

Thurrock Council

Level 1 Strategic Flood Risk Assessment

Appendix E: Mardyke Catchment Sensitivity Analysis
Report Version 2

Thurrock Council

AECOM Project number: 60689110

September 2023

Quality information

Prepared by	Checked by	Verified by	Approved by
Katie Pearson Technical Director Hydraulic Modelling	Lydia Crowther – Senior Consultant (Water)	Helen Judd Associate	Sarah Littlewood Principal Consultant
Mayuresh Padalkar Consultant (Water)	Veronica Makhesh – Senior Consultant (Water)		
Lewis Deakin Civil Engineering Apprentice			

Revision History

Revision	Revision date	Details	Authorized	Name	Position
P1	25/07/2023	Version 1	SL	Sarah Littlewood	Project Manager
P2	15/09/2023	Version 2	SL	Sarah Littlewood	Project Manager

Prepared for:

Thurrock Council
Civic Offices,
New Road
Grays
Essex, RM17 6SL

Prepared by:

AECOM Limited
Midpoint, Alencon Link
Basingstoke
Hampshire, RG21 7PP
United Kingdom

T: 01256 310200
aecom.com

© 2023 AECOM

AECOM Limited ("AECOM") has prepared this Report for the sole use of Thurrock Council ("Client") in accordance with the terms and conditions of appointment ref: PS/2022/131 dated 07.06.2022 ("the Appointment").

AECOM shall have no duty, responsibility and/or liability to any party in connection with this Report howsoever arising other than that arising to the Client under the Appointment. Save as provided in the Appointment, no warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by AECOM.

This Report should not be reproduced in whole or in part or disclosed to any third parties for any use whatsoever without the express written authority of AECOM. To the extent this Report is reproduced in whole or in part or disclosed to any third parties (whether by AECOM or another party) for any use whatsoever, and whether such disclosure occurs with or without the express written authority of AECOM, AECOM does not accept that the third party is entitled to rely upon this Report and does not accept any responsibility or liability to the third party. To the extent any liability does arise to a third party, such liability shall be subject to any limitations included within the Appointment, a copy of which is available on request to AECOM.

Where any conclusions and recommendations contained in this Report are based upon information provided by the Client and/or third parties, it has been assumed that all relevant information has been provided by the Client and/or third parties and that such information is accurate. Any such information obtained by AECOM has not been independently verified by AECOM, unless otherwise stated in this Report. AECOM accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to AECOM from the Client and/or third parties.

Table of Contents

1.	Executive Summary.....	5
1.1	Background.....	5
1.2	Summary of findings	5
2.	Context.....	7
3.	Existing models	8
4.	Scenario modelling	9
5.	Discussion	19

Figures

Figure 3-1 Mardyke model extent and catchment areas (from 2019 model)	8
Figure 4-1 Mardyke Catchment Model: Sub-catchments and nodes.....	11
Figure 4-2 Mardyke Catchment Model: Model results showing in-channel flow at 1D nodes (1% AEP)	12
Figure 4-3 Mardyke Catchment Model: Model results showing in-channel peak flood level at 1D nodes (1% AEP)	13
Figure 4-4 Mardyke Catchment Model: Maximum flood depth (1% AEP) for baseline (top) and for a sensitivity test with a +10% increase in runoff in all sub-catchments (bottom)	18

Tables

Table 4-1 Mardyke model - model inflows in each of the seven sub-catchments.....	9
Table 4-2 Mardyke: Sensitivity testing scenarios.....	10
Table 4-3 Mardyke Catchment Model - in-channel levels (m AOD) at key locations (1% AEP) for baseline and sensitivity tests	14
Table 4-4 Mardyke Catchment Model - in-channel flows (m ³ /s) at key locations (1% AEP) for baseline and sensitivity tests	16

1. Executive Summary

1.1 Background

Thurrock Council have commissioned AECOM to update their Strategic Flood Risk Assessment to provide an up-to-date assessment of flood risk from all sources. In accordance with the National Planning Policy Framework (NPPF) a Strategic Flood Risk Assessment (SFRA) should consider the cumulative impact of development on flood risk and identify opportunities to reduce the causes and impacts of flooding. This Technical Note refers to fluvial and surface water flood risk in the Mardyke catchment area. Other sources of flooding are described in the SFRA Main Report.

Planning policy relating to the approach to sustainable drainage systems (SuDS) is evolving quickly, with the initial findings of the latest government review¹ recommending that SuDS be mandatory for all new developments in England to reduce the risk of surface water flooding, pollution and help alleviate pressures on our traditional drainage and sewerage systems. Thurrock Council specifically have a need to understand the potential impact of future development in the West Horndon area and in the River Mardyke catchment more generally, to determine the potential cumulative impact of development on fluvial and surface water flood risk in this area. Thurrock Council also consider it prudent to assess the cumulative impact of development around the Tilbury Flood Storage Reservoir to demonstrate the need to preserve this asset.

Thurrock Council and AECOM have agreed a scope of services to undertake indicative modelling to better understand the potential cumulative impact of development on fluvial and surface water flood risk in these areas. The outcomes of the modelling will form part of the SFRA and may, where required, provide the necessary evidence to support the development of appropriate policies.

This report documents the sensitivity analysis undertaken for the River Mardyke catchment. This may form an appendix to the updated SFRA, part of the technical evidence base which will be used by Thurrock Council in the development of their Local Plan.

1.2 Summary of findings

In the 'Call for Sites' for their Local Plan, Thurrock Council have received a number of potential sites within the River Mardyke catchment. Thurrock Council need to consider the cumulative impact of potential development on flood risk and identify opportunities to reduce the causes and impacts of flooding. This should be considered at a strategic scale in the drainage catchment and within their planning area. Although individual potential development sites should have no impact on runoff if designed in accordance with national planning policy, the potential risk of cumulative impacts has not been assessed. The strategic assessment needs to consider the potential for increases in runoff as a consequence of development and the impact an increase in runoff could have on flood risk in the area. At this stage and scale, the details of potential developments, including measures to management surface water, are not known, so the assessment undertaken is indicative only, to give Thurrock Council an understanding of the extent and magnitude of flood risk impacts that could occur under a range of potential development scenarios.

Modelling tests have been undertaken to assess how sensitive flood levels and flows across the catchment are to the runoff from the seven sub-catchments in the existing model setup. The runoff from these sub-catchments has been increased by 10% in sensitivity test scenarios to provide an indication of how flood risk might be affected if runoff is increased as a result of potential development in the catchment. All sensitivity testing has been undertaken for a 1% Annual Exceedance Probability (AEP) design event because this is a key design event for development and planning.

The inflows into the model (ReFH2 inflows) already have a scaling factor applied that has been used to match FEH statistical peak flow estimates for the catchment, so these scaling factors have been further adjusted to represent the potential effects of development. This is a simple way of varying the runoff volume from each hydrograph to represent the desired effect.

¹ Defra, 10th January 2023, Policy paper: Sustainable drainage systems review
<https://www.gov.uk/government/publications/sustainable-drainage-systems-review>

The results of the sensitivity testing undertaken for the River Mardyke catchment indicate that if runoff is increased, the upper part of the catchment is more likely to show an increase in flood risk (flood levels and flow) than the lower part of the catchment. Further down in the catchment, the changes in hydrograph volume do not have such a noticeable effect on flood level and flow. This may be because flood risk in the lower part of the catchment is more strongly influenced by conditions in the River Thames than by conditions in the upper catchment.

The setup of the River Mardyke catchment model used here, including the inflow hydrographs, is easily manipulated to give a strategic representation of potential changes in the catchment, including increased development. Having a model of the whole catchment enables Thurrock Council to strategically assess the cumulative impact of potential development or other changes in the catchment. The model is an important part of the evidence base for the updated SFRA for Thurrock Council.

2. Context

- 2.1.1 The River Mardyke catchment, in Essex, is approximately 100km² and the river flows in a south-westerly direction through the administrative boundary of Thurrock Council to discharge into the River Thames at Mardyke Sluice. The catchment is low-lying (much of the area is below 8 metres above ordnance datum (m AOD)) and is predominantly rural with some small urban areas in the upper catchment and more urbanisation in the lower reaches at Purfleet. The River Mardyke is an Environment Agency Main River and there are a number of Ordinary Watercourses, sewers and ditches which combine with the Main River in the upper catchment draining these rural parts. There are no designated flood defences on the River Mardyke in this catchment.
- 2.1.2 There have been previous Environment Agency modelling studies of the Mardyke catchment for flood mapping, most recently the PDU4 Mardyke Project, the modelling report was completed in May 2019². The project approach incorporated three models:
- 2D modelling of Barnards Sewer tributary (less urbanised) for flood zone map updates
 - Updated Infoworks ICM model of West Horndon village to derive flood extents; and
 - 1D-2D modelling (Flood Modelling – TUFLOW) of the main River Mardyke
- 2.1.3 In the 'Call for Sites' for their Local Plan, Thurrock Council has received a considerable number of sites within the Mardyke catchment. Thurrock Council need to consider the cumulative impact of potential development on flood risk and to identify opportunities to reduce the causes and impacts of flooding. This should be considered at a strategic scale in the catchment and within their planning area. The strategic assessment needs to consider the potential for increases in runoff as a consequence of development and the impact an increase in runoff could have on flood risk in the area.
- 2.1.4 At this stage and scale, the details of the developments, including surface water management plans are not known so the assessment undertaken is indicative only, to provide Thurrock Council an understanding of the extent and magnitude of flood risk impacts that could occur under a particular development scenario. This assessment is effectively a sensitivity test, using existing modelling, to assess how sensitive the flood risk modelling results are to the modelled runoff inputs.
- 2.1.5 A further analysis of the potential impacts of development in and around West Horndon and Bulphan in the upper Mardyke Catchment is also required and has been undertaken separately, refer to SFRA Appendix F.

² Environment Agency (Mott MacDonald) PDU4 Mardyke Model Report. Hydraulic Modelling Report *River Mardyke Hydraulic Modelling Report 393325BF_03_B_noID*. Pdf May 2019

3. Existing models

- 3.1.1 As part of the 2019 project, Mott MacDonald on behalf of the Environment Agency, developed a hydraulic model for the River Mardyke (2019). The model has been developed for the purposes of updating flood risk mapping products for the River Mardyke in Essex, and to improve the Environment Agency's understanding of flood risk mechanisms at their key communities at risk within the catchment.
- 3.1.2 The model extends from upstream of West Horndon to the tidal limit of the River Mardyke at Mardyke Sluice, Purfleet. The main tributaries of Orsett Fen Sewer, Golden Bridge Sewer, Stringcock Sewer, New Mardyke, Armess Sewer, Field House Sewer, Barnards Sewer, Puddledock Sewer and Monks Farm Sewer have all been incorporated explicitly into the model.
- 3.1.3 The 2019 model is a 1D-2D linked hydrodynamic model built using Flood Modeller Pro and TUFLOW software covering the main catchment. A grid size of 10m has been used to represent the floodplain upstream of Stifford, and key features within the floodplain have been enforced.
- 3.1.4 AECOM have obtained the FMP-TUFLOW model from the Environment Agency and undertaken a brief review of the reporting and a test-run to prepare a methodology for this exercise. Figure 2 of the Mardyke Hydraulic Modelling Report (replicated as Figure 3-1) shows the seven sub-catchments for which peak flow estimates were derived and where ReFH inflow hydrographs are available within the model.

Figure 2: Target flow locations

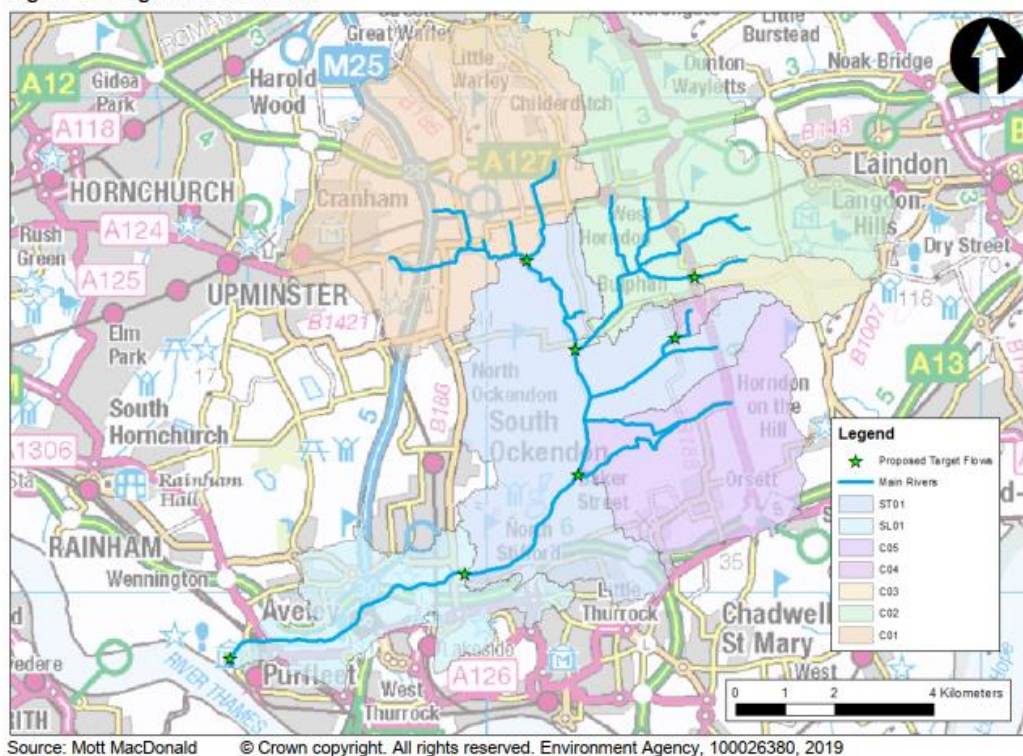


Figure 3-1 Mardyke model extent and catchment areas (from 2019 model)

4. Scenario modelling

- 4.1.1 Tests have been undertaken to assess how sensitive flood levels and flows across the catchment are to the runoff from these seven key sub-catchments. The sensitivity tests provide an indication of how flood risk might be affected if runoff is increased due to potential development in the catchment.
- 4.1.2 The first sensitivity test represents an increase in runoff across the whole catchment with all model inflows increased by 10%. It is this scenario where runoff has been varied in all sub-catchments which provides the most useful information for Thurrock Council.
- 4.1.3 Another seven sensitivity tests show the potential impact of an increase in runoff in each of the seven sub-catchments separately, representing more gradual development in the catchment. In some sub-catchments there is more than one ReFH inflow node in the sub-catchment (Table 4-1) and in these cases all model inflow nodes within that sub-catchment are increased by 10%. The purpose of these tests is to identify if flood risk in the catchment is more sensitive to changes in runoff in some parts of the catchment than others.

Table 4-1 Mardyke model – model inflows in each of the seven sub-catchments

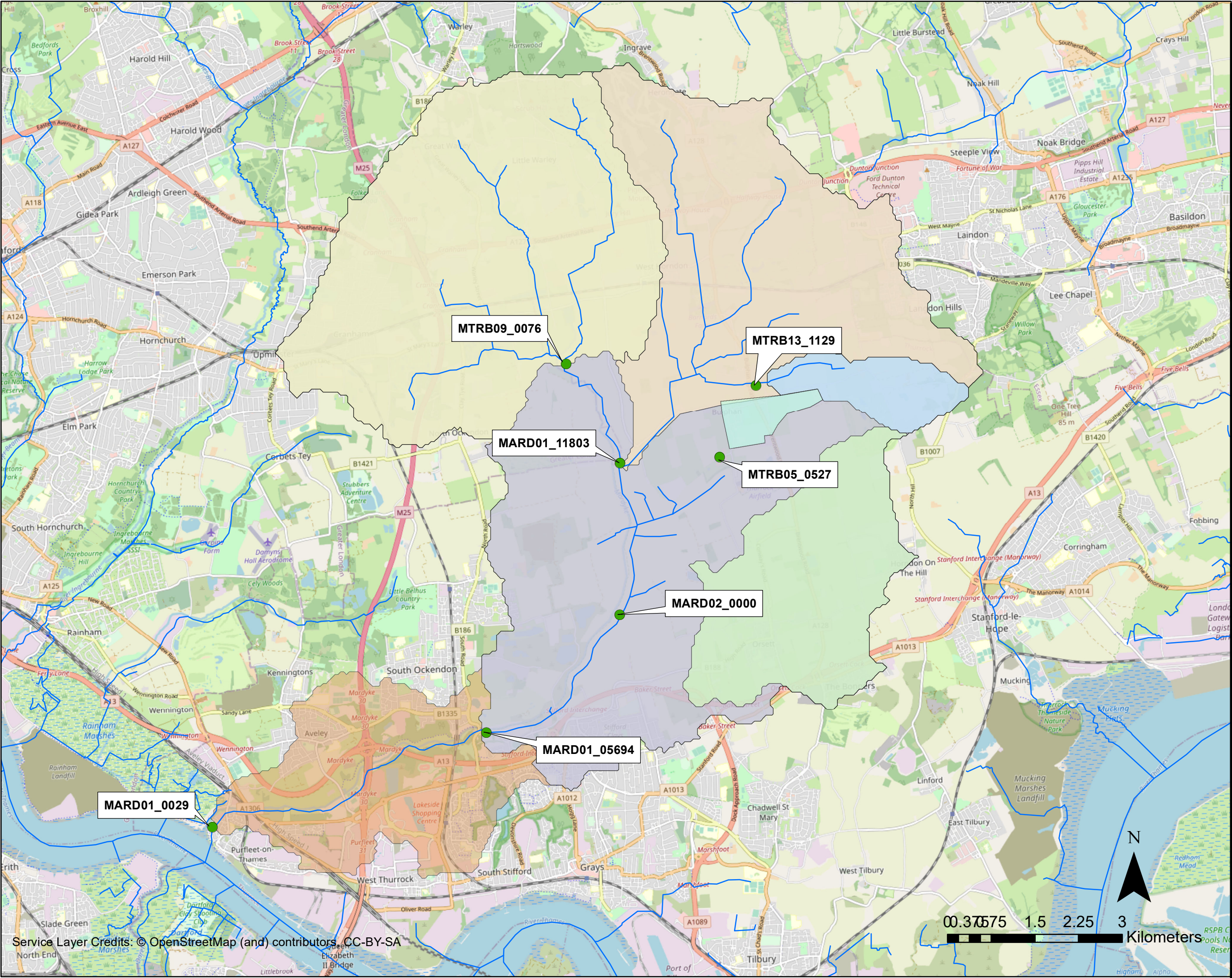
Sub-catchment	ReFH inflow(s) in sub-catchment
C01	MTRB09_2469, NBMA10, MTRB10_692, MTRB11_1500, MTRB08_3068, WBMA20
C02	FHSW10, MTRB07_1721, MTRB06_1255, MTRB12_1777, NMAR10
C03	MTRB13_2335
C04	MTRB05_1434
C05	MTRB02_2913, MTRB03_3309
ST01	MTRB04_2849, SCSW10, MARD40, MARD30, MARD70
SL01	MARD15

- 4.1.4 All sensitivity testing has been undertaken for a 1% AEP design event as this is a key probability event for SFRAs and planning. A 15.5h storm duration has been used, as per the previous Mardyke catchment modelling and mapping.
- 4.1.5 The ReFH inflows into the model listed in Table 4-1 already have a scaling factor applied that has been used to match FEH statistical peak flow estimates for the catchment, so these scaling factors have been further adjusted to represent the potential effects of potential development. This is a simple way of varying the runoff volume from each hydrograph to represent the desired effect.

Table 4-2 Mardyke: Sensitivity testing scenarios

Scenario	Run File names	Comments
Baseline	MM_Mardyke_100_15d5_Design_V10.ief	Baseline model run without any changes to the existing ReFH boundary inflows
Sensitivity test 1: Runoff volume + 10% (all sub-catchments)	MM_Mardyke_100_15d5_Design_V10_plus10_v2.ief	Runoff volume from all sub-catchments increased by 10% from existing (for one design event, the 1% AEP) to assess overall potential for increase in flood risk if runoff is not controlled.
Sensitivity test 2: Runoff volume + 10% in sub-catchment C01	MM_Mardyke_100_15d5_Design_V10_plus10_C01_v2.ief	Runoff volume from one sub-catchment increased by 10% from existing (for one design event, the 1% AEP) to assess how sensitive flood risk is to changes in runoff in specific parts of the catchment.
Sensitivity test 3: Runoff volume + 10% in sub-catchment C02	MM_Mardyke_100_15d5_Design_V10_plus10_C02_v2.ief	
Sensitivity test 4: Runoff volume + 10% in sub-catchment C03	MM_Mardyke_100_15d5_Design_V10_plus10_C03_v2.ief	
Sensitivity test 5: Runoff volume + 10% in sub-catchment C04	MM_Mardyke_100_15d5_Design_V10_plus10_C04_v2.ief	
Sensitivity test 6: Runoff volume + 10% in sub-catchment C05	MM_Mardyke_100_15d5_Design_V10_plus10_C05_v2.ief	
Sensitivity test 7: Runoff volume + 10% in sub-catchment ST01	MM_Mardyke_100_15d5_Design_V10_plus10_ST01_v2.ief	
Sensitivity test 8: Runoff volume + 10% in sub-catchment SL01	MM_Mardyke_100_15d5_Design_V10_plus10_SL01_v2.ief	

4.1.6 Seven points in the model (nodes) have been identified for use in analysing the results of these sensitivity tests. The nodes have been selected to provide a good spread across the model extent and catchment area, as shown in Figure 4-1. At these nodes the maximum water level and in-channel flow for the baseline and eight sensitivity tests have been extracted from the model results and tabulated, see Table 4-3 and Table 4-4. When reviewing the results it should be noted that an increase in the maximum in-channel flood level does not necessarily cause an increase in flood risk because that is dependent on the baseline flood risk, the pathway from the source to the receptor and the vulnerability of the receptor to flooding.



Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA

AECOM

PROJECT

Thurrock SFRA

CLIENT

Thurrock Council

CONSULTANT

AECOM Limited
Royal Court Basil Close
Chesterfield
S41 7SL
T: 01246 209221
www.aecom.com

LEGEND

- Nodes For Results Reporting
- Watercourses

Subcatchment ID's

- C04
- C03
- C01
- C02
- C05
- ST01
- ST02

NOTES

Copyright statements
and
source of data

ISSUE PURPOSE

FINAL

PROJECT NUMBER

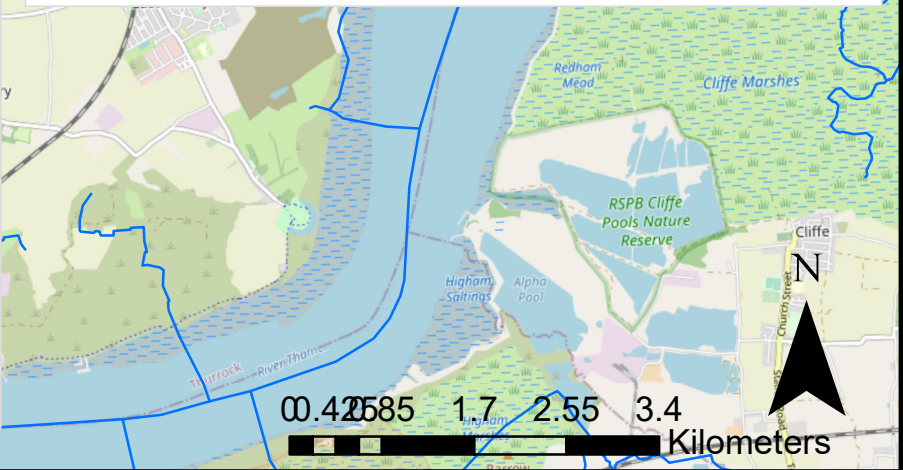
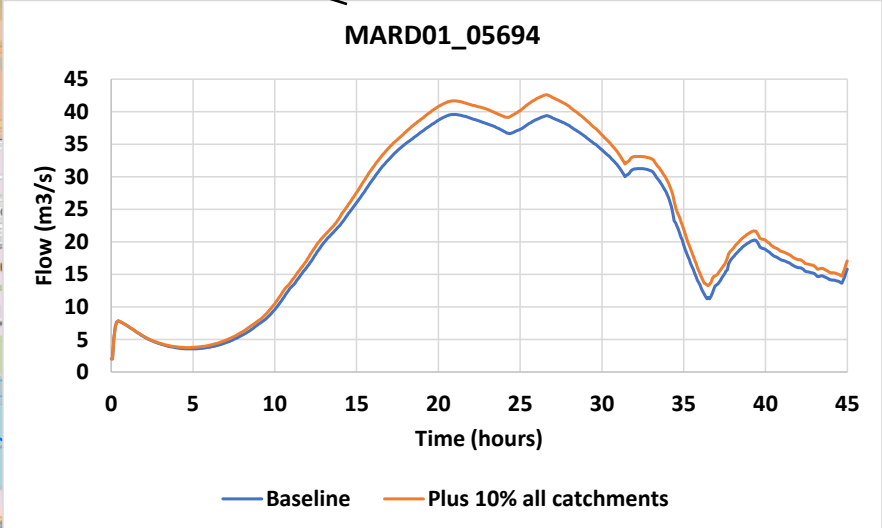
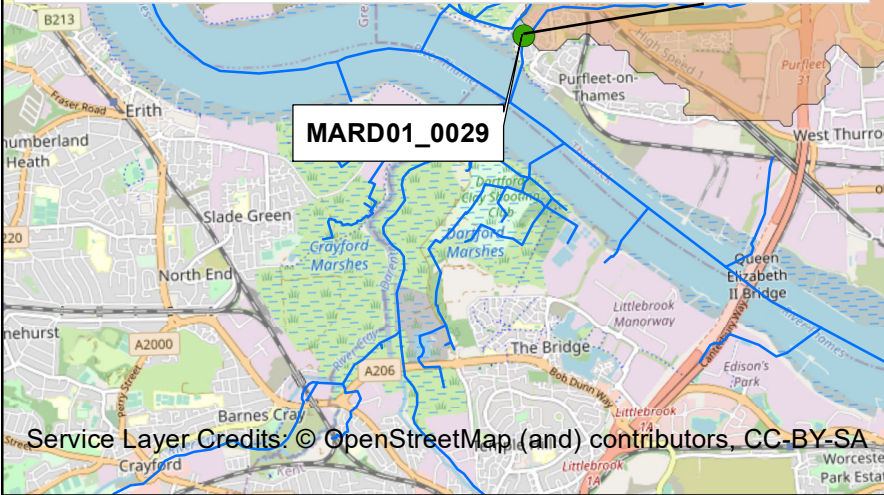
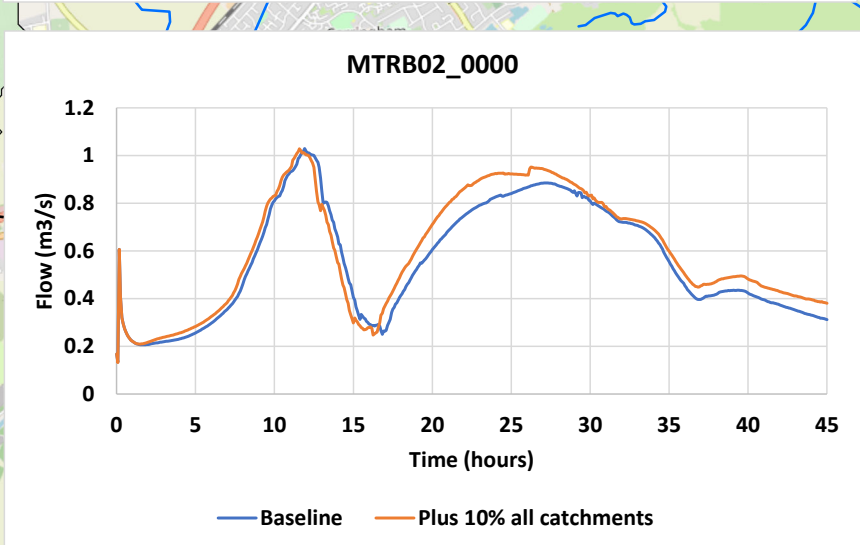
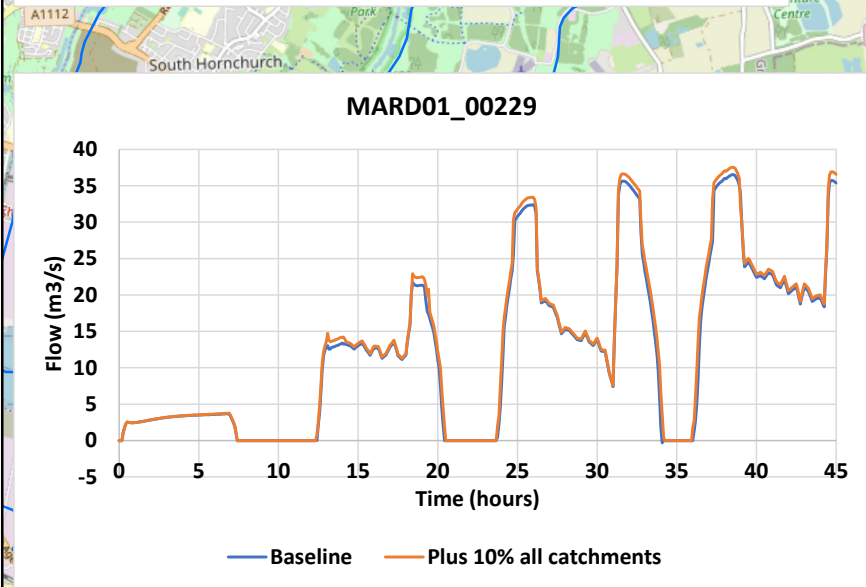
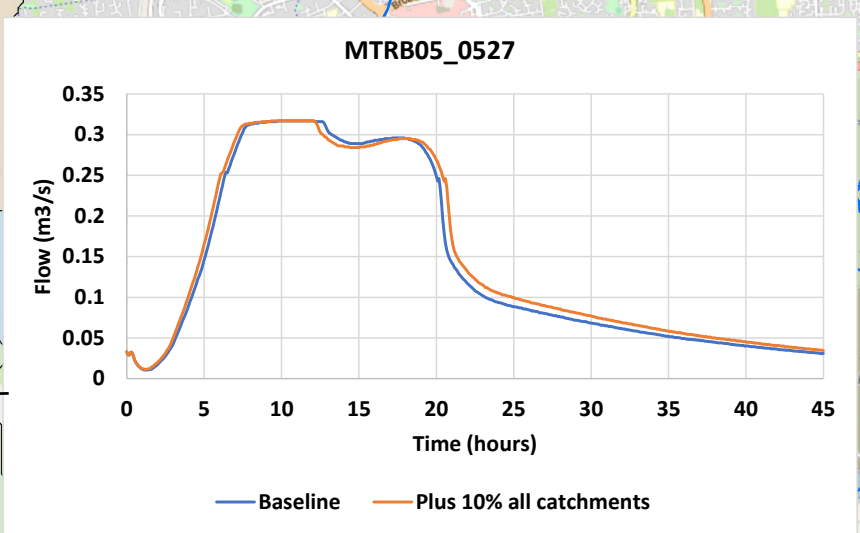
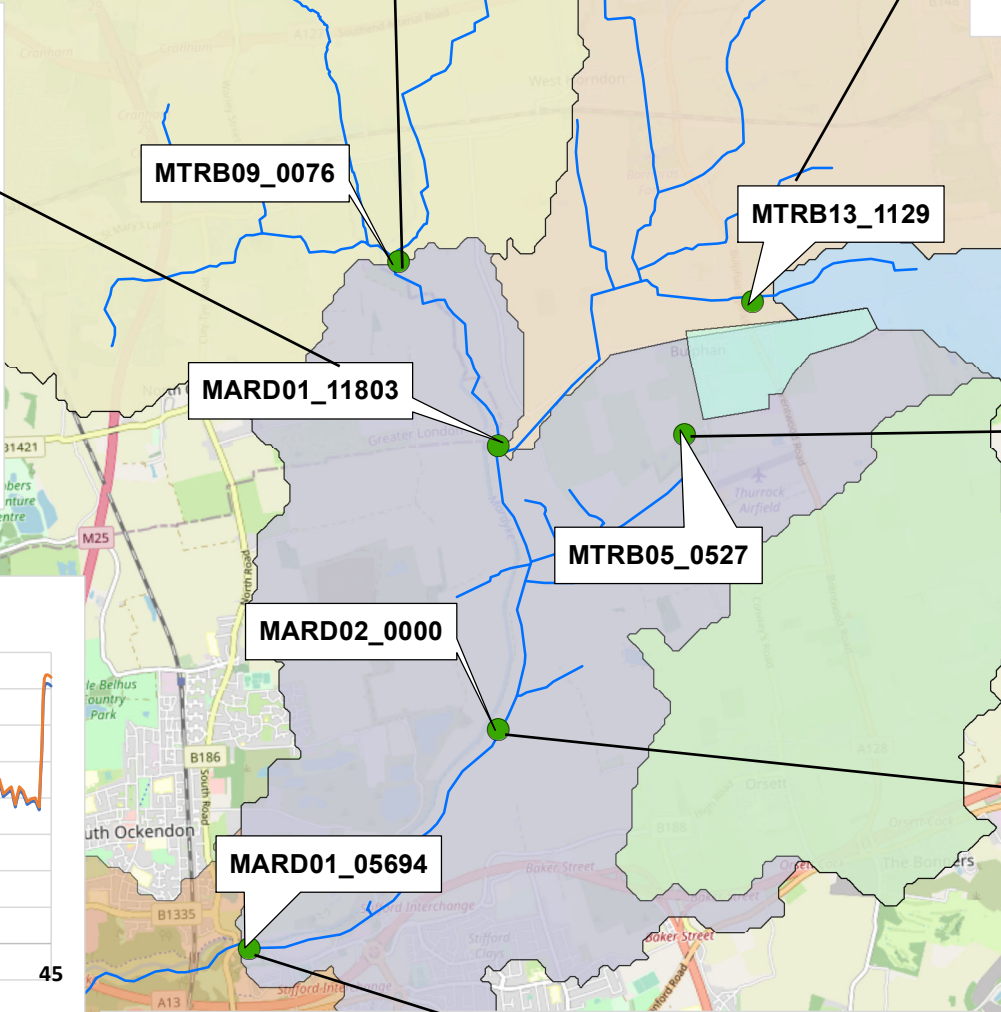
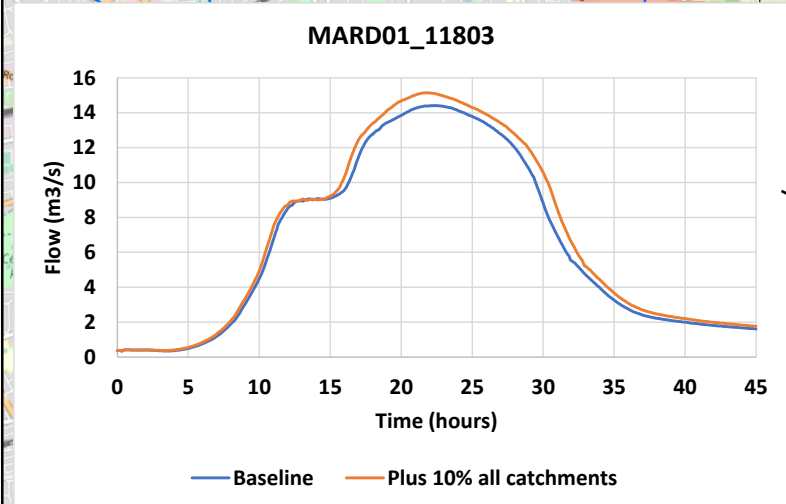
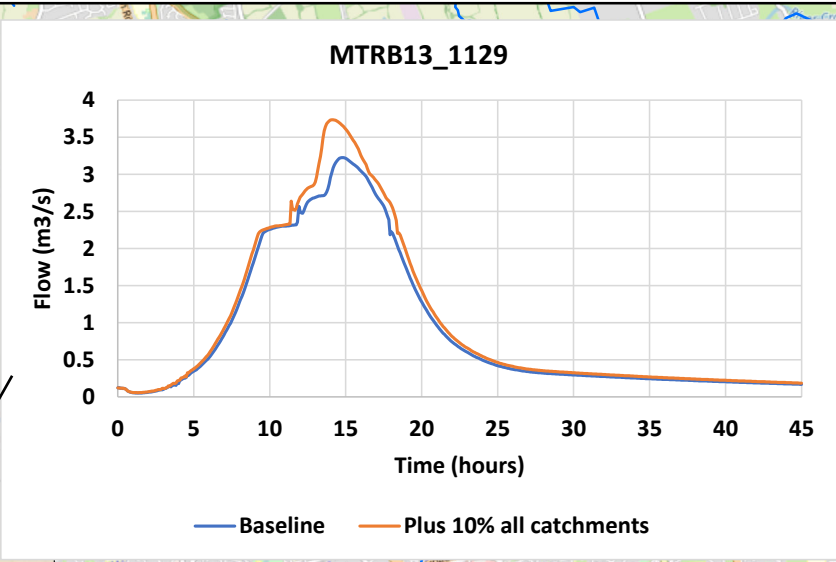
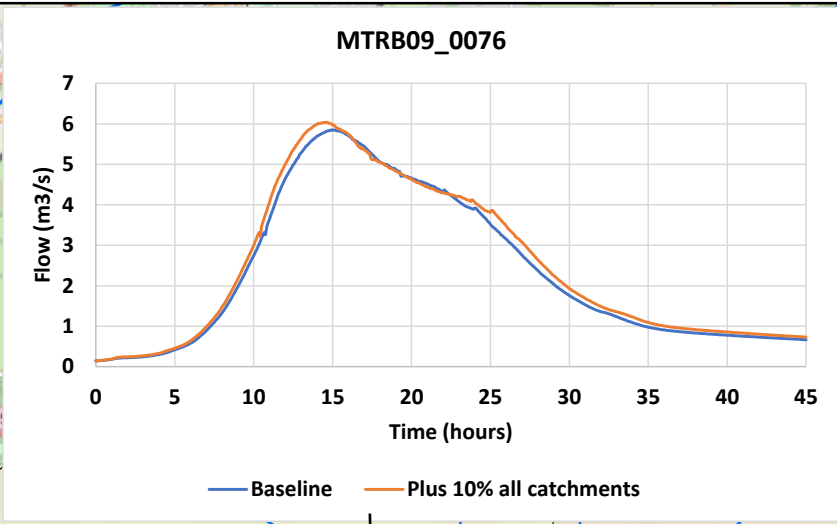
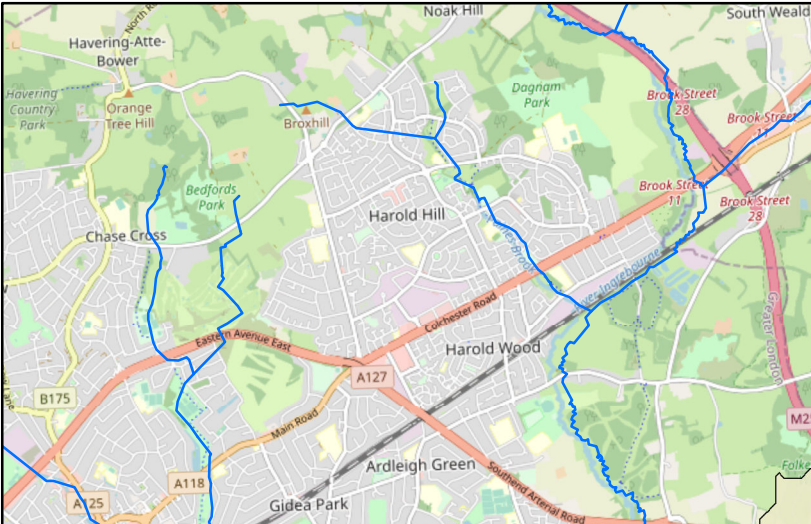
60492009

SHEET TITLE

Mardyke Catchment Model:
Subcatchments and nodes
for results reporting

SHEET NUMBER

Figure 4-1



AECOM

PROJECT
Thurrock SFRA

CLIENT
Thurrock Council

CONSULTANT
AECOM Limited
Royal Court Basil Close
Chesterfield
S41 7SL
T: 01246 209221
www.aecom.com

LEGEND
Nodes For Results Reporting
Watercourses

Subcatchment ID's

- C04
- C03
- C01
- C02
- C05
- ST01
- ST02

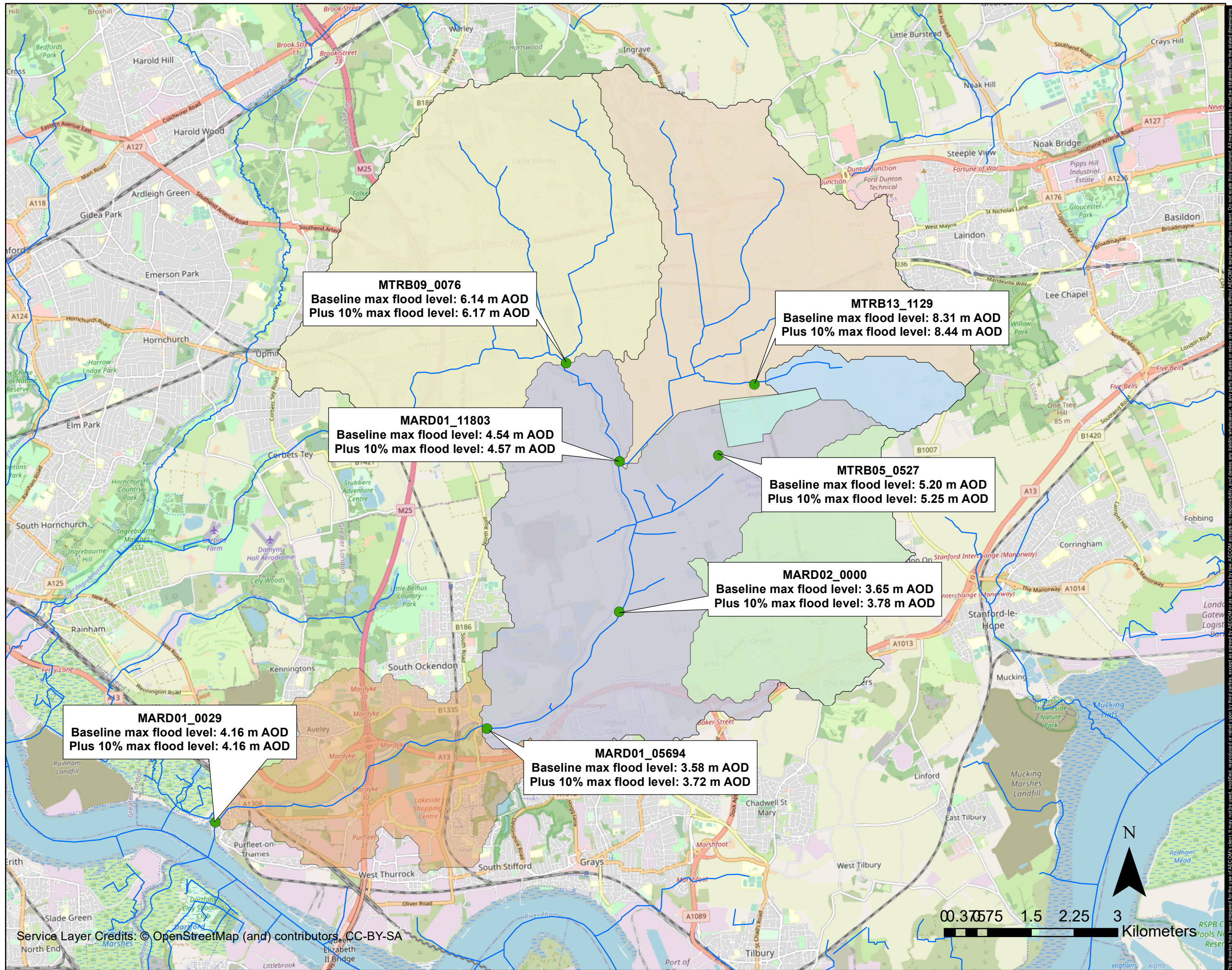
NOTES
Copyright statements
and
source of data

ISSUE PURPOSE
FINAL

PROJECT NUMBER
60492009

SHEET TITLE
Mardyke Catchment Model:
Model results showing
in-channel flow at 1D nodes
(1% AEP) for sensitivity
test 1

SHEET NUMBER
Figure 4-2



4.1.7 Table 4-3 shows the maximum water level at seven model nodes for the baseline scenario and sensitivity tests, extracted from the model results and tabulated. The values in brackets for the sensitivity tests show the difference (in m) from the baseline model results with green text highlighting specific nodes or scenarios where there is a difference of 0.05m or more from the baseline maximum flood level. These results show that when runoff is increased by +10% on all inflow nodes in the model, the impact on maximum in-channel level is up to + 0.14m compared to the baseline results. This indicates that if runoff from the catchment as a whole is increased as a consequence of development there is the potential for an increase in flood risk (indicated by an increase in flood level) across the catchment.

Table 4-3 Mardyke Catchment Model - in-channel levels (m AOD) at key locations (1% AEP) for baseline and sensitivity tests

	MARD01_05694	MTRB13_1129	MARD01_11803	MTRB05_0527	MARD01_00229	MTRB09_0076	MTRB02_0000
Baseline	3.58m AOD	8.31m AOD	4.54m AOD	5.20m AOD	4.16m AOD	6.14m AOD	3.65m AOD
Sensitivity test 1: Runoff volume + 10% (all sub-catchments)	3.72m AOD (+ 0.14m)	8.44m AOD (+ 0.13m)	4.57m AOD (+ 0.03m)	5.25m AOD (+ 0.05m)	4.16m AOD (+ 0.00m)	6.17m AOD (+ 0.03m)	3.78m AOD (+ 0.13m)
Sensitivity test 2: Runoff volume + 10% in sub-catchment C01	3.63m AOD (+ 0.04m)	8.31m AOD (+ 0.00m)	4.56m AOD (+ 0.02m)	5.20m AOD (+ 0.00m)	4.16m AOD (+ 0.00m)	6.17m AOD (+ 0.03m)	3.69m AOD (+0.04m)
Sensitivity test 3: Runoff volume + 10% in sub-catchment C02	3.61m AOD (+ 0.03m)	8.31m AOD (+ 0.00m)	4.55m AOD (+ 0.01m)	5.20m AOD (+ 0.00m)	4.16m AOD (+ 0.00m)	6.14m AOD (+ 0.00m)	3.68m AOD (+ 0.03m)
Sensitivity test 4: Runoff volume + 10% in sub-catchment C03	3.59m AOD (+ 0.00m)	8.44m AOD (+ 0.13m)	4.54m AOD (+ 0.00m)	5.20m AOD (+ 0.00m)	4.16m AOD (+ 0.00m)	6.14m AOD (+ 0.00m)	3.66m AOD (+ 0.01m)
Sensitivity test 5: Runoff volume + 10% in sub-catchment C04	3.58m AOD (+ 0.00m)	8.32m AOD (+ 0.00m)	4.54m AOD (+ 0.00m)	5.24m AOD (+ 0.04m)	4.16m AOD (+ 0.00m)	6.14m AOD (+ 0.00m)	3.65m AOD (+ 0.00m)
Sensitivity test 6: Runoff volume + 10% in sub-catchment C05	3.61m AOD (+ 0.03m)	8.31m AOD (+ 0.00m)	4.54m AOD (+ 0.00m)	5.20m AOD (+ 0.00m)	4.16m AOD (+ 0.00m)	6.14m AOD (+ 0.00m)	3.68m AOD (+ 0.03m)
Sensitivity test 7: Runoff volume + 10% in sub-catchment ST01	3.62m AOD (+ 0.04m)	8.31m AOD (+ 0.00m)	4.54m AOD (+ 0.00m)	5.21m AOD (+ 0.00m)	4.16m AOD (+ 0.00m)	6.14m AOD (+ 0.00m)	3.68m AOD (+ 0.03m)
Sensitivity test 8: Runoff volume + 10% in sub-catchment SL01	3.59m AOD (+ 0.01m)	8.32m AOD (+ 0.00m)	4.54m AOD (+ 0.00m)	5.20m AOD (+ 0.00m)	4.16m AOD (+ 0.00m)	6.14m AOD (+ 0.00m)	3.66m AOD (+ 0.01m)

- 4.1.8 Table 4-4 shows the maximum in-channel flow at seven model nodes for the baseline scenario and sensitivity tests, extracted from the model results and tabulated. The values in *italics* for the sensitivity tests show the difference (as a %) from the baseline model results. It should be noted that these are in-channel flows only and do not include any floodplain flow (which would be within the 2D part of the model). Model node MTRB13_1129 shows the greatest increase in in-channel flow (up to 16%) when runoff is increased by 10% in all model inflow nodes so may be a particular area of sensitivity to increases in runoff. This was also seen in sensitivity test 4 where runoff from the C03 sub-catchment is increased.

Table 4-4 Mardyke Catchment Model - in-channel flows (m³/s) at key locations (1% AEP) for baseline and sensitivity tests

	MARD01_05694	MTRB13_1129	MARD01_11803	MTRB05_0527	MARD01_00229	MTRB09_0076	MTRB02_0000
Baseline	39.6 m³/s	3.2 m³/s	14.4 m³/s	0.3 m³/s	36.5 m³/s	5.9 m³/s	1.0 m³/s
Sensitivity test 1: Runoff volume + 10% (all sub- catchments)	42.6 m³/s	3.7 m³/s	15.1 m³/s	0.3 m³/s	37.5 m³/s	6.0 m³/s	1.0 m³/s
	8%	16%	5%	0%	3%	3%	0%
Sensitivity test 2: Runoff volume + 10% in sub- catchment C01	40.5 m³/s	3.2 m³/s	14.7 m³/s	0.3 m³/s	36.8 m³/s	6.1 m³/s	1.0 m³/s
	2%	0%	2%	0%	1%	4%	0%
Sensitivity test 3: Runoff volume + 10% in sub- catchment C02	40.1 m³/s	3.2 m³/s	14.9 m³/s	0.3 m³/s	36.7 m³/s	5.8 m³/s	1.0 m³/s
	1%	0%	3%	0%	1%	0%	0%
Sensitivity test 4: Runoff volume + 10% in sub- catchment C03	39.6 m³/s	3.7 m³/s	14.5 m³/s	0.3 m³/s	36.6 m³/s	5.8 m³/s	1.0 m³/s
	0%	16%	0%	0%	0%	0%	0%
Sensitivity test 5: Runoff volume + 10% in sub- catchment C04	39.6 m³/s	3.2 m³/s	14.4 m³/s	0.3 m³/s	36.5 m³/s	5.8 m³/s	1.0 m³/s
	0%	0%	0%	0%	0%	0%	0%
Sensitivity test 6: Runoff volume + 10% in sub- catchment C05	40.5 m³/s	3.2 m³/s	14.4 m³/s	0.3 m³/s	36.7 m³/s	5.9 m³/s	1.0 m³/s
	2%	0%	0%	0%	1%	0%	1%
Sensitivity test 7: Runoff volume + 10% in sub- catchment ST01	40.4 m³/s	3.2 m³/s	14.4 m³/s	0.3 m³/s	36.8 m³/s	5.8 m³/s	1.0 m³/s
	2%	0%	0%	0%	1%	0%	-1%
Sensitivity test 8: Runoff volume + 10% in sub- catchment SL01	39.5 m³/s	3.2 m³/s	14.4 m³/s	0.3 m³/s	36.6 m³/s	5.8 m³/s	1.0 m³/s
	0%	0%	0%	0%	0%	0%	0%

- 4.1.9 The previous tables indicate that increasing runoff from all sub-catchments by 10% has the potential to increase flood risk in the catchment as in-channel flood levels are flows are increased. However, this increase does not necessarily mean there will be an increase in flood risk to potential receptors that are located in the catchment (on the floodplain).
- 4.1.10 To provide an indication of the impact on the floodplain the baseline maximum flood depths have been compared to the maximum flood depths as a result of increasing runoff from all sub-catchments by 10%. The mapped results in Figure 4-4 show that there are some noticeable increases in the predicted extent of flooding in the sensitivity test where all runoff is increased by 10% compared to the baseline. Increases in the depth of flooding can also be seen and this seems to be more noticeable in the east part of the catchment, i.e. around Bulphan with flow routes from these areas noticeably deeper when there is an increase in runoff. Increases in floodplain depth are approximately 10mm within these areas.
- 4.1.11 Comparing sensitivity tests 3 – 8 to identify if there is particular sensitivity to changes in runoff from certain parts of the catchment shows particularly noticeable impacts in some parts of the catchment in sensitivity test 4, where runoff from sub-catchment C03 is increased. Sub-catchment C03 is a small area, located in the east of the catchment where there is an area of fields surrounded by wooded areas and then more developed areas.

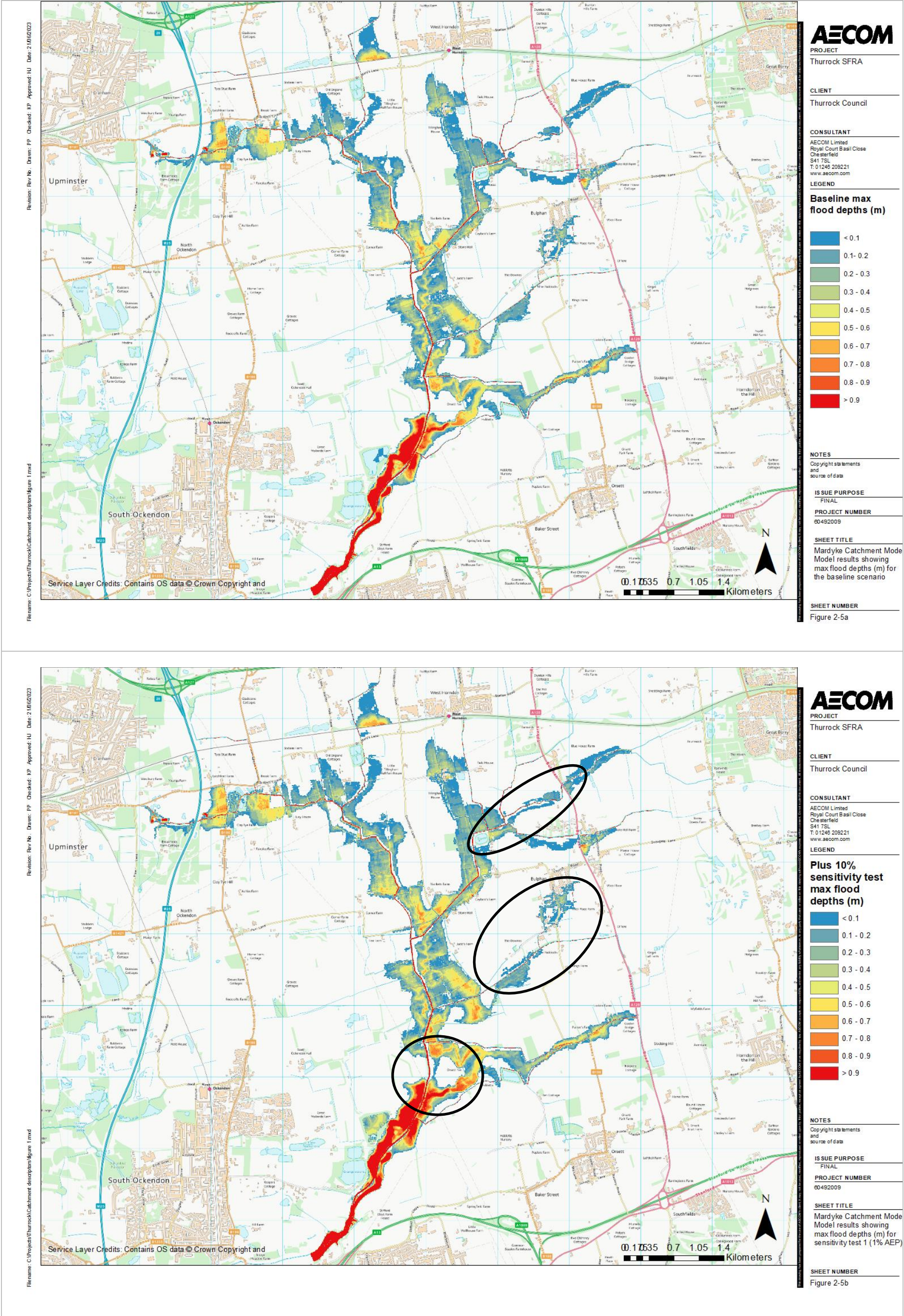


Figure 4-4 Mardyke Catchment Model: Maximum flood depth (1% AEP) for baseline (top) and for a sensitivity test with a +10% increase in runoff in all sub-catchments (bottom)

5. Discussion

- 5.1.1 The setup of the Mardyke catchment model used here, including the inflow hydrographs, is easily manipulated to give a strategic representation of potential changes in the catchment, including increased development. Having a model of the whole catchment enables Thurrock Council to strategically assess the cumulative impact of potential development or other changes in the catchment. The model is an important part of the evidence base for the updated SFRA for Thurrock Council.
- 5.1.2 The results presented above indicate that if runoff is increased at the catchment, as a consequence of potential development, there is an increase in the modelled in-channel flood levels. The increase in in-channel flood level in sensitivity test 1 is up to 0.14m with in-channel flows increasing by 16% in some places, as a consequence of runoff increasing by 10%. The results also appear to indicate that in-channel flood levels may be more sensitive to an increase in runoff from some sub-catchments (e.g. sub-catchment C03) than others although it is not easy to draw conclusions.
- 5.1.3 The results indicate that if runoff is increased, the upper part of the catchment is more likely to show an increase in flood levels and flow than the lower part of the catchment. In the lower catchment down in, the changes in runoff are not having a noticeable impact on flood level and flow which is possibly be due to the lower catchment being more strongly influenced by conditions in the River Thames.
- 5.1.4 The assessment undertaken was a very simple representation of what impacts increases in runoff from impermeable surfaces in the catchment may have. A more refined representation of the effects of potential development in specific areas of the catchment is presented in Appendix F (West Horndon) and Appendix G (Tilbury Flood Storage Reservoir).

