

Croudace Homes Limited

Stoneyfields, Oxted

Hydraulic Modelling Report

REPORT REF.

2404420_A-ACE-XX-XX-RP-C-0321

October 2025

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Document Control Sheet

REV	ISSUE PURPOSE	AUTHOR	CHECKED	APPROVED	DATE
-	DRAFT	JA	BC	DRAFT	October 2025
	FINAL	JA	JA	BC	13 October 2025

Distribution

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Return Periods / Annual Exceedance Probability Events

The following return periods / annual exceedance probability (AEP) events are referenced in the text:

Return Period	Annual Exceedance Probability
1 in 1-year	100%
1 in 2-year	50%
1 in 5-year	20%
1 in 10-year	10%
1 in 20-year	5%
1 in 30-year	3.3%
1 in 100-year	1%

1. Introduction

- 1.1. Ardent Consulting Engineers (hereafter referred to as Ardent) has been instructed by Croudace Homes Limited to undertake technical hydraulic modelling work in relation to a proposed development at Stoneyfields, Oxted.
- 1.2. A surface water hydraulic modelling study was undertaken in November 2024 covering the site and surrounding catchment. The modelling was used to refine the understanding of the existing surface water flood risk and to inform the development of mitigation measures for managing overland flow paths from offsite without increasing flood risk. Details of the modelling are outlined within a technical model report (report ref: **2404420-ACE-XX-XX-RP-C-0501**) accompanying the site Flood Risk Assessment (FRA).
- 1.3. The Lead Local Flood Authority (LLFA) provided no objection to the FRA and surface water hydraulic modelling, and were satisfied that the requirements of the NPPF and the Tandridge Local Plan were complied with.
- 1.4. Tandridge District Council refused the outline planning application, with one reason for refusal being '*The applicant has not demonstrated that the proposed development, and in particular the outline drainage proposals, will not result in the loss or deterioration of an irreplaceable habitat both on-site and off-site, that is The Bogs ancient woodland, within and adjoining the site boundary*'.
- 1.5. Within the accompanying Officer's Report it is detailed that concerns relating to The Bogs ancient woodland (hereafter referred to as The Bogs) are in part associated with a lack of information provided regarding the hydrological impacts of the development proposals on flows reaching The Bogs.
- 1.6. This included comments from a third party flood risk consultant instructed on behalf of the Parish Council that stated the modelling report '*shows a reduction in flood levels to the south of the site, which would also mean a reduction in flow to The Bogs. Given the area of ancient woodland with a wet woodland dominated landscape, a reduction in flow may not be a desirable outcome and could have adverse impacts on the biodiversity of the area.*'
- 1.7. This technical note has been prepared to assess surface water flows in the pre and post development scenario entering The Bogs. These surface water flows enter The Bogs via onsite and offsite overland flows. The offsite overland flow route is predicted to form during extreme storm events, entering the site in the northwest

corner and flowing overland towards The Bogs located to the south of the site. The Bogs receive flows from an ordinary watercourse running along the western site boundary before flowing through The Bogs.

1.8. This note outlines the updates made to the existing hydraulic modelling to support this assessment, and details the model outputs in terms of the impacts on flows to The Bogs from offsite.

1.9. A separate note is prepared by Motion to address the contribution of flows to The Bogs from runoff generated by rainfall falling within the site boundary in the existing and proposed conditions.

Site location and existing hydrology

1.10. The Site locations and surrounding area is shown in **Figure 1-1**. Additionally, the approximate catchment areas draining to The Bogs are shown in **Figure 1-2**, with the catchment areas estimated from Environment Agency 1m LIDAR Digital Terrain Model (DTM) elevation data and Southern Water asset data.



Figure 1-1: Site location plan

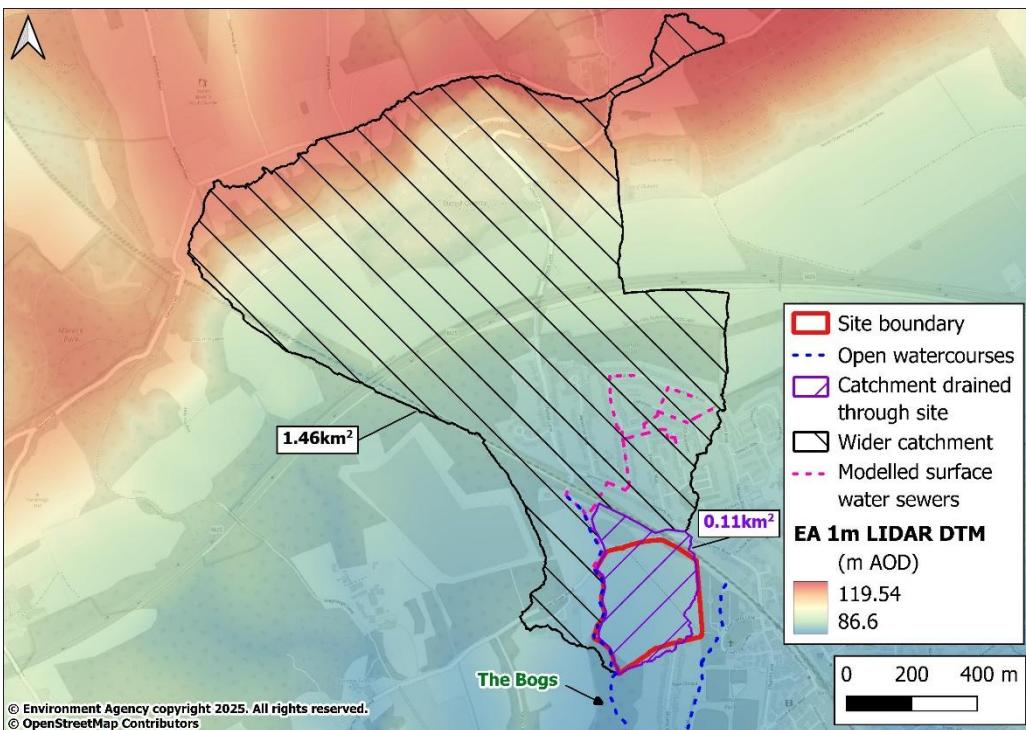


Figure 1-2: Catchment areas draining to The Bogs during rainfall events

1.11. The Bogs are primarily fed by an ordinary watercourse running along the western site boundary. The ordinary watercourse receives flows from a Southern Water surface water sewer network draining a residential area to the north of the railway line. The sewer outfalls to the watercourse adjacent to the northwest corner of the site. The sewer network mapping is provided in **Appendix A**. An open ditch also runs along Chalkpit Lane before connecting into the surface water sewer network at Barrow Green Road.

1.12. During a typical rainfall event, the sewer network and ordinary watercourse drain an area of approximately 1.46km² to The Bogs at the downstream extent of the site. The site and immediately adjacent area drains through to The Bogs via a topographic catchment with an area of approximately 0.11km².

2. Model Updates

2.1. To allow for the impacts on The Bogs to be assessed during higher frequency, lower magnitude storm events, the hydrological assessment undertaken as part of the existing hydraulic modelling was updated to derive new rainfall profiles using ReFH2 methodologies. The assessment was undertaken in line with the approach used in the existing modelling.

2.2. Rainfall hyetographs were generated for the 1 in 1-year, 1 in 2-year, 1 in 5-year, and 1 in 10-year storm return periods. The design and net rainfall profiles were derived and applied to the model in line with the approach used in the existing approved model.

2.3. Within the post-development scenario, the overall catchment model previously removed rainfall from the developed site catchment as this area was picked up by the site surface water piped drainage design. The outflow from the surface water network was applied as a point inflow within the overall catchment model. The outflow from the surface water drainage network was applied at a constant rate restricted to a 1 in 2-year greenfield discharge rate for all rainfall events.

2.4. The latest surface water drainage proposals restrict runoff to greenfield rates. This means that flows from the development will be discharged at equivalent greenfield rates so it does not exceed or reduce the natural runoff rate that would occur if the land were undeveloped (greenfield). As a result, the post-development catchment model was revised with rainfall applied across the entire site, replicating the pre-development scenario with runoff generated in the model at greenfield rates.

2.5. This approach allows for a direct comparison between the pre- and post-development scenarios to demonstrate the impacts of the ground level modifications associated with the development on flows reaching The Bogs. The technical note prepared by Motion provides more details on the impacts of the on-site surface water drainage network on runoff from The Site to The Bogs.

2.6. The development proposals incorporate ground level reprofiling along the west of the site to divert an overland flow path away from residential development during extreme rainfall events. The post-development scenario was updated to ensure the latest configuration of the reprofiling was represented, including the interaction with adjacent drainage basins designed to be set above the peak flood levels during the 1 in 100-year plus 45% climate change (CC) storm event. As with the previous

modelling, post-development ground levels represented within the model are indicative and subject to detailed design.

2.7. Flow result lines were added to the pre- and post-development models. These flow result lines will assess flows entering The Bogs in the pre and post development scenario and their impact.

2.8. No other updates were made to the pre- and post-development model, with the modelling undertaken in line with the existing approved model that was used to inform the FRA approved by the LLFA. As per the previous study the model outputs were filtered to remove depths below 0.05m.

2.9. The revised pre- and post-development models were also run for the following storm events: 1 in 1-year, 1 in 2-year, 1 in 5-year, 1 in 10-year, 1 in 30-year, 1 in 100-year, and 1 in 100-year plus 45% climate change uplift.

3. Impacts of development proposals on flows

Pre-development scenario

3.1. The peak modelled flood extents during the pre-development scenario are shown in

Figure 3-1. The model outputs show that during the lower magnitude, higher frequency storm events, flows conveyed towards The Bogs are predominantly via the ordinary watercourse that is fed by flows from the Southern Water sewer and wider catchment. The overland flow path through the site is only predicted to form in the higher magnitude, more extreme storm events.

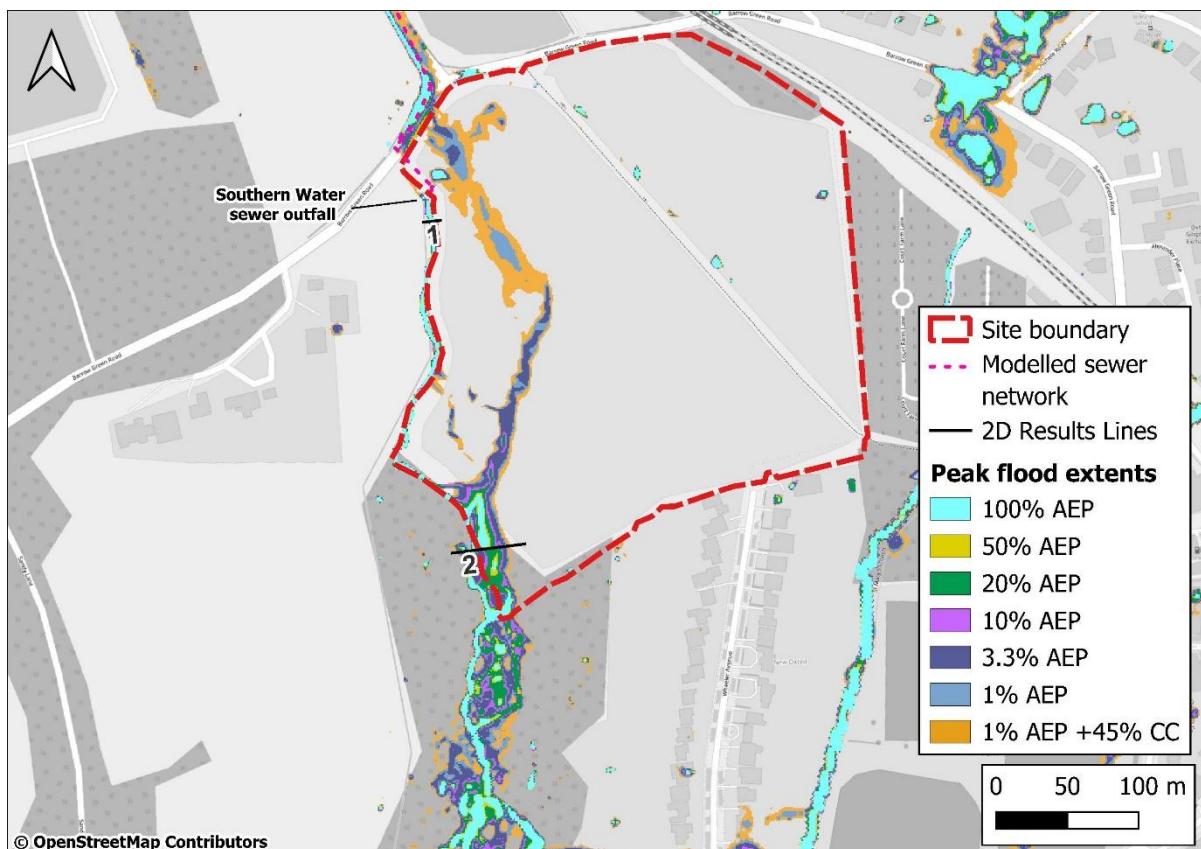


Figure 3-1: Pre-development scenario peak modelled flood extents

3.2. The first peak flow result line (1) is located within the ordinary watercourse immediately downstream of the outfall from the Southern Water sewer (result line 1). The second peak flow result line (2) is located within The Bogs at the downstream extent of the Site (result line 2). The flows associated with the various events are shown in **Table 3-1**. The location of the result lines is shown in **Figure 3-1**.

Table 3-1: Pre-Development peak flows at results lines shown in Figure 3-1

Return period	Results Line peak flow (m ³ /s)		
	1	2	Diff
1 in 1-year	0.17	0.19	0.02
1 in 2-year	0.22	0.24	0.02
1 in 5-year	0.41	0.45	0.04
1 in 10-year	0.55	0.61	0.06
1 in 30-year	0.79	1.09	0.30
1 in 100-year	0.87	1.42	0.55
1 in 100-year + Climate Change	0.99	2.10	1.11

3.3. During the lower magnitude events most of the flows reaching The Bogs is from the ordinary watercourse. During the 100% AEP event there is only a minor increase of 0.02m³/s in the peak flow between the outfall of the sewer network and the downstream extent of the Site, with an increase of 0.02m³/s also predicted during the 50% AEP event. Refer to **Table 3-1** above.

3.4. During the higher magnitude events flows also reach The Bogs via the overland flow path through the site, resulting in a greater difference in the peak flows between the outfall from the Southern Water sewers and the downstream extent of the Site. For example, an increase of 0.30m³/s is predicted during the 3.3% AEP event and an increase of 0.55m³/s in the 1% AEP event.

Post-development condition

3.5. The peak modelled flood extents during the post-development scenario are shown in **Figure 3-2.**

3.6. As with the pre-development scenario, no overland flow path is predicted to form during the lower magnitude events. During the storm events larger than and including the 3.3% AEP event the overland flows are modelled to be diverted around the western area of the site away from the residential development. The ground level reprofiling is designed to divert the flows back towards The Bogs in the same location as the pre-development scenario. This approach ensures there is a negligible impact on how overland flows reach The Bogs.

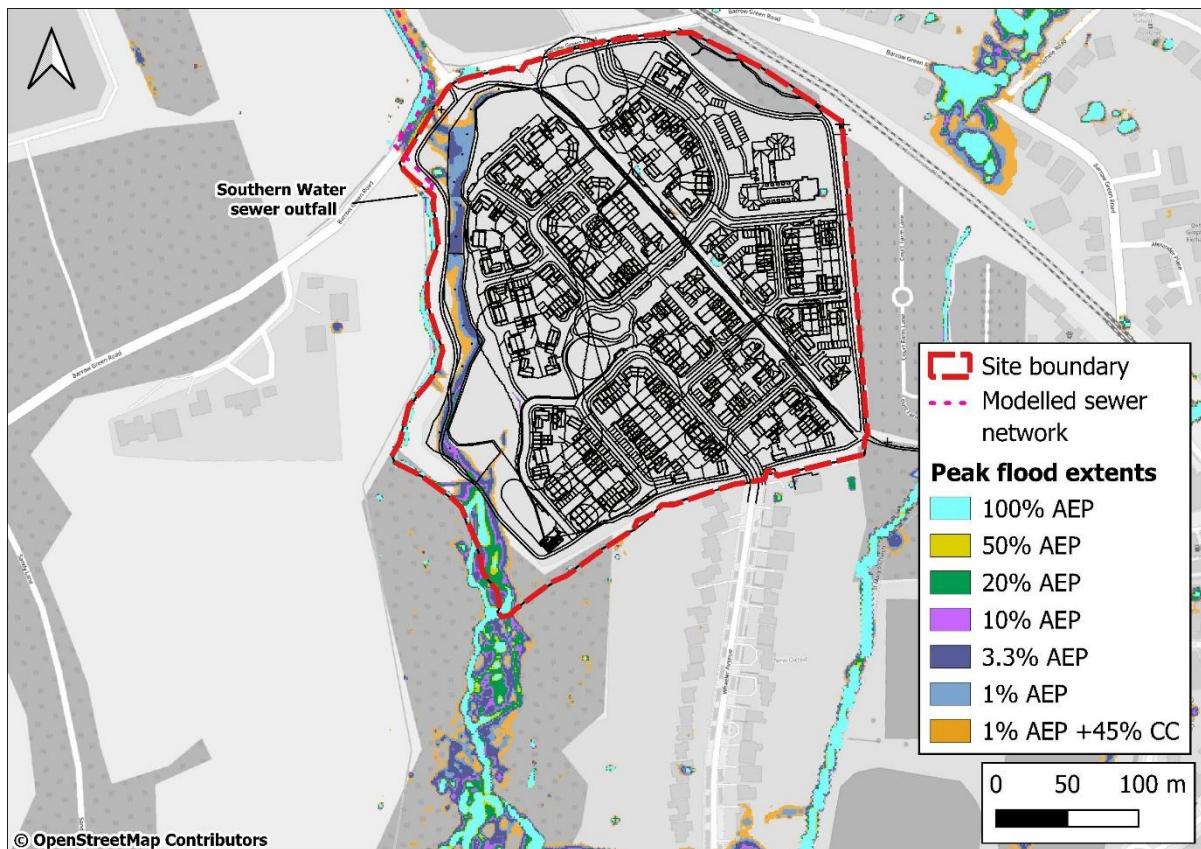


Figure 3-2: Post-development scenario peak modelled flood extents

Impact of proposals on flows to The Bogs

3.7. The peak flows during the pre-development and post-development scenarios for all modelled events for result lines 1 and 2 (see **Figure 3-1**) are shown in **Table 3-2**.

Table 3-2: Pre-Development and Post-development peak flows at results lines shown in Figure 3-1

Results Line	Results Line peak flow (m ³ /s)					
	1			2		
Return Period	Pre-development	Post-development	Change	Pre-development	Post-development	Change
1 in 1-year	0.17	0.17	0	0.19	0.19	0
1 in 2-year	0.22	0.22	0	0.24	0.24	0
1 in 5-year	0.41	0.41	0	0.45	0.47	+0.02
1 in 10-year	0.55	0.55	0	0.61	0.63	+0.02
1 in 30-year	0.79	0.79	0	1.09	1.09	0
1 in 100-year	0.87	0.87	0	1.42	1.41	-0.01
1 in 100-year + Climate Change	0.99	0.99	0	2.10	2.10	0

3.8. The development proposals will have a negligible impact on flows reaching The Bogs via the ordinary watercourse. This is supported by the fact that during each

modelled event there is predicted to be no change to the flows in the watercourse immediately downstream of the Southern Water outfall.

3.9. The comparison of peak flows at the downstream extent of the site also shows a negligible change in the peak flows reaching The Bogs during each modelled event. The model results therefore demonstrate that the proposed ground level modifications within the site have a negligible impact on the hydrology of The Bogs in terms of routing of overland flows.

3.10. The change in peak flood depths between the pre-development and post-development scenarios is shown in **Figure 3-3**. The model results demonstrate that a negligible change in the peak flood depths is predicted during the high frequency, low magnitude 100% AEP event.

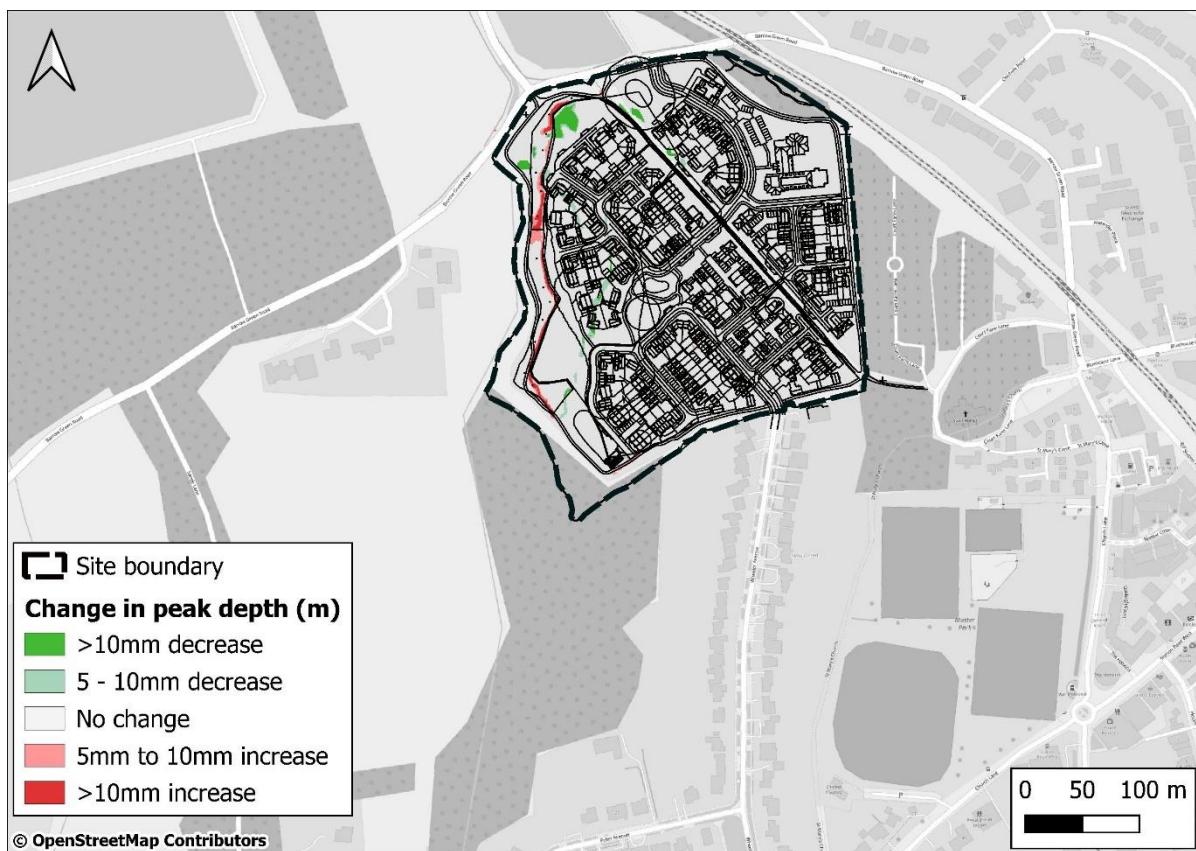


Figure 3-3: Change in peak flood depths – 100% AEP event – pre-development vs post-development scenario

3.11. The change in peak flood depths between the pre-development and post-development scenarios is shown in **Figure 3-4**. The model results demonstrate that a negligible change in the peak flood depths is also predicted during the low frequency, high magnitude 1% AEP plus 45% climate change event.

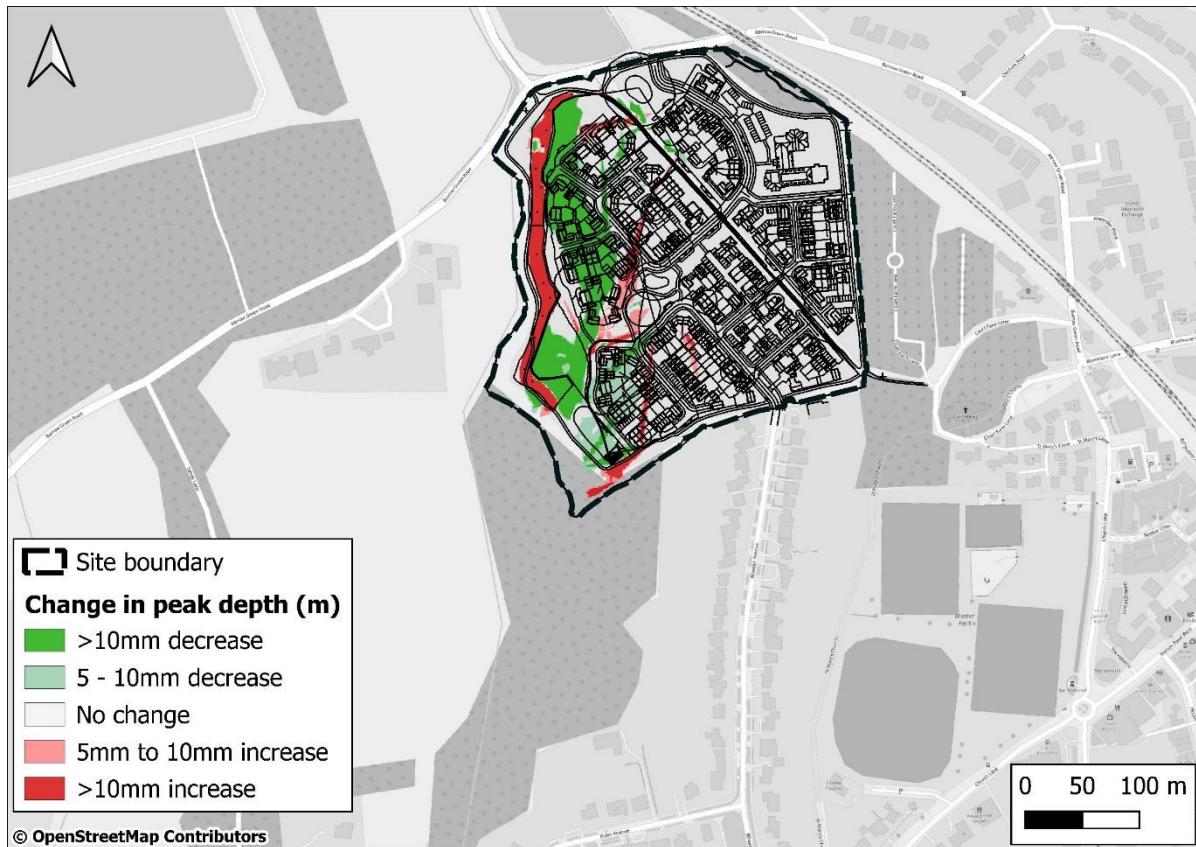


Figure 3-4: Change in peak flood depths – 1% AEP plus 45% climate change event – pre-development vs post-development scenario

3.12. The ground level changes associated with the post-development proposals are therefore considered to have a negligible impact on flood depths and flows within The Bogs during a range of storm events.

4. Summary

4.1. Ardent Consulting Engineers has been instructed by Croudace Homes Limited to undertake technical hydraulic modelling work in relation to a proposed development at Stoneyfields, Oxted.

4.2. This technical note has been prepared to assess surface water flows in the pre and post development scenario entering The Bogs. These surface water flows enter The Bogs via onsite and offsite overland flows. The offsite overland flow route is predicted to form during extreme storm events, entering the site in the northwest corner and flowing overland towards The Bogs located to the south of the site. The Bogs receive flows from an ordinary watercourse running along the western site boundary before flowing through The Bogs.

4.3. A separate note is prepared by Motion to address the contribution of flows to The Bogs from the surface water runoff generated by rainfall falling within the site boundary in the pre- and post-development scenarios.

4.4. The pre-development and post-development catchment models have been updated to reflect the latest proposals, with rainfall hyetographs derived for high frequency, low magnitude storm events not previously assessed. The updated models were rerun for the following storm events: 1 in 1-year, 1 in 2-year, 1 in 5-year, 1 in 10-year, 1 in 30-year, 1 in 100-year, and 1 in 100-year plus 45% climate change uplift.

4.5. The model results demonstrate that during low magnitude storm events the flows reaching The Bogs are primarily via the ordinary watercourse running along the western site boundary. An overland flow path through the site is only predicted to form during extreme rainfall events greater than and including the 3.3% AEP event.

4.6. The development proposals will have a negligible impact on flows reaching The Bogs via the ordinary watercourse. This is supported by the fact that during each modelled event there is predicted to be no change to the flows in the watercourse immediately downstream of the Southern Water outfall providing the dominant source of flow.


4.7. The comparison of peak flows at the downstream extent of the site also shows a negligible change in the peak flows reaching The Bogs during each modelled event. The model results therefore demonstrate that the proposed ground level modifications within the site have a negligible impact on the hydrology of the bogs in terms of the development.

4.8. Comparison of peak flood depths shows a negligible change between the pre-development and post-development scenarios during the high frequency, low magnitude 100% AEP event and during the low frequency, high magnitude 1% AEP plus 45% climate change event.

4.9. The ground level changes associated with the development proposals are therefore considered to have a negligible impact on flood depths and flows within The Bogs during a range of storm events.

Appendices

Appendix A – Southern Water Asset Mapping



Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert					
5101	C	0.00	0.00		9601	F	122.00	120.07		9602	F	120.33	118.03		9603	F	120.20	118.78		9604	F	120.35	118.40		9701	F	124.76	123.34						
5102	C	0.00	0.00		9702	F	123.17	121.42		0350	S	110.31	108.58		0351	S	113.70	112.16		0450	S	117.39	115.53		0451	S	118.32	117.24						
5103	C	0.00	0.00		0452	S	119.46	119.22		0453	S	119.92	122.58		0550	S	122.00	120.16		0651	S	121.11	119.53		0552	S	120.77	118.86						
5104	C	0.00	0.00		0553	S	117.37	116.13		0650	S	124.08	122.37		0651	S	125.22	0.00		0652	S	0.00	0.00		1350	S	110.37	109.12						
6101	C	0.00	0.00		1351	S	0.00	0.00		1352	S	109.47	108.56		1353	S	109.65	108.30		1354	S	109.33	107.82		1355	S	109.67	108.48						
6201	C	0.00	0.00		1450	S	112.95	112.12		1550	S	119.53	116.90		1551	S	119.21	116.88		1552	S	117.75	116.76		1650	S	121.03	119.43						
6202	F	107.96	105.80		1651	S	116.24	117.92		1652	S	118.65	117.63		1653	S	123.74	0.00		1654	S	121.74	119.09		1750	S	123.56	121.89						
6203	F	109.53	105.38		1751	S	122.86	121.17		2350	S	0.00	0.00		5350	S	0.00	0.00		5450	S	107.25	105.48		5451	S	0.00	0.00						
6204	F	0.00	0.00		6150	S	102.64	100.19		6251	S	103.38	101.32		6252	S	103.55	100.62		6350	S	0.00	0.00		6351	S	0.00	0.00						
6205	F	0.00	0.00		6352	S	104.70	0.00		6450	S	109.16	107.29		6550	S	0.00	0.00		6650	S	118.00	116.47		6750	S	118.00	116.47						
6206	F	0.00	0.00		6850	S	121.68	119.87		7450	S	110.21	108.35		7451	S	110.58	108.64		7550	S	116.28	116.78		7551	S	111.87	0.00						
6207	F	0.00	0.00		7650	S	115.42	113.99		7650	S	115.42	113.99		7651	S	115.14	113.24		7652	S	112.79	0.00		7653	S	113.19	111.32						
6208	F	0.00	0.00		7654	S	112.76	111.24		7750	S	118.82	117.35		7751	S	118.73	116.65		7850	S	122.40	120.39		8550	S	119.97	117.56		8551	S	119.04	117.20	
6209	F	0.00	0.00		8552	S	118.50	116.90		8650	S	119.02	116.16		8651	S	117.34	115.58		8652	S	117.18	115.63		8653	S	0.00	0.00		8654	S	117.28	116.39	
6210	F	0.00	0.00		8655	S	118.50	116.81		8656	S	118.00	116.60		8657	S	118.00	116.60		8658	S	120.20	118.14		8659	S	121.85	120.02						
6211	F	119.30	117.47		8751	S	114.17	112.44		9650	S	122.10	120.17		9651	S	120.40	118.10		9652	S	120.40	118.10		9653	S	120.40	118.87		9654	S	120.39	118.38	
6212	F	118.74	0.00		9750	S	123.07	121.54		9751	S	124.90	123.53		12550	S	120.20	118.14		12551	S	113.19	111.32		12552	S	112.76	111.24		12553	S	118.82	117.35	
6213	F	123.93	122.47		12554	S	118.73	116.65		12555	S	118.73	116.65		12556	S	122.40	120.39		12557	S	122.40	120.39		12558	S	122.40	120.39		12559	S	122.40	120.39	
6214	F	121.85	119.90		125510	S	122.40	120.39		125511	S	122.40	120.39		125512	S	122.40	120.39		125513	S	122.40	120.39		125514	S	122.40	120.39		125515	S	122.40	120.39	
6215	F	0.00	0.00		125516	S	122.40	120.39		125517	S	122.40	120.39		125518	S	122.40	120.39		125519	S	122.40	120.39		125520	S	122.40	120.39		125521	S	122.40	120.39	
6216	F	0.00	0.00		125522	S	122.40	120.39		125523	S	122.40	120.39		125524	S	122.40	120.39		125525	S	122.40	120.39		125526	S	122.40	120.39		125527	S	122.40	120.39	
6217	F	0.00	0.00		125528	S	122.40	120.39		125529	S	122.40	120.39		125530	S	122.40	120.39		125531	S	122.40	120.39		125532	S	122.40	120.39		125533	S	122.40	120.39	
6218	F	0.00	0.00		125534	S	122.40	120.39		125535	S	122.40	120.39		125536	S	122.40	120.39		125537	S	122.40	120.39		125538	S	122.40	120.39		125539	S	122.40	120.39	
6219	F	0.00	0.00		125540	S	122.40	120.39		125541	S	122.40	120.39		125542	S	122.40	120.39		125543	S	122.40	120.39		125544	S	122.40	120.39		125545	S	122.40	120.39	
6220	F	0.00	0.00		125546	S	122.40	120.39		125547	S	122.40	120.39		125548	S	122.40	120.39		125549	S	122.40	120.39		125550	S	122.40	120.39		125551	S	122.40	120.39	
6221	F	0.00	0.00		125552	S	122.40	120.39		125553	S	122.40	120.39		125554	S	122.40	120.39		125555	S	122.40	120.39		125556	S	122.40	120.39		125557	S	122.40	120.39	
6222	F	0.00	0.00		125558	S	122.40	120.39		125559	S	122.40	120.39		125560	S	122.40	120.39		125561	S	122.40	120.39		125562	S	122.40	120.39		125563				