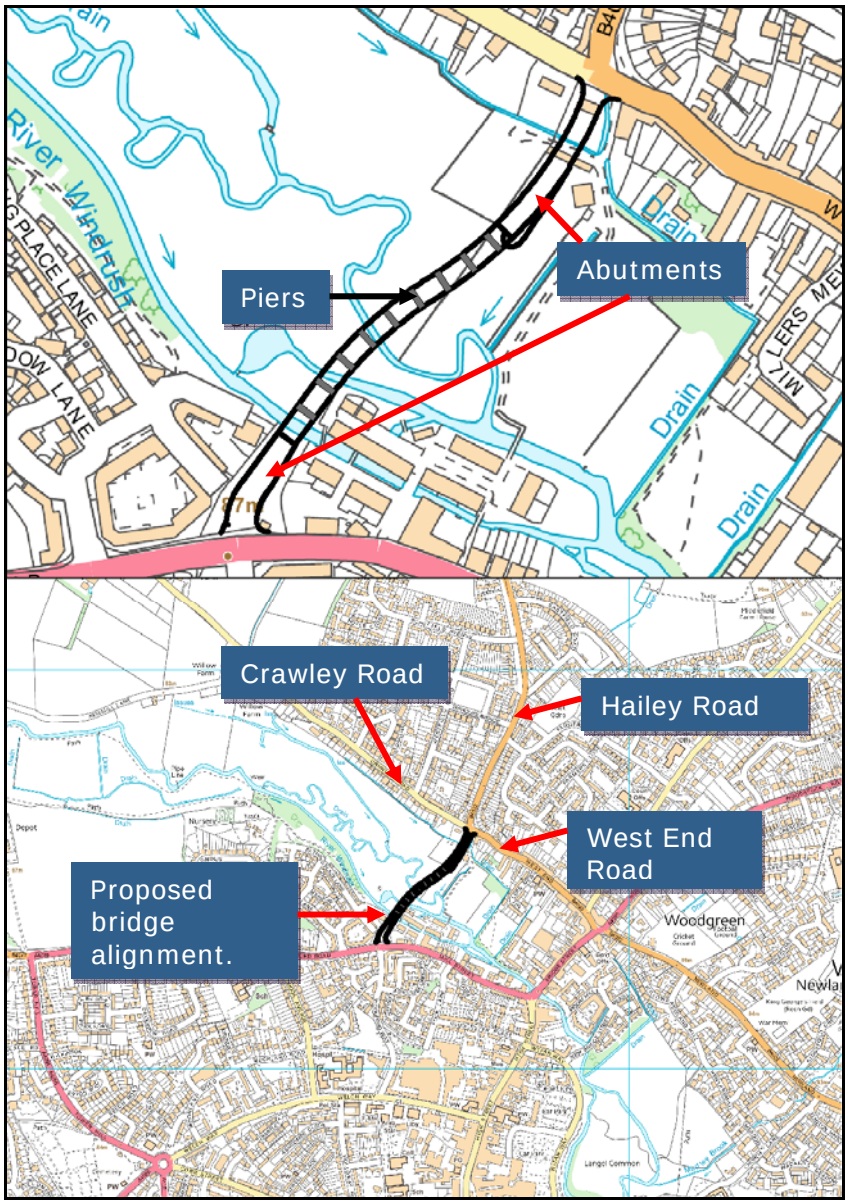


Figure 1: Proposed bridge alignment and location

3.4 The Environment Agency's Indicative Flood Zone Map (Figure 2) shows that the proposed bridge crosses the NPPF defined Flood Zones 3, 2 and 1.

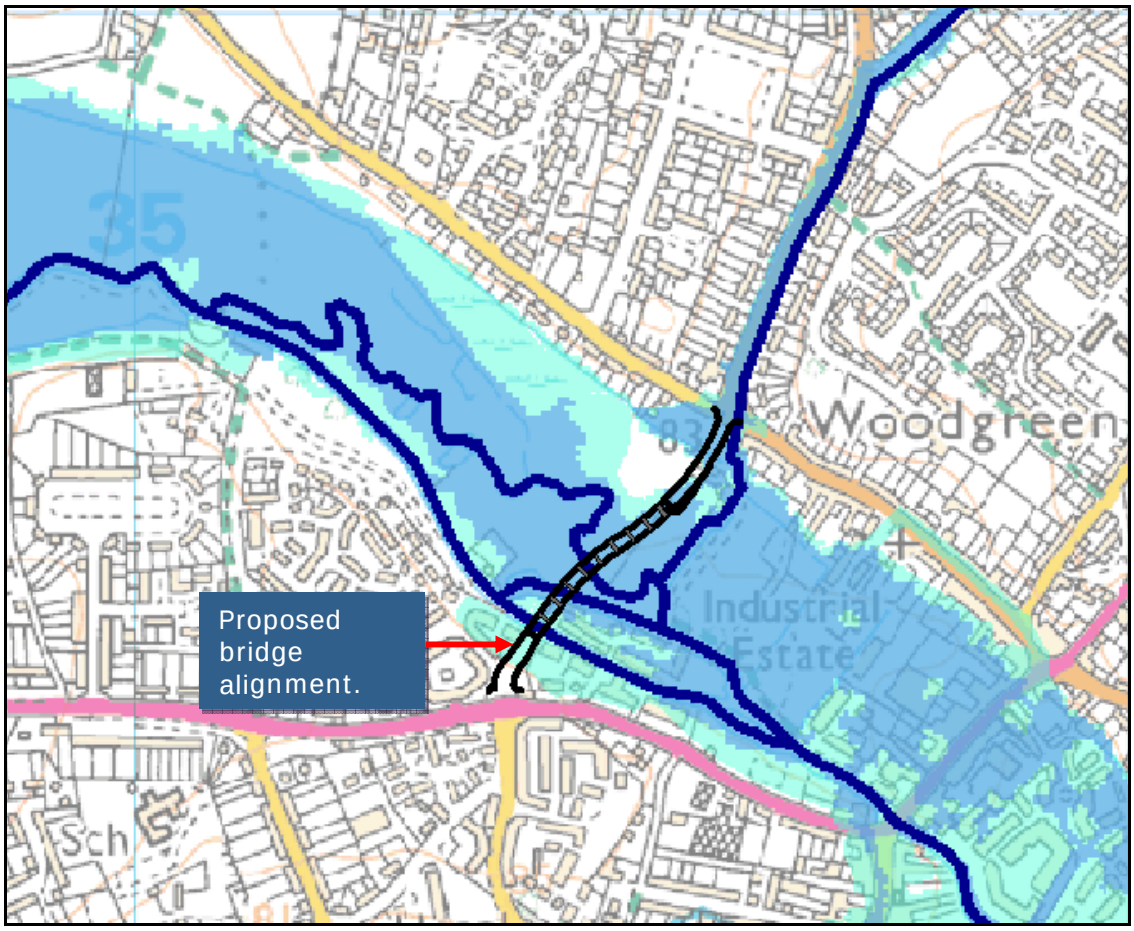


Figure 2: Environment Agency Indicative Flood Map (Source: Environment Agency, 2015)

4. MODELLING APPROACH

4.1 Introduction

4.1.1 For this assessment, model 'W_100yrCC_v4.ief', which was provided by the Environment Agency and which references ISIS model file 'Witney_v3.dat', has been used together with the TUFLOW run file 'W_100yrCC_v4.tcf', which was also provided by the Environment Agency.

4.1.2 In this Chapter the modifications to this baseline model are described further. For a more detailed description of the model schematisation, the 'Modelling Report – Post 2007 ABD – Windrush: Worsham to Witney (A40)' (Environment Agency, 2014) should be consulted.

4.2 Revised Model Extent

4.2.1 In order to reduce the run time of the baseline Windrush Model and to focus on areas most relevant to the proposed bridge's location, the model extent was reduced. The upstream boundary of the model was therefore relocated to the downstream end of Crawley Bridge (Figures 3 and 4). However, no changes to the downstream extent of the model were made. Furthermore, no changes to the 2D domain orientation or grid resolution were made.

4.2.2 The existing model input files (e.g. z-lines, hx-lines) were amended to reflect the shortened upstream extent.

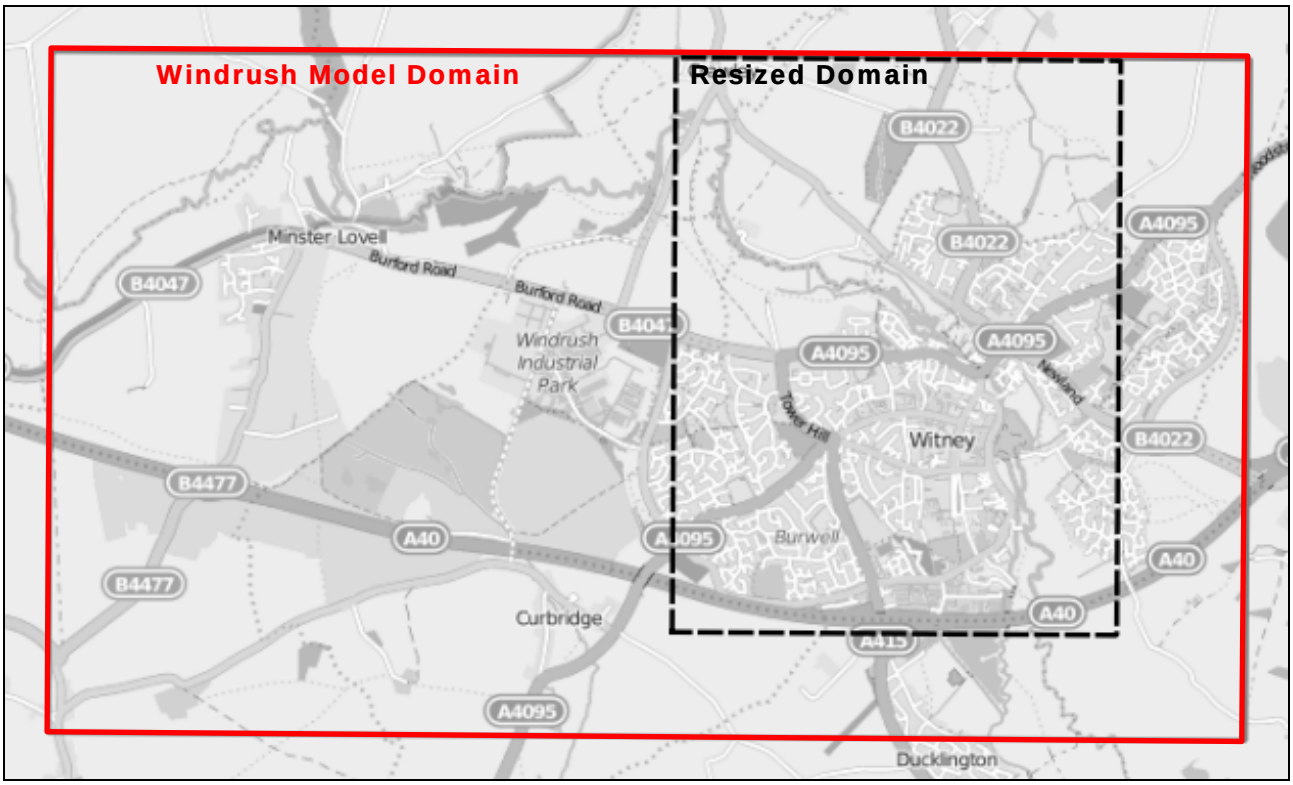


Figure 3: 2d Domain Extents

4.3 Boundary Conditions For Revised Model Extent

4.3.1 At the upstream extent a new ISIS Flow/Time boundary (node '10.013') and TUFLOW Flow/Time boundary (2d_bc line: 'Crawley_L') were introduced (Figure 4). The flow hydrographs of the 1 in 100 year plus climate change event for these new boundaries were extracted from the baseline ISIS and TUFLOW results files.

4.3.2 No detailed review or update of the Windrush Model hydrology has been undertaken as this is outside of the scope of the assessment and it is considered that sufficient checks and validation has been carried out by the Environment Agency and their consultants when considering the reliability of the baseline model.

Figure 4: Revised Upstream Boundary (2d flow-time boundary: Crawley_L; 1D flow-time boundary: 10.013)

4.4 Schematisation of Proposed Bridge Design

4.4.1 Two bridge design scenarios (A and B) were considered in this study, which required modification of both the 1d and 2d schematisation. Drawing Number 43163-S-11 shows the location and scale of the proposed bridge as provided by the Client.

4.4.2 From Figure 5 it can be seen that the proposed bridge would cross the floodplain in a braided reach of the River Windrush approximately 375m upstream of the existing Bridge Street bridge. In this location, the proposed bridge would have to cross three river channels (Figures 5 and 7).

4.4.3 In order to consider a worst-case scenario, instead of modelling the bridge with ten openings as shown on Drawing Number 43163-S-11, for both scenarios A and B considered in this study it was assumed that the bridge openings were only present at three locations where the bridge would cross each of the aforementioned the river channels.

4.4.4 A z-shape with a nominal crest elevation of 90mAOD was inserted into the 2d domain to represent the blocked/redundant bridge openings along the other points of the proposed bridge alignment.

4.4.5 In the 1d domain, three USBPR type bridge units were added to the ISIS network (Figure 6). The upstream and downstream cross-section data was based on either existing ISIS river-sections in the relevant location or by using the nearest upstream/downstream river-sections as a surrogate. No adjustments to the default calibration factors were made.

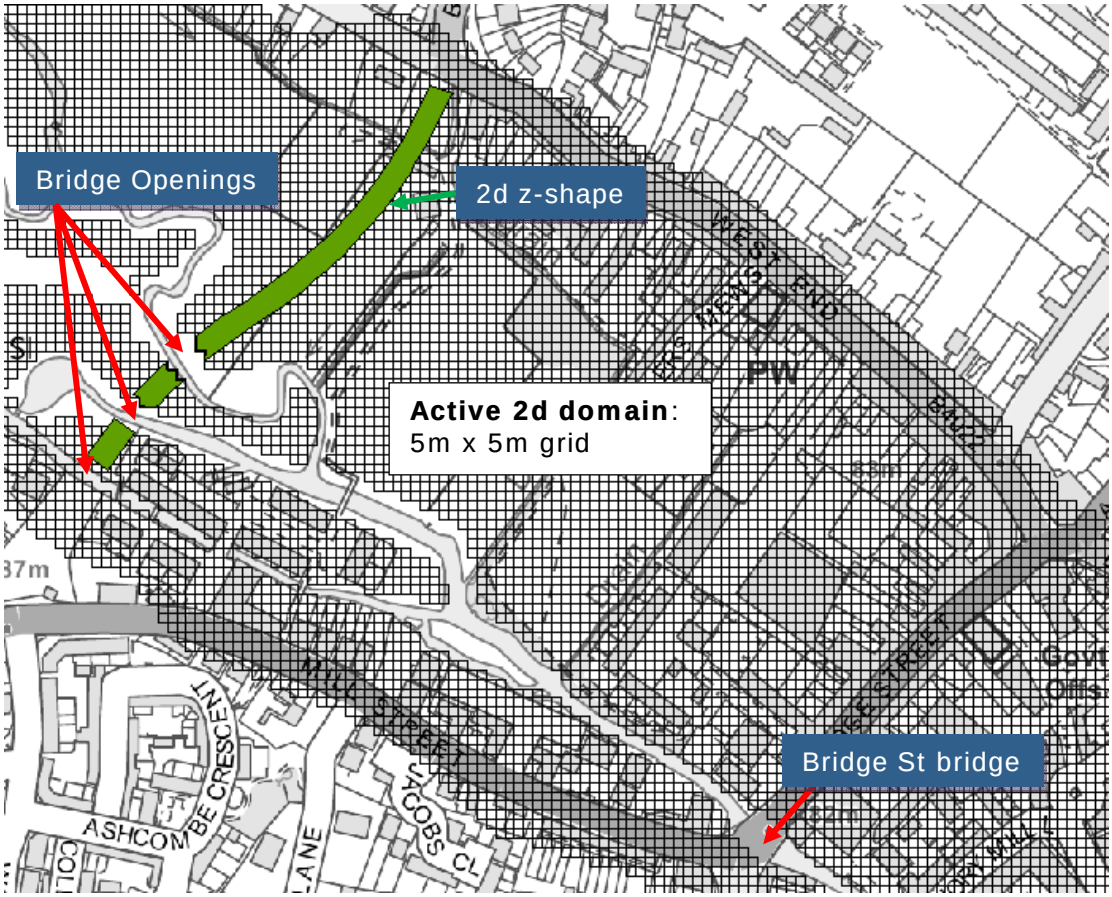


Figure 5: 2d schematisation (z-shape) of the proposed bridge

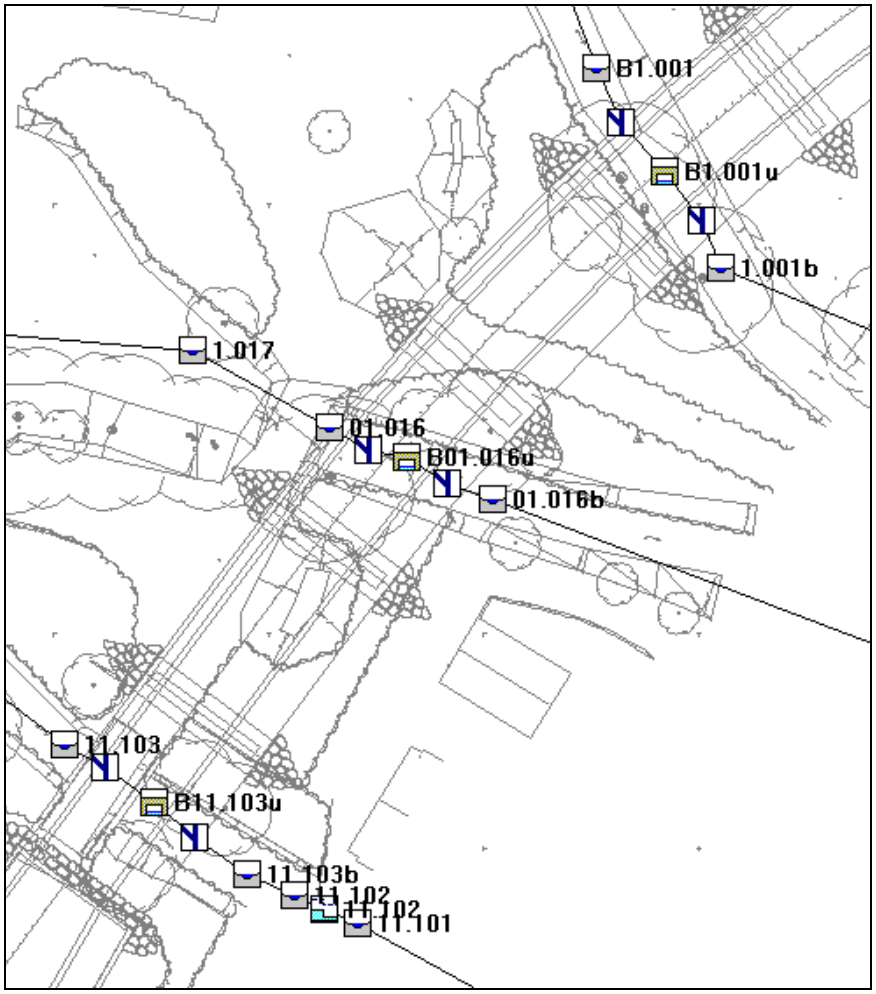


Figure 6: 1d Schematisation of Proposed Bridge

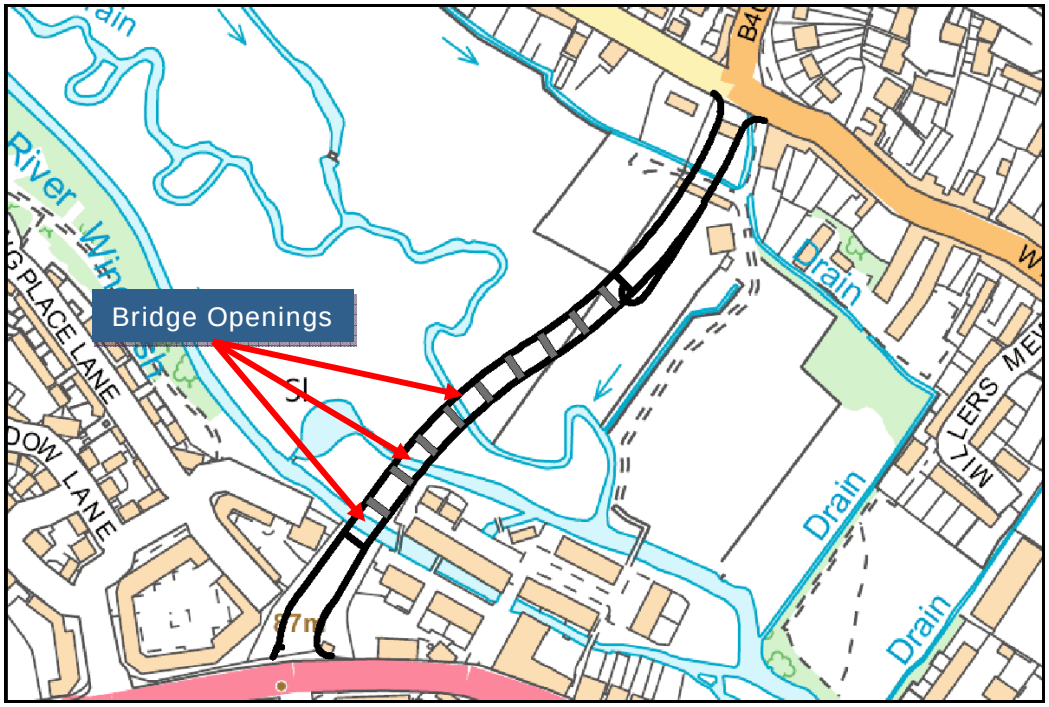


Figure 7: Bridge opening locations

4.5 Bridge Modelling Scenarios

1) **Bridge Scenario A** – To determine the impacts on flood levels caused by the bridge, the dimensions of the bridge openings were based on the proposed bridge design (Drawing Number 43163-S-11) and limited only to the three locations where the bridge crosses the river channels (Figures 5-7).

2) **Bridge Scenario B** – To determine any reduction in flood level which might provide betterment to residents downstream of the bridge, the dimensions of the bridge openings (as in Scenario A) were reduced (Figures 8-10). It was considered appropriate to reduce the total area of the openings to match the total flow area of the downstream Bridge Street bridge (i.e. approximately 20 sq m), as included in the Windrush Model.

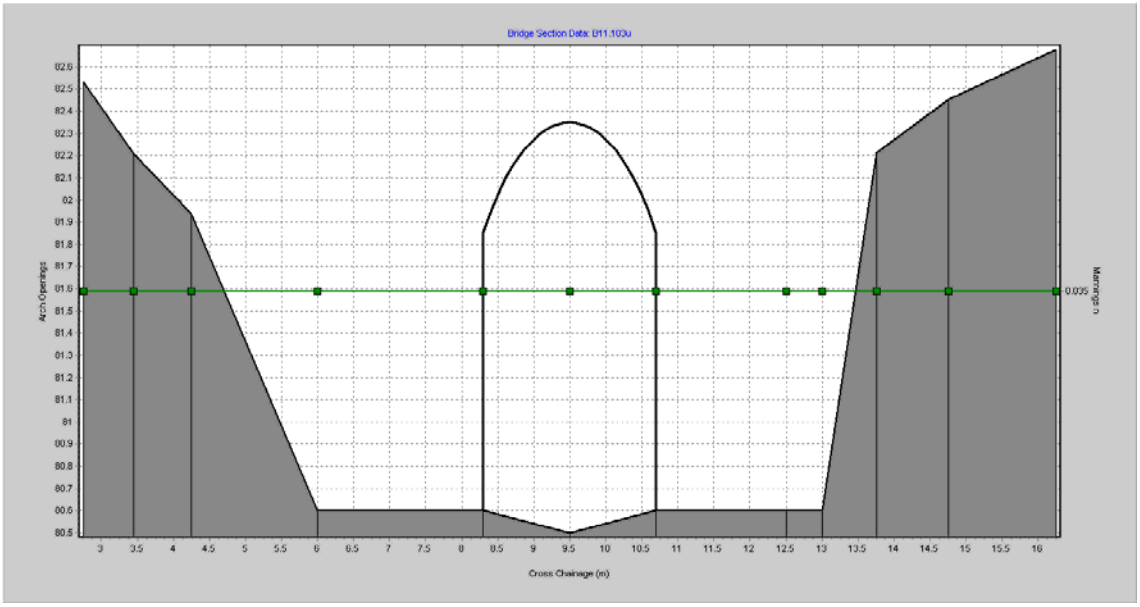


Figure 8: 1d cross section representation of Bridge Section B11.103u (Scenario B) – for location see Figure 6

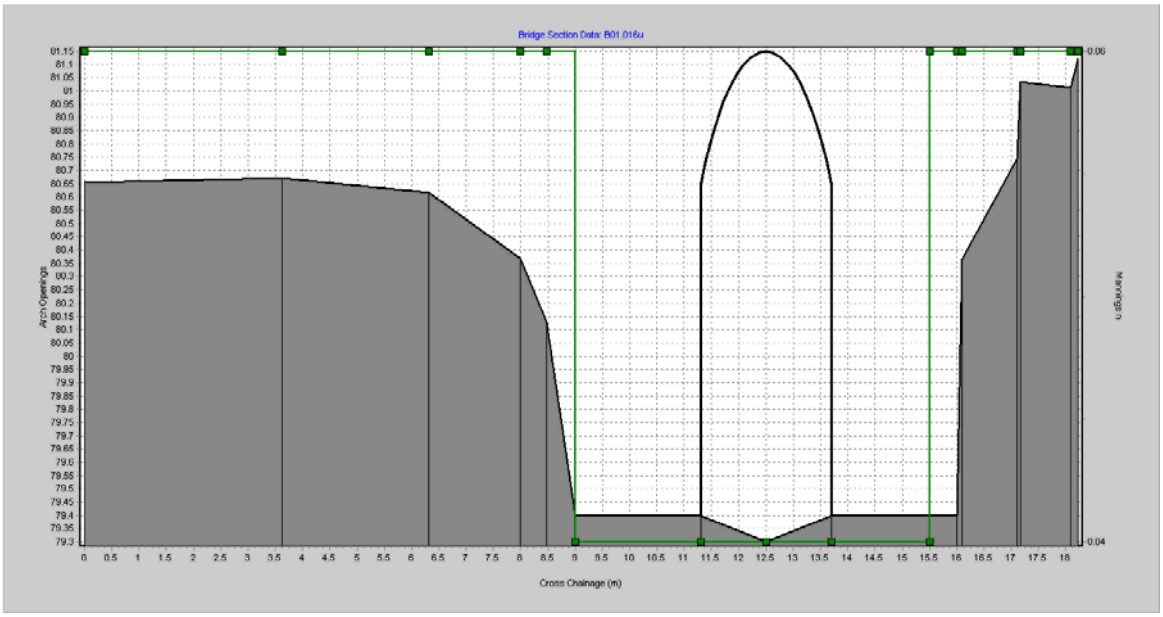


Figure 9: 1d cross section representation of Bridge Section B01.016u (Scenario B) – for location see Figure 6

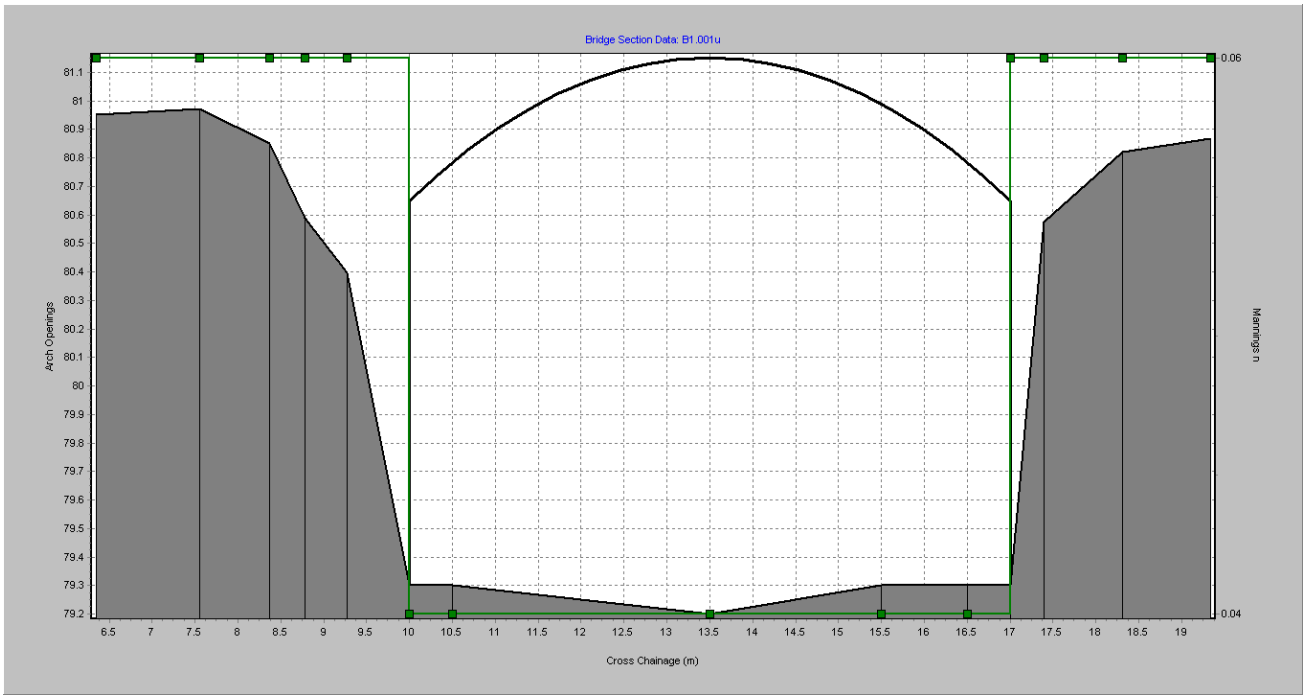


Figure 10: 1d cross section representation of Bridge Section B1.001u (Scenario B) – for location see Figure 6

4.6 Run Parameters

4.6.1 Discussions with software providers CH2M Hill about the use of ISIS/TUFLOW licenses with this model resulted in all simulations being carried out using TUFLOW build 2012-05-AE-iDP-w32 and ISIS version 3.7.0. None of the model parameters of the baseline model were modified.

4.6.2 The following simulations were run for the 100 year plus climate change event:

1) Baseline Scenario – Trimmed River Windrush model
2) Bridge Scenario A – Proposed Design
3) Bridge Scenario B – Reduced Flow Area

5. RESULTS

5.1 Results Locations

5.1.1 In the following sections the results of this modelling study are presented for selected 1d ISIS nodes and a series of fixed 2d results locations (Figure 11).

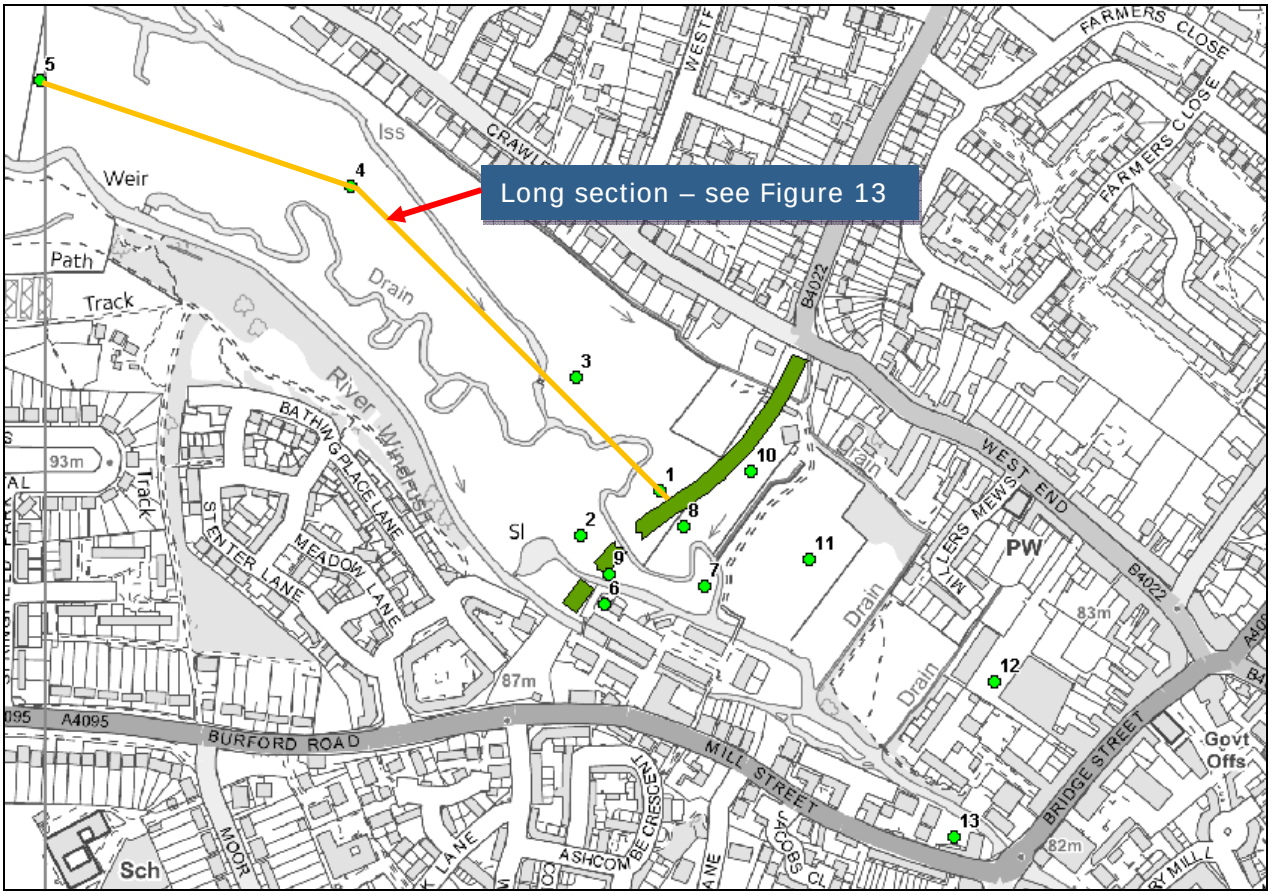


Figure 11: Witney Modelling Assessment Area (Points: 2D Domain Results Location, Polygon: Indicative bridge location)

5.2 Baseline Scenario

5.2.1 In this section the water level and flow results of the Baseline Scenario are compared to the Windrush Model results provided by the Environment Agency.

2d Domain Results

5.2.2 From the 2d domain maximum water level results presented in Table 2 and Figure 12 it can be seen that the baseline model results compare well with the results provided by the Environment Agency.

Table 2: 100 Year plus Climate Change Event – 2d Domain Maximum Water Level Results

Results Location	100 Year plus Climate Change Event - Maximum Water Levels (mAOD)		
	EA Windrush Model Results	Baseline Model	Difference (mm)
1	81.60	81.61	2
2	81.61	81.61	2
3	81.64	81.64	2
4	81.73	81.73	2
5	82.17	82.17	1
6	81.61	81.61	2
7	81.52	81.52	2
8	81.60	81.60	2
9	81.60	81.61	2
10	81.60	81.60	2
11	81.60	81.60	2
12	81.59	81.60	2
13	81.52	81.52	2

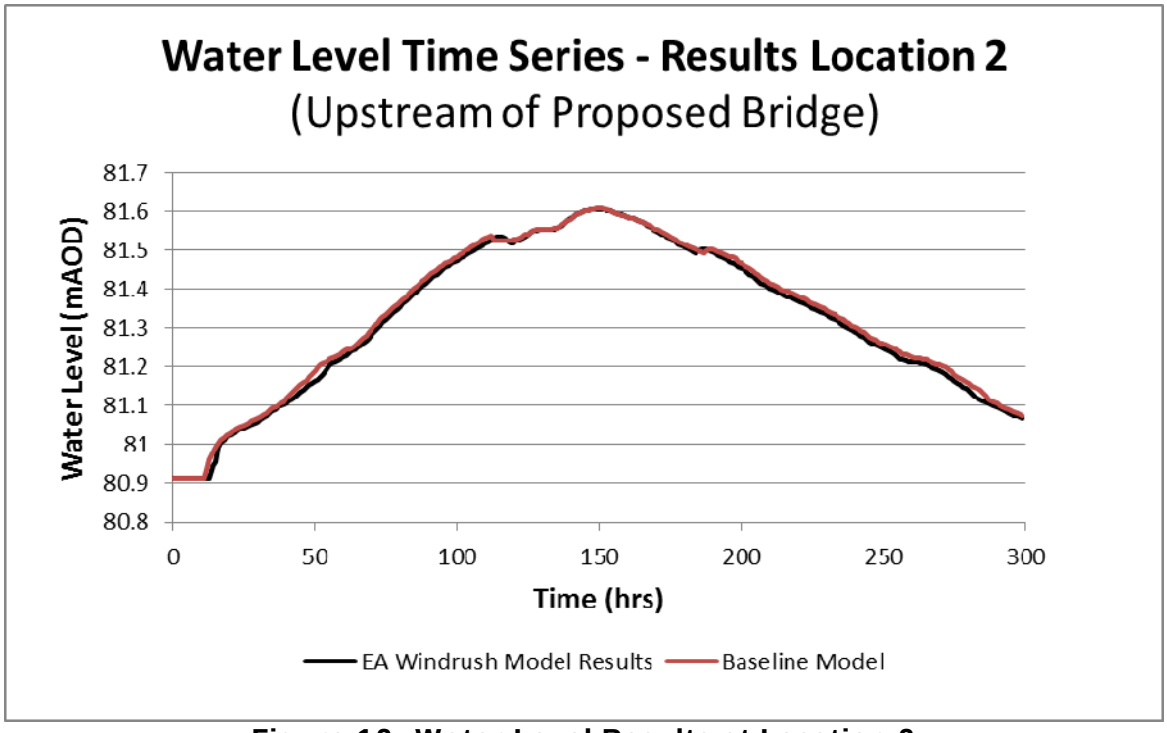


Figure 12: Water Level Results at Location 2

1d Domain Results

5.2.3 As outlined in Chapter 2, the ISIS results provided with the Product 6 data request were derived using a different version of the Windrush model 1d network (i.e. 'WITNEY_ONLY_002.dat'). As part of the Product 6 data, a GIS results layer in NFCDD

format was also provided. The maximum water levels and flows in Table 3 were extracted for ISIS node 01.010d (shown on Figure 13) as this is a logical location and immediately downstream of the confluence of the three river channels.

Table 3: 1d results comparison between datasets

Maximum Water Level (m AOD)	Maximum Flow (cu m/s)
NFCDD GIS Layer = 81.599	NFCDD GIS Layer = 27.702
Product 6 ISIS Results File = 81.616	Product 6 ISIS Results File = 31.395
Baseline Model created in this study = 81.601	Baseline Model created in this study = 27.699

5.2.4 The results of the baseline model compare well with the NFCDD results. The Product 6 ISIS results show higher values than the NFCDD and baseline model results. Since the schematisation of the 'WITNEY_ONLY_002.dat' network is unknown at the time of writing, it has been assumed that the results produced with this network are not directly comparable to the Baseline model results.

5.2.5 Overall, it was concluded that the 'trimmed' Windrush Model (i.e. Baseline Model created in this study) adequately reproduces the flows and water level within the assessment area as shown on Figure 12.

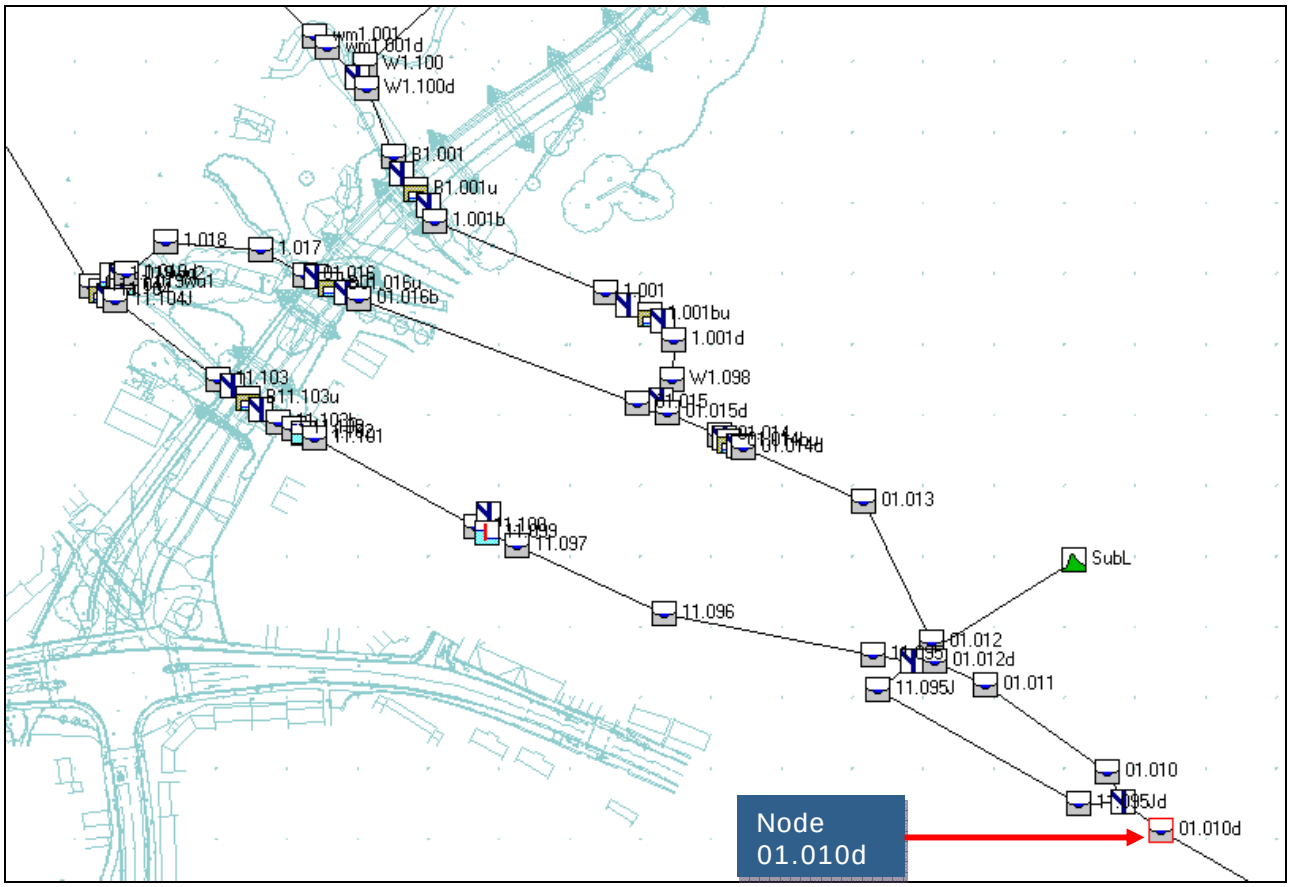


Figure 13: Baseline 1d ISIS Network at proposed bridge location

5.3 Bridge Scenarios

5.3.1 In this section the model results of Bridge Scenarios A and B are compared to the Baseline results as this will determine any impacts on flood levels caused by the proposed bridge design.

5.3.2 The maximum water level results are shown in Table 4 and the maximum depth results are shown in Table 5. Water level hydrographs for two results locations (see Figure 11), upstream and downstream of the proposed bridge are shown on Figure 14 and Figure 15 respectively. Figure 16 shows the maximum water levels for a long section upstream of the proposed bridge for all scenarios.

Table 4: 100 Year plus Climate Change Event – 2d Domain Maximum Water Level Results

Results Location	100 Year plus Climate Change Event - Maximum Water Levels (m)				
	ERCL Baseline Model	Bridge Scenario A	Difference to Baseline (mm)	Bridge Scenario B	Difference to Baseline (mm)
1	81.61	81.64	39	81.90	296
2	81.61	81.62	16	81.89	278
3	81.64	81.66	25	81.91	268
4	81.73	81.75	17	81.94	207
5	82.17	82.17	0	82.17	2
6	81.61	81.61	-1	81.59	-18
7	81.52	81.52	-1	81.57	43
8	81.60	81.60	-8	81.60	-6
9	81.61	81.60	-6	81.58	-25
10	81.60	81.60	-3	81.61	4
11	81.60	81.60	-2	81.60	3
12	81.60	81.59	-2	81.60	0
13	81.52	81.52	-2	81.52	-1

Table 5: 100 Year plus Climate Change Event – 2d Domain Maximum Depth Results

Results Location	100 Year plus Climate Change Event - Maximum Depth (m)		
	ERCL Baseline Model	Bridge Scenario A	Bridge Scenario B
1	0.45	0.49	0.75
2	0.68	0.70	0.96
3	0.67	0.70	0.94
4	0.55	0.57	0.76
5	0.24	0.24	0.24
6	0.19	0.19	0.17
7	0.92	0.92	0.96
8	0.84	0.83	0.84
9	0.86	0.76	0.75
10	0.80	0.79	0.80
11	1.15	1.15	1.15
12	0.66	0.66	0.66
13	0.47	0.47	0.47

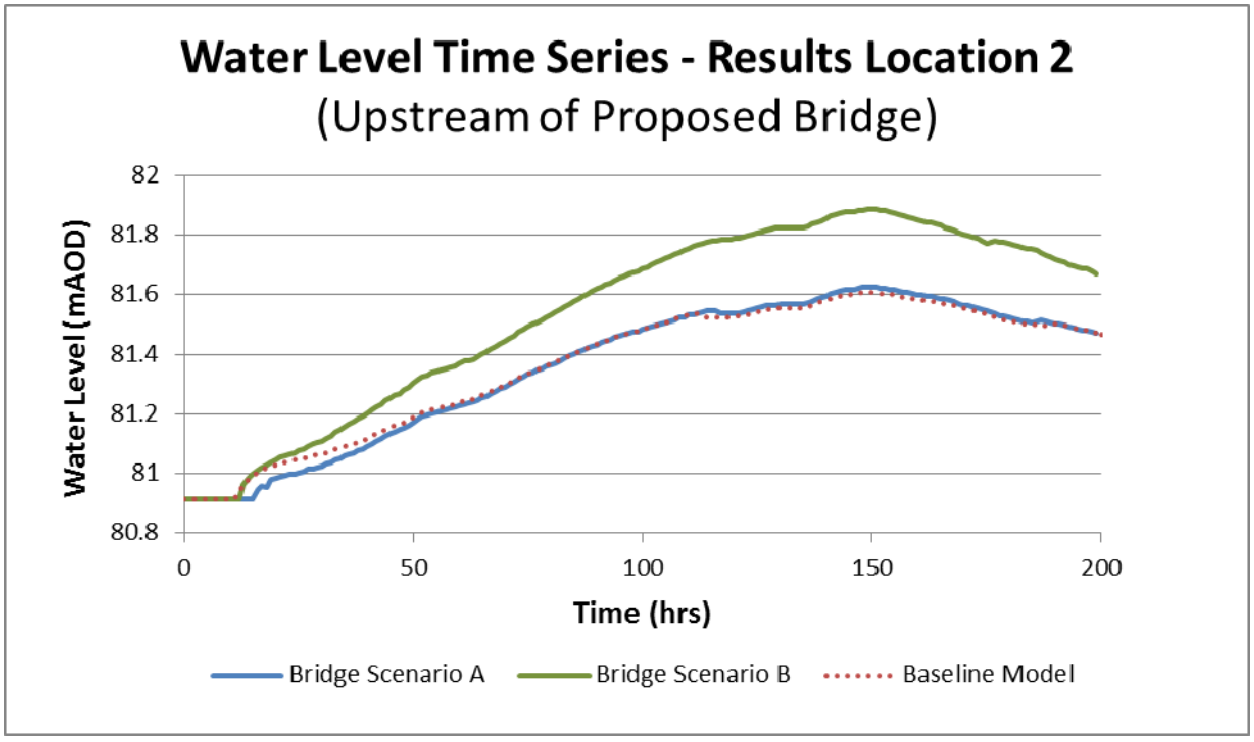


Figure 14: Baseline Model and Bridge Scenarios - Water Level Results at Location 2

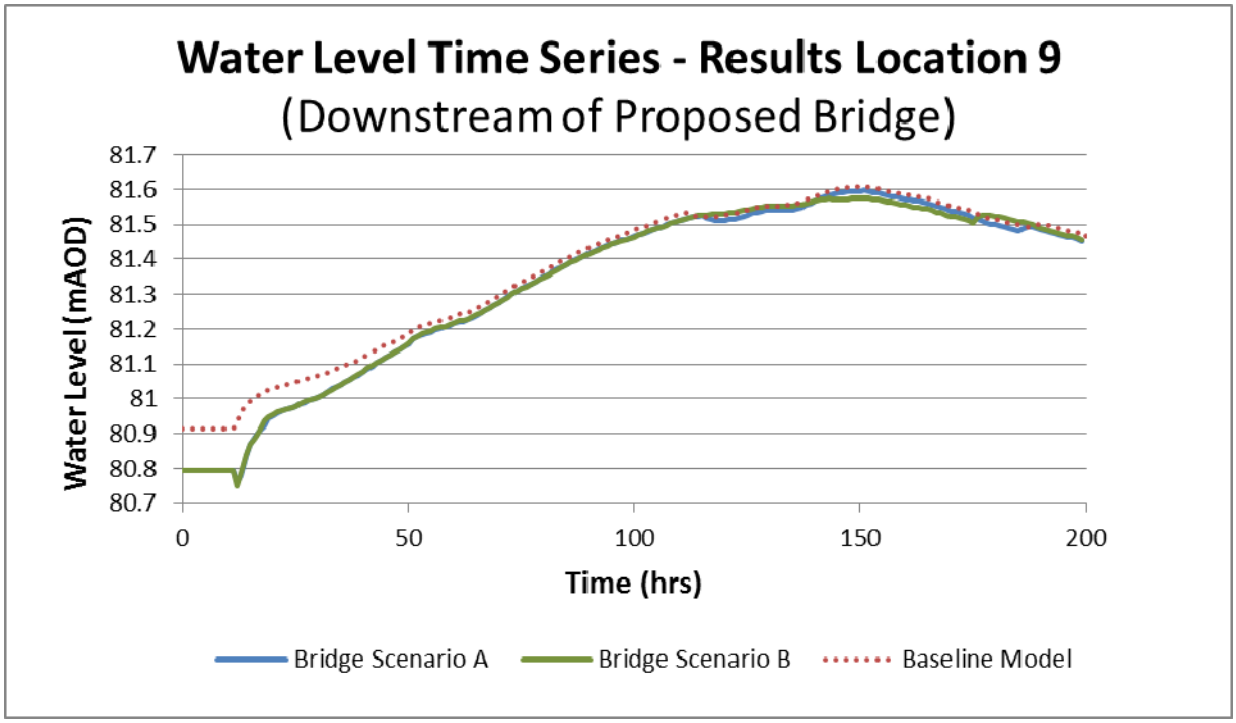


Figure 15: Baseline Model and Bridge Scenarios - Water Level Results at Location 9

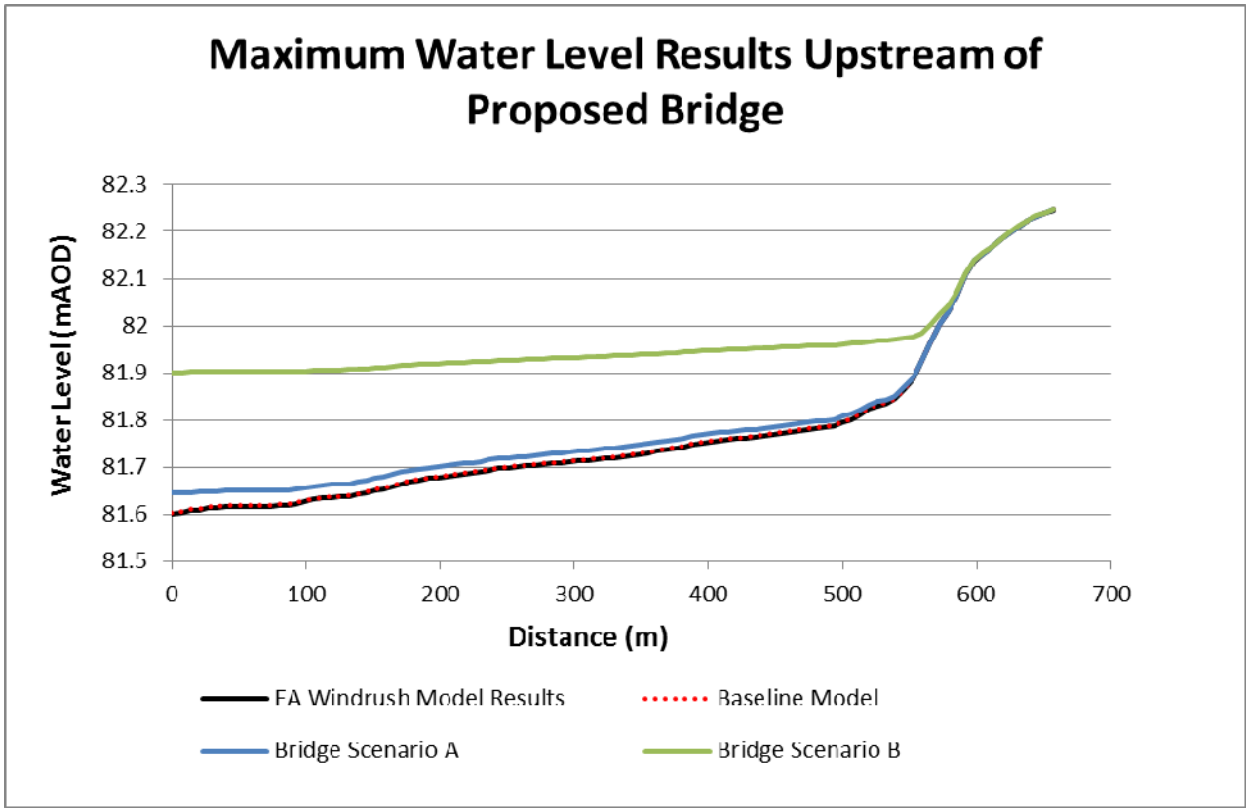


Figure 16: Long Section - Maximum Water Level (mAOD) Upstream of the Proposed Bridge (see also Figure 11)

Bridge Scenario A

5.3.3 Table 4 shows that the impact of the proposed bridge on the maximum water levels is very localised with a maximum increase of 39mm immediately upstream of the bridge (i.e. at Location 1). This difference significantly reduces over a distance of 500m upstream (see also Figure 16). From Figure 17 it can be seen that there are negligible changes to the maximum flood extent as a result of introducing the bridge.

5.3.4 Table 4 also shows that the maximum water levels downstream of the bridge are reduced by up to 8mm. This does not affect the maximum flood extent in this area.

Bridge Scenario B

5.3.5 Table 4 shows that there is a significant increase (i.e. up to 296mm) in the maximum water levels upstream of the proposed bridge (i.e. at Location 1) when considering Bridge Scenario B. Generally the increase in maximum water levels extends up to 600m upstream of the bridge. By consulting Figure 17 it can be seen that the flood extent for this scenario is significantly wider compared to the baseline model flood extent.

5.3.6 Figure 17 also shows that when considering this scenario, there is an increased flood risk to rear gardens of properties along Crawley Road.

5.3.7 Table 4 shows that there is some localised variability in flood levels when compared to the baseline model downstream of the proposed bridge (i.e. 43mm increase at Location 7 and 25mm decrease at Location 9). However, these differences are small and result in no significant changes to the maximum flood extent downstream of the proposed bridge.

5.3.8 Therefore, no flood alleviation opportunities to downstream areas can be offered by reducing the bridge openings and there is an overall negative impact on water levels when considering this scenario.

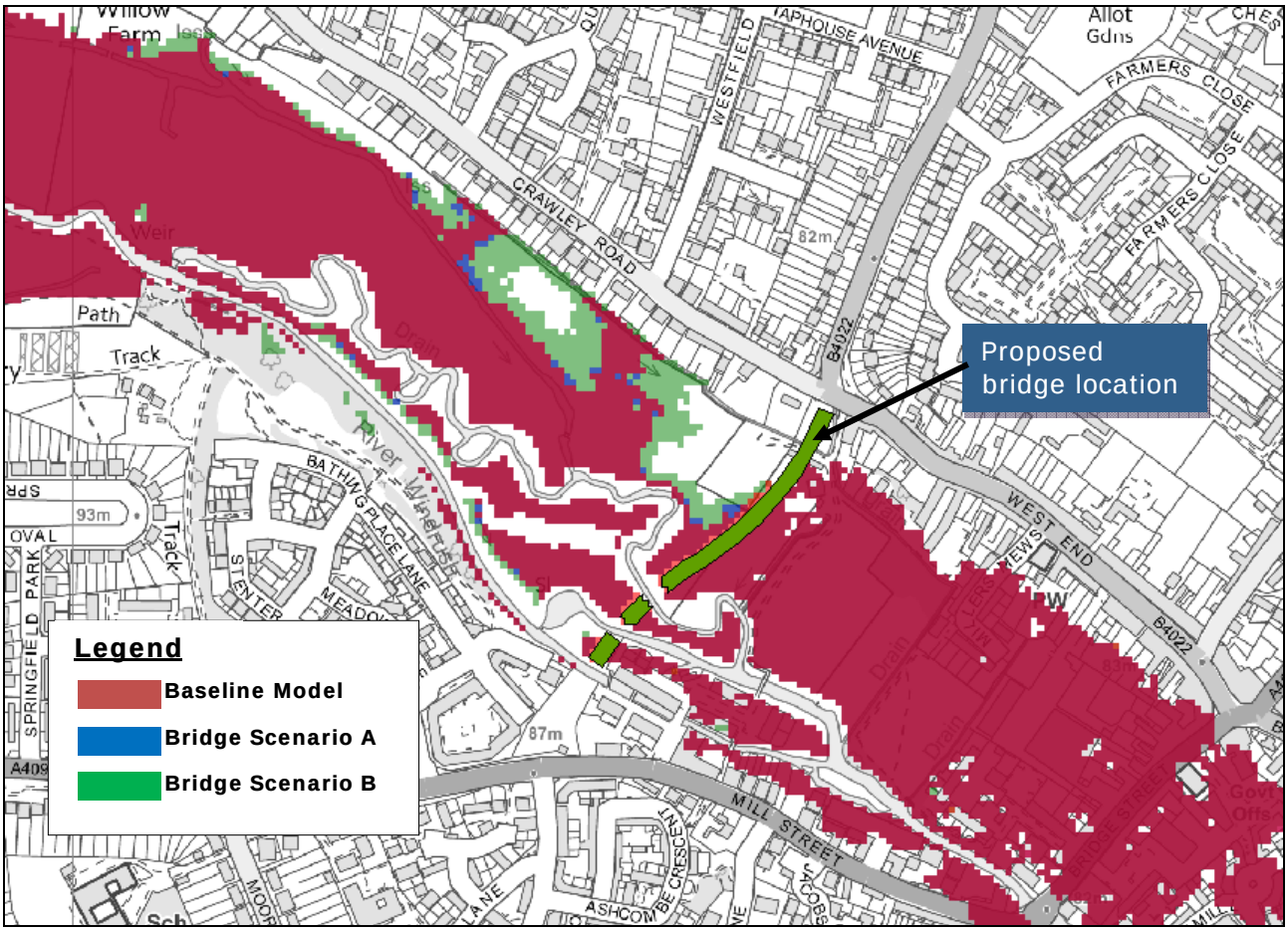


Figure 17: Maximum Flood Extents

6. LIMITATIONS AND UNCERTAINTY

6.1 The scope of this assessment was on the basis that the existing Environment Agency supplied River Windrush ISIS/TUFLOW model would be used and that no critical changes to the model build/structure would be undertaken (e.g. grid orientation, changes to catchment inflow rates etc).

6.2 Inspection of the model indicates that the grid orientation of the 2d domain is set at zero degrees (as shown on Figure 5). In order to optimise the representation of the flow in the assessment area through the 2d domain, it would be more preferable to have the grid aligned at an approximate 45 degree angle. This would also allow for better representation of the bridge piers within the floodplain.

6.3 Further inspection of the model indicates that the grid size of the 2d domain is 5m x 5m. Inspection of Drawing Number 43163-S-11 indicates that the proposed bridge piers have a width of 4m. Therefore, in order to represent the bridge piers/openings in the 2d domain more accurately, it would be more preferable to reduce the grid cell size in addition to re-orientating the model grid.

6.4 However, it is considered that despite these limitations, the findings of this study are reliable and follow well established modelling techniques. It is also considered that such changes to the model are unlikely to significantly change the results when considering both scenarios and the baseline model.

7. CONCLUSIONS

7.1 This modelling assessment has determined that there is negligible impact on flood levels during the climate change 1 in 100 year event as a result of a proposed bridge crossing over the River Windrush and its floodplain.

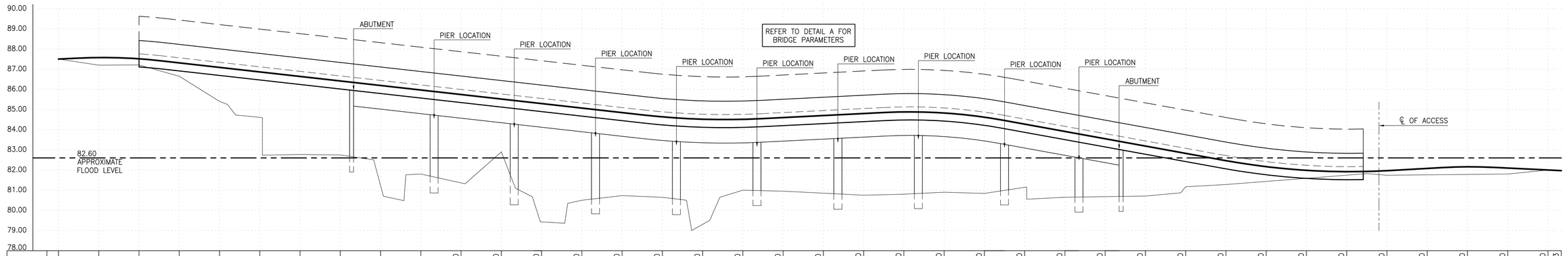
7.2 This assessment has investigated the possibility of alleviating properties of flooding downstream of the proposed bridge location by reducing the proposed bridge openings. The results have shown that there is negligible impact on water levels downstream of the proposed bridge during the climate change 1 in 100 year event, however, water levels upstream of the proposed bridge increase significantly which, in turn, results in an increased flood risk to properties along Crawley Road.

7.3 Therefore, it is recommended that Bridge Scenario B is not pursued further.

7.4 When considering Scenario A, despite three openings being modelled, it is considered that the original scheme as provided by the Client and shown on Drawing Number 43163-S-11, (which includes additional openings), would have even less of an impact on water levels in comparison to the baseline model results and Bridge Scenario A.

DRAWINGS

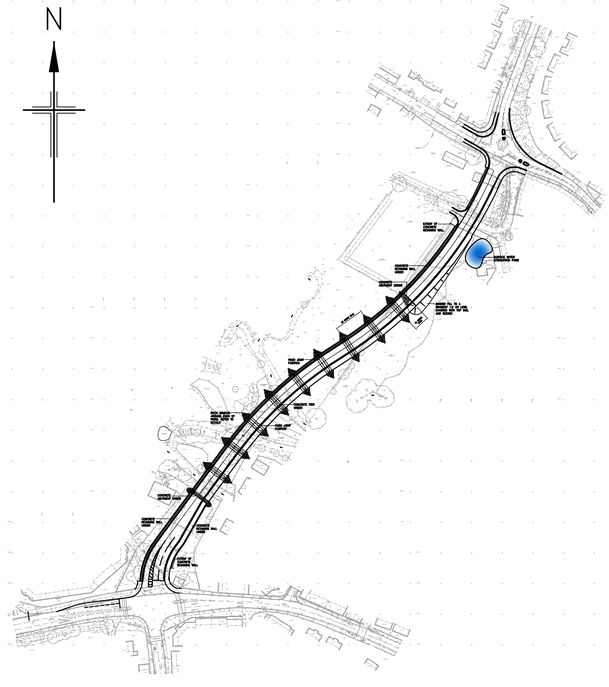
DO NOT SCALE



CHAINAGE	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0	320.0	330.0	340.0	350.0	360.0	370.0	373.3
EXISTING GROUND	87.50	87.20	87.21	86.65	85.40	84.61	82.77	82.75	81.20	81.80	81.36	82.90	79.43	80.50	80.73	80.65	79.30	81.00	80.95	80.85	80.75	80.80	80.90	80.84	81.14	80.65	80.68	80.71	81.17	81.28				81.74			81.80	82.00	81.96
℄ ROAD	87.50																																					81.96	

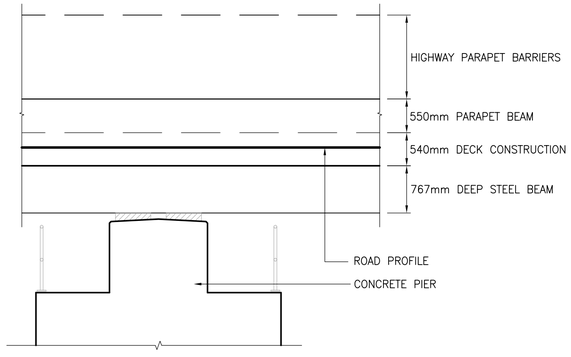
LONG SECTION ALONG CENTRE LINE OF BRIDGE

SCALE 1:500H
SCALE 1:100V



OVERVIEW PLAN OF BRIDGE

SCALE 1:2000



DETAIL A OF BRIDGE MAKE-UP

SCALE 1:50

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. ALL LEVELS ARE IN METRES AND RELATE TO ORDNANCE SURVEY DATUM.
3. ROAD DESIGN TO 50KPH DESIGN SPEED IN ACCORDANCE WITH DMRB TD9/93.
4. BRIDGE LENGTH 190M WITH 2 FIXED JOINT LOCATIONS AND 9 MOVEMENT JOINT LOCATIONS.
5. BRIDGE DESIGN IS PRELIMINARY AND SUBJECT TO TECHNICAL APPROVAL.
6. TO BE READ IN CONJUNCTION WITH DRAWINGS 43163-S-10/11/12/13

REV	DATE	DESCRIPTION	DRAWN	CHKD

REVISIONS

Project: LAND AT NORTH WITNEY	Title: LONG SECTION & CROSS SECTION OF BRIDGE ALIGNMENT	Client: MERIDIAN STRATEGIC LAND LTD	Drawn: M. HOUSE; Date: 28.09.11; Job Manager: M DOUGHTY; Checked: ; Approved: ; Scale: VARIES

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.

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Drawing No. 43163-S-11 | Revision -

Drawing Status
☒ INFORMATION ☐ APPROVAL ☐ COSTING
☐ TENDER ☐ CONSTRUCTION ☐ AS CONSTRUCTED

A1


EVANS
Rivers and Coastal