C Appendix C - Key modelled structures

C.1 Tributary, access culvert

Included in model? (state reason if not):	Yes
Model label:	FUL_449, FUL_449CU, FUL_449CD
Type:	Circular concrete culvert
How has structure been modelled?	The structure was modelled as circular culvert unit using FLOOD MODELLER. The following modelling parameters were used:

FUL_499	CULVERT	INLET	FUL_499CU
FUL_499CU	CONDUIT	CIRCULAR	
FUL_499CD	CONDUIT	CIRCULAR	
FUL_499CD	CULVERT	OUTLET	FUL_492

Inlet Control Data

Conduit Type Code:	K:	M:
TYPE A	0.0078	2
C:	Y:	
0.0292	0.74	
Ki:	Headloss Type:	Reverse Flow Mode:
0.3	STATIC	CALCULATED

Geometry

Distance to Next Conduit:	Elevation Of Invert:	Diameter:
7.200	155.770	1.200

Friction

Equation:	Value Below Axis:	Value Above Axis:
MANNING	0.02500	0.02500

Overtopping of the structure was represented within the 2D domain due to the length of the culvert (water is not likely to spill along the culvert`s centre line).

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

C.2 Pipe crossing

Included in model? (state reason if not):	Yes
Model label:	BLI_1594, BLI_1594B, BLI_1594BD
Type:	Pipe crossing
How has structure been modelled?	The structure was modelled as circular culvert unit using FLOOD MODELLER. The following modelling parameters were used:

BLI_1594	JUNCTION	OPEN	BLI_1594B	BLI_1594SU	
BLI_1594B	BRIDGE	USBPR1978	BLI_1594BD	BLI_1594	BLI_1594D
BLI_1594SU	SPILL		BLI_1594SD		
BLI_1594BD	JUNCTION	OPEN	BLI_1594SD	BLI_1594D	

Dual Bridge: Model as Dual Bridge; Bridge Width: 0.000; Dual Distance: 0.000

Piers: Specify Piers / Specify Soffit Shape; Soffit Shape: FLAT

Calibration Coefficient: 1.000; Skew Angle: 0.000; Abutment Type: 3; Abutment Alignment: ALIGNED

Channel Section:

Cross-Chainage (m)	Elevation (m AD)	Mannings n	Embankments
29.106	156.270	0.060	
29.631	156.284	0.060	
32.737	156.344	0.060	
33.443	156.348	0.060	
33.473	156.348	0.040	
33.518	155.537	0.040	

Openings:

Start (m)	Finish (m)	Springing Level (m AD)	Soffit Level (m AD)
33.443	37.828	156.800	156.800

Overtopping of the structure was represented within the 1D domain using an in-line spill unit at level 158.41 mAOD.

Upstream face, looking downstream

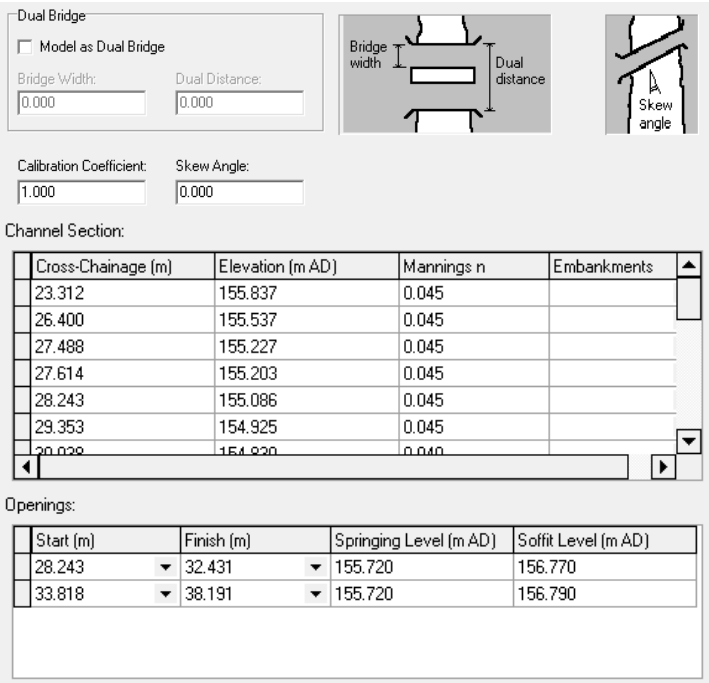


Downstream face, looking upstream

NO PHOTO AVAILABLE

C.3 Bridge crossing, Cresswell Road

Included in model? (state reason if not):	Yes
Model label:	BLI_1374, BLI_1374D
Type:	Arch bridge
How has structure been modelled?	The structure was modelled as arch bridge unit using FLOOD MODELLER. The following modelling parameters were used:



Overtopping of the structure was represented within the 2D domain due to the length of the culvert (water is not likely to spill cross the bridge along its centre line).

Upstream face, looking downstream



Downstream face, looking upstream



C.4 Access bridge 1

Included in model? (state reason if not):	Yes
Model label:	BLI_1145, BLI_1145B, BLI_1145BD
Type:	Bridge
How has structure been modelled?	The structure was modelled as bridge unit using FLOOD MODELLER. The following modelling parameters were used:

BLI_1145	JUNCTION	OPEN	BLI_1145B	BLI_1145SU	
BLI_1145B	BRIDGE	USBPR1978	BLI_1145BD	BLI_1145	BLI_1145D
BLI_1145SU	SPILL		BLI_1145SD		
BLI_1145BD	JUNCTION	OPEN	BLI_1145SD	BLI_1145D	

Dual Bridge: Model as Dual Bridge; Bridge Width: 0.000; Dual Distance: 0.000

Piers: Specify Piers / Specify Soffit Shape; Soffit Shape: FLAT

Calibration Coefficient: 1.000; Skew Angle: 0.000; Abutment Type: 3; Abutment Alignment: ALIGNED

Channel Section:

Cross-Chainage (m)	Elevation (m AD)	Mannings n	Embankments
19.000	156.320	0.030	
19.836	156.328	0.030	
20.089	156.335	0.045	
20.098	156.050	0.045	
20.517	155.703	0.045	
21.419	155.077	0.045	
22.512	154.764	0.045	

Openings:

Start (m)	Finish (m)	Springing Level (m AD)	Soffit Level (m AD)
20.517	31.091	155.990	155.990

Overtopping of the structure was represented within the 1D domain using an in-line spill unit at level 157.76 mAOD (top of stone wall).

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

C.5 Access bridge 2

Included in model? (state reason if not):	Yes
Model label:	BLI_862, BLI_862B, BLI_862BD
Type:	Bridge
How has structure been modelled?	The structure was modelled as bridge unit using FLOOD MODELLER. The following modelling parameters were used:

BLI_862	JUNCTION	OPEN	BLI_862B	BLI_862SU	
BLI_862B	BRIDGE	USBPR1978	BLI_862BD	BLI_862	BLI_862D
BLI_862SU	SPILL		BLI_862SD		
BLI_862BD	JUNCTION	OPEN	BLI_862SD	BLI_862D	

Dual Bridge: Model as Dual Bridge; Bridge Width: 0.000; Dual Distance: 0.000

Piers: Specify Piers; Specify Soffit Shape; Soffit Shape: FLAT

Calibration Coefficient: 1.000; Skew Angle: 0.000; Abutment Type: 3; Abutment Alignment: ALIGNED

Channel Section:

Cross-Chainage (m)	Elevation (m AD)	Mannings n	Embankments
19.922	154.595	0.045	
20.963	154.464	0.045	
23.394	154.158	0.045	
23.575	154.138	0.045	
23.882	154.062	0.045	
23.912	154.053	0.045	

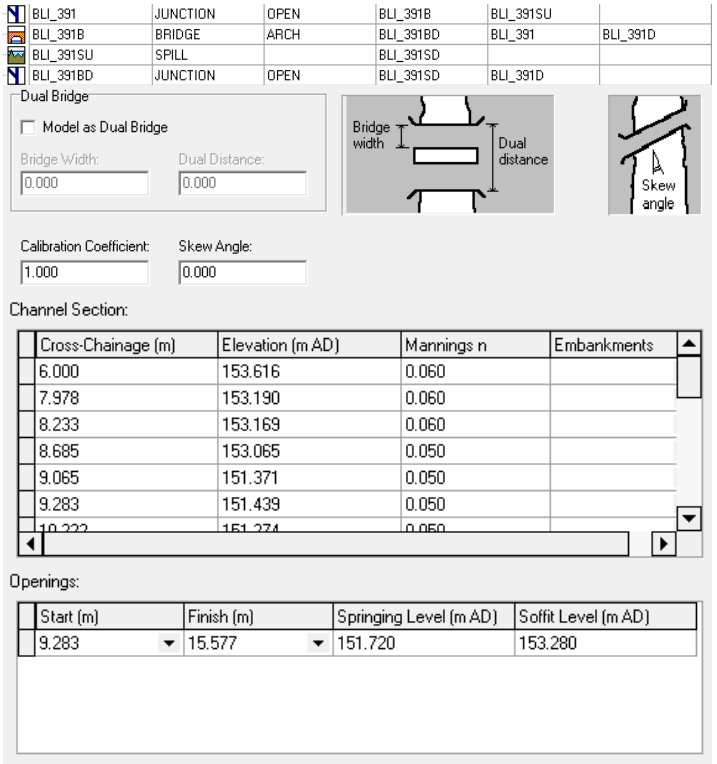
Openings:

Start (m)	Finish (m)	Springing Level (m AD)	Soffit Level (m AD)
23.575	30.545	154.150	154.150

Overtopping of the structure was represented within the 1D domain using an in-line spill at level 155.42 mAOD (top of stone wall).

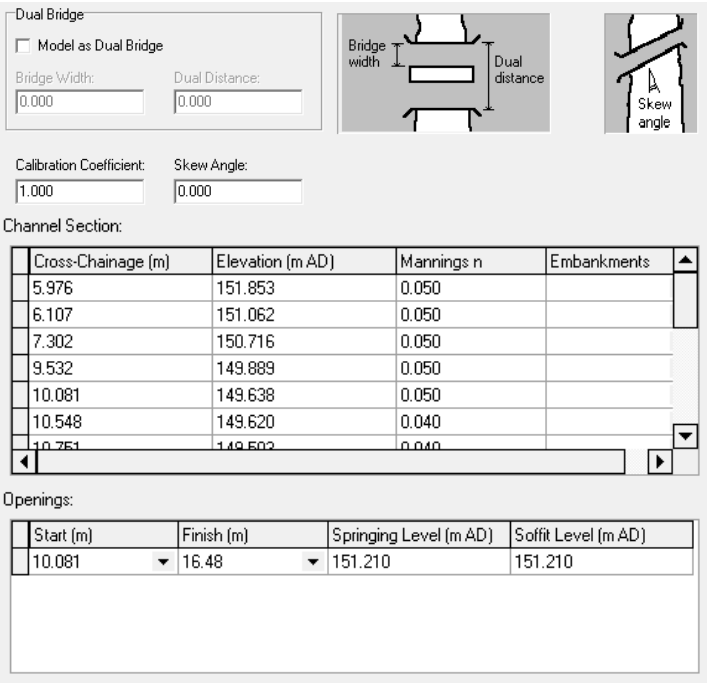
Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

C.6 Access bridge 3

Included in model? (state reason if not):	Yes
Model label:	BLI_391, BLI_391B, BLI_391BD
Type:	Brick arch within a pipe
How has structure been modelled?	The structure was modelled as a full arch conduit unit using FLOOD MODELLER. The following modelling parameters were used:  BLI_391 | JUNCTION | OPEN | BLI_391B | BLI_391SU BLI_391B | BRIDGE | ARCH | BLI_391BD | BLI_391 | BLI_391D BLI_391SU | SPILL | BLI_391SD BLI_391BD | JUNCTION | OPEN | BLI_391SD | BLI_391D Dual Bridge Model as Dual Bridge Bridge Width: 0.000 Dual Distance: 0.000 Bridge width Dual distance Skew angle Calibration Coefficient: 1.000 Skew Angle: 0.000 Channel Section: Cross-Chainage (m) | Elevation (m AD) | Mannings n | Embankments 6.000 | 153.616 | 0.060 7.978 | 153.190 | 0.060 8.233 | 153.169 | 0.060 8.685 | 153.065 | 0.050 9.065 | 151.371 | 0.050 9.283 | 151.439 | 0.050 Openings: Start (m) | Finish (m) | Springing Level (m AD) | Soffit Level (m AD) 9.283 | 15.577 | 151.720 | 153.280 Overtopping of the structure was represented within the 1D domain using an in-line spill unit at level 153.84 mAOD.

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

C.7 Access bridge 4

Included in model? (state reason if not):	Yes
Model label:	BLI_0, BLI_0D
Type:	Bridge
How has structure been modelled?	The structure was modelled as bridge unit using FLOOD MODELLER. The following modelling parameters were used:  Overtopping of the structure was represented within the 2D domain due to the length of the culvert (water is not likely to spill cross the bridge along its centre line).

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D Appendix D - Model Sensitivity Analysis

The hydraulic model was tested for sensitivity to key model parameters which might impact flood risk at the proposed development site. This included the following scenarios:

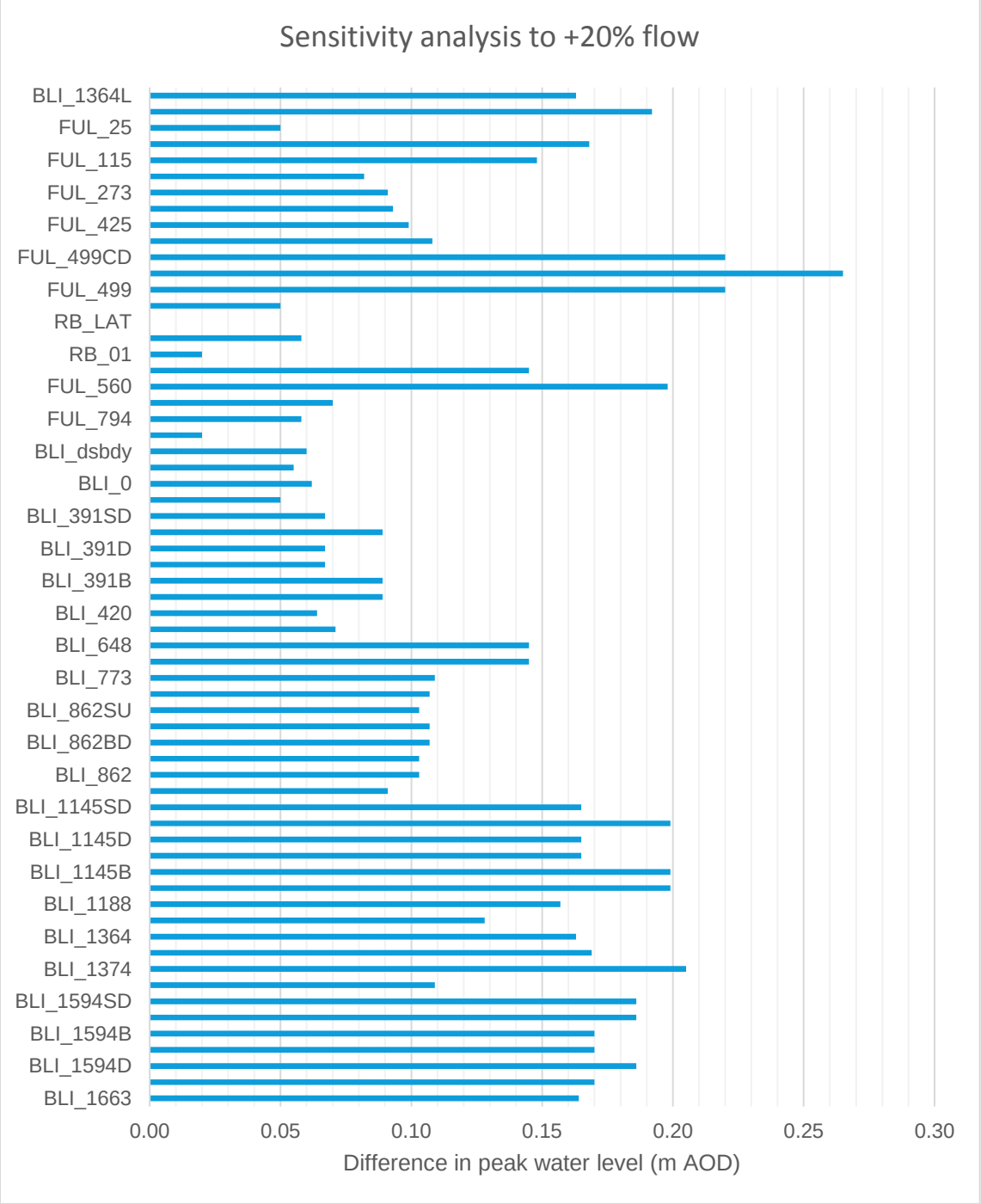
- Increasing the Manning's 'n' values by +20%. This was done both in the Flood modeller 1D channel and in the 2D TUFLOW domain
- Increasing flows by 20%
- Increasing the downstream boundary by 250mm in the 1D domain.

The following sections discuss the impacts of this sensitivity scenarios.

D.1 Sensitivity to flow

Figure 4-1 shows the changes in peak water level compared to the baseline 100-year event when an increase of 20% is applied to all inflows. There is a maximum increase in peak water level of 0.26m at FUL_499CU. The average increase in peak water level throughout the model is 0.12m. The model is most sensitive to an increase in peak flow at the upstream end of the Fulford tributary and between cross section BLI_1445 to BLI_1663.

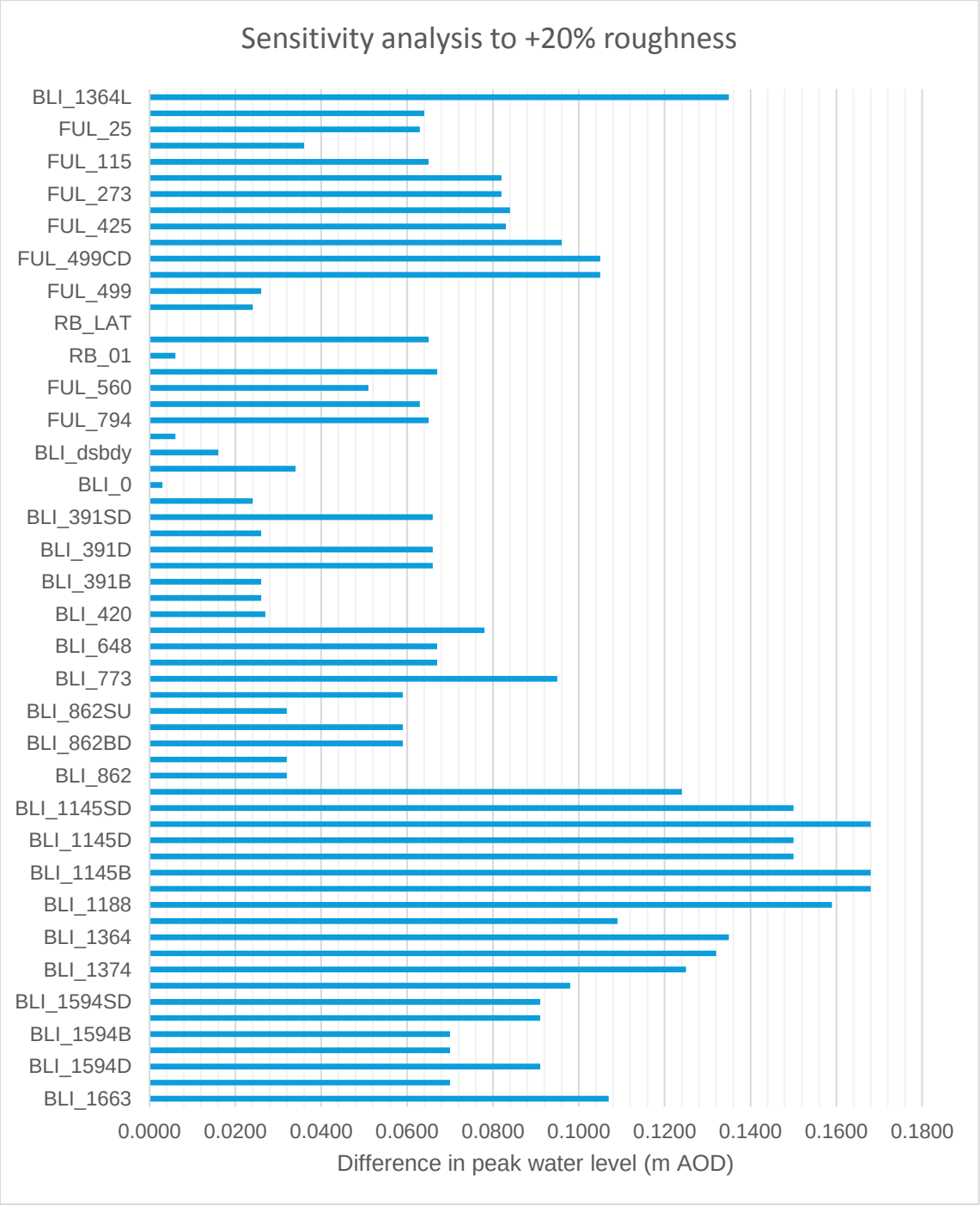
Figure 4-1: Change in peak water levels with the 100-year + 20% increase in flow



D.2 Sensitivity to roughness

Figure 4-2 shows the change in peak water level compared to the baseline 100-year event when an increase of 20% mannings n is applied in both the 1D and 2D domains. There is a maximum increase in peak water level of 0.17m at cross section BLI_1145. The average increase in peak water level throughout the model is 0.08m. The model is most sensitive to an increase in roughness between cross section BLI_1145 to BLI_1374.

Figure 4-2: Change in peak water levels with the 100-year + 20% increase in manning's n



D.3 Sensitivity to downstream boundary

An increase in the stage values within the head-time (HT) boundary of +250mm was shown to have little impact on the hydraulic model peak water levels for the 100-year flood event. Changes in the peak water level are not exhibited upstream of cross section BLI_420. There is no increase in flood extent within the vicinity of the development site as a result of increasing the downstream boundary by 250mm.

Figure 4-3: Changes in peak water level with the 100-year plus 250mm increase in downstream boundary

