HIGHWAYS AGENCY

Fluvial Hydraulic Modelling Report

1. Basic Model Information

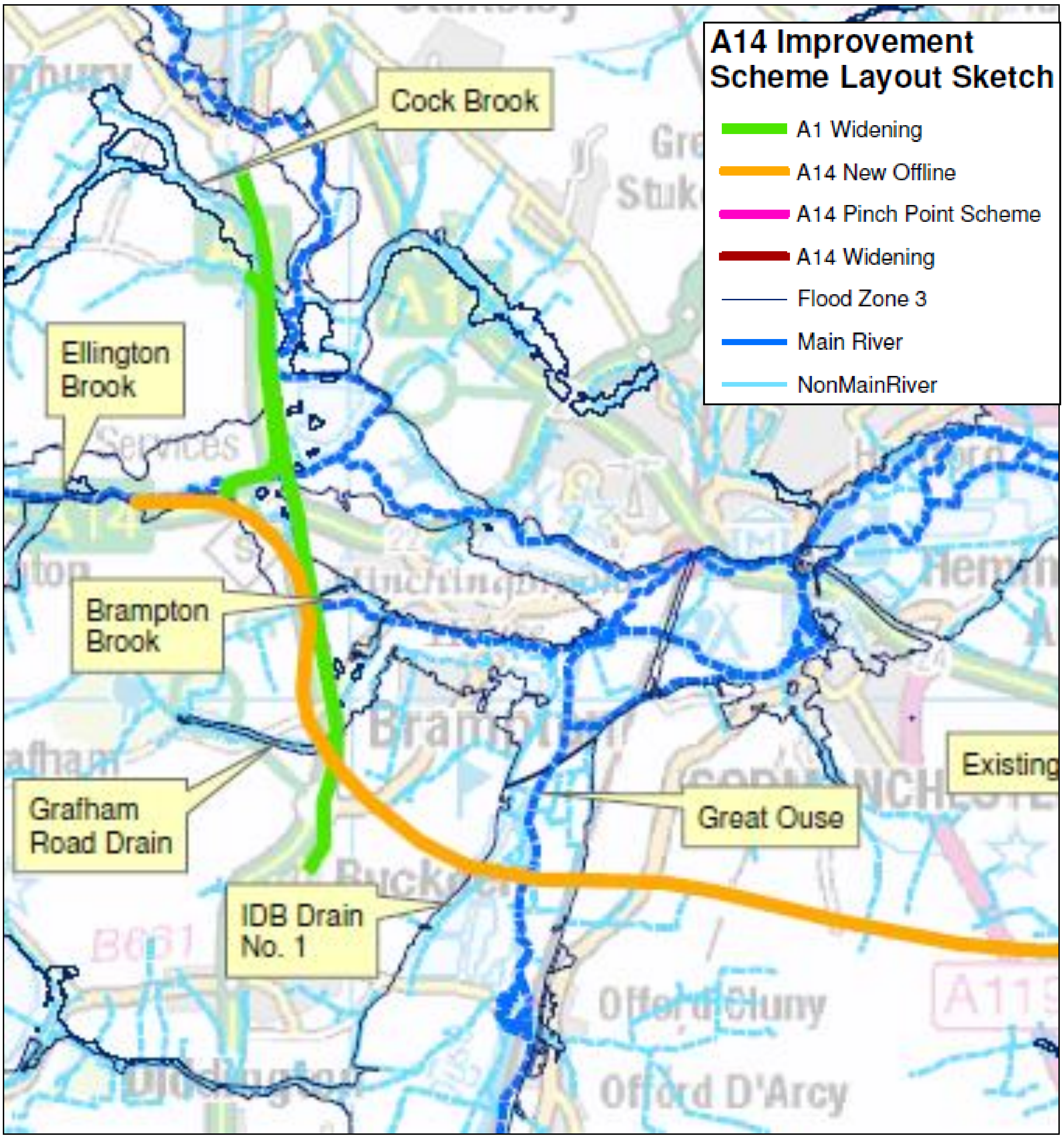
Model Name:	A14 Brampton Brook	
Primary Watercourses / Water Bodies	Brampton Brook	
Designation	Main river	
Model ID	The following table presents information regarding the Existing and Scheme Model Scenario ID	
Model Scenario ID	**Scenario**	**Return Period**
A14_BRM_BL_025_004.DAT	Existing Model	1 in 25 years (4% AEP)
A14_BRM_BL_100_004.DAT		1 in 100 years (1% AEP)
A14_BRM_BL_100CC_004.DAT		1 in 100 years + 20% (1%+CC AEP)
A14_BRM_025_004_designV2.DAT	Scheme Model	1 in 25 years (4% AEP)
A14_BRM_100_004_designV2.DAT		1 in 100 years (1% AEP)
A14_BRM_100CC_004_designV2.DAT		1 in 100 years + 20% (1%+CC AEP)

2. Survey Data and Base Mapping

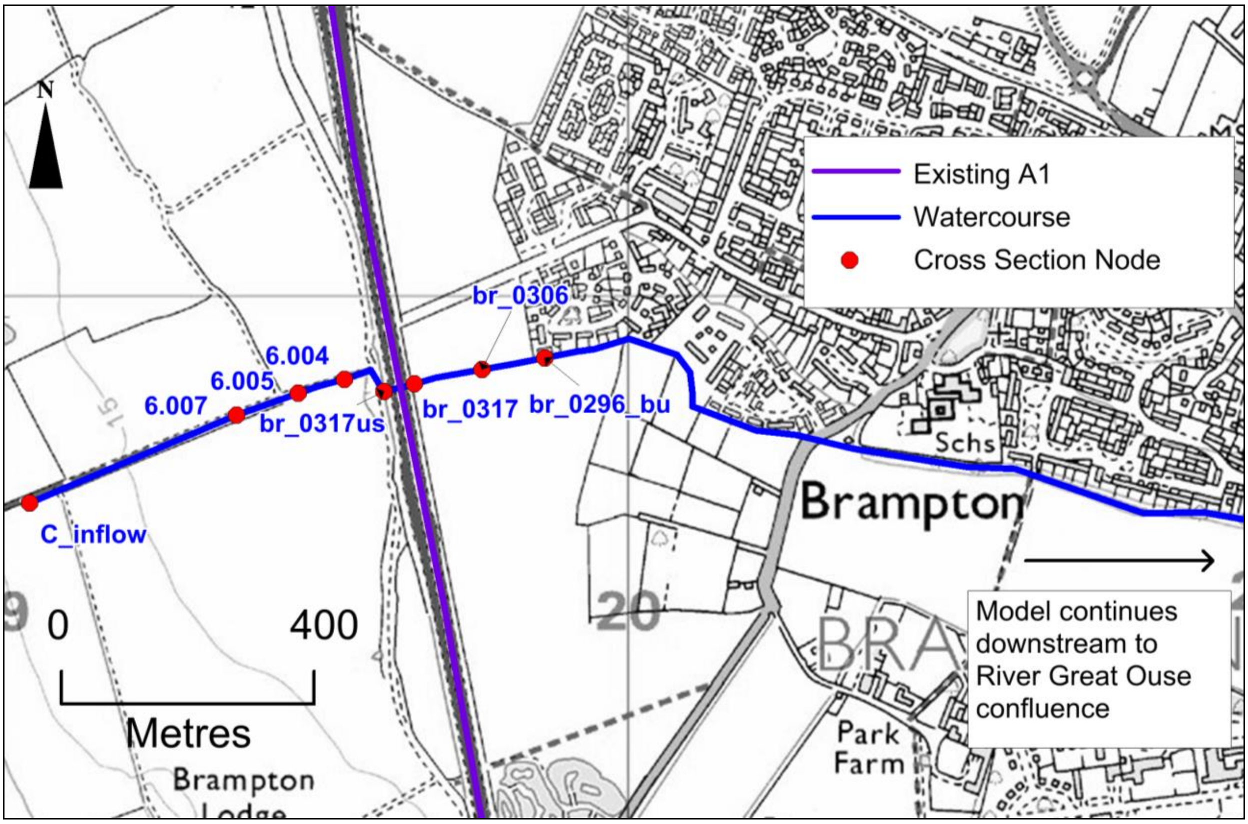
2.1 Base Mapping:	1 to 10,000 Scale Raster Reference: TL1060, TL1070, TL2060, TL2070
2.2 DTM for 2D Model domain:	N/A 1D Model
2.3 River channel/Structures survey	All survey data have been retained as in existing model. Number of cross-sections included in this model: 83

3. Baseline Hydraulic Model Schematisation		
3.1 Software:	**1D domain:**	ISIS Version 3.7.0.233 (32 bit - Single Precision)
	2D domain(s):	N/A
3.2 Baseline model:	Atkins 2009 ISIS 1D Model	
3.3 Baseline Model Reference	Atkins (2009) Ellington to Fen Ditton Phase 1a: A14 Hydraulic Modelling Report	
3.4 Model area / extent:	The areal extent of the model and model schematisation in the proximity of the new A14 are presented in the following figures There were some problems with the baseline model e.g. glass walling at some cross sections and over extended cross sections creating unrealistic extra storage. To resolve this, the cross sections were amended by Jacobs. Cross section 6.004 and 6.001 were extended to higher ground to remove glass walling. Cross section 6.005 was trimmed to remove extra storage.	

Areal Extent of Brampton Brook



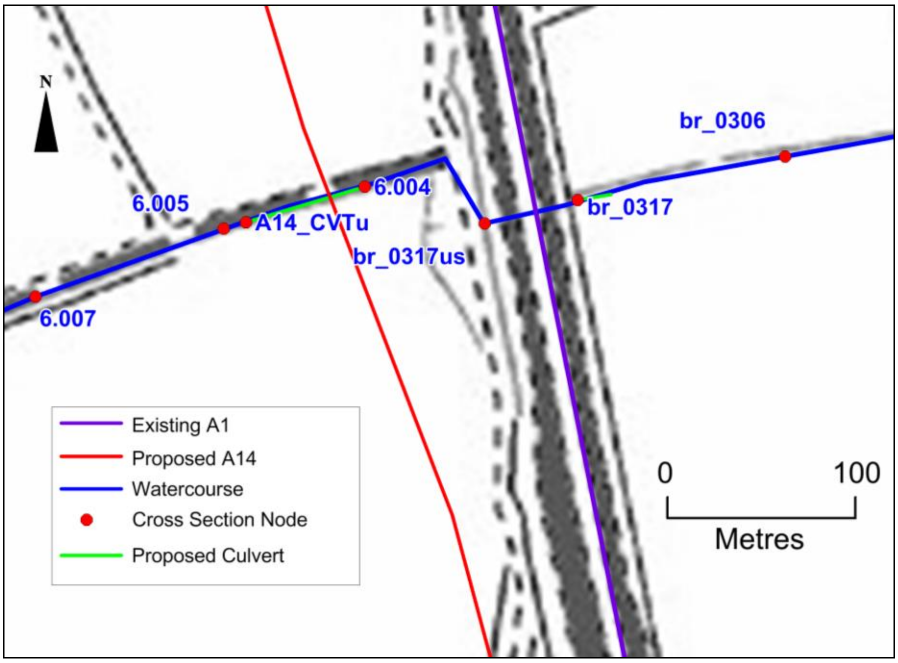
Model Schematisation including upstream model nodes and key node locations. Due to the size of the model the downstream model node is not shown (Distance in between cross sections nodes have been approximated based on ISIS 1D model distances).

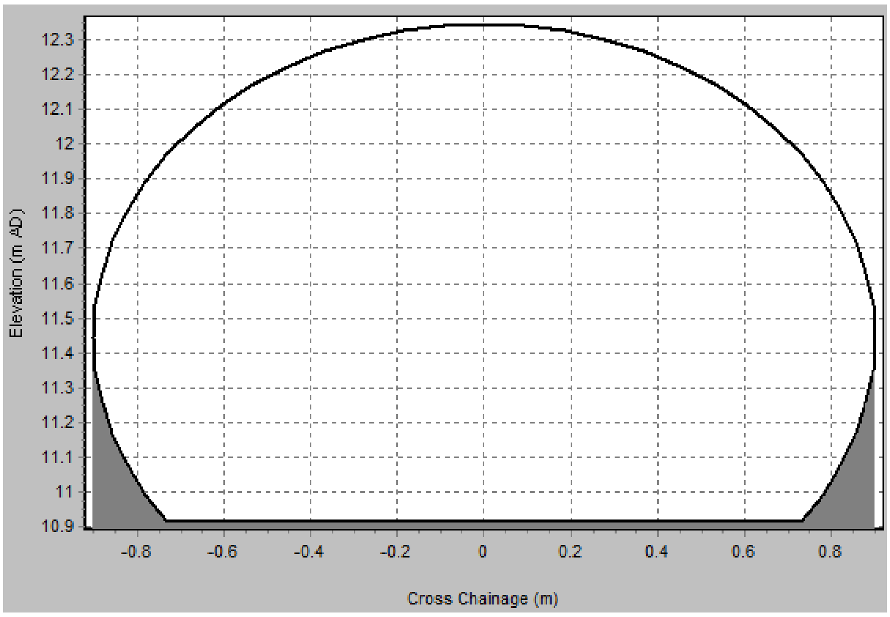


3.5 Model reaches:	The following model reaches as shown on the maps referred above have been defined in the model:		
Watercourse name	**Upstream model node**	**Downstream model node**	
Brampton Brook	C_inflow	br_0001_ds	
Total model length (km):	3.417		
3.6 Key Model structures:	A 1.5m culvert passes Brampton Brook under the existing A1		
3.6 Floodplain schematisation	Floodplain areas have been modelled using a 1D approach in the ISIS model, using extended cross sections		
3.7 Model Boundaries - Inflows	Hydrological flow hydrographs are input into the model as point inflows at locations indicated in the table below:		
(a) Existing Model	Peak inflows (m^3/s) are summarised in the table below for the existing model.		

Input Node in the Hydraulic Model	**Annual Exceedance Probability**		
	4%	**1%**	**1% + CC**
A_inflow	3.061	4.348	5.218
B_inflow	1.769	2.543	3.051
C_inflow	0.944	1.375	1.650
C_IDB	0.282	0.411	0.493
D_inflow	0.824	1.172	1.407
13.026	1.179	1.179	1.179

3.8 Model Boundaries – Downstream Conditions	Downstream boundary conditions adopted in the model are as follows:
	The outflows at the downstream end of the model extent are modelled using a nominal stage-time boundary set at a level of 10.2m AOD. This boundary condition was applied at node br_0001_ds, which is approximately 3km downstream of the existing A1.

4. Scheme Model Build	
4.1 Scenario Definition	Inclusion of a 65m circular culvert of 1.5m under the new A14 alignment. 17m extension of the existing A1 culvert, to allow the road to be widened.
ISIS 1D Model	
4.2 Model Extent of the Affected area	**Design model schematisation showing key nodes and the new and extended culverts** 
4.3 Modelling approach for the new structures	Culvert br_0317us has been extended by 17m on the downstream side. The bed level on the downstream side of the culvert remains flat for 110m, therefore to allow for the extension the downstream cross section was moved 17m downstream, without changing the bed levels. A new circular conduit (br_0317con3) was added downstream of the existing conduit (br_0317con2). Originally, in the model received by the Environment Agency the existing culvert br_0317 had a diameter of 1.4m. Based on new survey provided by the Highways Agency the diameter of this culvert was updated to 1.5m. The proposed culvert extension also has a diameter of 1.5m. The new 65m culvert is located approximately 170m upstream of the A1. In the ISIS model the proposed culvert is located between cross sections 6.005 and 6.004. A copy was made of 6.005 to create A14_CVTu, 8m downstream. Bed levels for the new cross section were amended by interpolating between the cross sections either side. The new culvert was added using two symmetrical conduit units. The bottom 20% of the circular conduits was set at a flat profile, to represent the base of the conduit being buried (as described in section 4.5). The existing cross section 6.004 was in an appropriate place to be used as the downstream end of the new culvert.
4.4 Model Units added/removed	The culvert extension was modelled using the following units: Culvert Inlet Unit = br_0317us

	Circular Conduit Unit (x3) = br_0317con1, br_0317con2, br_0317con3 Culvert Outlet Unit = br_0317con3 Introduced Cross section Unit = br_0317con3 Proposed culvert was modelled using the following units: Culvert Inlet Unit = A14_CVTu Symmetrical Conduit Unit (x2) = A14_C1 and A14_C2 Culvert Outlet Unit = A14_C2 Introduced Cross section Unit = A14_CVTu
4.5 Culvert Inverts	Extended culvert upstream Invert = 9.93m (from existing model) Extended culvert Downstream Invert = 9.82m (from existing model) Extended culvert Inlet Control Data = Conduit Type A used (k= 0.0098, M=2, C= 0.0398, Y=0.67, Ki=0.5) – as in exiting model Extended culvert Outlet Loss Coefficient = 1.0 Proposed culvert upstream Invert = 10.065m Proposed culvert Downstream Invert = 9.956m (As upstream open section level) Proposed culvert Inlet Control Data = Conduit Type A used (k=0.0098, M=2, C=0.0398, Y=0.67, Ki=0.5) Proposed culvert Outlet Loss Coefficient = 1.0 The proposed culvert is buried by 20% of the culvert diameter. This effect has been reproduced by using a symmetrical conduit unit instead of a circular conduit unit. An example of this is shown in the following figure: 
4.6 Hydraulic Roughness of proposed units	For extended culvert Manning's n = 0.04 (from existing model) Roughness coefficients for proposed culverts based on design specifications. Bed roughness Colebrook-White Friction = 0.3 (For natural channel) Wall/Soffit roughness Colebrook-White Friction = 0.00015 (For smooth concrete)

5. Hydraulic Model Outputs

5.1 Model Simulations

The model outputs were processed to extract maximum stage values at key locations for the 4%, 1% and 1% + CC AEP.

a) Existing Model

Maximum Stage values for the Existing Model are provided in the table below at key locations

Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
115m u/s of A14	6007A	11.469	11.53	11.572
u/s of proposed A14	A14_CVTu	11.284	11.413	11.489
d/s of proposed A14 (at proposed extension outlet location)	6.004	11.26	11.412	11.489
u/s of A1	br_0317us	11.14	11.242	11.289
d/s of A1	br_0317	11.068	11.141	11.172
60m d/s of A1	br_0306	11.057	11.135	11.167

b) Scheme Model

Maximum Stage values for the Scheme Model are provided in the table below at key locations

Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
115m u/s of A14	6007A	11.529	11.669	11.771
u/s of proposed A14	A14_CVTu	11.458	11.658	11.769
d/s of proposed A14 (at proposed extension outlet location)	6.004	11.402	11.577	11.674
u/s of A1	br_0317us	11.22	11.331	11.389
d/s of A1	br_0317	11.083	11.145	11.172
60m d/s of A1	br_0306	11.067	11.136	11.165

Effect of proposed Structures

Model results were interrogated immediately u/s of proposed A14 structure (model node = A14_CVTu) and the increase in maximum stage was calculated as follows:

20yr event

Max stage rise: 174mm

100yr event

Max stage rise: 245mm

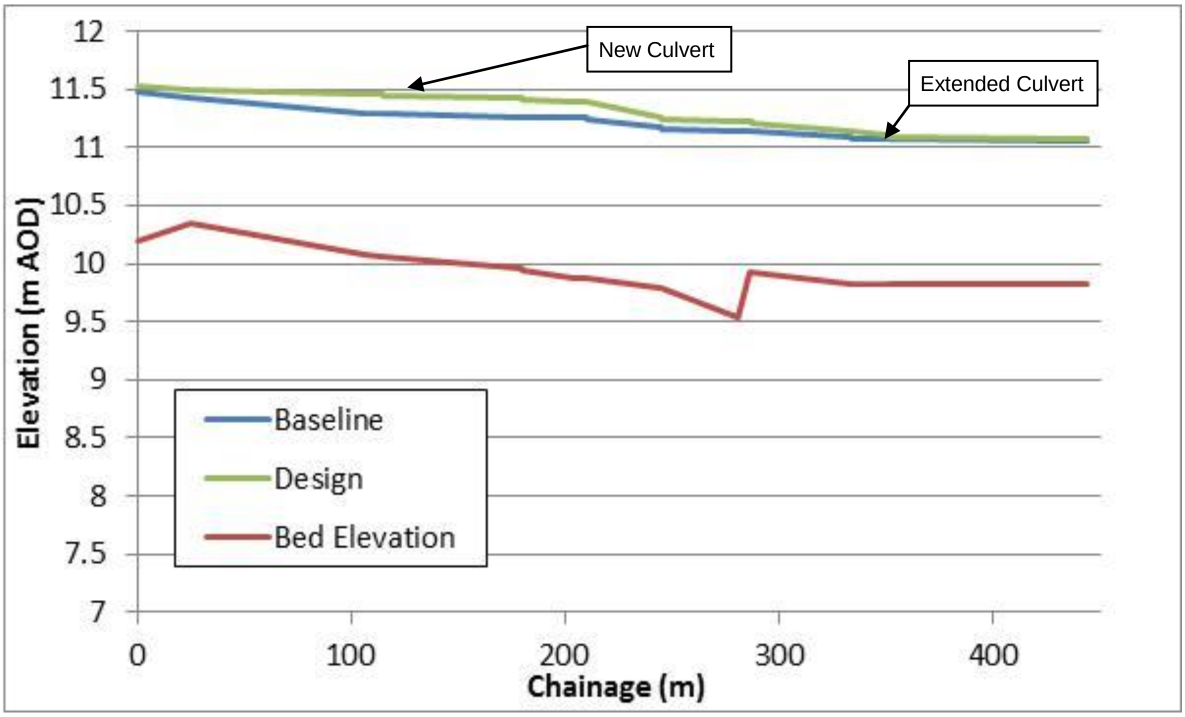
100yr CC event

Max stage rise: 280mm

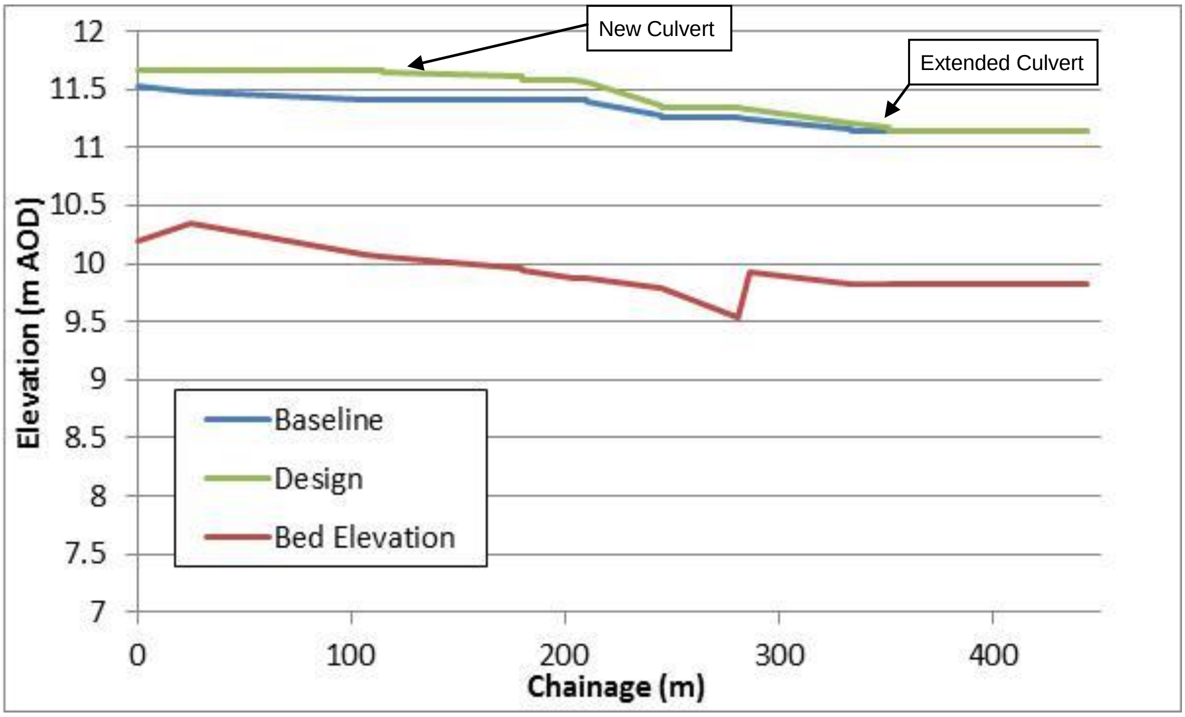
In all three return periods the upstream reach length influenced by the increase in stage extends beyond the upstream limit of the model. The upstream model node, C_inflow, is approximately 480m upstream of the proposed A14. At this location the maximum stage in the 20yr event design scenario is 90mm greater than in the baseline. For the 100yr event the design maximum stage is 70mm greater than the baseline. For the 100yr cc event the difference in maximum stage between the baseline and design is 120mm, at the upstream extent of the model.

The following figures present a comparison between maximum stage for the Existing and Scheme Models for the 4%, 1% and 1% + CC AEP.

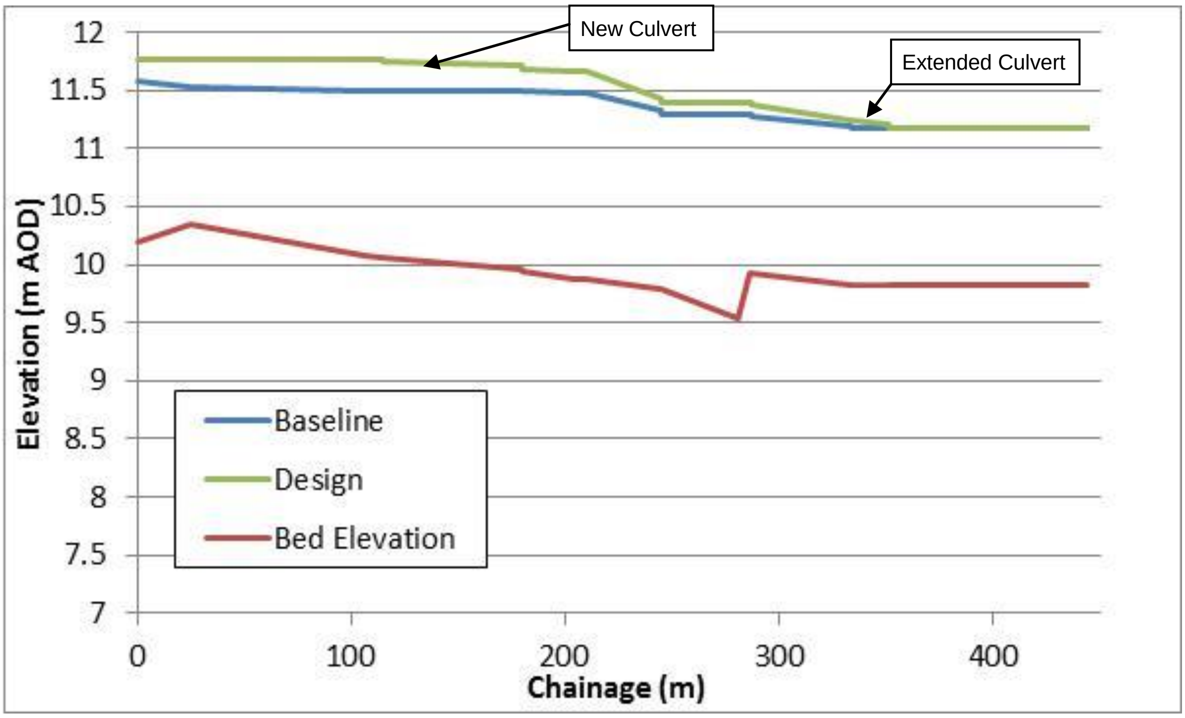
Maximum Stage Upstream and Downstream of proposed culvert – 4% AEP



Maximum Stage Upstream and Downstream of proposed culvert – 1% AEP



Maximum Stage Upstream and Downstream of proposed culvert – 1%+CC AEP



6. Key model assumption and limitations

- The supplied hydraulic models were assumed to be fit for purpose and no detailed review was undertaken for the purpose of Flood Risk Assessment of the A14 scheme.
- In the baseline model, some glass walling was identified in some locations. Any amendments to model to eliminate glass walling were beyond the scope of this comparative study. However, where the glass walling was most extensive and topographic data was readily available, the baseline model was amended.
- In the baseline model, some over extended cross sections were creating unrealistic extra storage. One such cross section was trimmed to remove extra storage.
- The location of the proposed culvert and extended existing culvert were calculated based on design drawings for the proposed A14 alignment.
- Cross sections have been copied and lowered as appropriate to retain existing channel gradient.
- No calibration or sensitivity testing simulations were carried out as part of this hydraulic modelling exercise