Technical design note

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1. Introduction

Hydrock has been commissioned by AECOM to update the existing hydraulic modelling of the Cold Brook as it flows through Barry in order to support an upcoming planning application for the redevelopment of the St Richard Gwyn Catholic High School.

This Technical Note has been prepared to set out the proposed methodology to be adopted and updates to the hydraulic modelling, and to present the preliminary findings of an assessment of the preferred mitigation option (Option 5) identified by the 2020 AECOM modelling study and accepted in principle by Natural Resources Wales (NRW).

1.1 Site Information

The site is located off Argae Lane, Barry and comprises the existing St Richard Gwyn Catholic High School, along with car parking, playing fields and other associated existing development. The site is bounded by Argae Lane to the north, existing agricultural fields to the east, an existing solar farm to the south and scrubland to the west.

The nearest watercourse to the site is the Cold Brook, which is located approximately 10m to the north, flowing west to east adjacent to the northern side of Argae Lane.

The approximate site address and Ordnance Survey Grid reference is presented in Table 1, with the Site location shown in Figure 1 overleaf.

Table 1: Site Referencing Information

Site Referencing Information	
Site Address	Argae Lane, Barry, CF63 1BL
Grid Reference	ST1376997 313748 , 169921

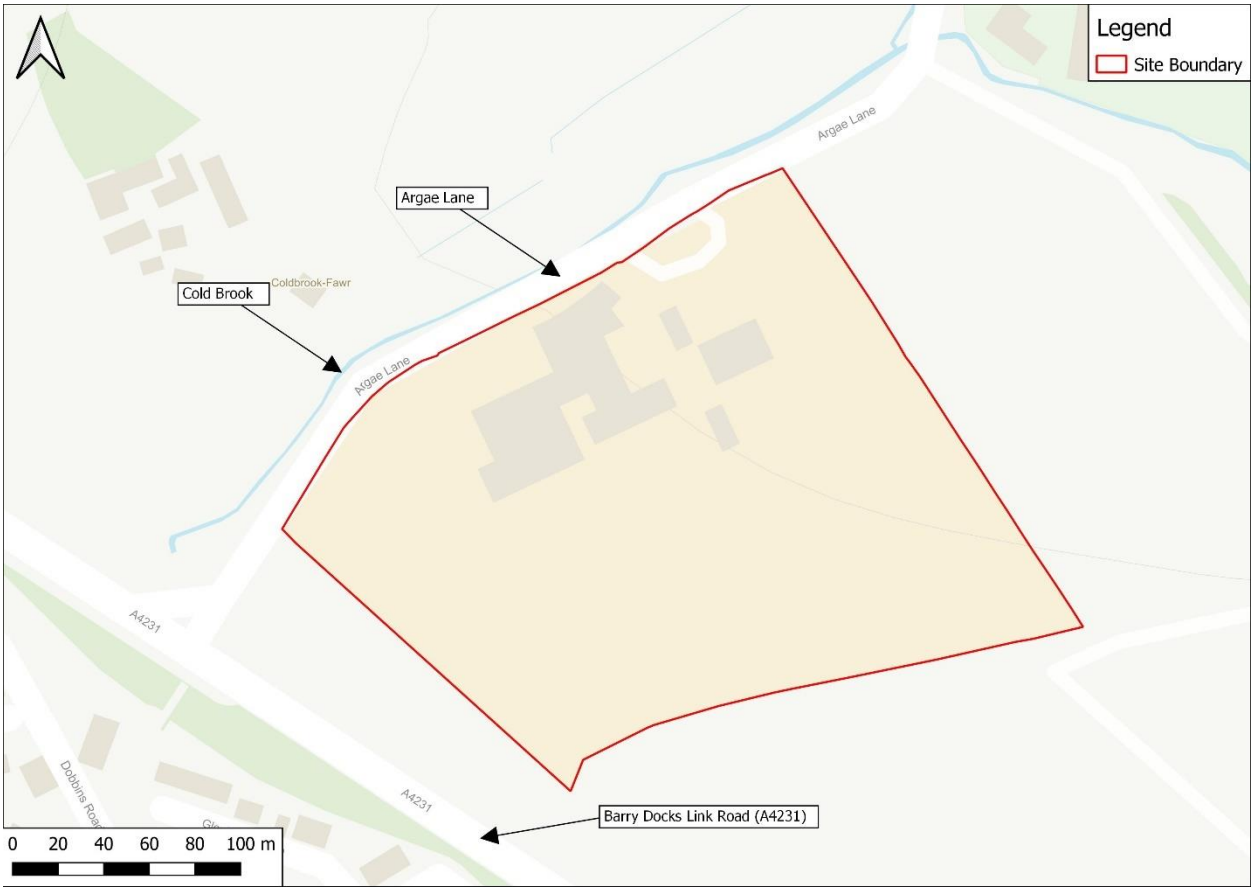

Figure 1: Site Location

2. Background

The hydraulic model of the Cold Brook was originally developed in 2018 as part of the Vale of Glamorgan Council (VoGC) Cold Brook Catchment Flood Risk Management Scheme. Following the initial 2018 study, AECOM were commissioned by VOGC in 2019 to undertake a review of the as-built model to determine its suitability for undertaking an optioneering study in relation to a proposed development at the St Richard Gwyn Catholic High School.

Following the initial suitability review, various updates were carried out to the model by AECOM in 2021, and further updates were implemented in 2022 following a review of the model by NRW.

Hydrock were commissioned to review the 2022 model and to explore options to improve the model's stability and further refine the preferred mitigation Option 5.

During a review of the 2022 model, it was found that substantial instabilities were present in both the 1D Flood Modeller Pro (FMP) and the 2D TUFLOW models, and as such the model would not run to completion for larger flood events, such as the 1 in 1000 year event. In order to assess the risk of flooding for a full suite of flood events, AECOM had truncated the model upstream of Dobbins Road to remove the problematic portions of the model. This resulted in two separate models, a full model for events up to and including the 1 in 100 year plus 30% climate change event, and a separate, truncated model for the 1 in 1000 year event (see Figure 2 overleaf).

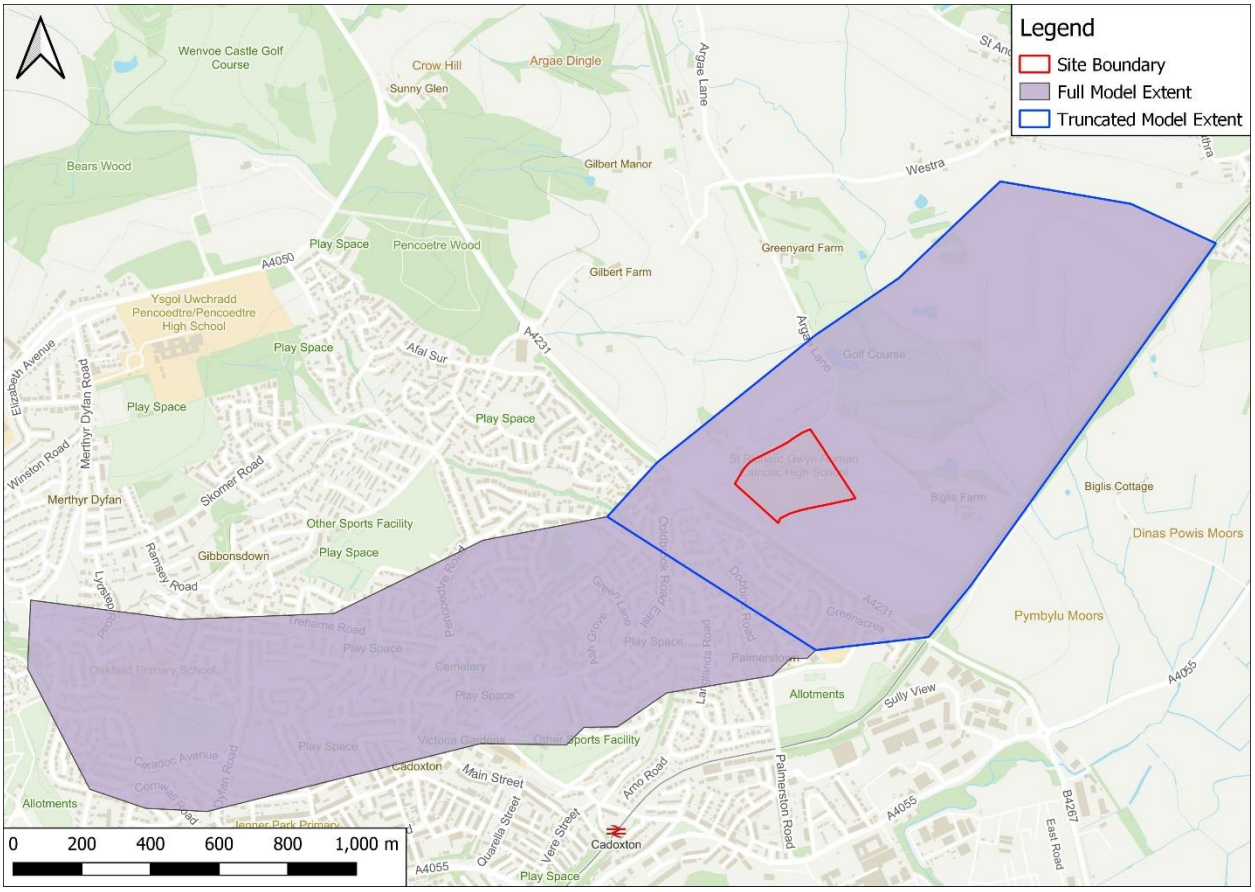

Figure 2: Model Domain Extents

3. Baseline Model Updates

Upon receiving the model, attempts were made to improve the stability of the full model in order to run a single model for the full suite events. The updates tested included amendments to the 1D and 2D models, such as stability patches in areas of high mass error, however, these were unsuccessful and the full model could not be stabilised for the 1 in 1000 year event.

Following attempts to stabilise the existing model, it was decided to explore converting the model to ESTRY-TUFLOW in line with recommendations from the NRW model review. However, due to the nature of the model, which includes substantial lengths of irregular culverts, the conversion process proved lengthy and problematic.

The final option explored was utilising the truncated model to simulate the full suite of flood events. In order to demonstrate that the truncated model is suitable to represent flood risk at the site, sensitivity tests are currently being carried out to determine the differences in on-site flood levels and depths between the full and truncated models, including tests on the various representations of the existing pedestrian subway found in the existing AECOM model.

Providing the results of the sensitivity tests indicate no/little change in modelled flood levels and depths on-site, further detail regarding the truncated model would be submitted as part of the upcoming planning application.

4. Post-development Model Updates

Following a review of the post-development model, it was noted that a number of refinements were required to update the submitted post-development model in line with the latest development proposals. These updates comprised the implementation of a preliminary proposed

ground model to represent the proposed level changes on-site (shown in Figure 1 below) which was implemented into the model grid as an ASC raster file.

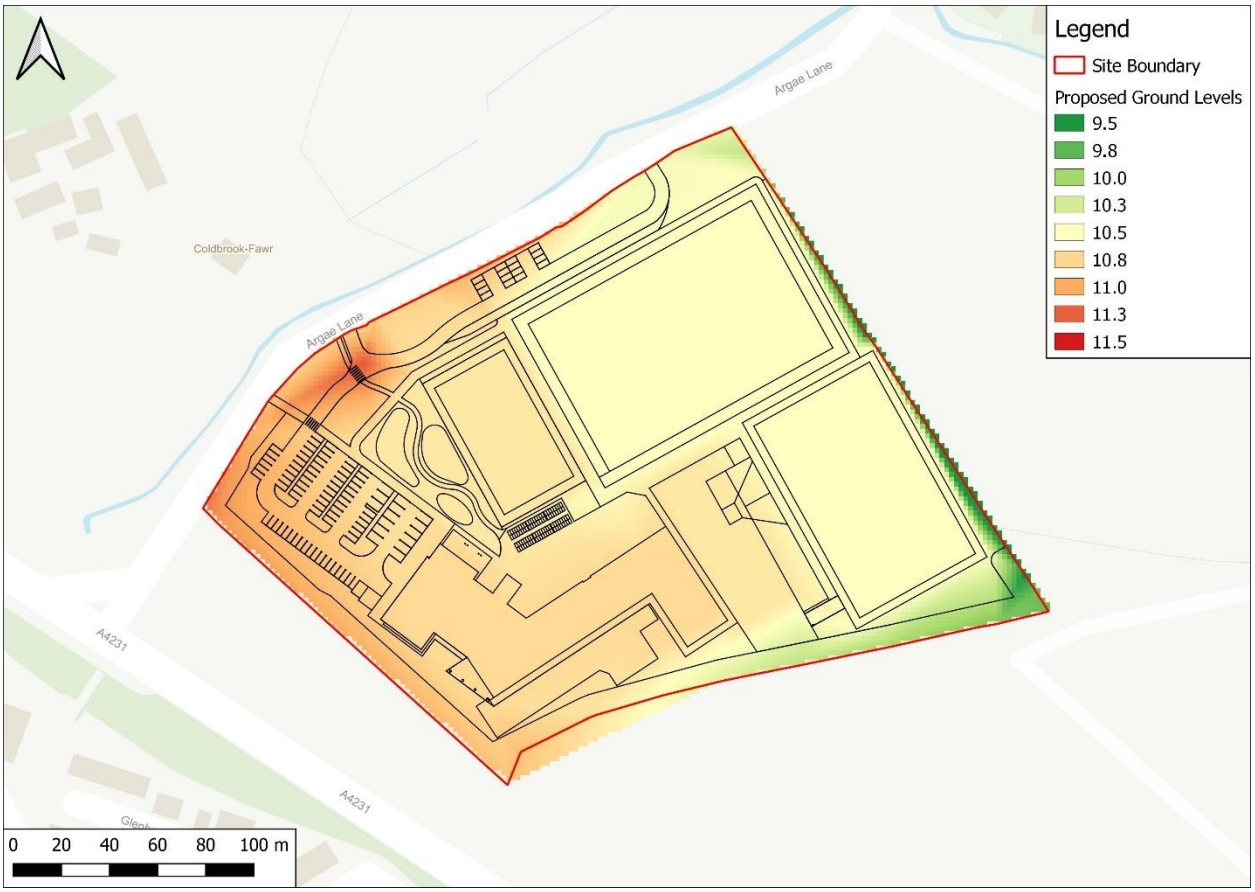

Figure 3: Proposed Development Layout and Ground Model

Assessment of the proposed ground levels on-site indicated that several refinements were needed to the proposed mitigation Option 5. In particular, the proposed raised bund adjacent to the ditch had been modelled at a level of 20.0m AOD, which resulted in an approximately 10.0m high wall between the proposed basin in the northwest of the site. Initially, the proposed bund was tested at a level of 11m AOD (approximately 0.2m to 0.4m high), however, subsequent iterations of the post-development model indicated that the bund was not required to retain flood waters within the proposed basin and ditch.

In addition to the amendments to the proposed bund, it was found that the location of the proposed basin and ditch clashed with portions of the proposed layout and subsequently amendments were required to the shape and location of these features. The current 'work in process' (WIP) version of the proposed mitigation is presented in Figure 2 below.

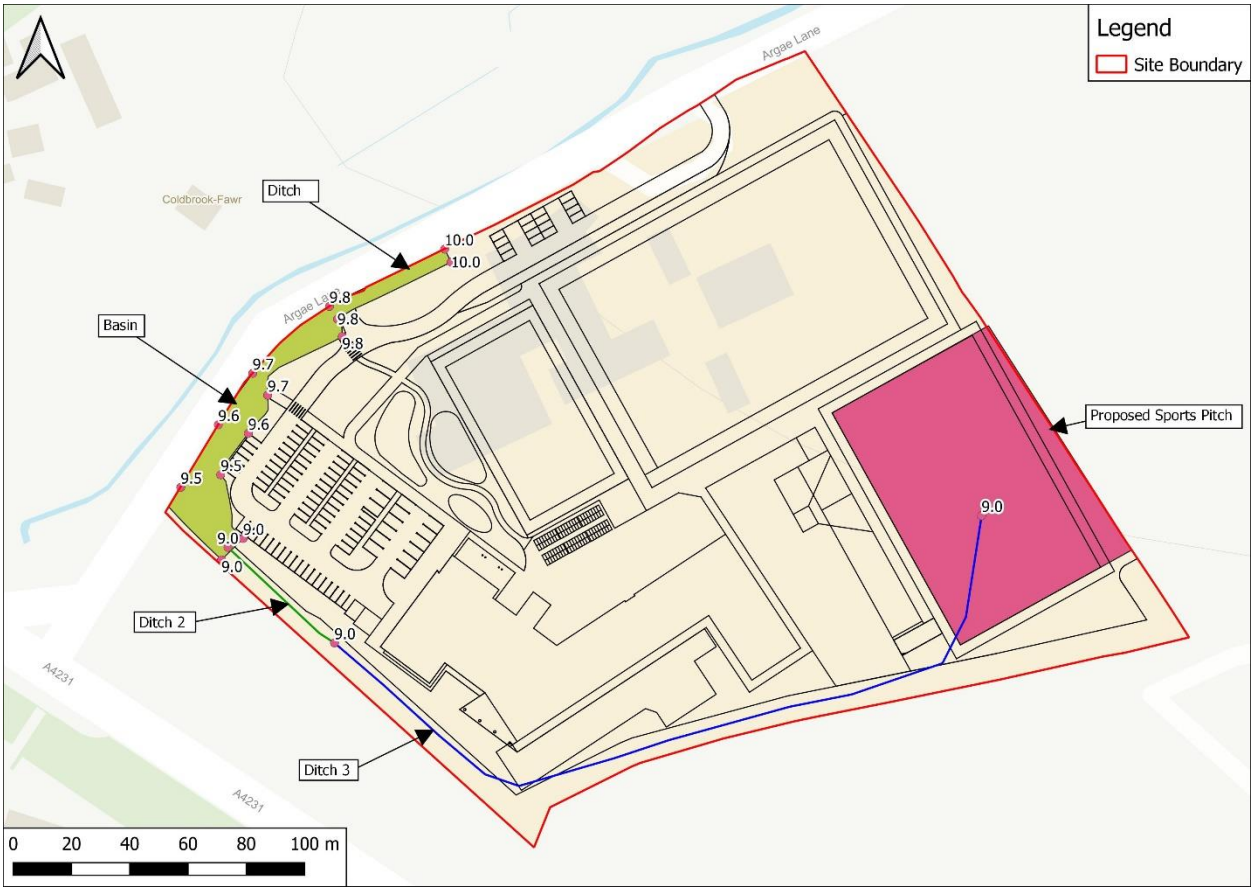

Figure 4: 'Work in Progress' Mitigation Measures

Below is a summary of changes from the submitted mitigation measures to the current WIP mitigation:

- Ditch 1 expanded to 5m wide by 45m long. Levels lowered by 0.1m to 10.0m AOD at the upstream end to 9.0m AOD at the downstream end.
- Basin geometry amended to suit the current proposed layout, avoiding the proposed car parking spaces in the northwest of the site. Approximately 1300m^2 plan area and approximately 1.0m to 2.0m deep.
- Ditch 2 increased to 8.0m wide by approximately 50m long and ditch 3 increased to 10m wide by approximately 240m long. The ditches have been widened and the bed lowered to 9.0m AOD for its entire length to provide additional storage volume as well as conveyance of flood waters across the site. The proposed 9.0m AOD ditch bed level provides more storage volume that required, therefore, further iterations of the mitigation design are likely to comprise a shallower ditch to minimise the earthworks required on-site.
- Proposed playing field lowered to 9.0m AOD to provide additional floodable area and ensure that flood waters from the proposed ditch outfall approximately at the location of the flow paths present in the baseline scenario, and no additional areas of third-party land to the east are affected as a result of the proposals.

5. Model Results

During the 1 in 100 year plus 30% climate change event (the design flood event) two separate flood mechanisms are predicted to affect the site in the baseline scenario. The first is the overtopping of the right (southern) bank of the Cold Brook at Argae Lane at approximately 3 hours into the model flood event. Flood water flows south across Argae Lane and enters the site to the east of the existing pedestrian access. The second flood mechanism is the overtopping of the Cold Brook

downstream of Dobbins Lane, to the south of Barry Docks Link Road. At approximately 3 hours and 20 minutes into the flood event, water levels in the Cold Brook overtop its banks and flood waters travel to the north and into the pedestrian subway below Barry Docks Link Road. The flow route passes through the subway before turning to the east and entering the site along its southwestern boundary. Flood waters from both flow routes travel across the site to the east, meeting roughly in the site's centre before continuing to meet the Cold Brook in the east.

The predicted flood depths during the baseline scenario design flood event are presented in Figure 5 below. During this event, flood depths are predicted to remain largely below 0.30m across the majority of the site. However, the maximum depths to the north and west of the existing buildings on-site are shown to reach approximately 0.60m with some isolated low spots reaching up to 0.75m. The maximum flood level on-site is shown to reach a maximum of 10.85m AOD in the north of the site, adjacent to Argae Lane, and 9.10m AOD in the east of the site, adjacent to the sites eastern boundary.

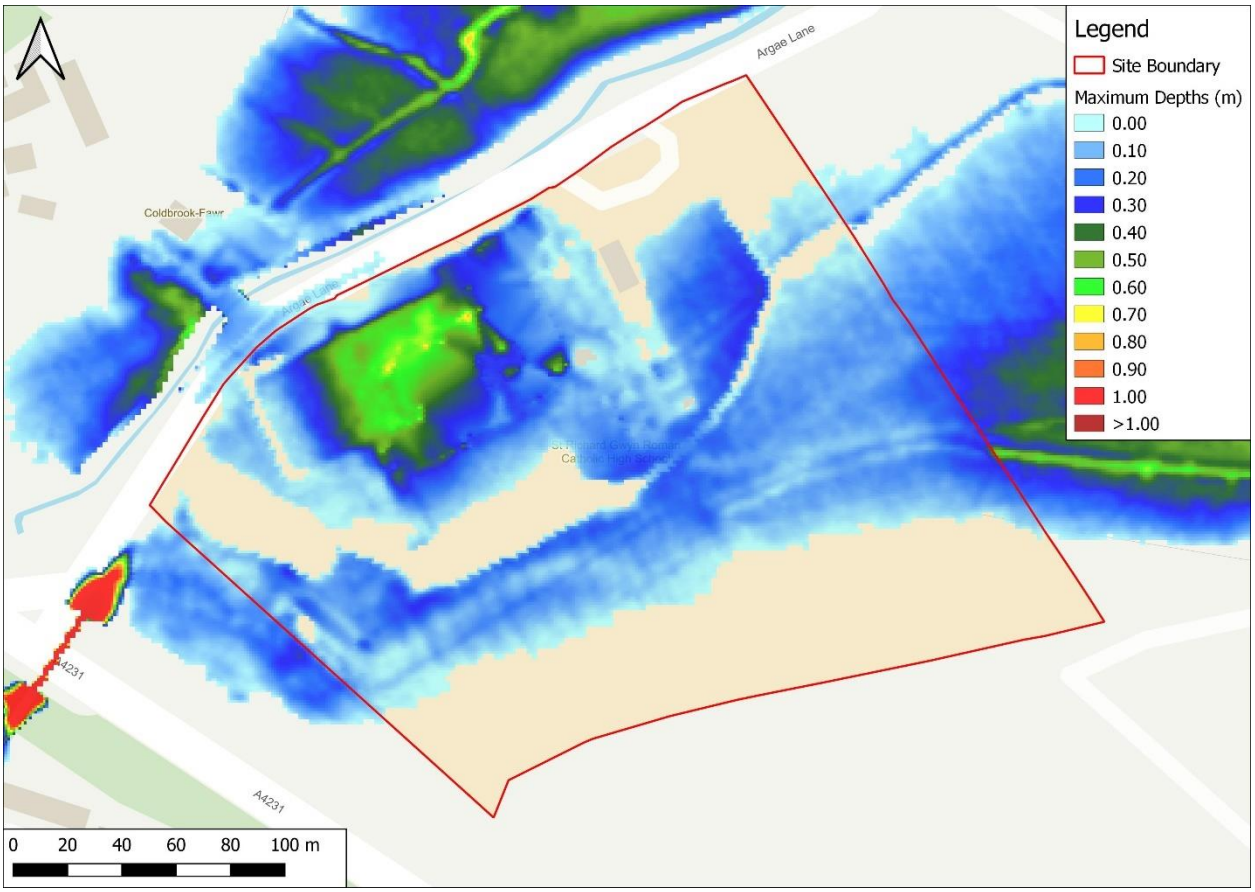

Figure 5: 1 in 100 year + 30% CC Maximum Depths - Baseline Scenario

The maximum flood depths during the post-development scenario are shown in Figure 6 overleaf. During this scenario, flooding on-site is shown to be contained within the proposed basin, ditches and sports pitch. Flood depths within the proposed basin and ditch are shown to reach a maximum of 1.0m at the basin outlet with depths in the proposed playing field shown to reach a maximum of 0.30m.

Figure 6 shows that the full flood volume on-site can be accommodated within the proposed basin, ditches and sports pitch to ensure that the proposed development would remain free of flooding over its lifetime.

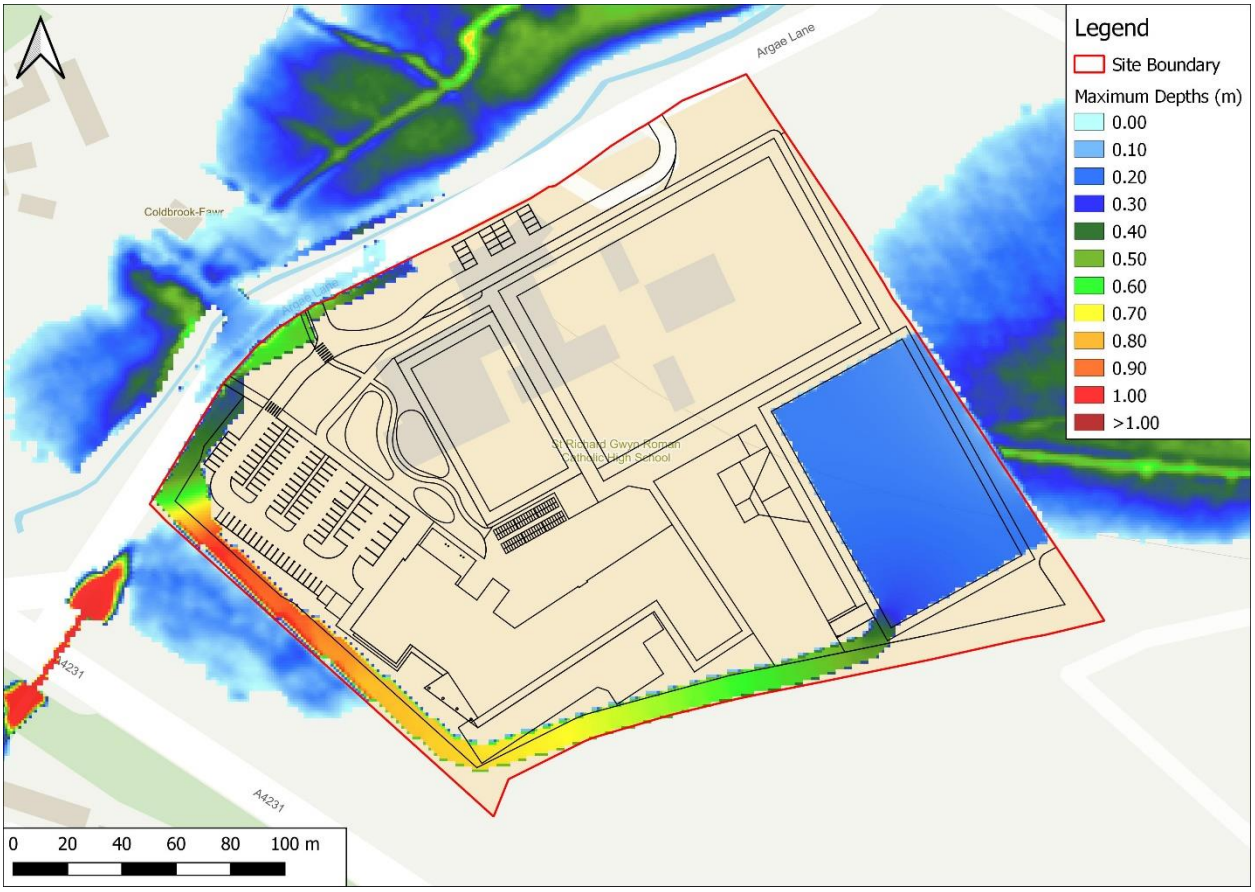

Figure 6: 1 in 100 year + 30% CC Maximum Depths - Post-development Scenario

In order to ensure that there is no increase in flooding to third-party land as a result of the development, a depth comparison has been carried out to determine the change in flood depths on-site and in the surrounding areas. Figure 7 overleaf indicates that there are reductions in on-site flood depths observed, with depths reducing by a maximum of 0.70m in the north of the site, adjacent to the existing buildings and approximately 0.20m elsewhere. Flood depths in the location of the proposed basin, ditches and playing field are shown to increase by a maximum of 1.0m.

Off-site, flood depths are shown to remain largely the same as during the baseline scenario, however, some reductions of up to 0.20m are seen in the vicinity of Barry Docks Link Road and Coldbrook Road to the west of the site, and in the agricultural fields to the east of the site. Flood depths within Argae Lane to the north of the site are observed to increase by a maximum of 0.20m over a very small area. Investigations are ongoing to mitigate these increases in flood depths. The current option being investigated is amendments to the existing on-site verge levels along the Argae Lane footway.

It should be noted that the above results are preliminary only, and the final results would be confirmed and submitted alongside the planning application, following investigation of the impacts of truncating the model.

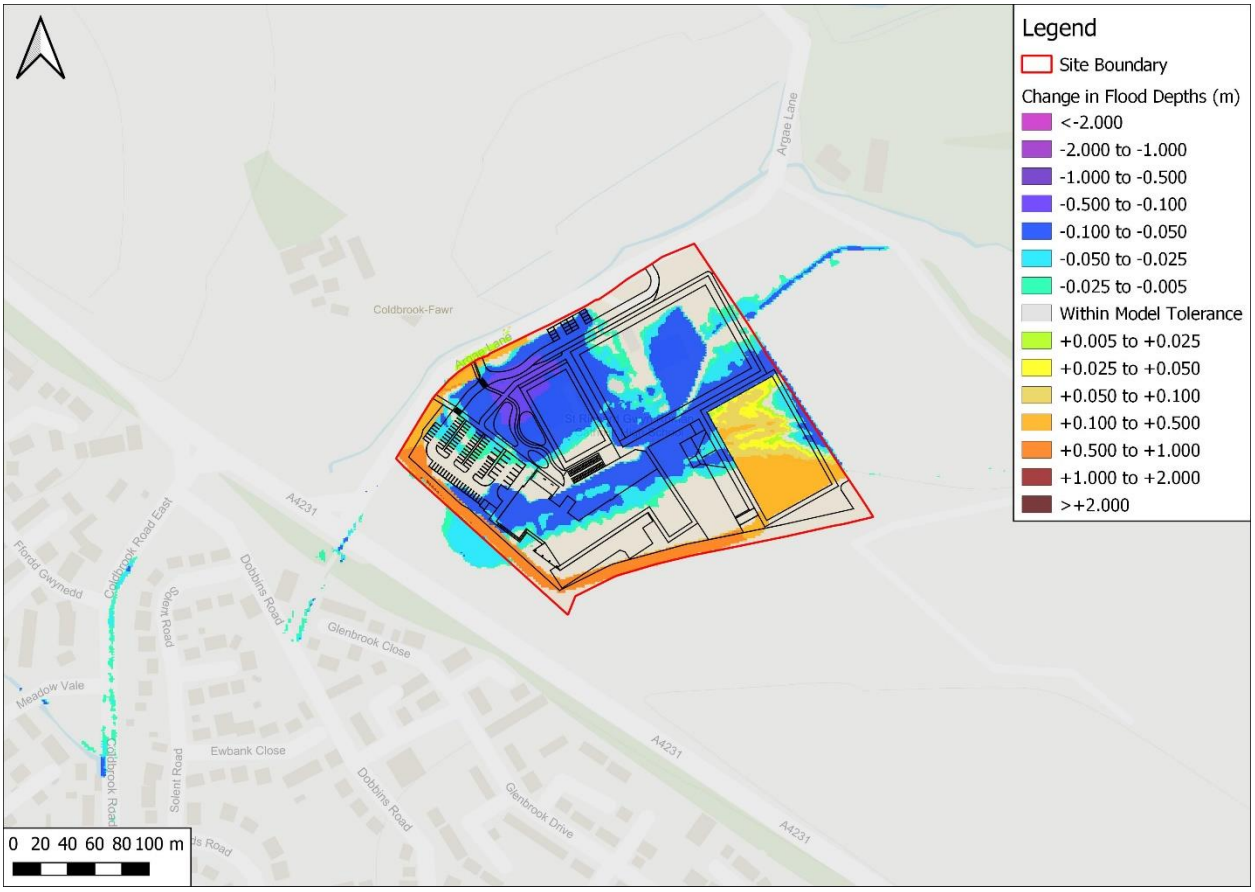

Figure 7: Change in Flood Depths from Baseline to Proposed

6. Summary

Hydrock have obtained and updated the existing hydraulic modelling of the Cold Brook in order to investigation options to improve the stability of the existing model and to assess the preferred mitigation Option 5 to support the proposed development.

Based on the information contained within this report, it can be seen that mitigation Option 5 can be refined in order to accommodate the proposed development on-site, and to ensure that there is no increase in flooding elsewhere as a result of the development.

However, it should be noted that testing is still ongoing to determine the impacts of the truncated model on flood levels and depths on-site and in the surrounding areas. Should the testing find little/no change in flood levels and depths between the full model and the truncated model, the truncated model would be progressed for assessment of flooding at the site and would be submitted in support of the upcoming planning application.