Accrington Road, Whalley – Hydraulic model update

Technical note

December 2022

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Report reference:	2022s0790
Revision:	0006
Client:	M&P Gadsden Consulting Engineers/Oakmere Homes
Date:	December 2022
Authors:	Gregory Brown (Senior Analyst)
Reviewer / Sign-off:	Stuart Harwood (Senior Analyst)
Subject:	Hydraulic modelling update

1 Overview

Oakmere Homes is proposing a new residential development on land off Accrington Road, Whalley (see Figure 1-1). The aim of the modelling was to:

- Evaluate the flood risk impacts of the scheme through a comparative appraisal (baseline/existing vs post-development scenarios)
- Define design levels (including an allowance for climate change)
- Support the design of a flood mitigation strategy so the proposed development is adequately protected from flooding, whilst not increasing flood risk elsewhere

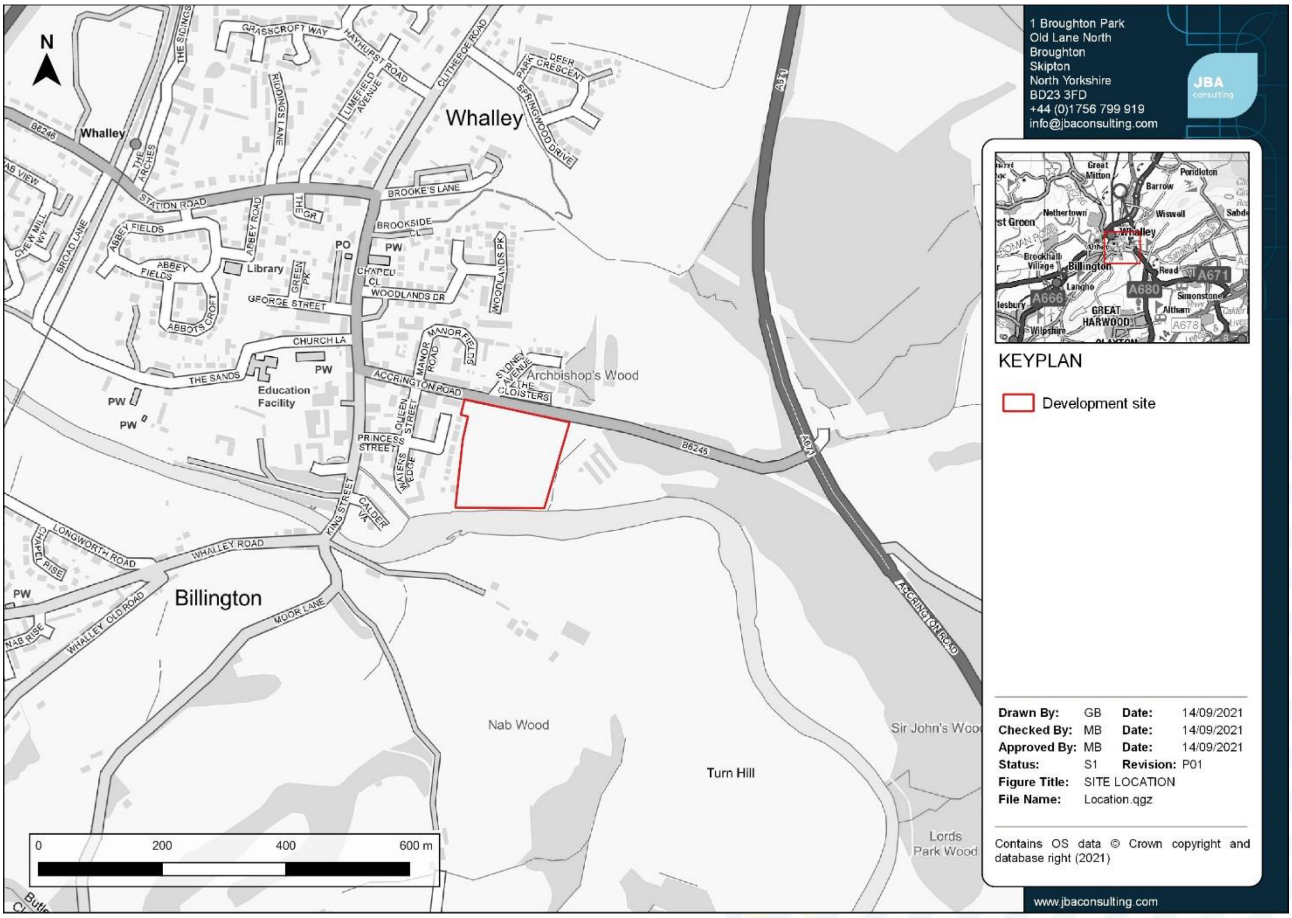

Figure 1-1: Site location

This technical note provides the methodology for the hydraulic model update. This document should be read in conjunction with the associated Flood Risk Assessment (OAKMERE-JBAU-XX-XX-RP-0002-S3-P06-AccringtonRdFRA, JBA Consulting, 2022).

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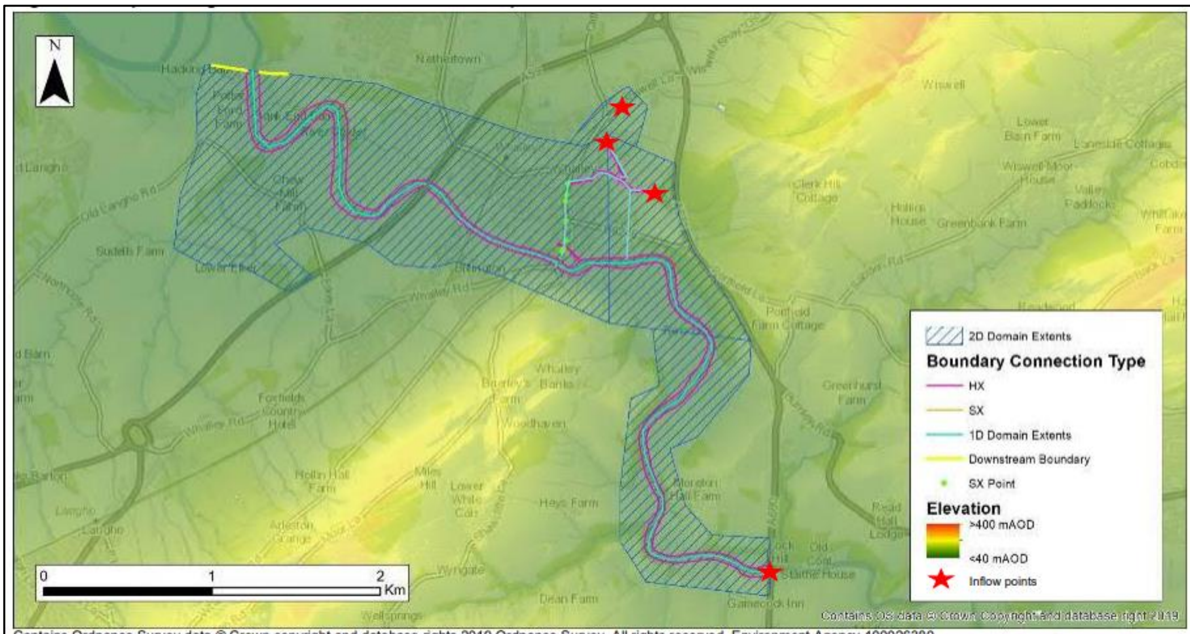
1.1 Available data

To assess the current flood risk to the site, the EA provided the 2020 Flood Risk Management Scheme appraisal model developed by Mott MacDonald[1]. This Flood Modeller-TUFLOW model was recommended by the EA because, of the models it holds, it contains the most up-to-date hydrology and hydraulic components and represents the weirs and Whalley Bridge more realistically. The 'Baseline Do Minimum' scenario in this model represents the present-day flood risk.

JBA Consulting (JBA) reviewed this model and agreed with the EA's opinion that the model was suitable for use in a site-scale appraisal. Figure 1-2 provides a schematic of the 2020 model.



Taken from Whalley FRMS OBC: Hydraulic Modelling Report (Mott MacDonald, 2020).

Figure 1-2: River Calder Flood Modeller-TUFLOW model schematic

[1] Mott MacDonald (2020) ENV0000427C-MMD-XX-XX-RP-HY-402462016-S8-A-L1900-3-LOD3-Whalley FRMS OBC: Hydraulic Modelling Report

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2 Hydraulic modelling

2.1 Model update

The provided 2020 Mott MacDonald model would not run initially, but a few minor revisions were applied including:

- An updated 2D model location line used to cover the full model extent. The supplied model file meant that the River Calder floodplain between the A680 road bridge and Banks Wood was missed from the model, despite the coverage of the 2D domain indicating it should be included. The 2D model location file was moved to allow the inclusion of the full 2D domain;
- A minor adjustment to the 1D-2D linked boundary (file: 2d_bc_WhalleyOBC_WISW_004_L) on Wiswell Brook at 373352, 436335. The original alignment caused the model to fail due to the application of two separate HX boundary lines to the same 2D cell.

These changes allowed the model to run without impacting on the results produced.

The EA requested that a range of standard design annual exceedance probability (AEP) events were tested. There was also a requirement to consider climate change. The following events were tested:

- 4% AEP (Q25)
- 2% AEP (Q50)
- 1.33% AEP (Q75)
- 1% AEP (Q100)
- 1% AEP plus 36% for climate change (the design flood event for the development)
- 0.1% AEP (Q1000)

The provided 2020 Mott MacDonald model was run using the above events with climate change incorporated. No standard design events (i.e. excluding an allowance for climate change) were provided. The provided climate change inflow files were adapted to provide the standard design inflow files for the events listed above.

Due to the lack of flooding in the design events up to the 1% AEP event within the development site in the baseline/'as existing' scenario; it was deemed unnecessary to re-run these events for the proposed/'as developed' scenario, as the results would be the same. Only the 1% AEP with climate change event was run for the proposed scenario.

2.2 Impact assessment and mitigation

The design event for the proposals was the 1% AEP event with 36% uplift for climate change. The baseline/as existing model results were used as a basis to define a required level for the development site to prevent flooding. With baseline flood levels during this event reaching 46.02mAOD at the Phase 1 site, M&P Gadsden Consulting Engineers prepared a scheme design reflecting this flood level setting ground levels across the majority of the Phase 1 site to higher than this level. The exception being along the western boundary where ground levels tie into existing levels which will be used as garden space and a car park.

The hydraulic model was updated to include the proposed development as a topographic modification in the 2D domain. Design drawings were used to define proposed ground levels in the Phase 1 development area to prevent flooding in the design flood. Building footprints were also raised to the finished floor levels as specified in designs. To the south, there is the compensatory storage and land profile changes associated with surface water management. It should be noted that the storage volume in the planned surface water basin was not included in the hydraulic model; the assumption being that this volume is reserved for surface water attenuation. Therefore, the basin was filled in to the top of the storage basin (46.0mAOD)

With the development site represented in the model, iterative testing was performed to design a floodplain compensation area so that no detrimental impact was caused elsewhere in the surrounding area. This testing found that a base level of 45.6mAOD for the storage area was appropriate.

Figure 2-1 provides a schematic for the location of the Phase 1 'raised platform' and compensatory storage.

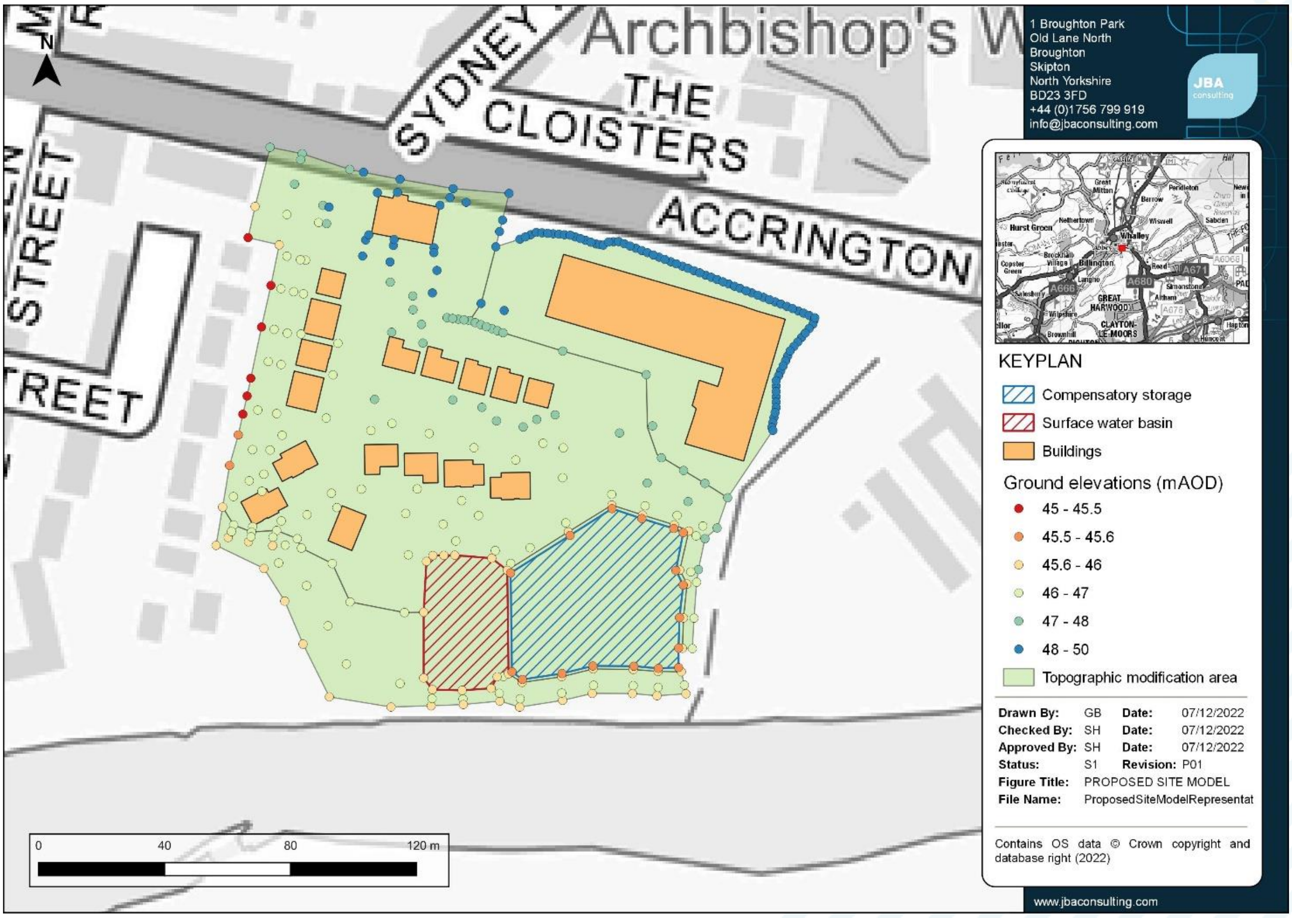

Figure 2-1: Location of planned changes in development site

2.3 Model run files

The model was run using Flood Modeller version 4.5 and TUFLOW version 2020-01-AB.

The files required to run the various model scenarios and events are provided in Table 2-1.

Table 2-1: Model run files

Scenario	Event	FM: IEF/IED	FM: DAT	TUFLOW TCF	TUFLOW run options
Baseline	4% AEP	WhalleyOBC_DM_Q25_v29.ief Inflow: Q25_v3-00.IED	WhalleyOBC_DM_v29.DAT	WhalleyOBC_~s1~_~s2~_~e1~.tcf (an .ecf file was also provided but this was only relevant for Mott MacDonald study options testing – not required for this study)	-S1 DM -S2 v29 -E1 Q25
	2% AEP	WhalleyOBC_DM_Q50_v29.ief Inflow: Q50_v3-00.IED			-S1 DM -S2 v29 -E1 Q50
	1.33% AEP	WhalleyOBC_DM_Q75_v29.ief Inflow: Q75_v3-00.IED			-S1 DM -S2 v29 -E1 Q75
	1% AEP	WhalleyOBC_DM_Q100_v29.ief Inflow: Q100_v3-00.IED			-S1 DM -S2 v29 -E1 Q100
	1% AEP plus 36% for climate change	WhalleyOBC_DM_Q100CC36_v29.ief Inflow: Q100_CC36_v3-00.IED			-S1 DM -S2 v29 -E1 Q100_CC36
	0.1% AEP	WhalleyOBC_DM_Q1000_v29.ief Inflow: Q1000_v3-00.IED			-S1 DM -S2 v29 -E1 Q1000
Proposed development	1% AEP	WhalleyOBC_Storage_Q100 _009.ief Inflow: Q100_CC36_v3-00.IED			-S1 OakStorage_Plan_009 -S2 v29 -E1 Q100
	1% AEP plus 36% for climate change	WhalleyOBC_Storage_Q100CC36 _v29_009.ief Inflow: Q100_CC36_v3-00.IED			-S1 OakStorage_Plan_009 -S2 v29 -E1 Q100_CC36
	0.1% AEP	WhalleyOBC_Storage_Q1000_v29_009.ief Inflow: Q1000_v3-00.IED			-S1 OakStorage_Plan_009 -S2 v29 -E1 Q1000

2.4 Model stability

The model runs are stable with limited non-convergence shown (see Figure 2-2). This is the case for both the baseline and proposed development scenarios.

The cumulative mass error for the 2D domain reaches -1.8% (outside the accepted limits of +/-1%) at the start of the simulation during the 1% AEP plus 36% increase for climate change event, however, there is limited flood volume in the 2D domain. During the main event when flooding is in progress, mass balance is -0.2% or less and by the end of the simulation the error is -0.1% (within the accepted limits). This cumulative mass error is a legacy issue from the provided EA model. The mass error is improved compared to the original supplied model with the 1% AEP plus 30% increase for climate change event previously reaching -2.5%. The cause of the mass error appears to be related to the discharge of water through two manholes on King Street from the culvert linking Wiswell Brook to the River Calder towards the start of the simulation. At this time, these manholes are the only location where water is entering the 2D domain with a flow of approximately 0.7 cumecs; this small flow entering the 2D domain leads to a mass error that appears relatively large without having a major impact on results. Once the main fluvial flooding starts to occur, the mass error reduces to -0.07% (well within the accepted +/-1% limit). With no major impact on model results, this initial mass error can be considered as inconsequential, and the overall 2D model stability is acceptable.

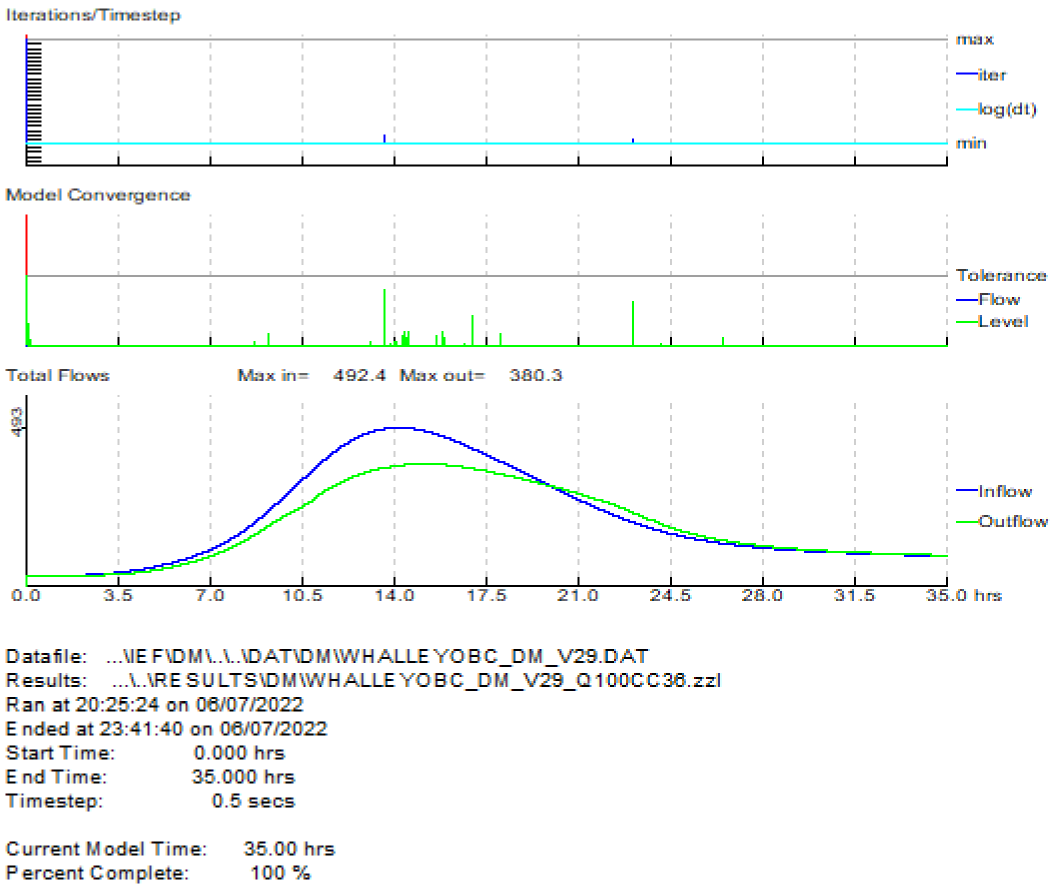

Figure 2-2: Model run plot (1% AEP plus 36% - baseline)

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3 Summary

The 2020 Mott MacDonald hydraulic model for the River Calder around Whalley provided by the EA required minor to changes to allow the model to work. This allowed the baseline flood risk to be established for the site.

The proposed development was then represented using a series of model topographic modifications that raised the proposed residential area above predicted flood levels and provided compensatory storage nearby.

Model runs were relatively stable and are improved compared to the EA supplied model.