HIGHWAYS AGENCY

Fluvial Hydraulic Modelling Report

1. Basic Model Information

Model Name:	West Brook	
Primary Watercourses / Water Bodies	West 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**
Baseline _fenstanton_Hilton(last updated_designrun)_25.sim11	Existing Model	1 in 25 years (4% AEP)
Baseline _fenstanton_Hilton(last updated_designrun)_100.sim11		1 in 100 years (1% AEP)
Baseline _fenstanton_Hilton(last updated_designrun)_100CC.sim11		1 in 100 years + 20% (1%+CC AEP)
Proposed _fenstanton_Hilton(last updated_designrun)_25.sim11	Scheme Model	1 in 25 years (4% AEP)
Proposed _fenstanton_Hilton(last updated_designrun)_100.sim11		1 in 100 years (1% AEP)
Proposed _fenstanton_Hilton(last updated_designrun)_100CC.sim11		1 in 100 years + 20% (1%+CC AEP)

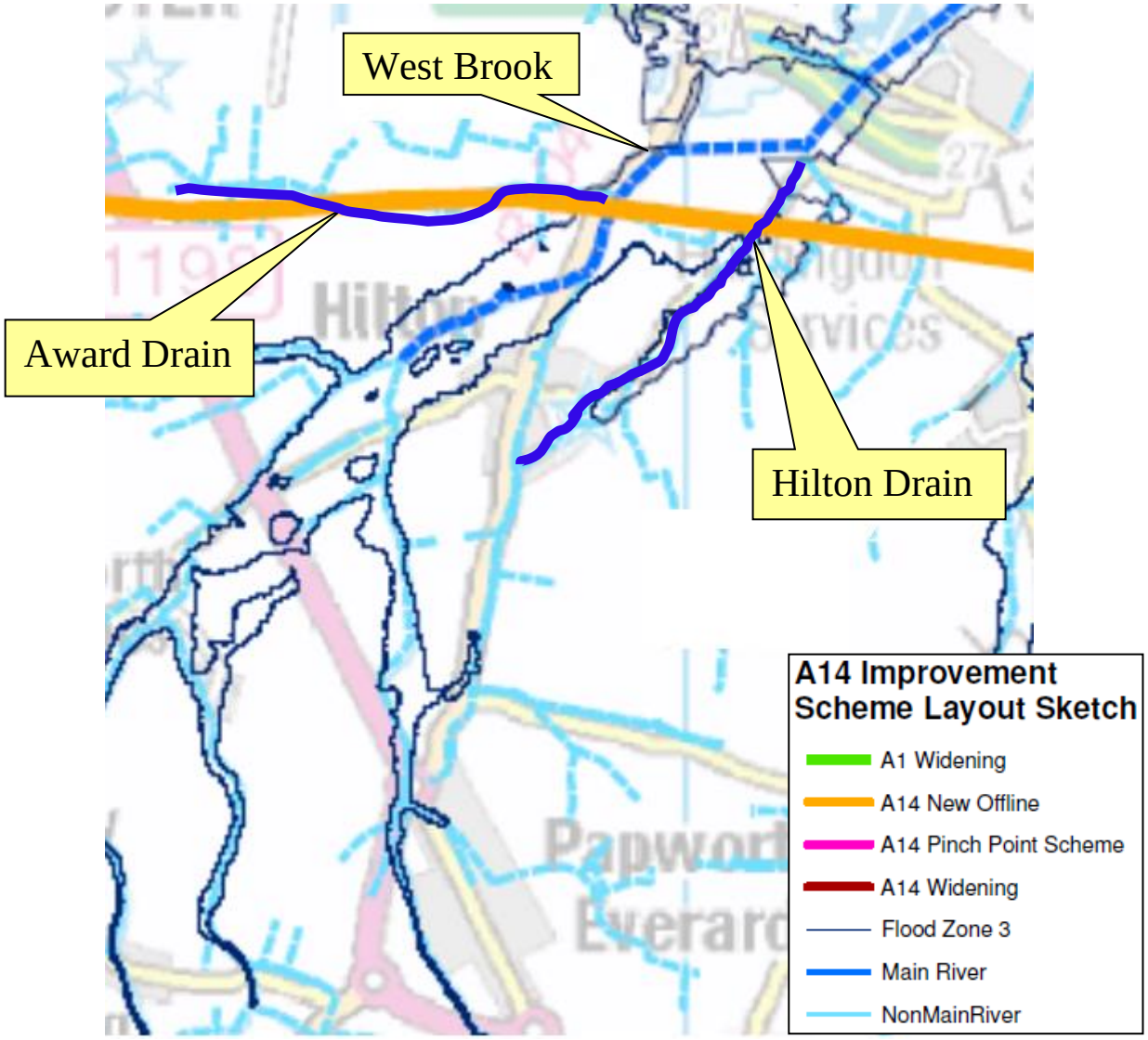
2. Survey Data and Base Mapping

2.1 Base Mapping:	1 to 10,000 Scale Raster Reference: TL3060
2.2 DTM for 2D Model domain:	N/A 1D Model
2.3 River channel/Structures survey	All cross section data from the original model has been retained as in existing model. Number of cross-sections included in this model: 93

3. Baseline Hydraulic Model Schematisation

3.1 Software:	**1D domain:** MIKE11 2011
	2D domain(s): N/A
3.2 Baseline model:	Atkins 2009 MIKE11 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. The model includes three reaches that are crossed, the Award Drain, the West Brook and the Hilton Drain. Model outputs and comparisons in the following sections show each of these reaches separately. The West Brook has been modelled using a separate ISIS Tuflow model and therefore only the Award Drain and Hilton Drain are reported below.

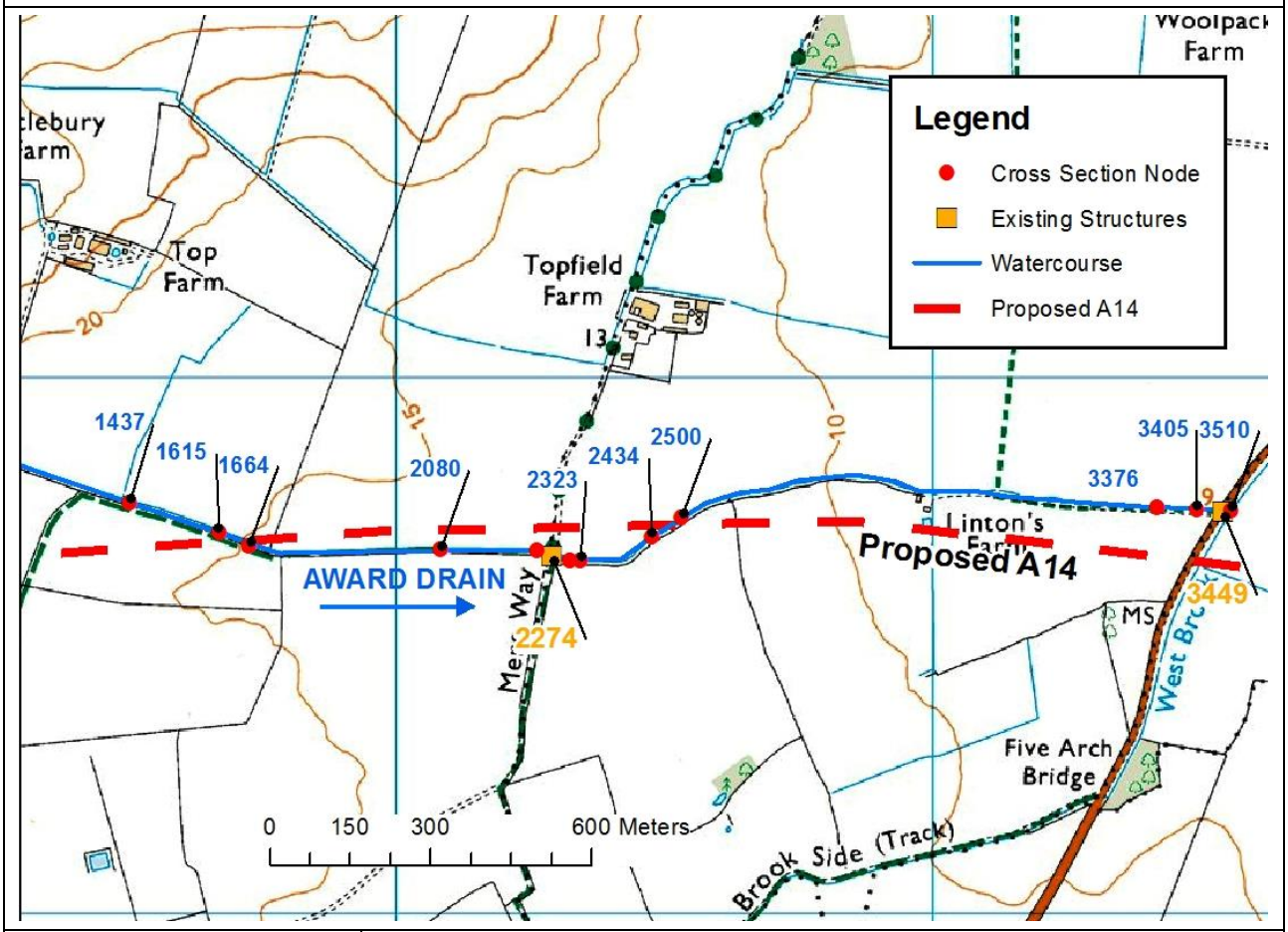
Areal Extent of Award Drain/Hilton Brook Model



Model Schematisation for the area of interest on Award Drain

(Distance in between cross sections nodes have been approximated based on MIKE11 model distances)

4. Award Drain Existing Model



4.1 Model reaches:	The following model reaches as shown on the maps referred above have been defined in the model:

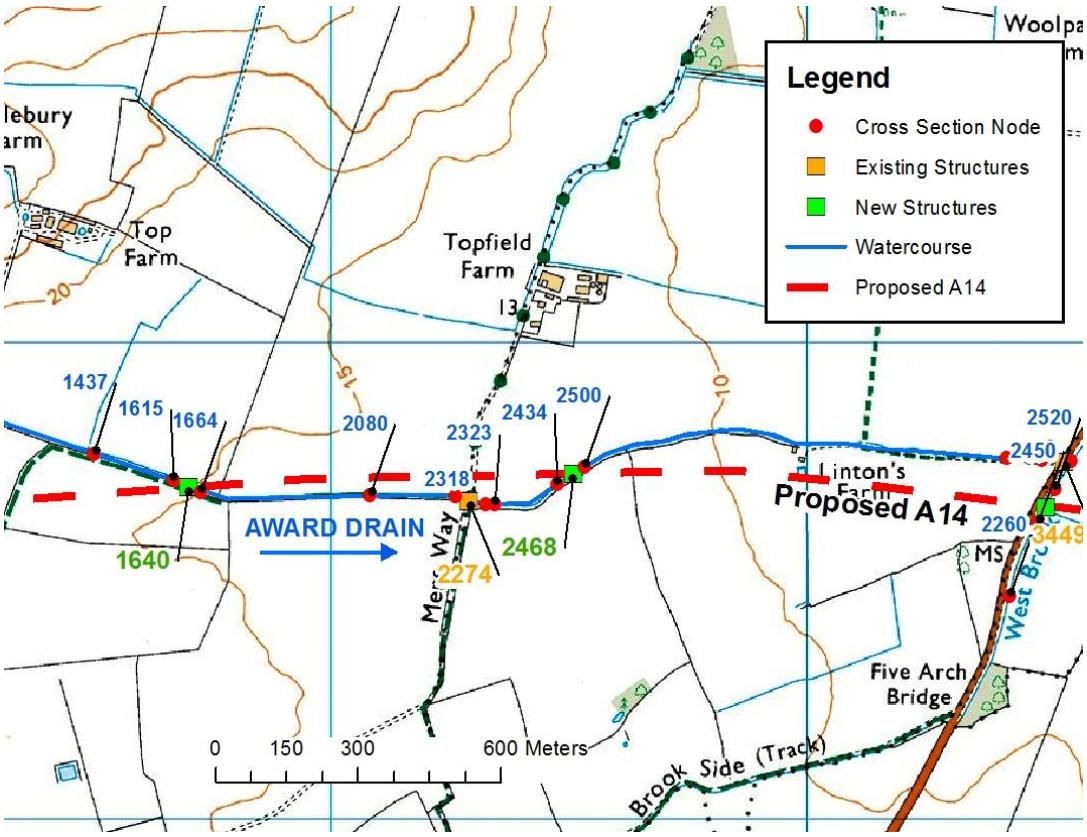
Watercourse name	**Upstream model node**	**Downstream model node**
Award Drain	0	3510
Total model length (km):	3.15	

4.2 Model structures:	2274 and 3449
4.3 Floodplain schematisation	Floodplain areas have not been modelled all flow is modelled with in the channel banks.
4.4 Model Boundaries - Inflows	Hydrological flow hydrographs are input into the model as a point inflow at 0m Chainage:
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**
0m	1.096	1.511	1.83

4.5 Model Boundaries – Downstream Conditions	The downstream boundary of the Award Drain are water levels in the West Brook.

5. Award Drain Scheme Model Build

5.1 Scenario Definition	Two new A14 stream crossings and two culvert upgrades on existing road crossings.
MIKE11 1D Model	
5.2 Model Extent of the Affected area	
5.3 Modelling approach for the new structures	The Award Drain has 4 new or upgraded crossings at road chainages 12+250, 13+000, 13+340, 14+250 these equate to model chainages 1640m, 2274m, 2468m, 3449m. New culverts added at 1640 and 2468, culverts at 2274 and 3449 are upgraded / replaced. Data has been included as per the design drawings, *A14-JAC-ZZ-E1-DR-Z-00009 and 00010 RevP01* and design data *Proposed A14_Structures on Watercourses_v1.xlsx*
5.4 Model Units added/removed	Proposed culverts were modelled using the following units: Culvert Units = 1640m, 2274m, 2468m, 3449m New Cross Section = AWARD DRAIN 1615, AWARD DRAIN 1664, AWARD DRAIN 2410, AWARD DRAIN 2500.

5.5 Culvert Details

Culvert Details are tabulated below;

Chainage	Proposed Road_ID	US IL	DS IL	Length	Manning n	Type	Dia (m)
1640	12+250 (New)	13.54	13.24	48	0.016	Circular	1.8
2274	13+000 (Replaced)	10.99	10.34	65	0.016	Circular	1.8
2468	13+340 (New)	9.74	9.54	64	0.016	Circular	1.8
3449	14+250 (Replaced)	6.75	5.71	100	0.016	Circular	2.2

5.6 Hydraulic Roughness of proposed units

Roughness coefficients based on design specifications using CIRIA Report 168

Bed roughness n = 0.03 (For natural channel)

Wall/Soffit roughness n = 0.016 (For smooth concrete)

6. Award Drain Hydraulic Model Outputs

6.1 Model Simulation	The model outputs were processed to extract maximum stage values at key locations for the 4%, 1% and 1% + CC AEP.
A1) 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
600m u/s of A14 12+250	1120	18.316	18.413	18.473
200m u/s of A14 12+250	1437	15.643	15.748	15.814
u/s of proposed A14 12+250	1615	14.573	14.687	14.757
d/s of proposed A14 12+250 (at proposed extension outlet location)	1664	14.245	14.36	14.432

A2) 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
600m u/s of A14 12+250	1120	18.316	18.413	18.473
200m u/s of A14 12+250	1437	15.653	15.756	15.821
u/s of proposed A14 12+250	1615	14.286	14.419	14.505
d/s of proposed A14 12+250 (at proposed extension outlet location)	1664	14.275	14.397	14.473

B1) 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
500m u/s of A14 13+000	1775	13.684	13.806	13.882
200m u/s of A14 13+000	2080	12.211	12.324	12.394
u/s of proposed A14 13+000	2258	11.611	11.684	11.732
d/s of proposed A14 13+000 (at proposed extension outlet location)	2318	11.254	11.369	11.443

B2) 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
500m u/s of A14 13+000	1775	13.684	13.805	13.881
200m u/s of A14 13+000	2080	12.273	12.407	12.492
u/s of proposed A14 13+000	2258	11.716	11.828	11.906
d/s of proposed A14 13+000 (at proposed extension outlet location)	2318	11.279	11.392	11.464

C1) 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
150m u/s of A14 13+340	2323	11.233	11.35	11.424
u/s of proposed A14 13+340	2434	10.846	10.974	11.054
d/s of proposed A14 13+340 (at proposed extension outlet location)	2500	10.67	10.794	10.873

C2) 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
150m u/s of A14 13+340	2323	11.25	11.356	11.425
u/s of proposed A14 13+340	2434	10.683	10.825	10.916
d/s of proposed A14 13+340 (at proposed extension outlet location)	2500	10.659	10.789	10.871

D1) Existing Model	Maximum Stage values for the Existing Model are provided in the table below at key locations

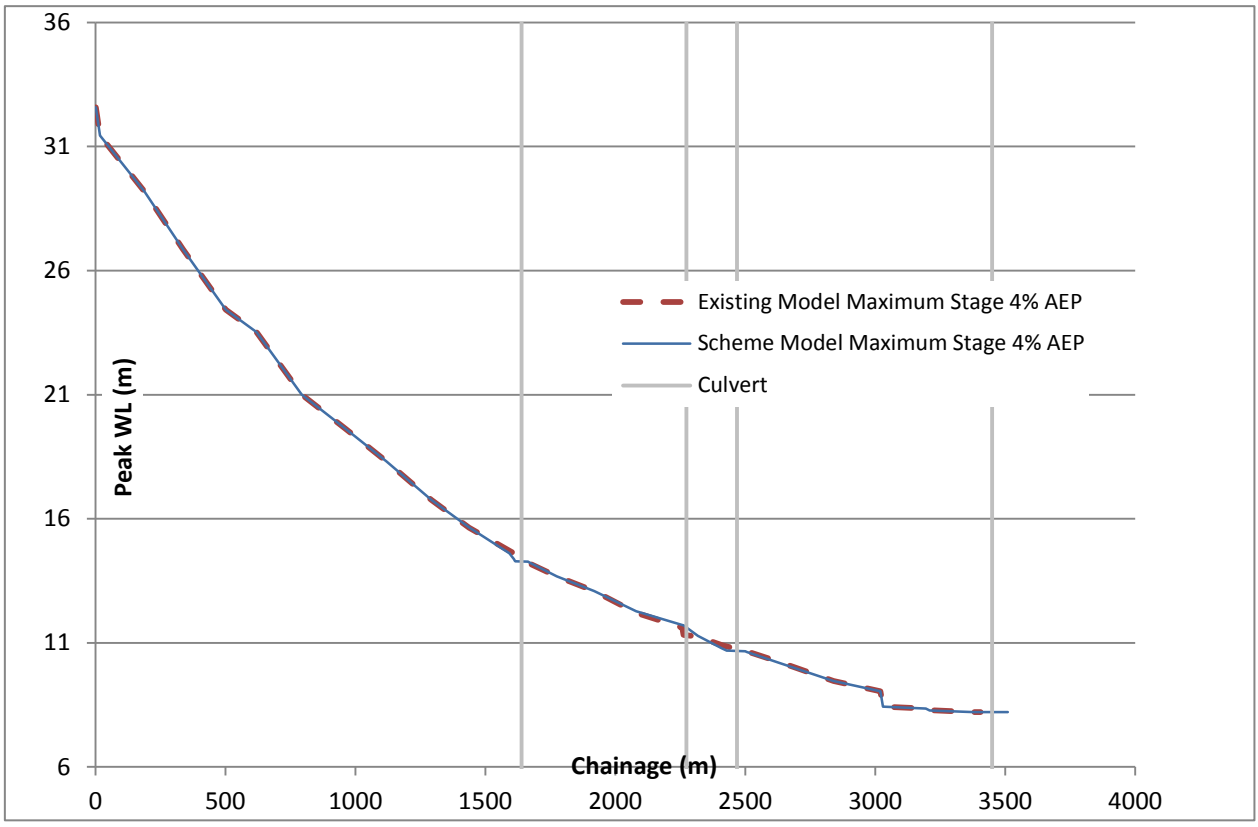
Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
400m u/s of A14 14+250	3020	9.052	9.149	9.217
100m u/s of A14 14+250	3376	8.213	8.456	8.636
u/s of proposed A14 14+250	3405	8.212	8.454	8.635
d/s of proposed A14 14+250 (at proposed extension outlet location)	3510	8.204	8.445	8.625

D2) Scheme Model	Maximum Stage values for the Scheme Model are provided in the table below at key locations

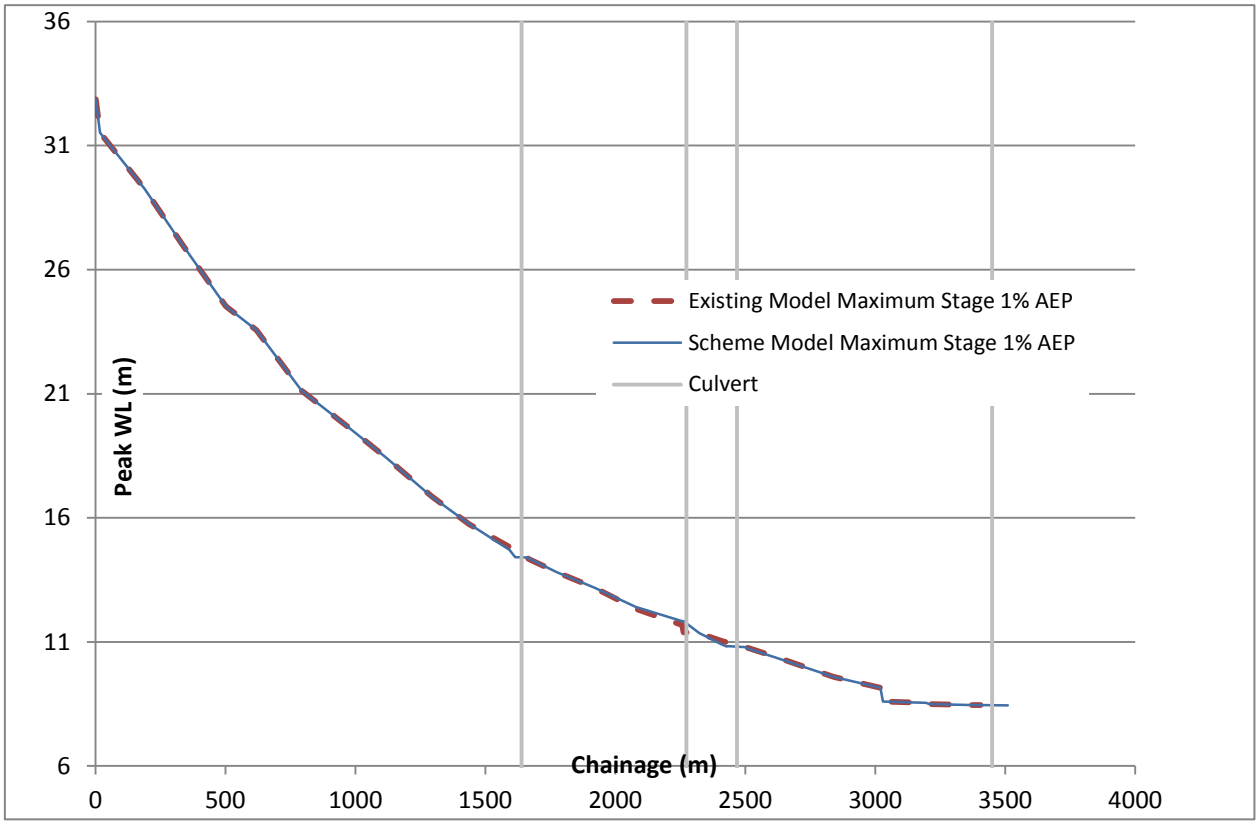
Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
400m u/s of A14 14+250	3020	9.052	9.149	9.217
100m u/s of A14 14+250	3376	8.212	8.454	8.625
u/s of proposed A14 14+250	3405	8.211	8.454	8.625
d/s of proposed A14 14+250 (at proposed extension outlet location)	3510	8.205	8.446	8.617

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

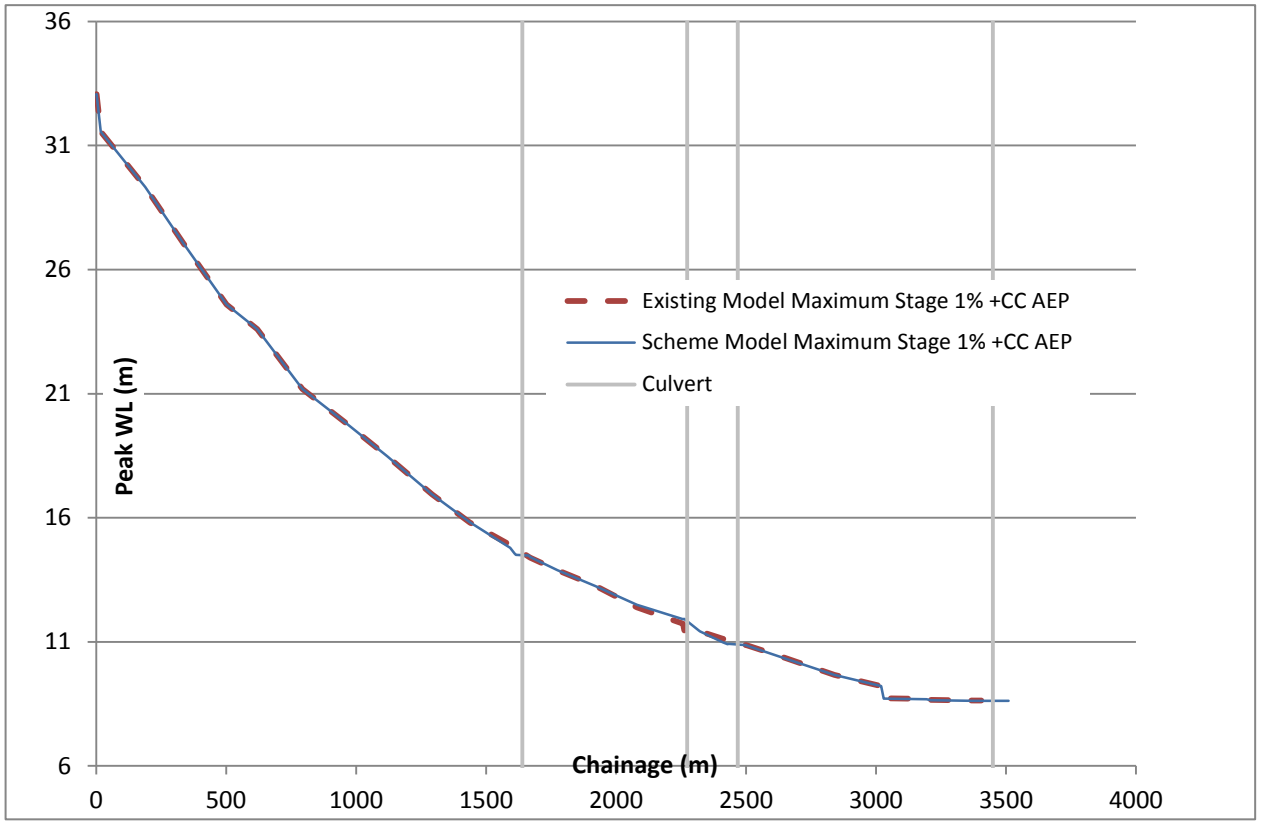
Maximum Stage Award Drain – 4% AEP



Maximum Stage Award Drain – 1% AEP



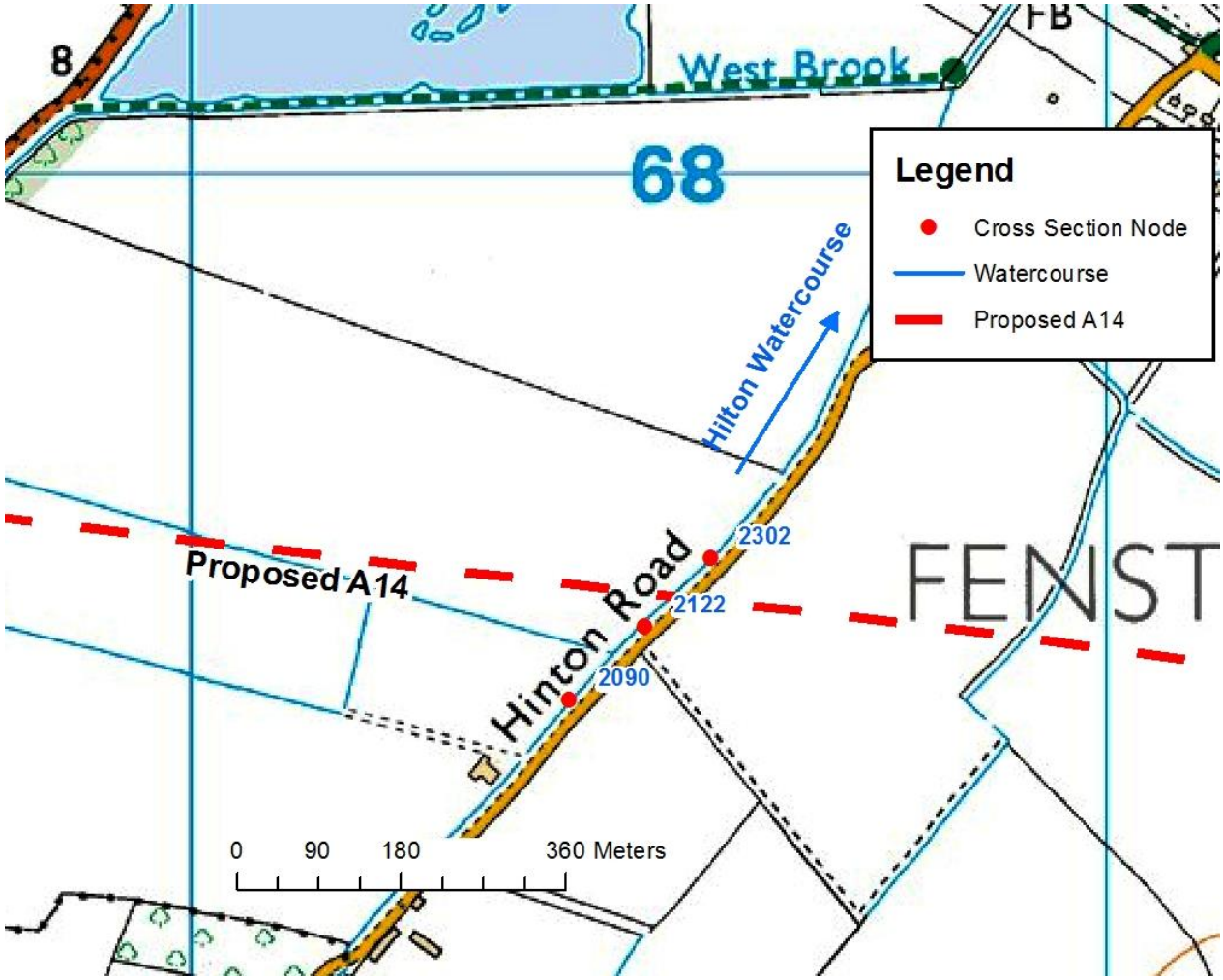
Maximum Stage Upstream and Downstream of proposed culvert – 1%+CC AEP



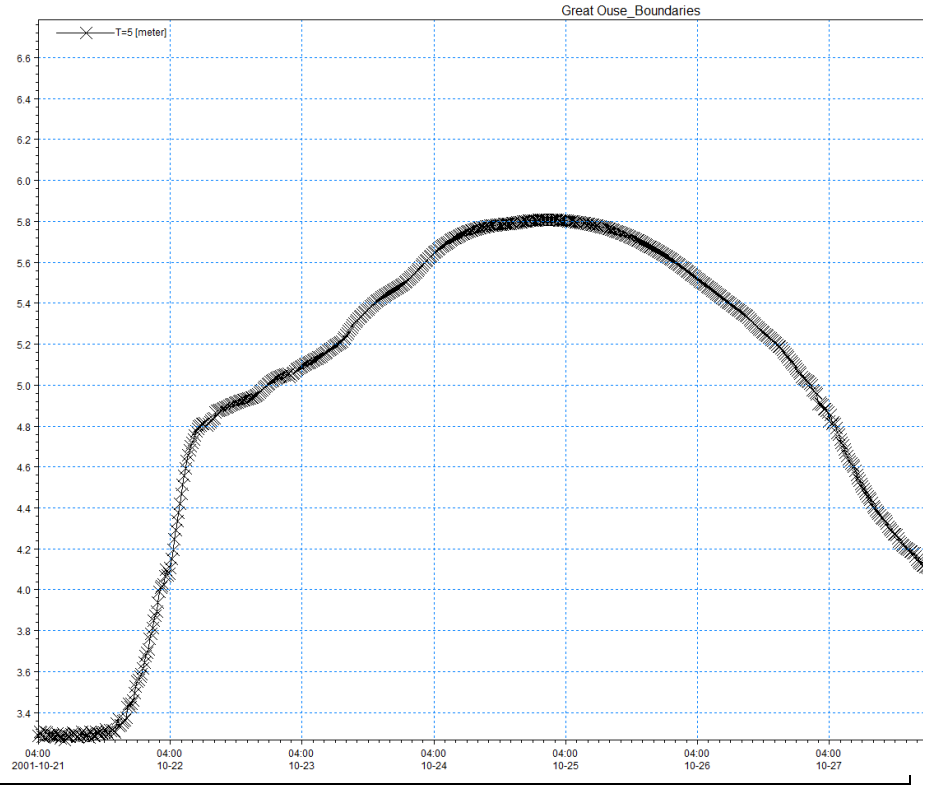
7. Key model assumption and limitations

- No cross section reference has been provided. The location of the proposed culverts were calculated based on design drawings for the proposed A14 alignment.
- New cross section data was interpolated from existing cross sections.
- Culvert Inlet design was assumed to feature 90° headwall and 45° bevels.
- The modelled network is a simplification of existing and proposed drainage network.

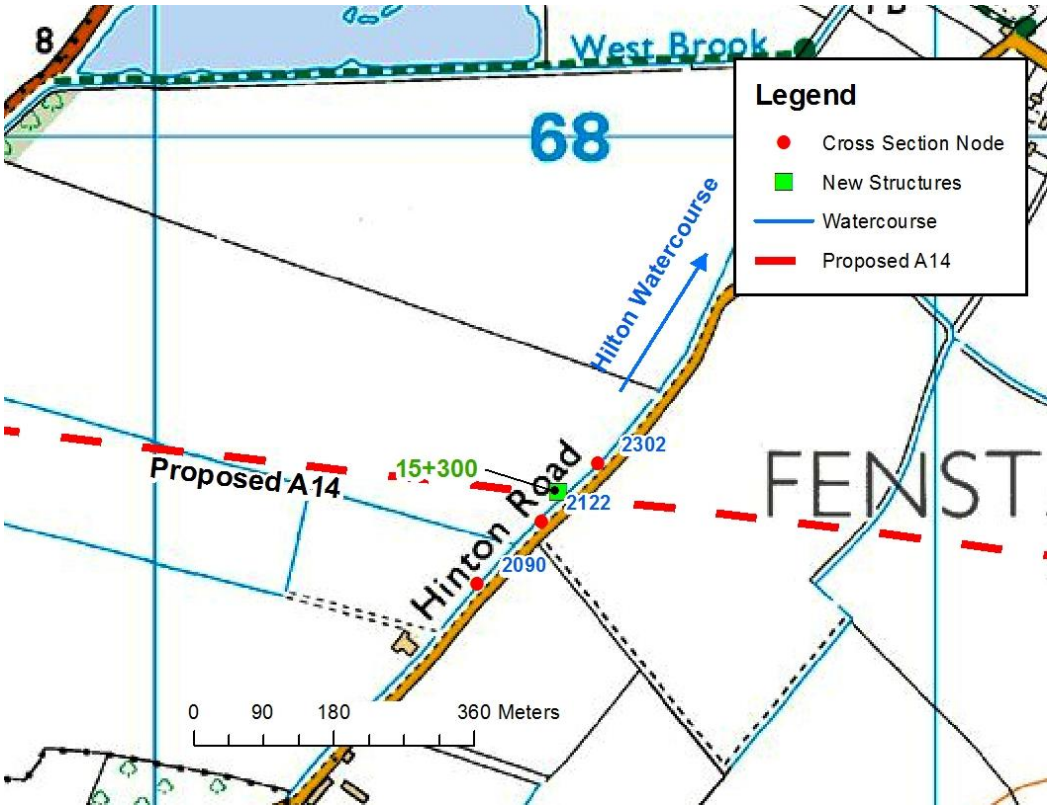
8. Hilton Drain Existing Model



8.1 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**	
West Brook	0	5740	
Total model length (km):	5.74		
8.2 Model structures:	N/A		
8.3 Floodplain schematisation	Floodplain areas have in part been modelled in the 1D cross sections.		
8.4 Model Boundaries - Inflows	Hydrological flow hydrographs are input into the model as a point inflow at 0m AND 995m Chainage:		
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**
0 m	3.00	4.269	5.122
995 m	1.33	1.89	2.69
8.5 Model Boundaries –	The downstream boundary for the West Brook is a time varying Water level		

Downstream Conditions	from the Great Ouse. All Scenarios use the same tailwater condition. 

9. Hilton Drain Scheme Model Build

9.1 Scenario Definition	One new A14 stream crossing was added to the model.
MIKE11 1D Model	
9.2 Model Extent of the Affected area	
9.3 Modelling approach for the new structures	A new structure representing the proposed A14 crossing at road chainage 15+300 and model chainage 2212 has been included as per the design drawings, *A14-JAC-ZZ-E1-DR-Z-00011 RevP01* and design data *Proposed A14_Structures on Watercourses_v1.xlsx*
9.4 Model Units added/removed	Proposed Crossing was modelled as a box culvert structure at 2212m New Cross Section = HILTON 2302
9.5 Culvert Details	Culvert Details Are tabulated below;

Branch	Chainage	Proposed Road_ID	US IL	DS IL	Length	Manning n	Type	Dia (m)
Hilton	2212	15+300	6.3	5.9	89	0.016	Rectangular	2.7 x 2.4

9.6 Hydraulic Roughness of proposed units	Roughness coefficients based on design specifications using CIRIA Report 168 Bed roughness n = 0.03 (For natural channel) Wall/Soffit roughness n = 0.016 (For smooth concrete)

10. Hilton Drain Hydraulic Model Outputs

10.1 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

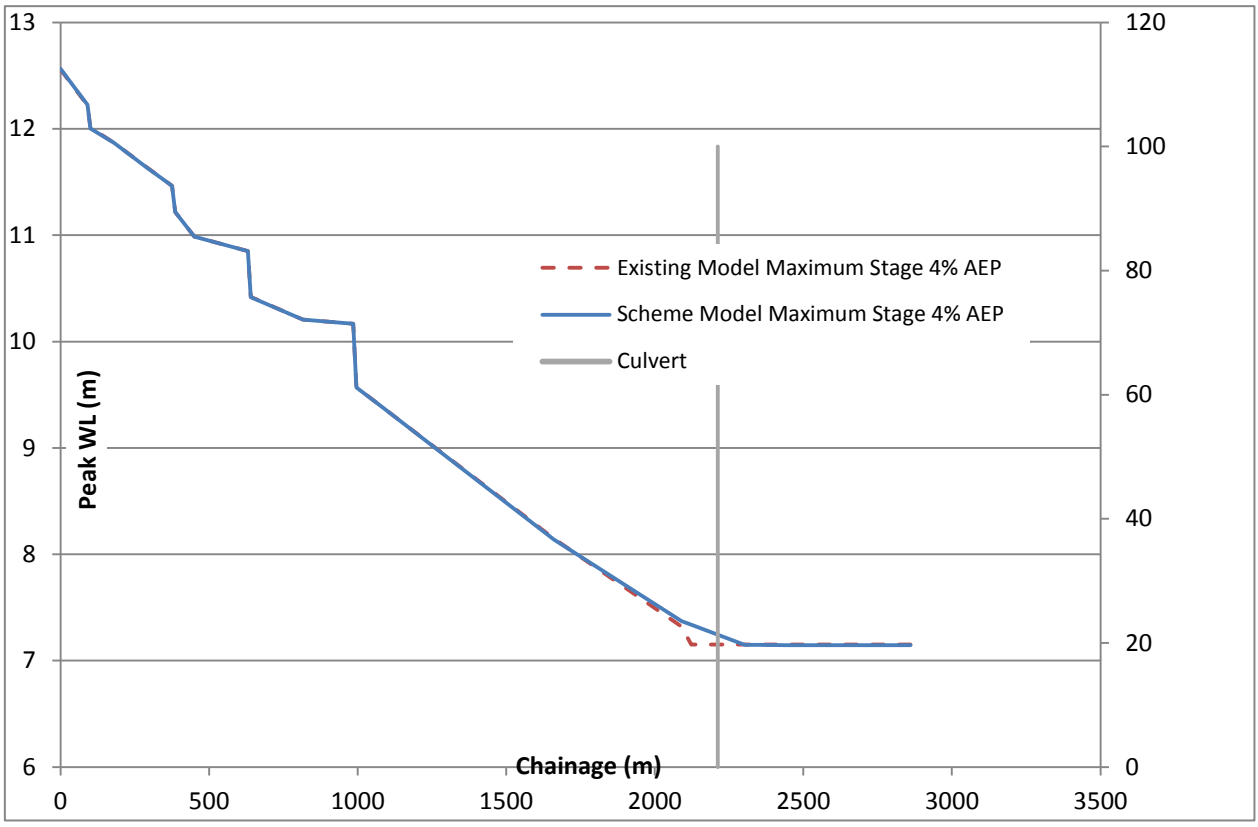
Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
550m u/s of A14	1660	8.149	8.309	8.354
130m u/s of A14	2090	7.321	7.696	8.068
u/s of proposed A14	2122	7.290	7.696	8.068
d/s of proposed A14 (at proposed extension outlet location)	2302	7.153	7.697	8.07

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

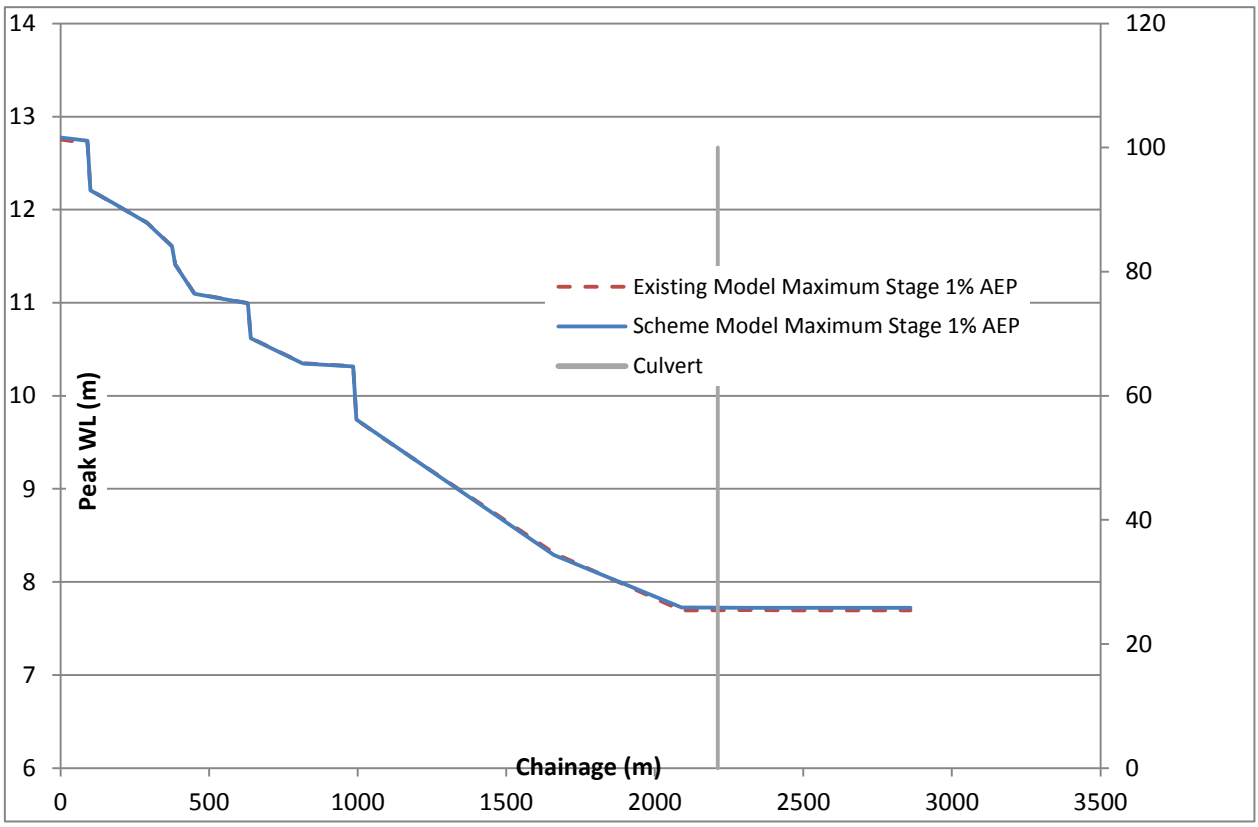
Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
550m u/s of A14	1660	8.139	8.288	8.334
130m u/s of A14	2090	7.372	7.726	8.132
u/s of proposed A14	2122	7.338	7.726	8.132
d/s of proposed A14 (at proposed extension outlet location)	2302	7.148	7.723	8.131

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

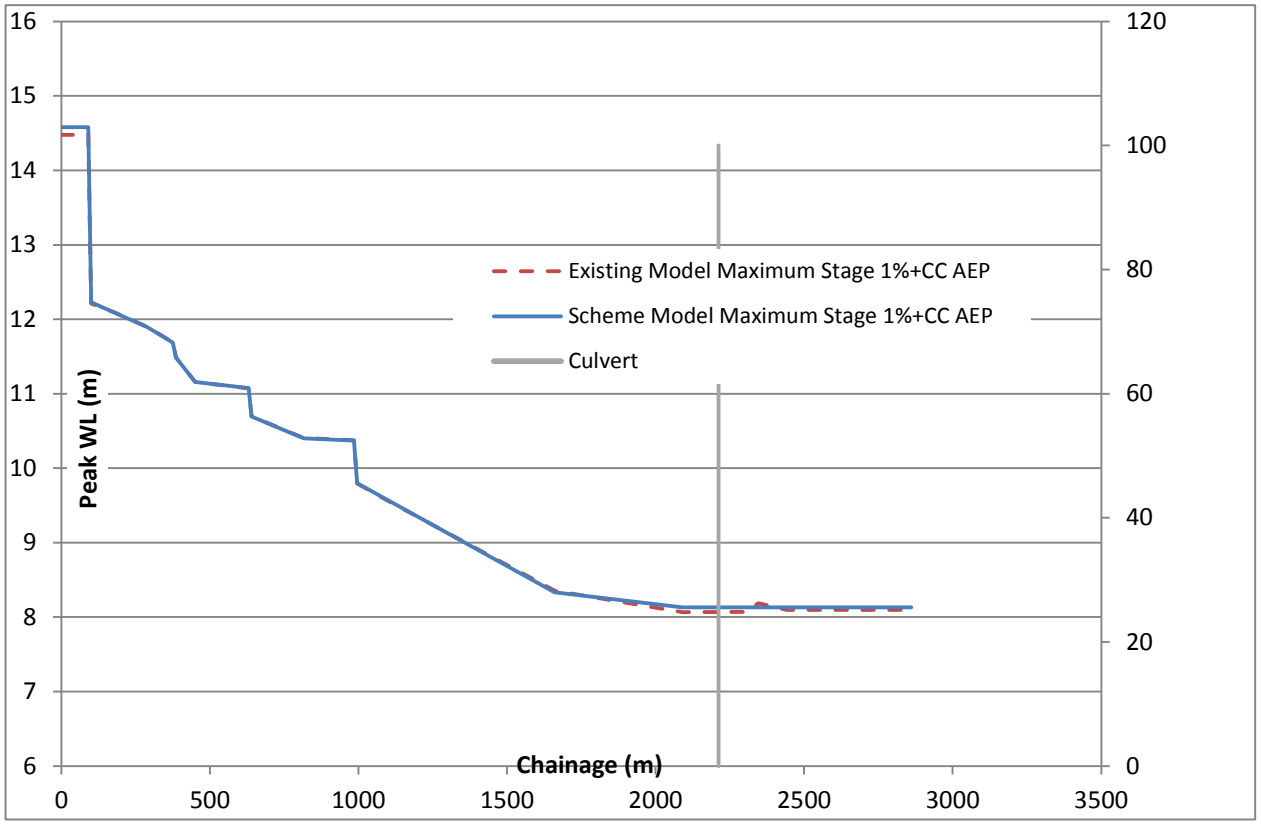
Maximum Stage Hilton Watercourse – 4% AEP



Maximum Stage Hilton Watercourse – 1% AEP



Maximum Stage Hilton Watercourse – 1%+CC AEP



11. 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.
- No cross section geo-referencing/schematics were provided with the model. The location of the proposed culvert was calculated based on design drawings for the proposed A14 alignment. The distance between the proposed A14 and existing A14 has been approximated from the drawings.
- New cross section data was interpolated from existing cross sections.
- Flood plain flow is not represented within the model and some glass walling occurs within the lower reaches of the model. Any amendments to model to eliminate glass walling were beyond the scope of this comparative study.
- No calibration or sensitivity testing simulations were carried out as part of this hydraulic modelling exercise