M11 Junction 7A

Ringway Jacobs / Essex County Council

Hydraulic Modelling Report Addendum

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Author:	Nick Cramp
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Jacobs U.K. Limited

1180 Eskdale Road
Winnersh, Wokingham
Reading RG41 5TU
United Kingdom
T +44 (0)118 946 7000
F +44 (0)118 946 7001
www.jacobs.com

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1. Introduction

This addendum has been prepared to supplement the original hydraulic modelling report following comments from the Environment Agency peer review.

The responses detailed in the letter *CC.EPF.08.17 170515.pdf* highlight the following;

'The outstanding requirements needing to be addressed for the model to be deemed suitable for usefollowing the most recent review are as follows:

1. *Topographic survey data should be provided for our review; including a survey report (further information to meet this requirement has since been submitted and will be reviewed once information to address all points has been provided)*
2. *A running model should be supplied - an attempt to run the model was made, but was unsuccessful with an error message being displayed.*
3. *The previously stated action to revise the model to find the cause of mass balance errors needs to be completed*
4. *Water levels from the ISIS/Tuflow model of the Upper and Middle Stort should be used for the downstream boundary; at least compared as a sensitivity test '*

The sections below cover the points raised above and provide further discussion on the updated model results.

2. Updates and Clarifications

2.1 Topographic data

The topographic data has been provided to Sacha Barnes (Environment Agency) on the 8th May 2017.

2.2 Model running issue

The update to Flood Modeller 4.2 since the model was built now causes the original model to crash. A non-convergence issue related to the drowning of the small culvert on the steep MOR tributary has been identified as the root cause of the crashing. This has been resolved by adding top slot to the conduit units and the model now runs without issue.

2.2.1 Software used

The hydraulic model now runs using the following hydraulic modelling software packages:

- 1D component: Flood Modeller v. 4.2 (64bit double precision)
- 2D component: Tuflow 2016-03-AE-iDP-w64

2.3 Model Mass Balance

The model has been reviewed and revised to improve the mass balance. This revised model is provided along with this report (Baseline _v038, Design _v019). No significant changes have been made to the model; the changes made are as follows;

a. Addition of top slot to 1D model to avoid instability at Culvert at Mor01_0126 as culvert capacity is exceeded.

b. Revision of 2d_bc HQ boundary at the downstream end of the 2D domain along the railway embankment. The topography and model boundary in the model originally issued (i.e. v_037) resulted in some high velocities and mass balance issues at the boundary. The boundary has been amended to remove this instability.

Figure 1 and Figure 2 below show the revised model performance for the 1% AEP event run.

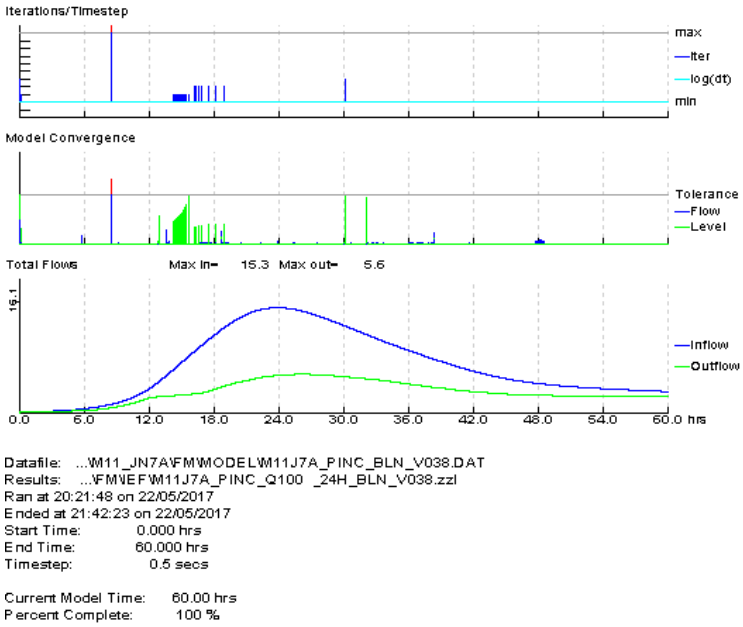

Figure 1 : 1D model convergence plot - 1% AEP event – Baseline scenario

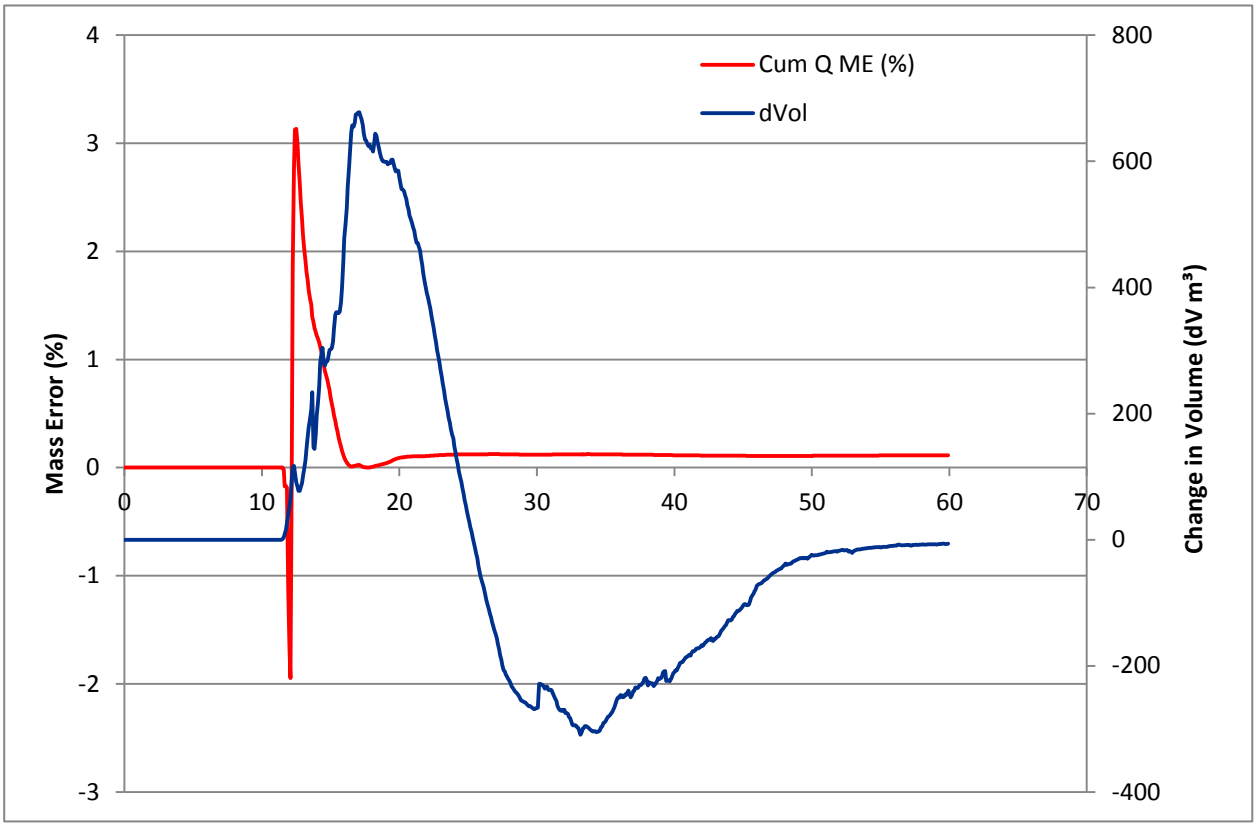

Figure 2 : 2D Mass Error and Change in Volume dV

The convergence plot from Flood Modeller Figure 1 shows the model performance to be acceptable and no instabilities have been identified in the 1D model results.

The Tuflow Mass Error and change in volume dV are presented in Figure 2.

For the 1% AEP model; the Final Cumulative Mass Error at the end of the model simulation is 0.12 and the peak cumulative mass error when flows are above 5% of the peak (Qi+Qo >5%) is 0.32. Peak Mass error is 3.16% at 12.46 hrs and occurs during the initial wetting of the 2D model when the model volume is less than 650 m³ and occurs as flows back up and recirculate behind the railway

embankment. When 2D volumes are between 4500 and 60,000 m³ the Mass Error is less than 1% and at the flood peak the Mass Error is 0.12%.

The Mass Error reports for the model are considered acceptable.

The dV plot shows some variation during the initial wetting phase of the 2D model but is otherwise smooth with a normal profile. Some undulation is evident but this is consistent with recirculating ponded flows behind road and rail embankments.

Over all the model performance is considered acceptable.

2.4 Downstream Boundary Conditions

In the model originally issued for Environmental Agency review the downstream boundary assumes normal depth condition (free flow). This was chosen on the conclusion that after some sensitivity testing any reasonable tailwater condition applied to the model did not impact the water levels at the scheme due to both upstream hydraulic constrictions and water elevations.

As suggested in the Environmental Agency review, an additional sensitivity test of the model has been rerun with a tailwater condition based on the River Stort peak flood level (43.79 m AOD) for the 1% AEP event.

The model results show peak water levels in the model upstream of the railway embankment are significantly higher than those downstream of the railway embankment and consequently we see no impact to water levels upstream of the railway embankment when using peak water levels from the River Stort Model. Furthermore there is no change in water levels 1.8 km upstream at the downstream extent of the proposed road scheme (see Table 1 and Figure 3).

The modelling concludes that peak water levels at the proposed road scheme location are not sensitive to the downstream boundary conditions applied in the model. Therefore the use of Normal Depth conditions at the downstream end of the model is justified.

Table 1 : Tailwater Comparison

NODE	Peak WL (m AOD) Baseline	Peak WL (m AOD) Stort Tailwater
PIN00_0000 (Downstream of railway embankment)	43.68	43.84
PIN01_0000 (Upstream of railway embankment)	44.11	44.12
PIN01_1278 (Downstream Extent of the Road Scheme)	45.85	45.85

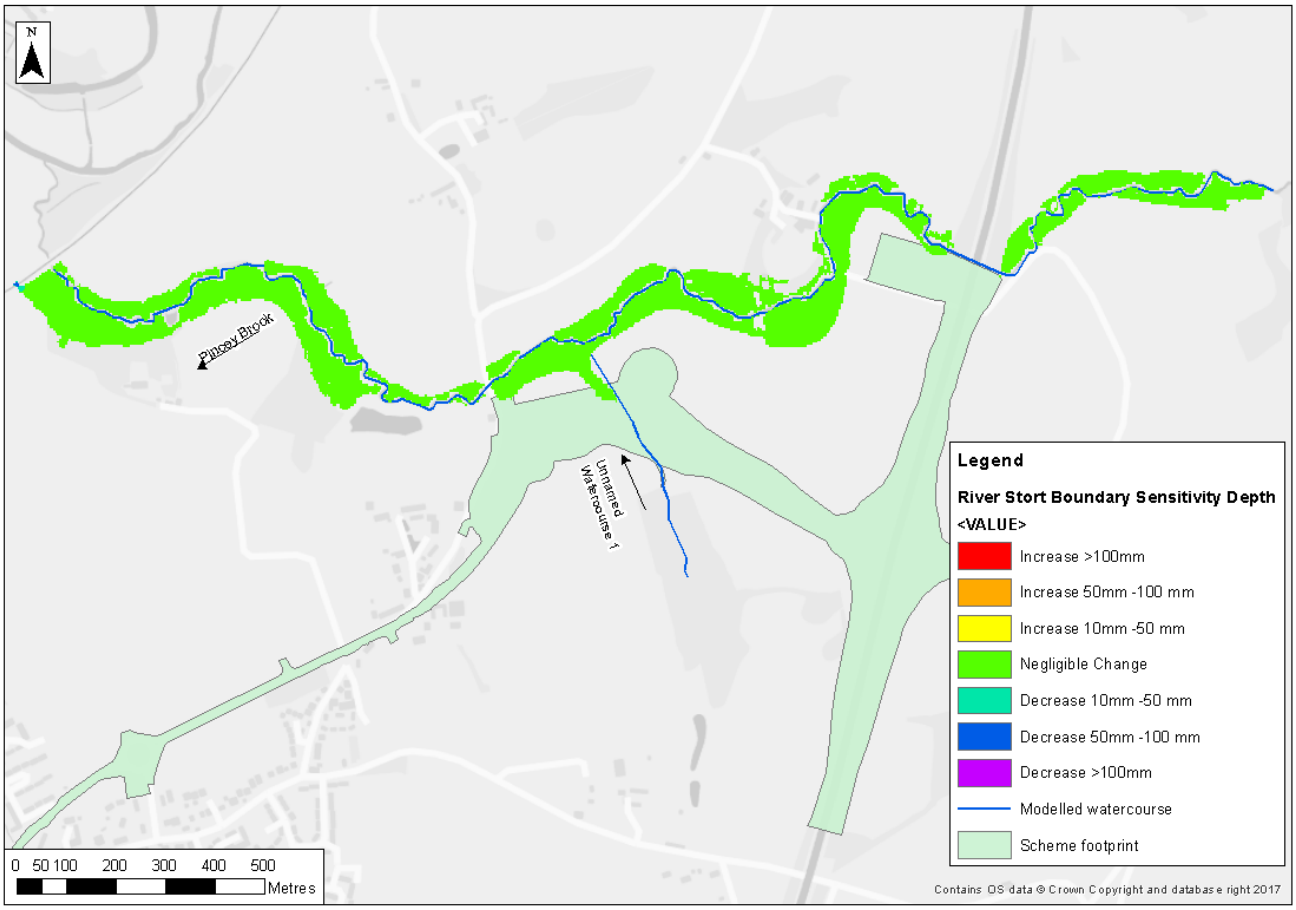

Figure 3 : Depth Difference Downstream boundary sensitivity

3. Results

This section compares results from the previously issued model (Baseline _v037, Design _v018) with the latest version of the model (Baseline _v038, Design _v019) to identify if the results presented in the existing FRA are still relevant.

3.1 Results comparison

The model has been rerun for 1% AEP, 1% AEP plus 35% and 70% climate change and 0.1% AEP events

Peak Water level between the current baseline (_v038) and previous baseline (_v037) are compared in Table 2.

Peak Water level between the current with-scheme (_v019) and previous with-scheme (_v018) are compared in Table 3.

The 1% AEP flood depth map is presented in Figure 4. The revised flood extent maps for the baseline and design are presented in Figure 5 and Figure 6.

A comparison for previous and new baseline and design flood depths for the 1% and 0.1%AEP is presented in Figure 7 to Figure 10.

A long section through the 1D model comparing 1% AEP peak water levels is presented Figure 11.

As evidenced in the tables and figures below, peak water levels are not significantly different within the proposed scheme area in either baseline or design model and therefore the change and update in model version is not considered to change the conclusions of the original hydraulic modelling report in the vicinity of the scheme. In general water levels have reduced slightly and therefore the results of the previous report can be considered conservative. The comparison between the previous and current baseline results show a minor reduction in water levels at the downstream end of the road scheme, this is thought to be due to the improved model stability in the tributary. The comparison of design scheme models shows no significant difference.

There is a more notable difference at the downstream end of the model where the 2D boundary has been revised and now provides more stable hydraulic conditions, with peak water levels 0.3 m lower in the revised model. There is some uncertainty to the exact dimensions of the flood relief culvert and the modelling in the previous hydraulic modelling report is considered to be a conservative approach. As discussed above uncertainty relating to the downstream boundary condition has been sensitivity tested and the model results show the scheme location not to be sensitive to downstream boundary conditions.

Table 2 – Baseline Peak Water Level Comparison

Inflow Location	Annual Exceedance Probability (AEP)											
	_v037 1%	_v038 1%	Diff (m)	_v037 1% (+35% CC)	_v038 1% (+35% CC	Diff (m)	_v037 1% (+70% CC)	_v038 1% (+70% CC)	Diff (m)	_v037 0.1%	_v038 0.1%	Diff (m)
	Peak Water Level (m AOD)											
PIN01_2818 (Upstream of M11)	47.882	47.883	0.001	48.123	48.124	0.001	48.325	48.324	-0.001	48.790	48.789	-0.001
PIN01_2521 (Downstream of M11)	47.466	47.467	0.001	47.547	47.547	0	47.618	47.617	-0.001	47.747	47.746	-0.001
PIN01_1627 (Mid Proposed Scheme)	46.042	46.031	-0.011	46.378	46.358	-0.020	46.734	46.704	-0.030	47.087	47.079	-0.008
PIN01_1278 (Downstream extent of proposed Scheme)	45.869	45.854	-0.015	46.237	46.216	-0.021	46.614	46.583	-0.031	49.986	46.976	-0.01
MOR01_0143	48.573	48.546	-0.027	48.596	48.581	-0.015	48.613	48.597	-0.016	48.633	48.624	-0.009

Table 3 – With Scheme Peak Water Level Comparison

Inflow Location	Annual Exceedance Probability (AEP)											
	_v018 1%	_v019 1%	Diff (m)	_v018 1% (+35% CC)	_v019 1% (+35% CC	Diff (m)	_v018 1% (+70% CC)	_v019 1% (+70% CC)	Diff (m)	_v018 0.1%	_v019 0.1%	Diff (m)
	Peak Water Level (m AOD)											
PIN01_2818 (Upstream of M11)	47.882	47.883	0.001	48.123	48.124	0.001	48.325	48.324	-0.001	48.790	48.790	0
PIN01_2521 (Downstream of M11)	47.466	47.467	0.001	47.547	47.547	0	47.618	47.617	-0.001	47.747	47.747	0
PIN01_1627 (Mid Proposed Scheme)	46.042	46.042	0	46.378	46.380	0.002	46.734	46.733	-0.001	47.111	47.110	-0.001
PIN01_1278 (Downstream extent of proposed Scheme)	45.869	45.870	0.001	46.237	46.240	0.003	46.614	46.613	-0.001	47.008	47.007	-0.001
MOR01_0287 ('with-Scheme' area)	48.676	48.680	0.004	48.718	48.721	0.003	48.754	48.757	0.003	48.810	48.812	0.002

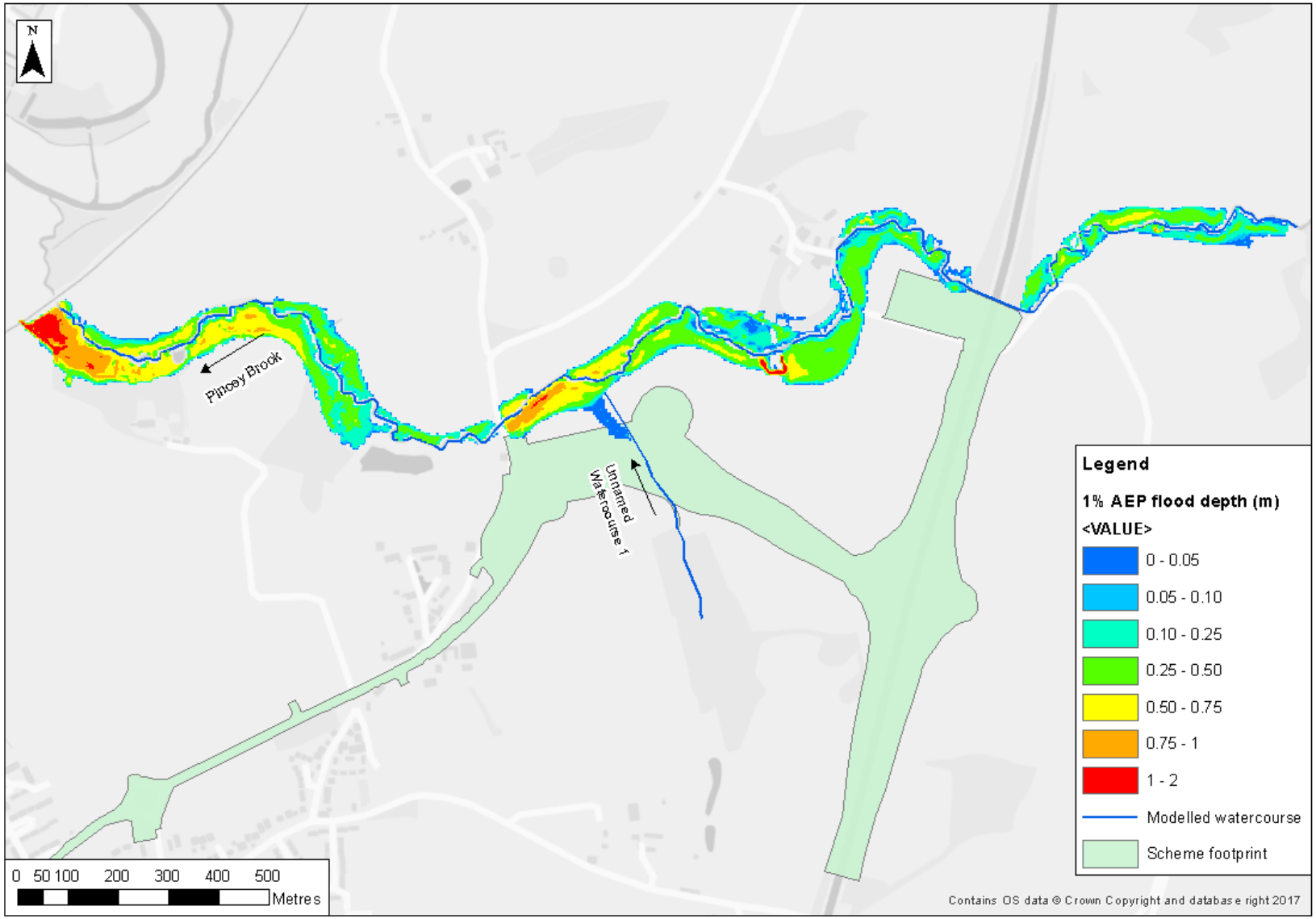

Figure 4 - 1% AEP maximum flood depths predicted by the hydraulic model

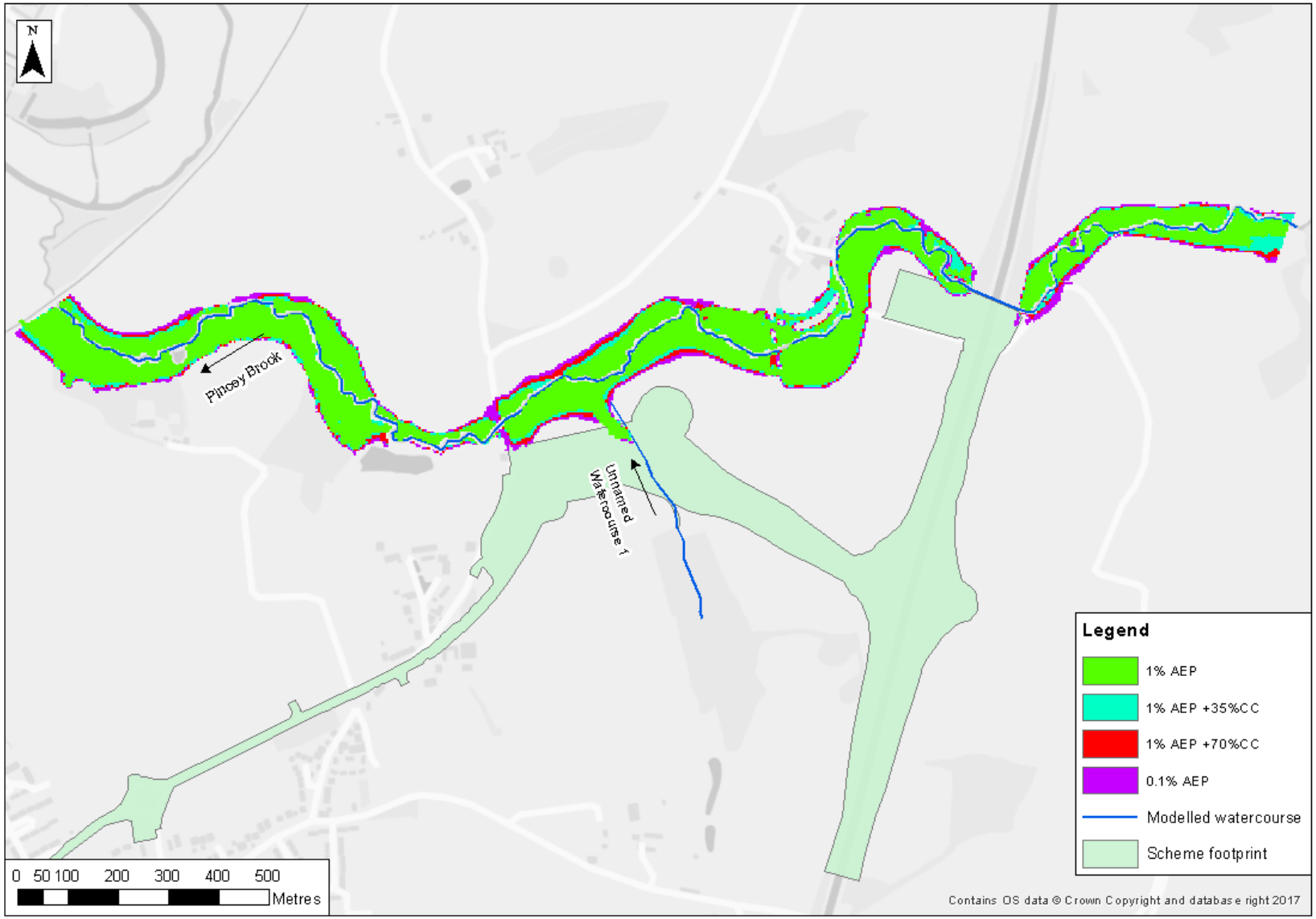

Figure 5 – Baseline 1%, 1% CC (+35% and +70%), 0.1% AEP maximum flood extents predicted by the hydraulic model

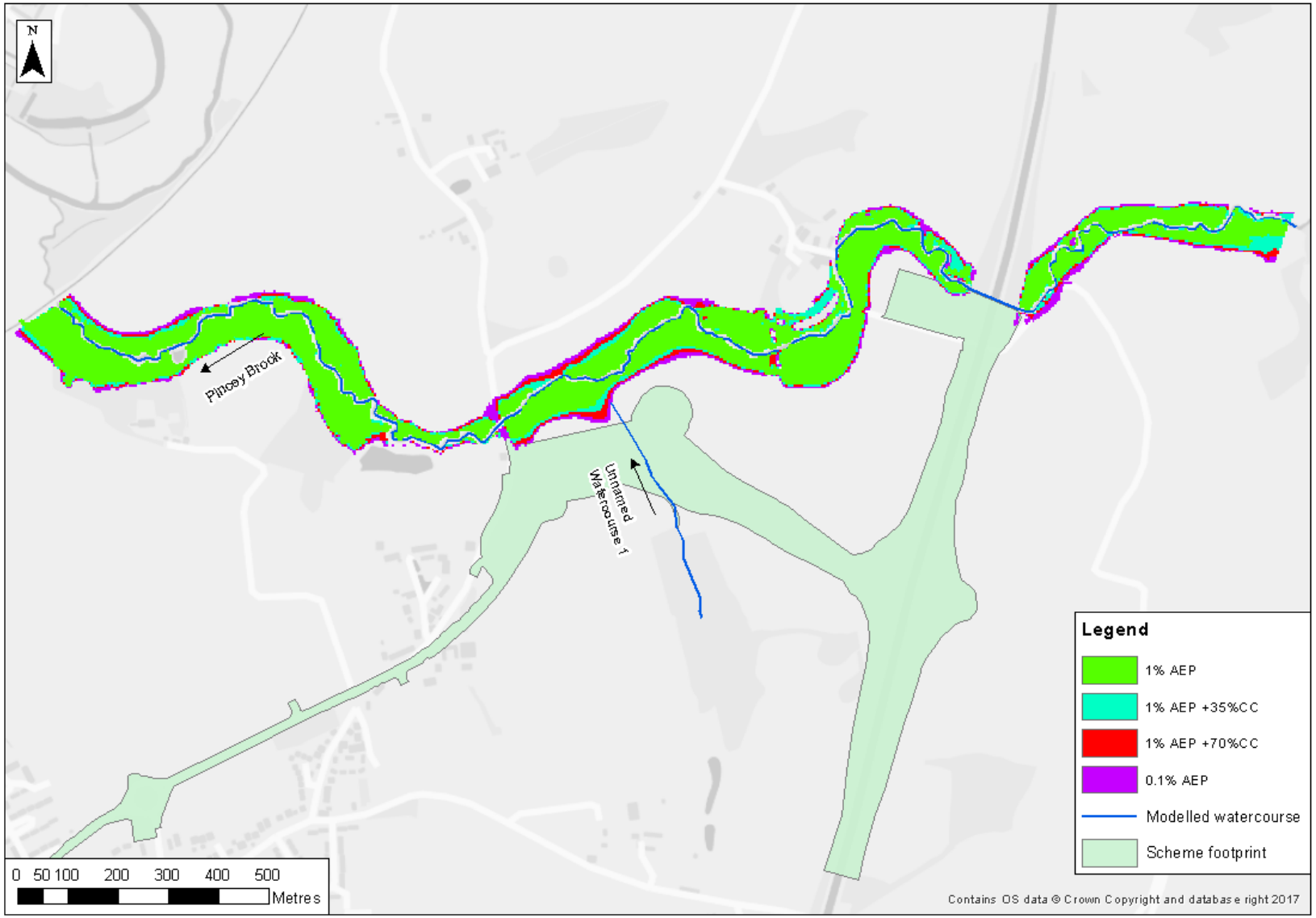

Figure 6 – With Scheme 1%, 1% CC (+35% and +70%), 0.1% AEP flood extents

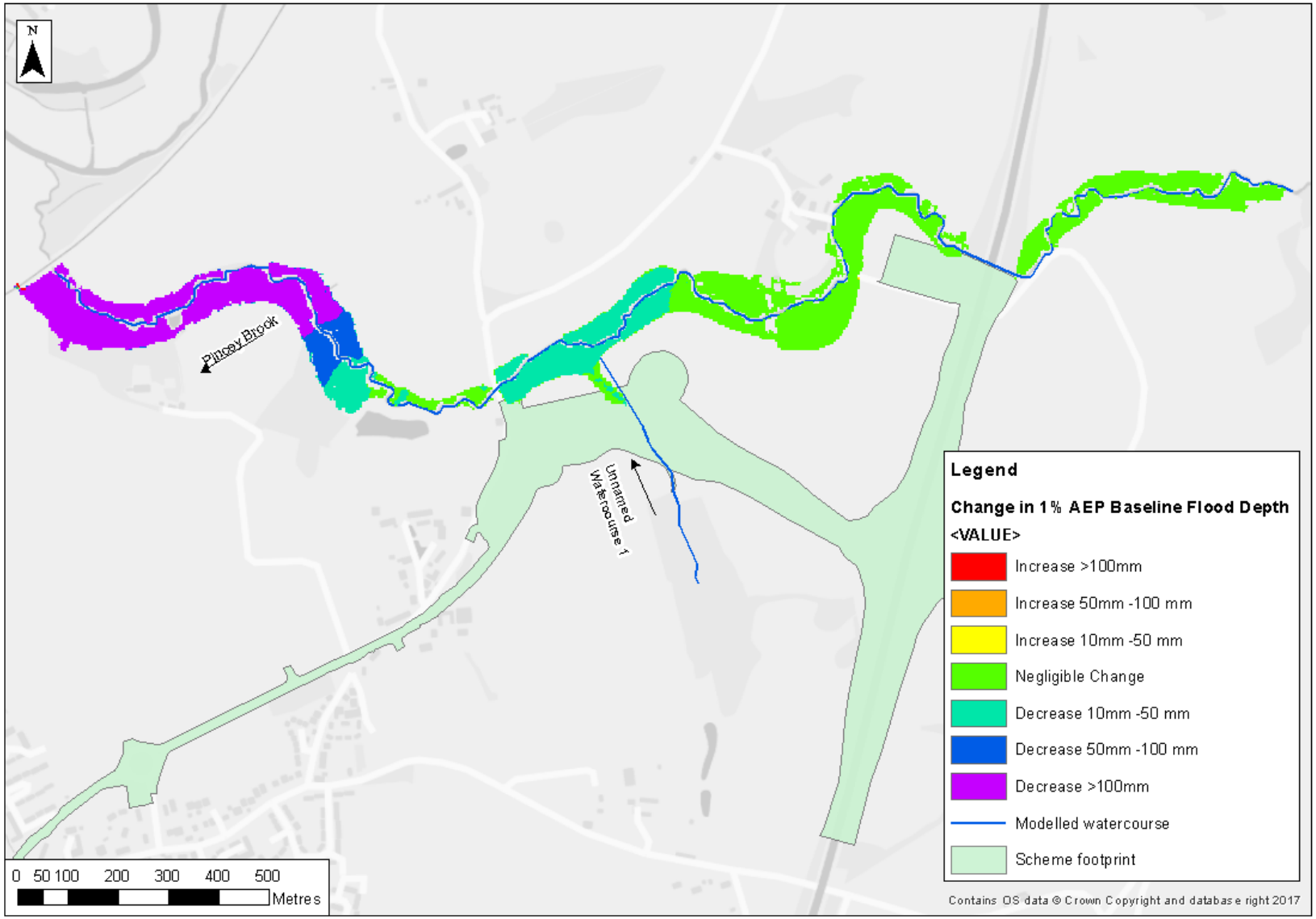

Figure 7 – Depth Difference Baseline _v037 Minus v038 1% AEP

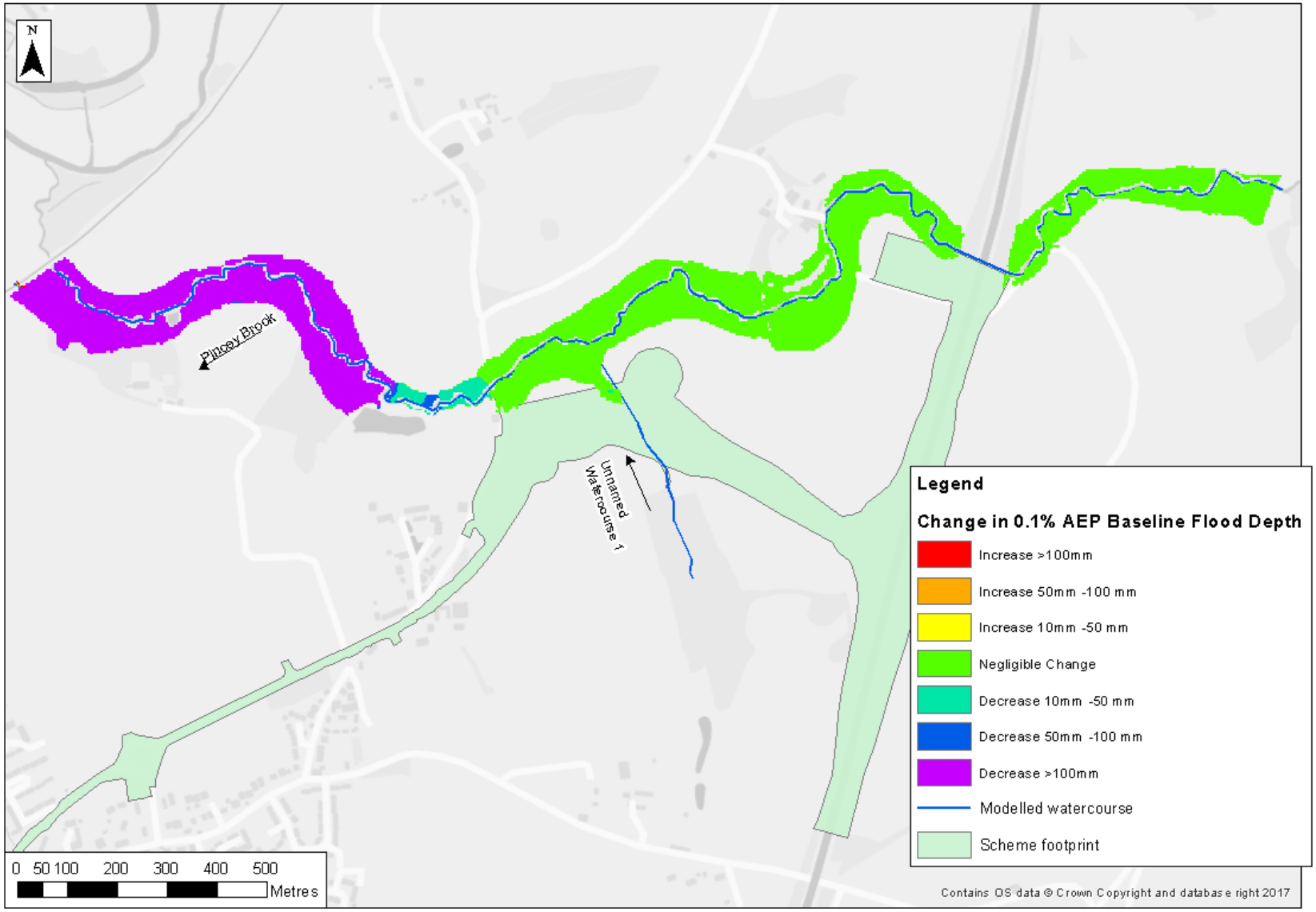

Figure 8 – Depth Difference Baseline _v037 Minus v038 0.1% AEP

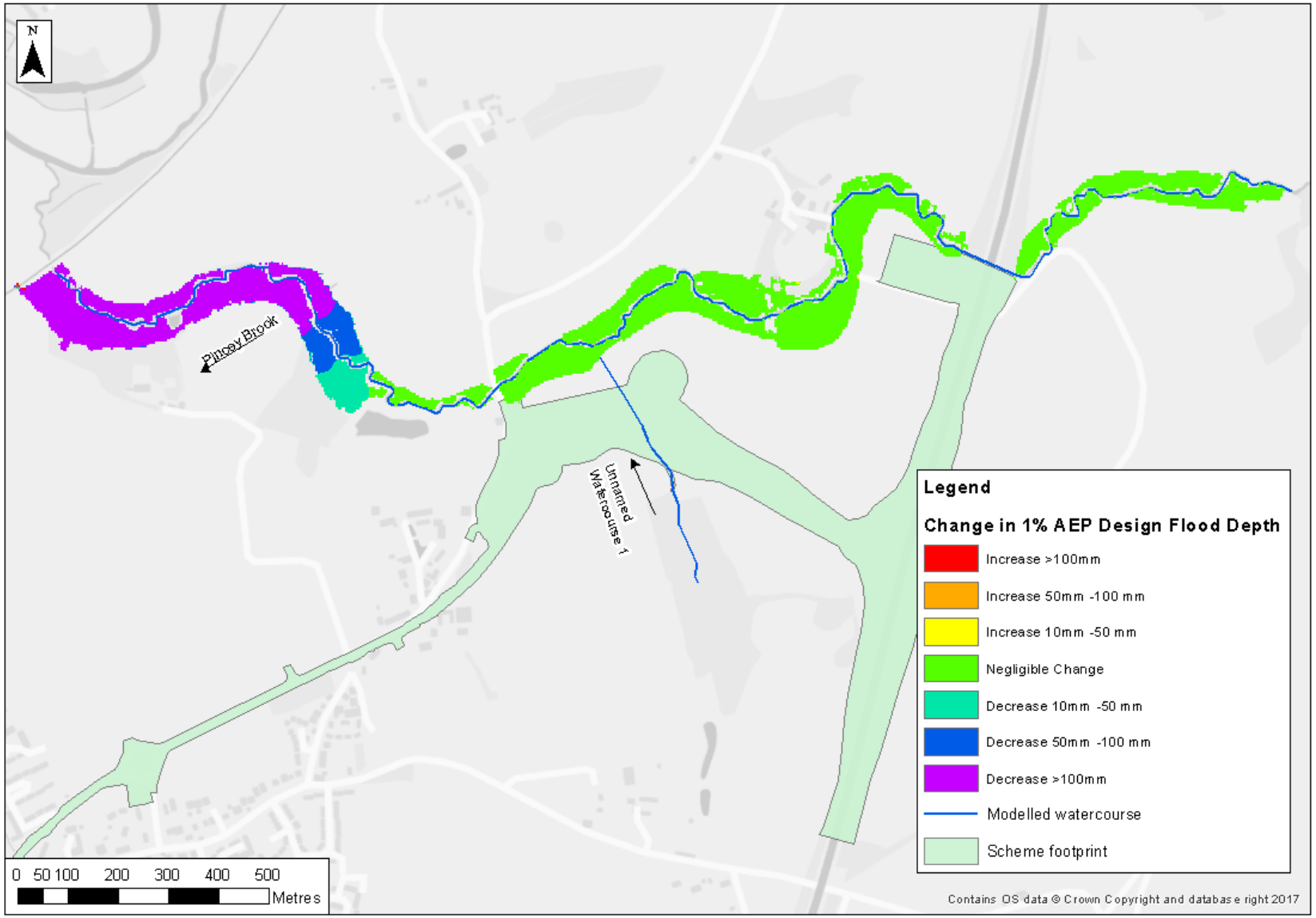

Figure 9 – Depth Difference Design _v018 Minus v019 1% AEP

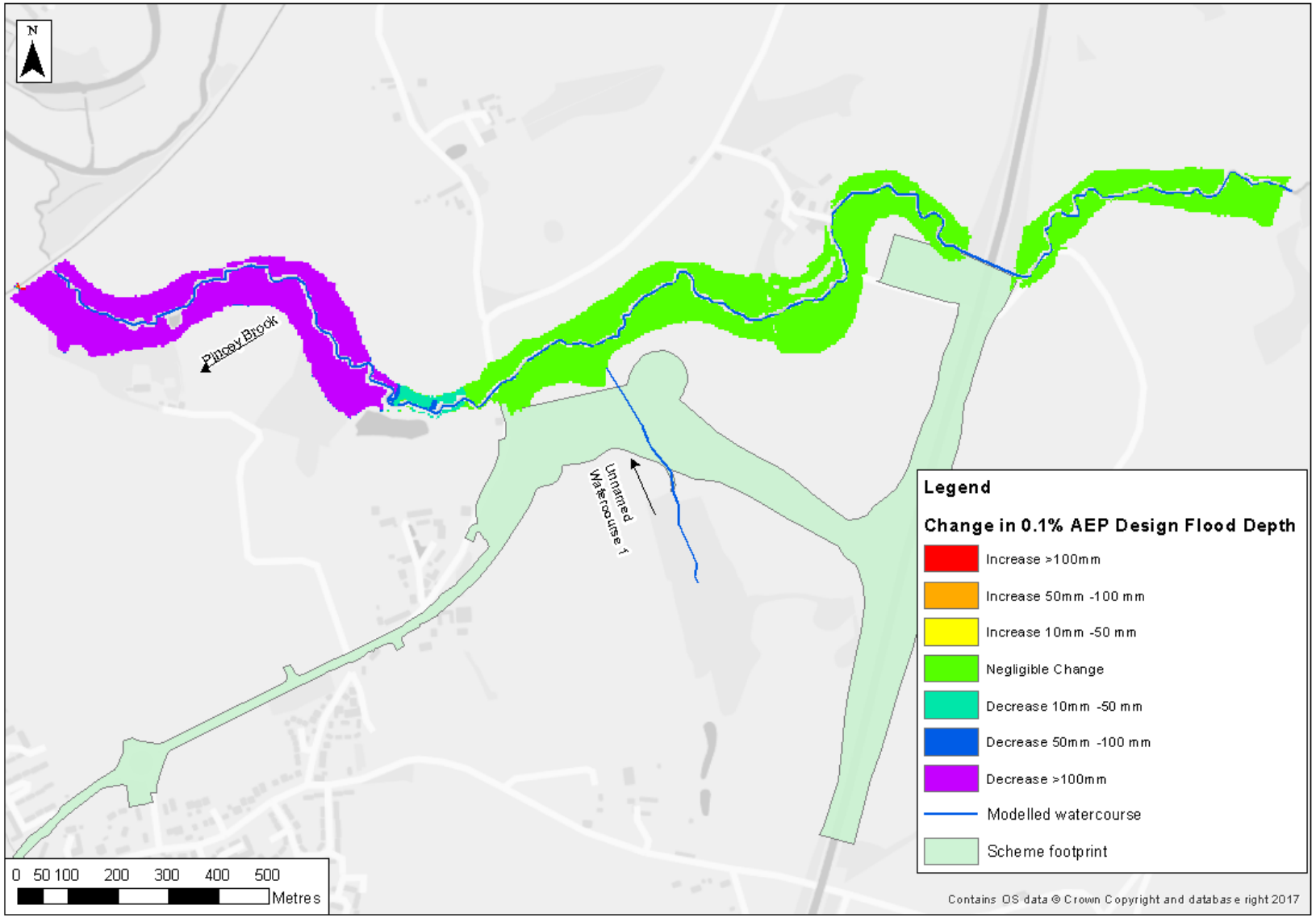

Figure 10 – Depth Difference Design _v018 Minus v019 0.1% AEP

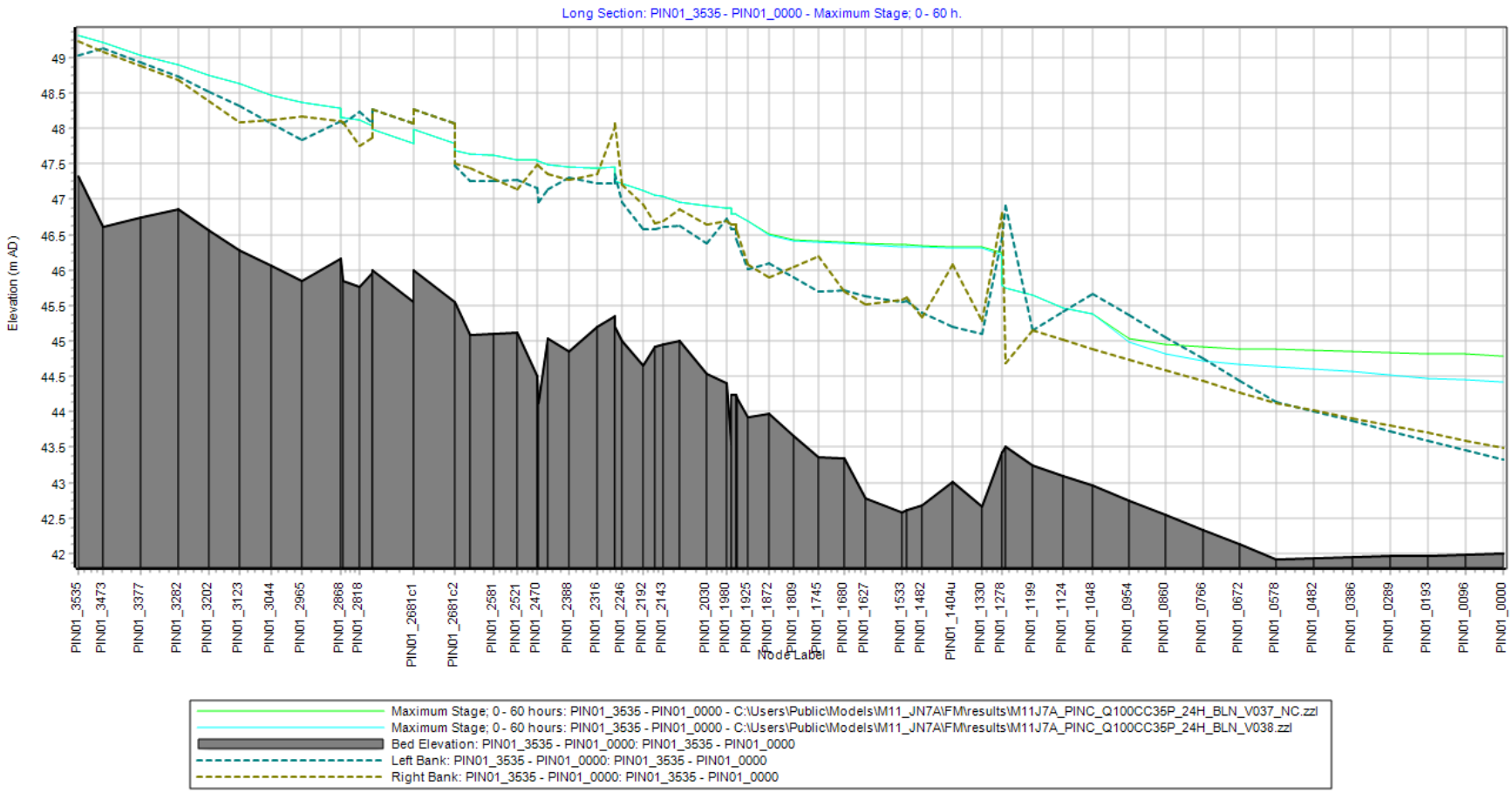

Figure 11 – Long Section Model Peak Water Results Comparison

1% AEP flood event plus 35% Climate change, comparison of model _v037 and _v038

4. Conclusions

This addendum report seeks to address comments from the Environment Agency in letter *CC.EPF.08.17 170515.pdf* and report the results of the revised modelling and how they compare to the previous modelling report.

The outstanding areas for clarification included;

- *Topographic survey data should be provided for our review; including a survey report (further information to meet this requirement has since been submitted and will be reviewed once information to address all points has been provided)*
- *A running model should be supplied - an attempt to run the model was made, but was unsuccessful with an error message being displayed.*
- *The previously stated action to revise the model to find the cause of mass balance errors needs to be completed*
- *Water levels from the ISIS/Tuflow model of the Upper and Middle Stort should be used for the downstream boundary; at least compared as a sensitivity test*

The topographic survey data has been provided and a working version of the model is provided with this report.

The model has been revised to improve the mass balance and sensitivity analysis has been undertaken on the downstream boundary condition from the River Stort model.

The results from the revised model do not show any significant change to the peak water level results reported in the previous modelling report and therefore the conclusions of that report are still considered valid.

Appendix A. Baseline Model reference files

1D domain	
DAT file	M11J7A_PINC_BLN_v038.DAT
ied files	PB_Des_2yr_24h.IED
	PB_Des_5yr_24h.IED
	PB_Des_20yr_24h.IED
	PB_Des_100yr_24h.IED
	PB_Des_100yrCC35p_24h.IED
	PB_Des_100yrCC70p_24h.IED
	PB_Des_1000yrp_24h_v2.IED
ief files	M11J7A_PINC_Q2_24h_BLN_v038.ief
	M11J7A_PINC_Q5_24h_BLN_v038.ief
	M11J7A_PINC_Q20_24h_BLN_v038.ief
	M11J7A_PINC_Q100_24h_BLN_v038.ief
	M11J7A_PINC_Q100CC35p_24h_BLN_v038.ief
	M11J7A_PINC_Q100CC70p_24h_BLN_v038.ief
	M11J7A_PINC_Q1000_24h_BLN_v038.ief
2D domain	
tcf files	M11J7A_PINC_Q2_24h_BLN_v038.tcf
	M11J7A_PINC_Q5_24h_BLN_v038.tcf
	M11J7A_PINC_Q20_24h_BLN_v038.tcf
	M11J7A_PINC_Q100_24h_BLN_v038.tcf
	M11J7A_PINC_Q100CC35p_24h_BLN_v038.tcf
	M11J7A_PINC_Q100CC70p_24h_BLN_v038.tcf
	M11J7A_PINC_Q1000_24h_BLN_v038.tcf
tbc file	M11_J7A_v012.tbc
tgc file	M11_J7A_v012.tgc
Material file	M11_J7A_v002.tmf

All model run time parameters were set to their default values, with the exception of the use of the automated Preissman slot option, which improve model stability by preventing the channel from running dry.

Baseline and Scheme model was run with a 1D timestep = 0.5sec and a 2D timestep = 1sec, The run time parameters used are summarised below.

Description	Value used
Initial conditions	From DAT file
Use of ied files	Yes
Run Type	Unsteady (Fixed timestep)
Start Time (hrs)	0
End Time (hrs)	60
Automated Preissmann slot for river sections	Yes
Parameters	Default
Advanced Parameters	Default

Appendix B. Tabulated Water levels

Table B.1 - Baseline peak water levels extracted from the 1D model

Model Node	- Maximum Water Level (m AOD)						
	50% AEP	20% AEP	5% AEP	1% AEP	1% AEP +35%CC	1% AEP +70%CC	0.1% AEP
PIN01_3535				49.224	49.311	49.365	49.457
PIN01_3473				49.102	49.218	49.3	49.413
PIN01_3377				48.911	49.025	49.121	49.279
PIN01_3282				48.768	48.892	48.991	49.169
PIN01_3202				48.622	48.74	48.836	49.042
PIN01_3123				48.517	48.628	48.717	48.946
PIN01_3044				48.346	48.466	48.587	48.904
PIN01_2965				48.284	48.363	48.47	48.843
PIN01_2868				48.106	48.29	48.447	48.838
PIN01_2868d				47.919	48.157	48.354	48.801
PIN01_2861				47.897	48.148	48.353	48.802
PIN01_2818				47.883	48.124	48.324	48.789
PIN01_2784				47.808	48.033	48.225	48.694
PIN01_2784c1				47.778	47.99	48.168	48.599
PIN01_2681c1				47.639	47.791	47.915	48.137
PIN01_2784c2				47.778	47.99	48.168	48.599
PIN01_2681c2				47.639	47.791	47.915	48.137
PIN01_2681				47.572	47.681	47.763	47.895
PIN01_2640				47.541	47.643	47.719	47.835
PIN01_2581				47.505	47.614	47.712	47.878
PIN01_2521				47.467	47.547	47.617	47.746
PIN01_2470				47.468	47.56	47.647	47.813
PIN01_2470d				47.456	47.539	47.611	47.756
PIN01_2467				47.456	47.539	47.611	47.757
PIN01_2444				47.428	47.492	47.551	47.696
PIN01_2388				47.405	47.446	47.486	47.618
PIN01_2316				47.391	47.44	47.494	47.557
PIN01_2272				47.389	47.458	47.484	47.629
PIN01_2266				47.135	47.249	47.339	47.477
PIN01_2246				47.102	47.225	47.311	47.459
PIN01_2192				47.012	47.13	47.217	47.38
PIN01_2164				46.95	47.051	47.135	47.313
PIN01_2143				46.941	47.037	47.116	47.293
PIN01_2100				46.861	46.959	47.048	47.251
PIN01_2030				46.803	46.909	47.011	47.236
PIN01_1980				46.779	46.873	46.963	47.185
PIN01_1967u				46.771	46.868	46.97	47.207
PIN01_1967d				46.706	46.785	46.894	47.161
PIN01_1957u				46.702	46.783	46.893	47.162
PIN01_1957d				46.702	46.783	46.893	47.162
PIN01_1952				46.684	46.767	46.893	47.167
PIN01_1925				46.611	46.687	46.841	47.144

PIN01_1872				46.362	46.5	46.755	47.107
PIN01_1809				46.161	46.411	46.728	47.095
PIN01_1745				46.085	46.387	46.719	47.09
PIN01_1680				46.054	46.373	46.712	47.086
PIN01_1627				46.031	46.358	46.704	47.079
PIN01_1533				45.986	46.333	46.69	47.068
PIN01_1520u				45.981	46.331	46.689	47.068
PIN01_1520d				45.981	46.331	46.689	47.068
PIN01_1482				45.963	46.322	46.684	47.064
PIN01_1404u				45.941	46.31	46.676	47.058
PIN01_1404d				45.941	46.31	46.676	47.058
PIN01_1330				45.933	46.309	46.677	47.059
PIN01_1278				45.854	46.216	46.583	46.976
PIN01_1278d				45.624	45.783	45.913	46.108
PIN01_1270				45.595	45.74	45.853	46.043
PIN01_1199				45.487	45.646	45.771	45.954
PIN01_1124				45.322	45.456	45.558	45.698
PIN01_1048				45.202	45.384	45.519	45.662
PIN01_0954				44.9	44.984	45.068	45.264
PIN01_0860				44.708	44.822	44.943	45.204
PIN01_0766				44.574	44.724	44.873	45.166
PIN01_0672				44.472	44.664	44.83	45.142
PIN01_0578				44.42	44.629	44.802	45.125
PIN01_0482				44.378	44.601	44.779	45.109
PIN01_0386				44.324	44.567	44.752	45.09
PIN01_0289				44.258	44.524	44.717	45.065
PIN01_0193				44.174	44.471	44.671	45.034
PIN01_0096				44.139	44.452	44.655	45.022
PIN01_0000				44.106	44.425	44.631	45.002
PIN01_0000c				44.06	44.355	44.544	44.884
PIN00_0200c				43.848	44.029	44.141	44.337
PIN01_0000r1				44.017	44.287	44.46	44.769
PIN00_0200r1				43.87	44.059	44.176	44.381
PIN01_0000r2				44.017	44.287	44.46	44.769
PIN00_0200r2				43.87	44.059	44.176	44.381
PIN00_0200				43.681	43.771	43.819	43.898
PIN00_0163				43.63	43.713	43.759	43.836
PIN00_0126				43.564	43.643	43.691	43.769
PIN00_0090				43.434	43.546	43.605	43.698
PIN00_0045				43.293	43.447	43.519	43.627
PIN00_0000				43.251	43.408	43.481	43.591
MOR01_0427				55.535	55.571	55.598	55.646
MOR01_0412				55.165	55.197	55.225	55.277
MOR01_0397				54.793	54.824	54.854	54.909
MOR01_0382				54.42	54.452	54.485	54.545
MOR01_0367				54.046	54.082	54.117	54.179
MOR01_0352				53.676	53.715	53.753	53.813
MOR01_0337				53.304	53.346	53.389	53.444
MOR01_0322				52.943	52.99	53.038	53.085

MOR01_0307				52.569	52.619	52.66	52.713
MOR01_0292				52.238	52.29	52.326	52.39
MOR01_0277				51.847	51.891	51.928	51.984
MOR01_0260				51.247	51.292	51.328	51.385
MOR01_0243				50.681	50.727	50.761	50.818
MOR01_0226				50.091	50.128	50.165	50.217
MOR01_0209				49.549	49.587	49.623	49.676
MOR01_0192				48.949	48.985	49.016	49.063
MOR01_0175				48.577	48.619	48.647	48.691
MOR01_0159				48.55	48.587	48.606	48.638
MOR01_0143				48.546	48.581	48.597	48.624
MOR01_0126				48.545	48.58	48.597	48.623
MOR01_0126c				47.513	47.555	47.772	48.512
MOR01_0101c				47.133	47.171	47.212	48.835
MOR01_0076c				46.574	46.58	47.042	48.906
MOR01_0050c				46.385	46.607	47.151	49.179
MOR01_0025c				46.734	47.019	47.385	49.154
MOR01_0000c				46.004	46.28	46.585	47.247

Table B.2 – With-scheme peak water levels extracted from the 1D model

Model Node	- Maximum Water Level (m AD)						
	50% AEP	20% AEP	5% AEP	1% AEP	1% AEP +35%CC	1% AEP +70%CC	0.1% AEP
PIN01_3535				49.224	49.311	49.365	49.457
PIN01_3473				49.102	49.218	49.3	49.413
PIN01_3377				48.911	49.025	49.121	49.279
PIN01_3282				48.768	48.892	48.991	49.169
PIN01_3202				48.622	48.74	48.836	49.042
PIN01_3123				48.517	48.628	48.717	48.946
PIN01_3044				48.346	48.466	48.587	48.905
PIN01_2965				48.284	48.363	48.47	48.843
PIN01_2868				48.106	48.29	48.447	48.838
PIN01_2868d				47.919	48.157	48.354	48.802
PIN01_2861				47.897	48.148	48.353	48.803
PIN01_2818				47.883	48.124	48.324	48.79
PIN01_2784				47.808	48.033	48.225	48.694
PIN01_2784c1				47.778	47.99	48.168	48.6
PIN01_2681c1				47.639	47.791	47.915	48.138
PIN01_2784c2				47.778	47.99	48.168	48.6
PIN01_2681c2				47.639	47.791	47.915	48.138
PIN01_2681				47.572	47.681	47.763	47.896
PIN01_2640				47.541	47.643	47.719	47.836
PIN01_2581				47.505	47.614	47.712	47.879
PIN01_2521				47.467	47.547	47.617	47.747
PIN01_2470				47.468	47.56	47.647	47.814
PIN01_2470d				47.456	47.539	47.611	47.758
PIN01_2467				47.456	47.539	47.611	47.759
PIN01_2444				47.428	47.492	47.551	47.698
PIN01_2388				47.405	47.446	47.479	47.622
PIN01_2316				47.391	47.44	47.461	47.56
PIN01_2272				47.389	47.458	47.482	47.633
PIN01_2266				47.135	47.249	47.339	47.482
PIN01_2246				47.102	47.225	47.311	47.465
PIN01_2192				47.012	47.13	47.218	47.389
PIN01_2164				46.95	47.051	47.137	47.325
PIN01_2143				46.941	47.037	47.119	47.306
PIN01_2100				46.861	46.959	47.052	47.267
PIN01_2030				46.803	46.91	47.017	47.253
PIN01_1980				46.779	46.874	46.969	47.206
PIN01_1967u				46.771	46.869	46.978	47.226
PIN01_1967d				46.706	46.786	46.905	47.185
PIN01_1957u				46.702	46.784	46.905	47.186
PIN01_1957d				46.702	46.784	46.905	47.186
PIN01_1952				46.684	46.769	46.905	47.191
PIN01_1925				46.61	46.689	46.858	47.17
PIN01_1872				46.363	46.51	46.779	47.136
PIN01_1809				46.166	46.429	46.755	47.125
PIN01_1745				46.094	46.407	46.747	47.121

PIN01_1680				46.065	46.393	46.741	47.116
PIN01_1627				46.042	46.38	46.733	47.11
PIN01_1533				46	46.357	46.72	47.1
PIN01_1520u				45.995	46.355	46.719	47.1
PIN01_1520d				45.995	46.355	46.719	47.1
PIN01_1482				45.978	46.347	46.714	47.096
PIN01_1404u				45.957	46.336	46.707	47.09
PIN01_1404d				45.957	46.336	46.707	47.09
PIN01_1330d				45.949	46.333	46.707	47.091
PIN01_1278				45.87	46.24	46.613	47.007
PIN01_1278d				45.632	45.793	45.922	46.116
PIN01_1270				45.603	45.748	45.861	46.049
PIN01_1199				45.495	45.655	45.78	45.962
PIN01_1124				45.329	45.464	45.565	45.704
PIN01_1048				45.211	45.394	45.527	45.666
PIN01_0954				44.904	44.989	45.074	45.275
PIN01_0860				44.712	44.83	44.953	45.217
PIN01_0766				44.579	44.735	44.884	45.179
PIN01_0672				44.479	44.676	44.842	45.156
PIN01_0578				44.427	44.642	44.815	45.139
PIN01_0482				44.386	44.615	44.793	45.123
PIN01_0386				44.333	44.581	44.765	45.104
PIN01_0289				44.268	44.539	44.73	45.08
PIN01_0193				44.185	44.487	44.686	45.049
PIN01_0096				44.151	44.468	44.67	45.038
PIN01_0000				44.118	44.441	44.645	45.018
PIN01_0000c				44.072	44.37	44.558	44.899
PIN00_0200c				43.855	44.038	44.149	44.346
PIN01_0000r1				44.028	44.301	44.472	44.782
PIN00_0200r1				43.877	44.069	44.184	44.39
PIN01_0000r2				44.028	44.301	44.472	44.782
PIN00_0200r2				43.877	44.069	44.184	44.39
PIN00_0200				43.685	43.775	43.822	43.901
PIN00_0163				43.633	43.717	43.762	43.839
PIN00_0126				43.567	43.647	43.694	43.772
PIN00_0090				43.438	43.551	43.609	43.701
PIN00_0045				43.3	43.454	43.524	43.631
PIN00_0000				43.258	43.414	43.486	43.595
MOR01_0545				55.547	55.579	55.608	55.66
MOR01_0535				55.338	55.37	55.4	55.454
MOR01_0525				55.129	55.161	55.192	55.247
MOR01_0516				54.92	54.953	54.984	55.04
MOR01_0506				54.711	54.744	54.776	54.834
MOR01_0496				54.503	54.535	54.568	54.628
MOR01_0486				54.292	54.326	54.361	54.422
MOR01_0476				54.085	54.12	54.154	54.217
MOR01_0467				53.87	53.907	53.944	54.01
MOR01_0457				53.674	53.716	53.755	53.818
MOR01_0447				53.433	53.474	53.51	53.565

MOR01_0439				53.195	53.236	53.273	53.327
MOR01_0431				52.958	52.999	53.035	53.09
MOR01_0423				52.721	52.761	52.797	52.852
MOR01_0421				52.664	52.702	52.737	52.792
MOR01_0419				52.612	52.645	52.676	52.729
MOR01_0417				52.598	52.598	52.61	52.651
MOR01_0415u				52.396	52.433	52.466	52.521
MOR01_0415i				52.396	52.433	52.466	52.521
MOR01_0415c				52.386	52.419	52.449	52.497
MOR01_0406				52.123	52.155	52.185	52.233
MOR01_0397				51.859	51.892	51.922	51.97
MOR01_0388				51.595	51.628	51.658	51.706
MOR01_0380				51.332	51.365	51.394	51.442
MOR01_0371				51.068	51.101	51.132	51.18
MOR01_0362				50.806	50.838	50.866	50.913
MOR01_0353				50.538	50.574	50.609	50.659
MOR01_0344c				50.383	50.428	50.468	50.53
MOR01_0344o				50.374	50.415	50.451	50.506
MOR01_0344d				50.374	50.415	50.451	50.506
MOR01_0335				50.103	50.144	50.18	50.235
MOR01_0326				49.832	49.873	49.909	49.964
MOR01_0317				49.561	49.602	49.638	49.693
MOR01_0308				49.29	49.331	49.367	49.422
MOR01_0298				49.019	49.06	49.096	49.151
MOR01_0289				48.748	48.789	48.825	48.88
MOR01_0287				48.68	48.721	48.757	48.812
MOR01_0285				48.612	48.653	48.689	48.744
MOR01_0283				48.545	48.585	48.622	48.676
MOR01_0280				48.477	48.518	48.554	48.609
MOR01_0278				48.412	48.451	48.486	48.54
MOR01_0276				48.359	48.386	48.418	48.47
MOR01_0274				48.346	48.344	48.348	48.389
MOR01_0271u				48.121	48.158	48.191	48.246
MOR01_0271i				48.121	48.158	48.191	48.246
MOR01_0271c				48.112	48.145	48.174	48.222
MOR01_0264				47.888	47.92	47.949	47.999
MOR01_0256				47.687	47.73	47.767	47.826
MOR01_0249c				47.596	47.649	47.695	47.764
MOR01_0249o				47.588	47.638	47.681	47.745
MOR01_0249d				47.588	47.638	47.681	47.745
MOR01_0202				46.942	46.991	47.032	47.137
MOR01_0162				46.487	46.552	46.728	47.099
MOR01_0121				46.095	46.357	46.717	47.097
MOR01_0081				45.96	46.339	46.709	47.092
MOR01_0040				45.952	46.334	46.707	47.09
MOR01_0000				45.949	46.333	46.705	47.089
MOR01_0000d				45.949	46.333	46.707	47.091