



McDonalds Pontardawe

Flood Consequence Assessment

For McDonalds

Date: 2 November 2022

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1. INTRODUCTION

This report has been prepared by Hydrock Consultants Limited (Hydrock) on behalf of our client McDonalds in support of a planning application for a proposed development off the A4067, Pontardawe.

This Flood Consequence Assessment (FCA) report has been prepared to address the requirements of Technical Advice Note 15: Development and Flood Risk (TAN15), through:

- Assessing whether the site is likely to be affected by flooding.
- Assessing whether the proposed development is justifiable in the proposed location.
- Presenting any flood risk mitigation measures necessary to ensure that the proposed development and occupants will be safe, whilst ensuring flood risk is not increased elsewhere.

2. SITE INFORMATION

2.1 Site Location

The site is situated in the car park of a Tesco Superstore, located off the A4067, Pontardawe. The site is bound to the north by an access road and the River Tawe, to the east by an access road and petrol station, to the south by the A4067, and to the west by Tesco Superstore and its associated parking.

The approximate site address and Ordnance Survey Reference Grid is in Table 1, with the site location shown in Figure 1.

Table 1. Site Referencing Information

Site Referencing Information	
Site Address	Gwyn's Drift, Pontardawe, Swansea, SA8 3AZ
Grid Reference	SN 72290 03496 272290 , 203496

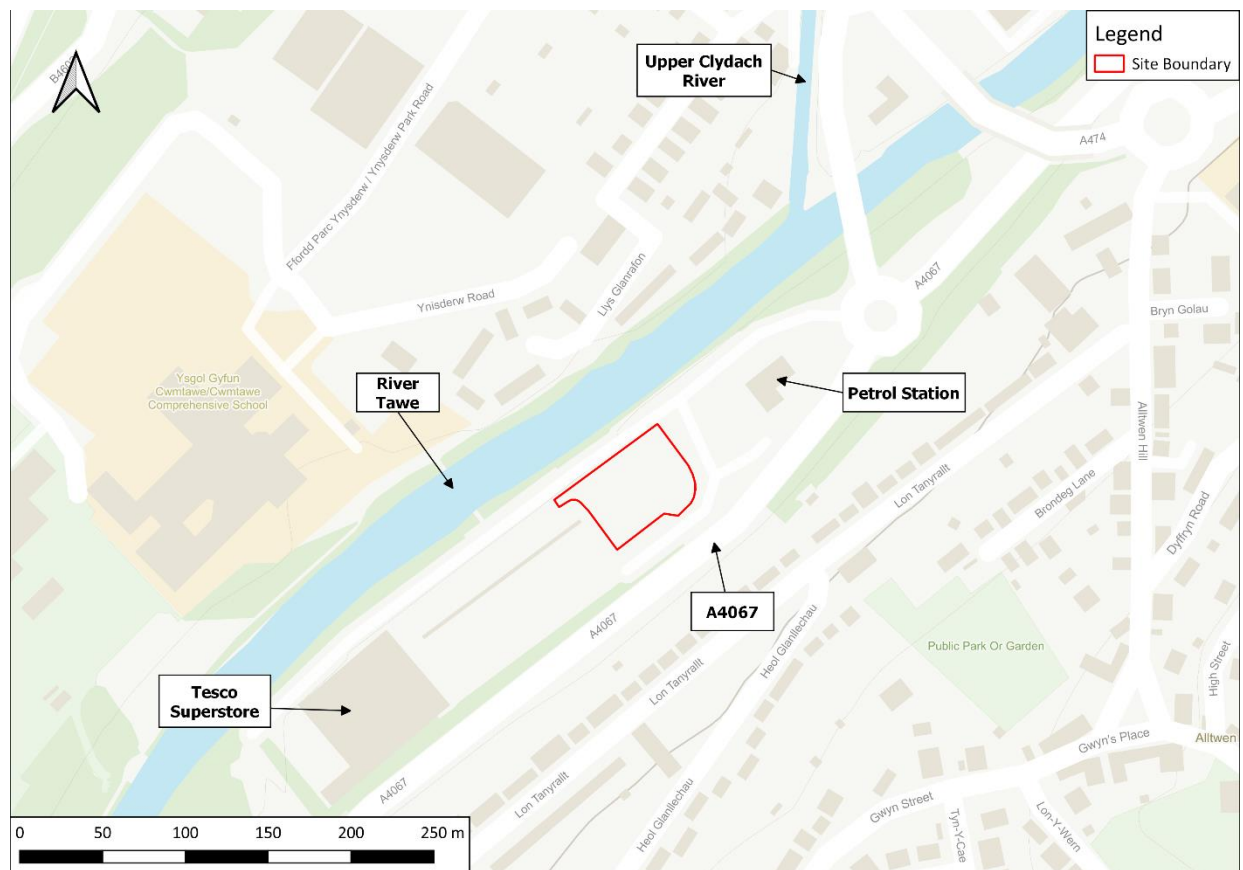


Figure 1. Site Location

2.2 Topography

A topographic survey has been undertaken and is included in Appendix A. The site is shown to be generally flat, with the majority of the site having an elevation of approximately 33m AOD. The

elevation falls slightly along the site's north-eastern corner, reaching a minimum elevation of 32.82m AOD.

2.3 Current Site Use

The site currently comprises of Tesco car park.

2.4 Proposed Development

The proposals are for the development of McDonalds - a fast-food restaurant, and associated infrastructure.

3. SOURCES OF FLOOD RISK

3.1 Fluvial Flooding

The closest watercourse to the site is the River Tawe which is located approximately 20m north of the site, and runs in a general south-westerly direction, parallel to the site's northern boundary.

Current NRW Flood Risk from Main River Mapping (Figure 2) shows the site to be at 'very low' risk of flooding from the River Tawe. The risk increases to 'high' just north of the site.

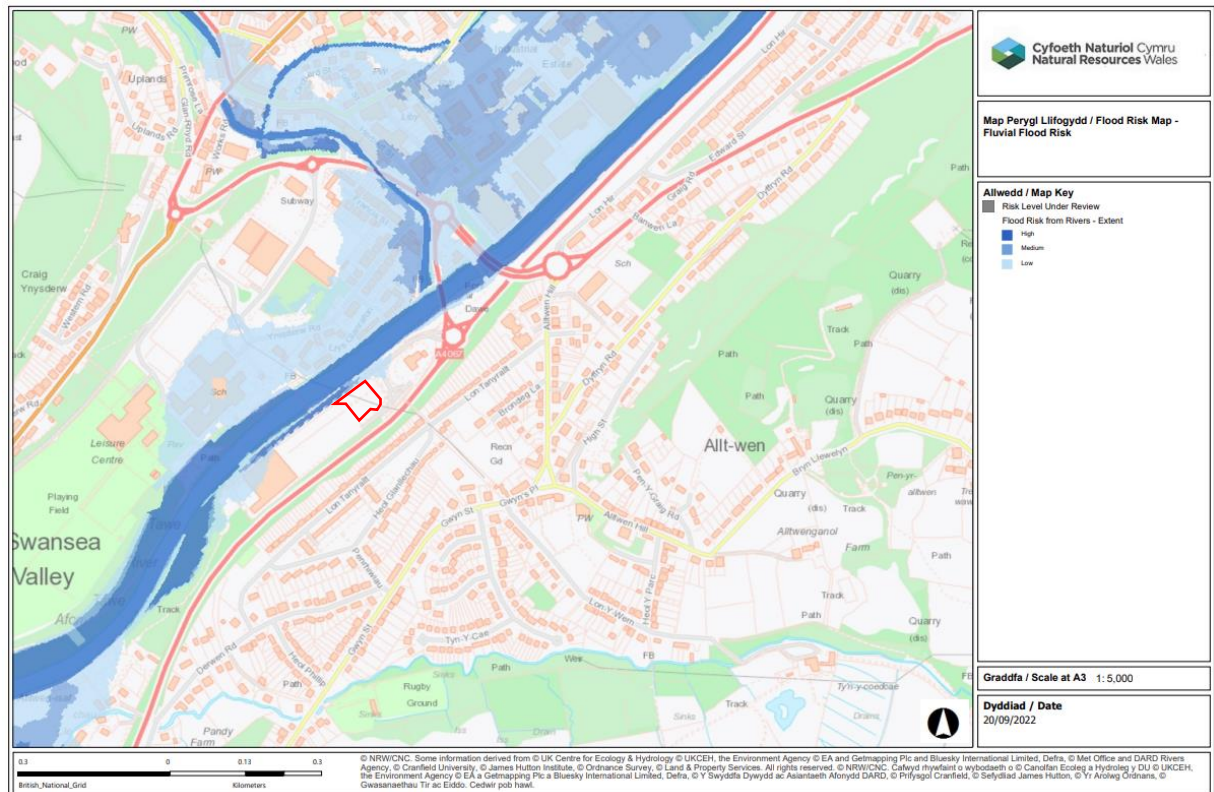


Figure 2. NRW Flood Risk from Main Rivers Mapping

The NRW Development Advice Map classifies the site as being entirely within Zone A, which is considered to be at little or no risk of fluvial or coastal / tidal flooding.

The Neath Port Talbot Preliminary Flood Risk Assessment (PFRA) (NPTCBC, 2011) has recorded two incidents of historic flooding (1979 and 1998) at the Pontardawe industrial estate north of the River Tawe however, the NRW has not recorded these incidents to have affected the site. Furthermore, the Local Flood Risk Management Strategy (LFRMS) (NPTCBC, 2013) does not indicate the site to be located within an indicative flood area.

The NRW were contacted to obtain the latest modelled data for the River Tawe and they confirmed that the model needs updating with the latest modelling software, hydrology and topographic information. Given the lack of detailed modelling for the watercourse, it has been discussed and agreed with the NRW that a detailed hydrological and hydraulic modelling review of the existing model will be undertaken by Hydrock to confirm the current and future fluvial flood risk, with the inclusion of climate change. The model review is included in Section 4.

3.2 Tidal Flooding

NRW Mapping shows the tidal limit of the River Tawe to be approximately 6.5km downstream of the site and therefore, the risk of tidal flooding is concluded to be 'low'.

3.3 Surface Water Flooding

Surface water flooding occurs as the result of an inability of intense rainfall to infiltrate the ground. This often happens when the maximum soil infiltration rate or storage capacity is reached. Flows generated by such events either enter existing land drainage features or follow the general topography which can concentrate flows and lead to localised ponding/flooding.

NRW Surface Water Flood Mapping (Figure 3) shows the entire site to be at 'very low' risk of surface water flooding. There is an area of increased risk along the northern site boundary however, this is not shown to enter the site.

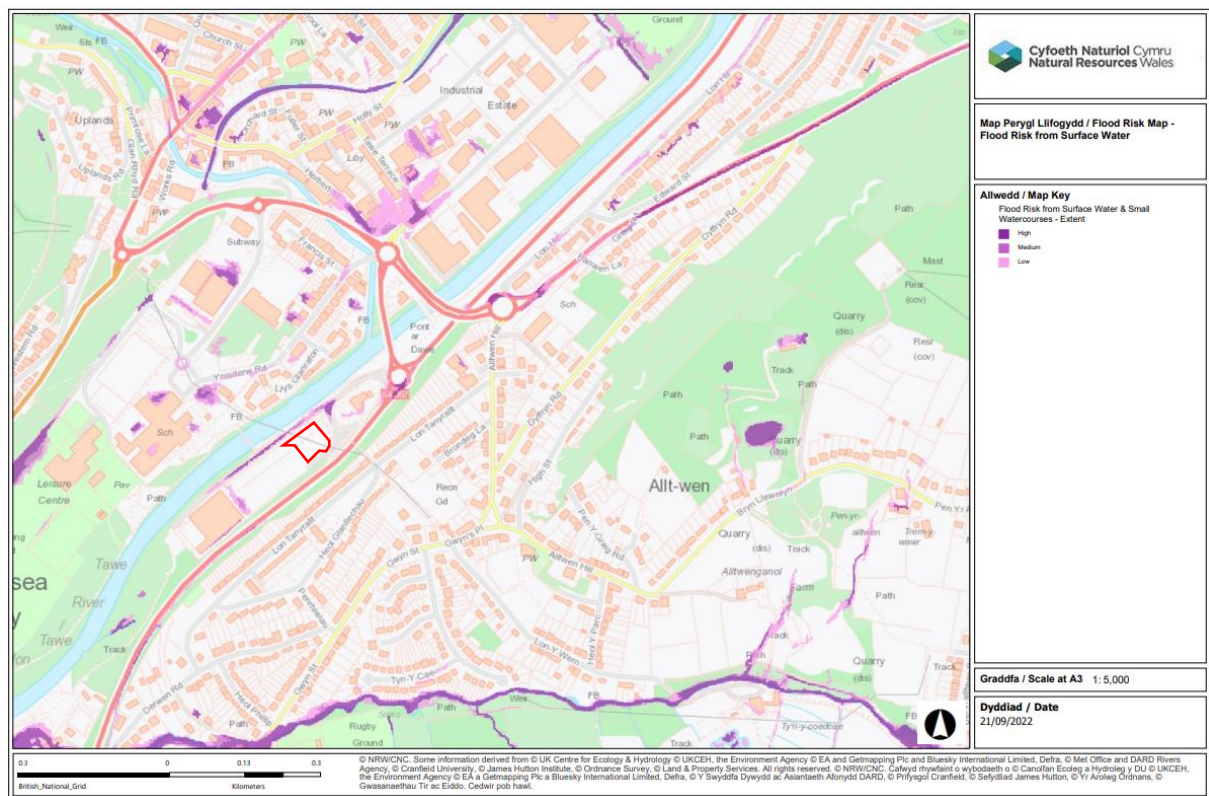


Figure 3. NRW Flood Risk from Surface Water & Small Watercourses

It must be noted that the NRW mapping does not take into account any drainage that may be serving the site and therefore represents the worst-case scenario.

As such, the site is concluded to be at 'low' risk of surface water flooding.

Whilst the potential effects of climate change could increase the frequency, depth and extent of on-site surface water flooding, given the current low risk identified, any increase in flood risk is considered unlikely to be of a magnitude which would result in a significant increase in the risk of on-site surface water flooding, as any surface water run-off will likely continue to be directed overland as shallow 'sheet-flow' with the prevailing topography and away from the site or be managed by surface water drainage features in the vicinity.

3.4 Groundwater Flooding

British Geological Survey (BGS) Mapping shows the entire site to be underlain by the Brithdir Member, consisting of mudstone, siltstone and sandstone. The site is overlain by glaciofluvial deposits, composing of devensian sand and gravel.

Given the generally low permeability of the bedrock geology, the risk of groundwater emergence is low. The PFRA indicates that there are no specific areas of historic flooding recorded in the Neath Port Talbot area and overall groundwater is not believed to be a major source of flooding.

Furthermore, Soilsmap shows the site to be overlain by 'slowly permeable, seasonally wet, acid, loamy and clayey soils' with 'impeded drainage'. As such, groundwater levels are unlikely to be responsive to rainfall.

As such, the site is concluded to be at 'low' risk of surface water flooding. As the determination of groundwater flood risk in this instance is driven by geological factors which will be unaffected by the potential effects of climate change, the risk of groundwater flooding posed to the site is considered unlikely to increase as a result of climate change.

3.5 Infrastructure Failure Flooding

Given the generally developed nature of the area, it is assumed that there is a public drainage system serving the site and the surrounding area. Any surcharging of sewer networks up-catchment will likely follow surface water flow routes and be directed towards the River Tawe. Given that the risk of sewer flooding is likely only in the event of failure or blockage, this is considered to be a 'residual' risk, and as such the risk of potential flooding from sewers is concluded to be 'low'.

The Swansea Canal is located approximately 350m north-west of the site. Consultation with the NRW has confirmed that canal flooding in the event of the tributary overflowing into the canal is one of the primary sources of flood risk to the site. As such, this scenario will be involved in the model review process. This is included in Section 4.

NRW Mapping does not show the site to be at risk of flooding in the event of reservoir failure. As such, the site is concluded to be at 'low' risk of flooding from reservoir failure.

4. NATURAL RESOURCES WALES MODEL REVIEW

The site is modelled within the 1D/2D ESTRY-TUFLOW Pontardawe Model which was undertaken by JBA on behalf of NRW in 2015.

Consultation with the NRW has confirmed that the model requires updating before it is fit for purpose. The required updates are:

- Run model on latest software
- Update hydrology
- Identify and update and major changes to topography
- Identify and update any major changes to overland flow routes, such as flood defences
- Update EA LiDAR data

Therefore, it has been discussed and agreed that Hydrock Consultants Limited (Hydrock) will update the hydrological and hydraulic model of the River Tawe on behalf of McDonalds.

4.1 Hydrological Model Review

The peak inflows have been calculated for three inflow points:

- Tawe_us (renamed as TAW_US in this report) - represents the 1D QT point inflow at the upstream extent of the Tawe.
- Cwm_Du_us (renamed as CWM_US in this report) - represents the 1D QT point inflow at the upstream extent of the Cwm Du
- Upper_Clydach_us (renamed as CLY_US in this report) - represents the 1D QT point inflow at the upstream extent of the Upper Clydach.

The peak inflows were originally calculated by the NRW using the FEH Statistical / ReFH 'Ratio' method with WINFAP V3 and data from HiFlows-UK V3.3.4, using Proforma V7.7.

However, this analysis was carried out in 2014 and it has therefore been agreed with NRW that the hydrology needs updating. The methodology used to calculate the hydraulic model inflows is documented in the Flood Estimation Calculation Record (FECR) included in Appendix B.

4.2 Hydraulic Model Review

4.2.1 1D Model Build

The cross sections are represented in 1d_xs layers using the 'XZ' Type, linking to .csv files which reference the cross-section geometry and roughness. The model cross sections are appropriately spaced and interpolated sections have been kept to a minimum.

In proximity to the site, the channel roughness varies from 0.025 to 0.075, and was allocated on the basis of surveyed photographs and observations. This is in a sensible range and a further site visit undertaken by Hydrock did not identify any significant changes to the channel.

The structures in proximity to the site were reviewed on a site visit carried out by Hydrock in order to identify any changes to structures. Visual inspection found the original survey to remain appropriate, with no changes to existing structures, or additional structures identified.

Structures are represented in the model in the 1d_nwke and 1d_xs files, with mid-sections represented in 1d_cs files.

In the 1d_nwke files, bridges were represented in the model as 'B' Type when represented in the 2D domain, and 'BW' Type when represented in the 1D domain. The 'B/BW' Type was updated to 'BB/BBW'. The advantage of this is that BB bridges differ from B bridges in that the losses due to flow contraction and expansion, and the occurrence of pressure flow is handled automatically and thus reduces human error.

The model uses node points in the 1d_nwke layer to override the default nodal storage to improve stability. The updated model was run without these nodes and the model remained suitably stable. As such the nodes were not included in the final model. A reduction in the stability measures applied to the model is likely to increase the accuracy of the final results.

The downstream boundary was represented in a flow versus level (QH) boundary in the 1D domain. This was generated using ISIS Utility, for the cross-section TAW0000, based on a bed slope gradient of 1 in 333. Given the constrained nature of the floodplain at the downstream extent of the model, a 2D downstream boundary was not built into the model. This is considered appropriate.

4.2.2 2D Model Build

The model covers an active area of approximately 3km². The model's grid size is set to 4m. Sensitivity testing carried out in the original modelling study confirmed the cell size to be appropriate.

Data distribution were contacted to provide the most recent LiDAR data however it has been confirmed that this is not publicly available. As such, the most recent publicly available NRW 1m DTM data was used as the best available data.

A site-specific topographic survey was undertaken (Appendix A). This was built into the model as an .asc file in order to improve the representation of levels on-site.

A site visit was undertaken to identify any major changes to the topography of the area. The visit found no visible changes and as such the modelled topography is considered appropriate.

The deck levels of structures were represented in the 2d_zsh_bridge_decks layer. It was noted that there were some inconsistencies between the surveyed deck level of bridges and those used in the model. As such, the 2d_zsh_bridge_decks layer was updated with the surveyed levels.

For the River Tawe, the 2d_bc_HX_Tawe_002 layer connects the 1D and 2D domain using HX lines along the left and right banks of the watercourses, which are connected to the 1D domain using CN line which run along the channel cross sections. The layer was updated (and renamed to 2d_bc_hxi_TAW_002_R002_L), with the HX lines extended so that they wrap around the downstream and upstream ends of the null channel where the spill is modelled in the 2D domain. This allows water to weir over structures and pass between the 1D and 2D domain. The 2d_bc_HX layers were reviewed for the remaining two watercourses however no changes were necessary.

The 2D roughness is represented in the 2d_mat layer. The layer was reviewed and the roughness values are considered appropriate.

4.2.3 Model Run

The updated flood model utilises the latest version of TUFLOW software (2020-10-AE).

4.2.4 Model Stability

The cumulative 1D mass error for the 1% AEP + 30% Climate Change scenario, shows that after an initial spike (reaching a peak of 0.19%) the mass balance decreases and settles around 0.00% and well within the $\pm 1\%$ tolerance and is therefore demonstrated to be stable in the 1D.

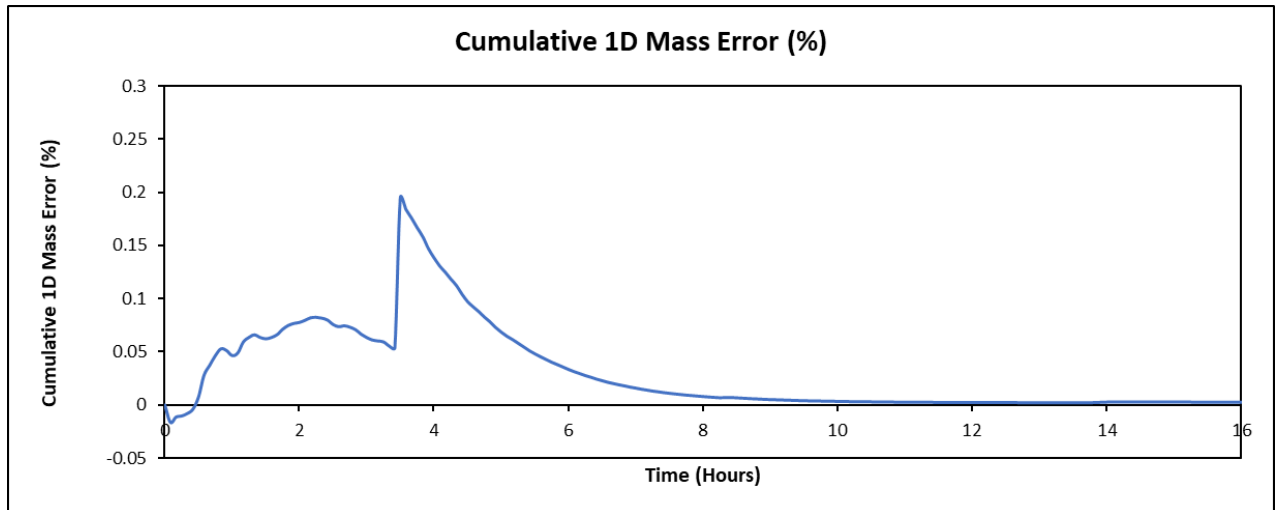


Figure 4. Cumulative 1D Mass Error (1% AEP + 30% CC Event)

The cumulative 2D mass error for the 1% AEP + 30% Climate Change scenario, shows that after initial fluctuations (reaching a peak of 0.04% and a minimum of -0.15%) the mass balance settles around -0.05% and well within the $\pm 1\%$ tolerance and is therefore demonstrated to be stable in the 2D.

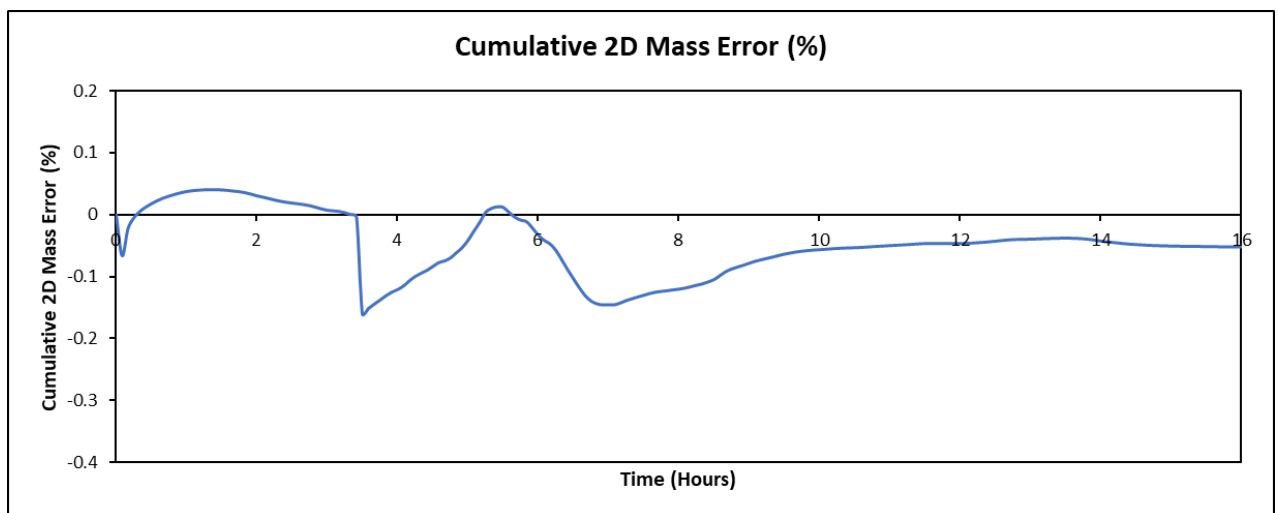


Figure 5. Cumulative 2D Mass Error (1% AEP + 30% CC Event)

4.2.5 Model Sensitivity

Sensitivity tests on the model were undertaken by JBA. The results of these tests show the model is shown to be sensitive to changes in roughness. The roughness values were re-assessed in the model review and were found to be representative and therefore we are confident with the model output. The model is shown to be insensitive to changes in the downstream boundary conditions, model cell size and structure loss coefficients. These parameters were not updated in the model update and as such no further testing was required.

A 20% increase and decrease of all model inflows was re-run with the updated flows for the 100yr event. The results show the model to be sensitive to the magnitude of model inflows, with the extent of flooding in proximity to the site increasing when inflows are increased by 20%. However, it is demonstrated that the site remains unflooded in all scenarios.

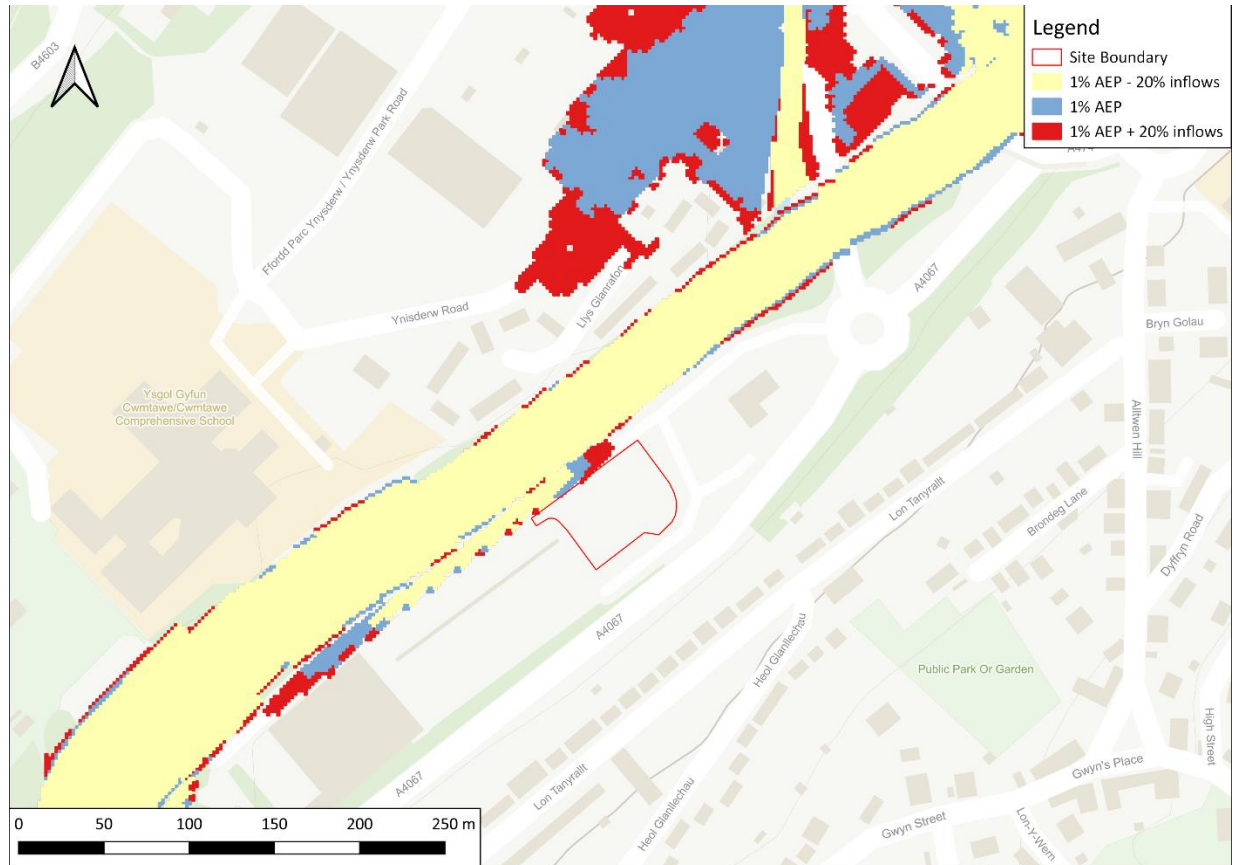


Figure 6. Flows Sensitivity Scenario Results

4.2.6 Warnings

The following warnings were found within the messages layer of the 100yr + 30% Climate Change simulation:

- » *Warning Negative Depth at Node CWMD0465.1* - 83 negative depth warnings occurring for a very short period on the rising limb of the design event. The number of warnings is a reduction on those in the original model, which were accepted on the basis that the instability occurs several hours before the peak. These warning are not in close proximity to the site and are considered acceptable.
- » *Warning 1100 - Structure TAW4108 crest/inverts is below bed of primary upstream channel TAW4307* - 2 warnings - acceptable consequence of modelling (irregular-crested) rock weirs with copied upstream and downstream sections.
- » *Warning 2118 - Lowered SX ZC Zpt by 0.42m to 1D node bed level* - 9 warnings - acceptable consequence of applying the 'Z' flag to floodplain culverts.

4.3 Model Review Summary

The model has been reviewed and updated in line with the most recent guidance. It is concluded that the updated model is of good quality and is suitable for use in informing flood levels on site.

5. HYDRAULIC MODELLING RESULTS

5.1 Defended Scenario

The maximum stage in each scenario from the 1D cross sections nearest the site is included in Table 2, with the output drawings included in Appendix C. The results for the 30yr, 100yr, 100yr + 30% Climate Change and 1,000yr events have been included in-line with the NRW Flood Risk Assessment Wales (FRAW) map. It is noted that the existing TAN 15 (2004), and the Development Advice Map remain the framework for assessing flood risk in the planning system.

Results show in all events, the site is shown to remain unflooded. Some out of bank flooding is projected in all events however, this is not predicted to extent into the site. As such, the site is confirmed to be at low risk of fluvial flooding.

Table 2. Maximum Stage (mAOD) at cross sections near site

	1 in 30yr Max Stage (mAOD)	1 in 100yr Max Stage (mAOD)	1 in 100yr + 30% CC Max Stage (mAOD)	1 in 1,000yr Max Stage (mAOD)
TAW0744	30.379	30.708	31.392	31.839
TAW0555	29.779	30.065	30.666	31.073
TAW0552	29.771	30.057	30.658	31.060

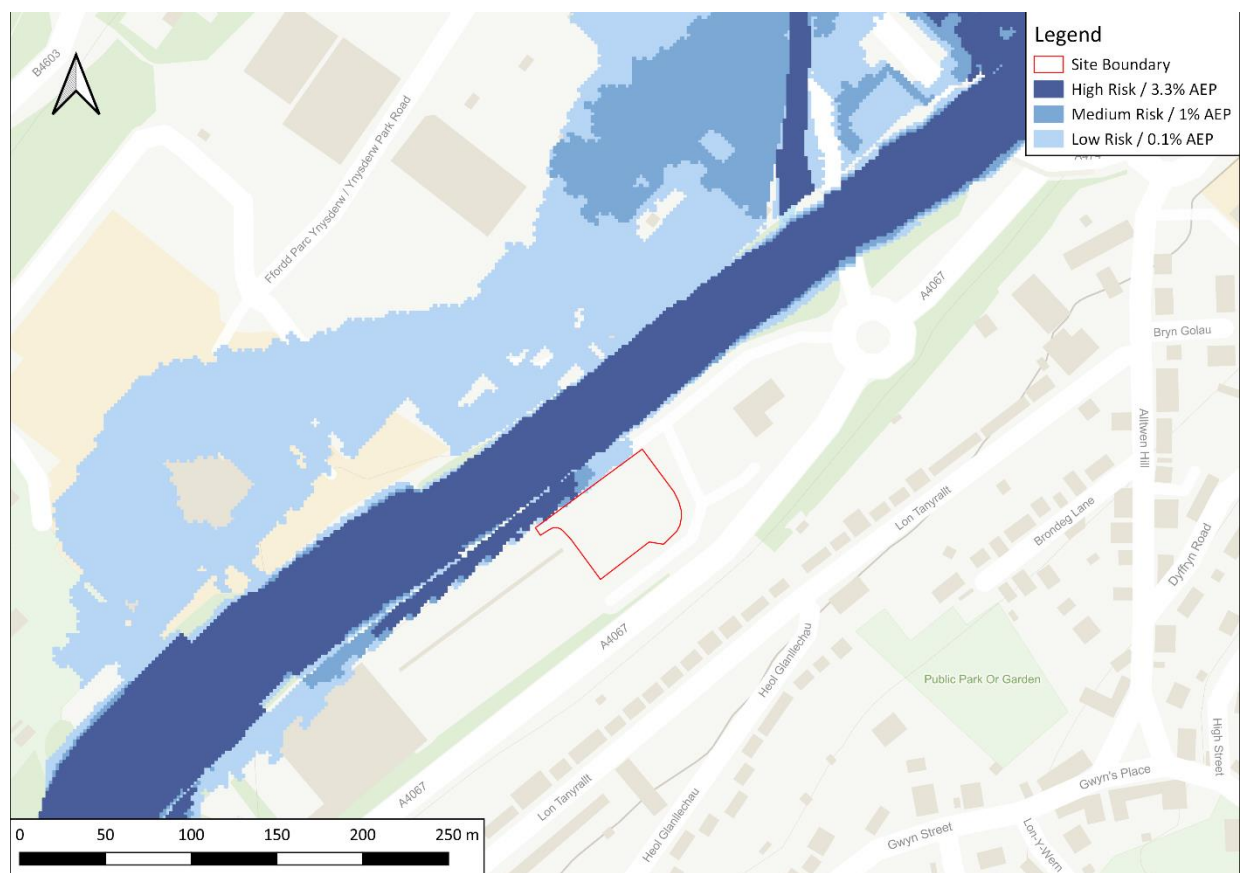


Figure 7. Modelled Flood Zones

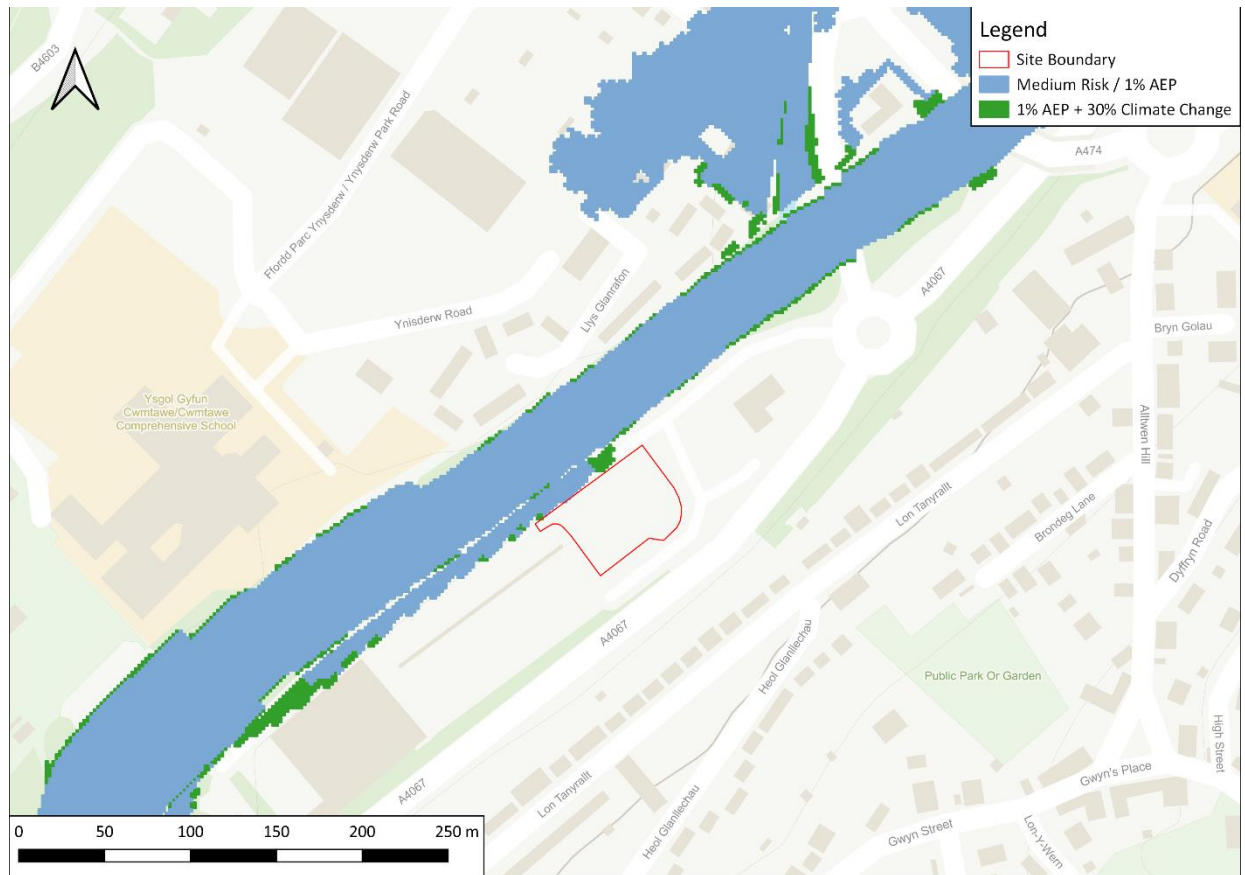


Figure 8. Climate Change Scenario

5.2 Undefended Scenario

The undefended scenario was run for the 100yr + 30% Climate Change and 1,000yr events. The results show there to be a minor increase in the extent of flooding in close proximity to the site in the undefended scenario however, the site remains unflooded in all scenarios.

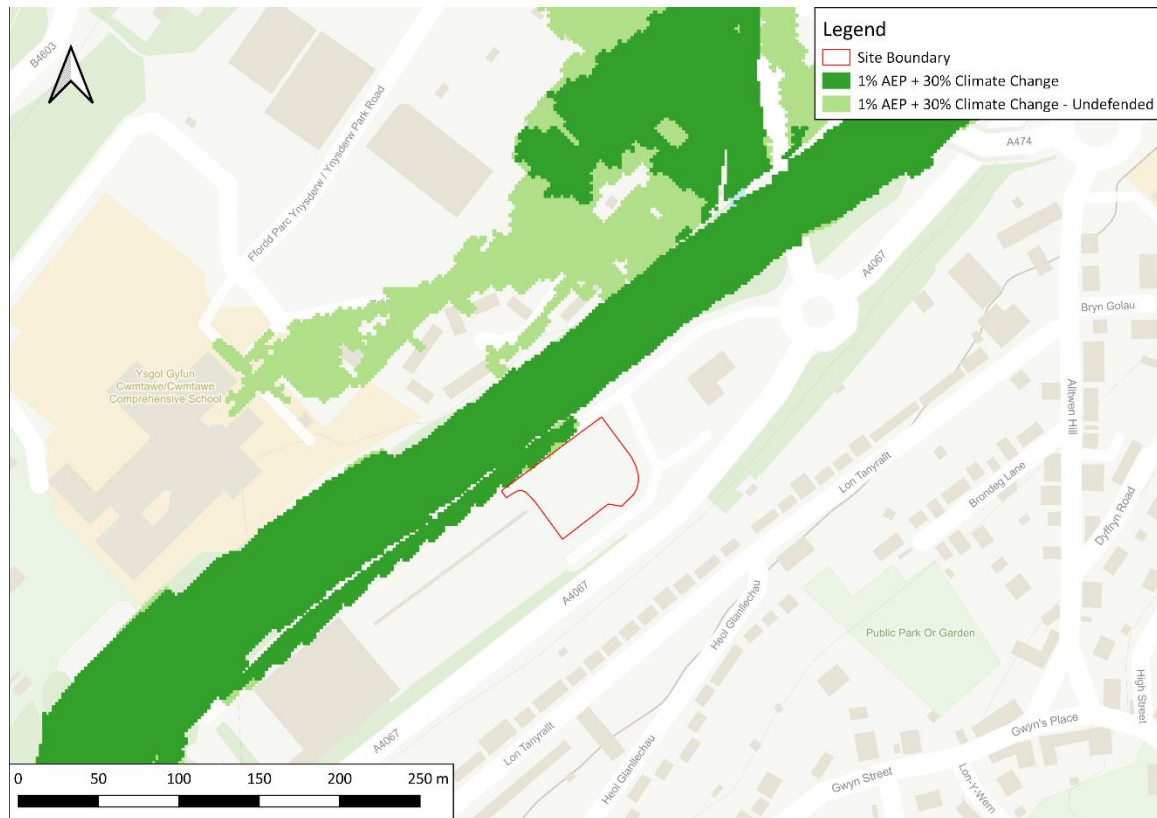


Figure 9. 100yr + 30% CC Flood Outlines - Defended and Undefended Scenarios

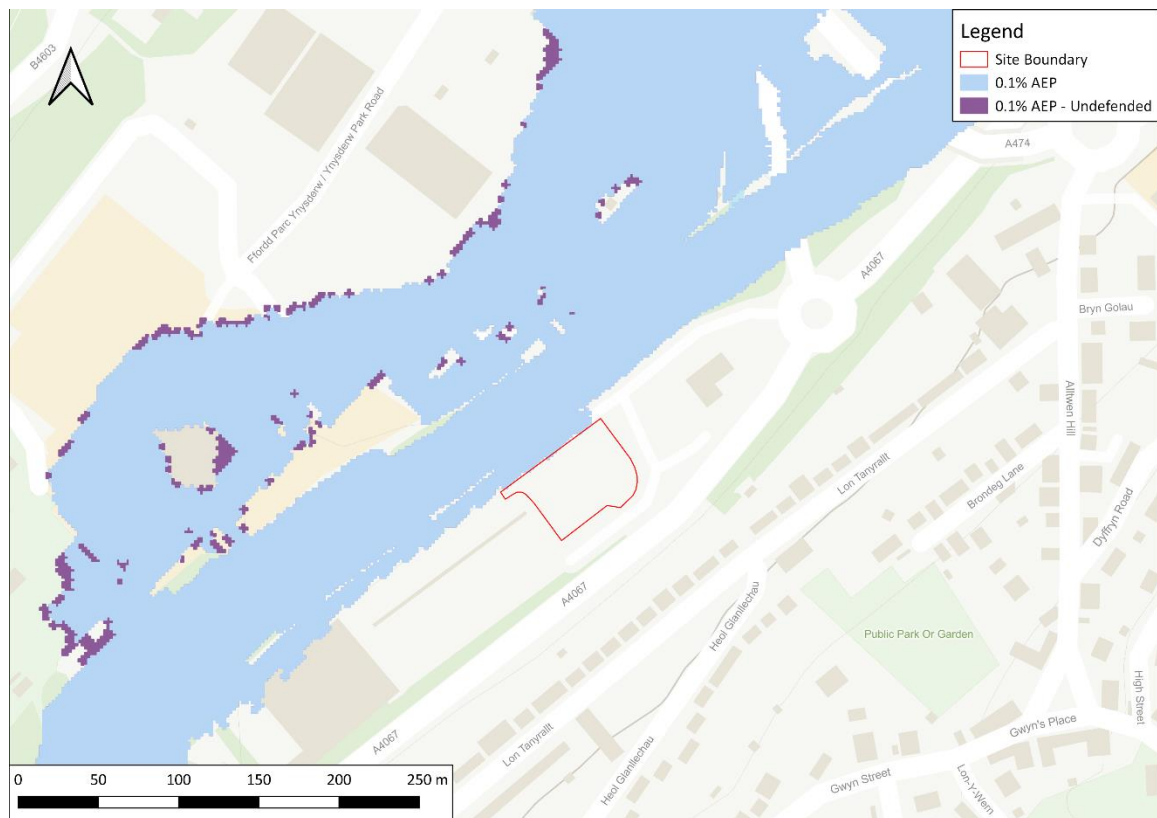


Figure 10. 1,000yr Flood Outlines - Defended and Undefended Scenarios

5.3 Summary

A detailed review and update of the 1D/2D ESTRY-TUFLOW Pontardawe Model (2015) has shown the site to remain unflooded in all modelled scenarios. There are out of bank flows in close proximity to site in all scenarios however, flood waters do not enter the site boundary. As such, the site is concluded to be at 'low' risk of fluvial flooding in current and future climate scenarios.

6. TAN 15 REQUIREMENTS

6.1 Justifying the Location of the Development

TAN 15 advises that new developments should be directed away from Zone C and towards suitable land in Zone A, otherwise to Zone B, where river or coastal flooding will be less of an issue.

This report has shown the site to be located entirely within Zone A, which is considered to be at little or no risk of fluvial or coastal / tidal flooding. Updates to the 1D/2D ESTRY-TUFLOW Pontardawe Model (2015) has confirmed the site to be at low risk of fluvial flooding, with the site remaining unflooded in all modelled scenarios. As such, the site is confirmed to be at 'low' risk of fluvial flooding. The site is at low risk of flooding from all other assessed sources.

On this basis, the justification test is not applicable in line with TAN 15 requirements.

6.2 Assessing Flood Consequences

For developments within Zone C, it is required that consequences of the development flooding must be addressed. This is not required in this instance as the proposed development lies within Zone A however, mitigation measures are outlined below in order to respond to any residual flood risk.

6.2.1 *Finished Floor Levels*

It is recommended that where possible, the ground floor thresholds are set above the adjacent ground levels by a minimum of 150mm, either by raising the floor levels above the existing ground levels or sloping ground levels away from the building. This will address any residual risks of surface water flooding (e.g., blockage of the proposed drainage network serving the site or exceedance of the drainage design capacity) by directing runoff away from the building.

6.2.2 *Flood Warning and Evacuation*

Access to the site is proposed through Tesco car park, which is connected to the wider area by an entrance off the A4067. The route is shown to be at low risk of flooding from all assessed sources and as such, safe access and egress is concluded to be possible to and from the site.

6.2.3 *Floodplain Storage*

The proposed development is at low risk of flooding and therefore lies outside of the functional floodplain. As such, it is not considered to increase flood risk within the catchment through a loss of floodplain storage, and accordingly no further mitigation measures are required in this respect.

7. SUMMARY

This Flood Consequences Assessment (FCA) has been prepared by Hydrock on behalf of McDonalds in support of a planning application for a proposed development off the A4067, Pontardawe.

A detailed assessment of flood risk has identified that the site is in Zone A, based on current NRW mapping. Updates to the 1D/2D ESTRY-TUFLOW Pontardawe Model (2015) has confirmed the site to be at 'low' risk of fluvial flooding. The site is at low risk of flooding from all other assessed sources. As such, the application of the justification test is not required.

It is recommended that where possible, FFLs are raised a minimum of 150mm above adjacent ground levels to address any residual risk of surface water flooding on site.

The site access route is shown to be at 'low' risk of flooding and as such, safe access and egress is concluded to be possible.

It has also been demonstrated that the proposed development is not considered to increase flood risk within the catchment through a loss of floodplain storage, on the basis that the development is at low risk of flooding from all assessed sources.

The report therefore demonstrates that, in respect to flood risk, the proposed development of the site:

- Is not likely to be affected by flooding.
- Is justified in the proposed location.
- Will allow the proposed development and occupants to be safe, whilst ensuring flood risk is not increased elsewhere.

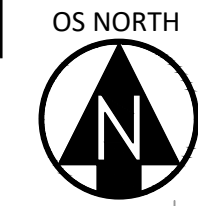
Based on the above, the application is concluded to meet the requirements of TAN 15.

Hydrock Consultants Limited

8. REFERENCES

Author	Date	Document
Neath Port Talbot County Borough Council	March 2011	Neath Port Talbot County Borough Council Preliminary Flood Risk Assessment (https://www.npt.gov.uk/media/4629/pfra_report_2011.pdf?v=20171123145433)
Neath Port Talbot County Borough Council	June 2013	Neath Port Talbot County Borough Council Local Flood Risk Management Strategy (https://www.npt.gov.uk/media/4930/lfrms_npt_local_flood_risk_management_strategy.pdf?v=20170627002244)

Appendix A - Topographic Survey



203475N

Please note: Whilst efforts have been made to accurately identify and survey all necessary features, we cannot guarantee that all features have been captured or correctly identified. All information contained within should be checked onsite prior to design work or construction work. Hydrock accepts no liability for inaccurate or misleading information shown within this drawing. Lidar data is shown in blue on layers named 3D LIDAR TRIANGLES and 3D LIDAR Contours within the CAD model - derived from a Environment agency source from 2011. Hydrock does not accept any liability for this data.

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions on are to be taken from this drawing. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

LEVEL INFORMATION

Heights in Metres
Datum : GPS controlled (OSGB36 -15)

COORDINATE INFORMATION

Values in Metres

All Coordinates are : Derived from OS (OSGB36(15)) and centered
ST01 (E- 272320.445 N- 203480.624 Z- 34.727)

COORDINATE SCHEDULE

Station	Easting	Northing	Level
ST01	272320.445	203480.624	34.727
ST02	272320.243	203566.967	32.377
ST03	272303.859	203538.497	32.005

ABBREVIATIONS

[illegible]

LF	Chain Link Fence	WPR	Wooden Post & Rail Fence
Walls			
L	Block	RW	Retaining Wall
C	Brick	W	Wall
C	Concrete		
@	Devon Bank		
IS	Dry Stone		
	Stone		

Rev	Date	Description	By	C
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Client

MCDONALDS
RESTAURANTS LIMITED

Project:
TESCO SUPERMARKET
PONTARDAWE

Project Number: 15297

Drawing title:
TOPOGRAPHICAL SURVEY

Drawn: PLS	Checked: JWH	Scale @ A0: 1:200	Drawn Date: 20/08/2021	First Issue: 20/08/2021
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Drawing Status. INFORMATION

Drawing No. 15297 - TS01 Sheet 1 of 1

Appendix B – Flood Estimation Calculation Record

Flood estimation – calculation record

Site/Project Name: McDonalds, Pontardawe

Date: 17/10/22

Introduction

This document is a supporting document to the Natural Resources Wales (NRW) Flood Estimation Technical Guidance Note V2. It provides a template for recording calculations and decisions made during flood estimation. It will often be complemented by more general hydrological information given in a project report. The information given here should be enough to enable the work to be reproduced in the future.

Note 1: Table, content or page layout can be adapted to best present relevant information. Additional rows should be added to, or removed, from tables as appropriate.

Note 2: Probability of flood occurrence is traditionally expressed within Hydrology as a Return Period, this is the average time between years with at least one larger flood. It can also be expressed as Annual Exceedance Probability (AEP), and this is often more appropriate to use when communicating with the public. Return Period has been retained within this document but can be replaced with AEP if wished.

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Approval

	Name	Qualifications	Date	Competence level
Calculations prepared by:	Zoe Nixon	MSc (Hons)	17/10/22	Graduate
Calculations checked by:	Connor Henderson	BEng (Hons)	21/10/22	Senior Consultant
Calculations approved by:	Simon Mirams	Bsc (Hons) MCIWEM C.WEM CSci	02/11/22	Technical Director BSc (Hons) MCIWEM C.WEM CSci
Competence levels: level 1 – hydrologist with minimum approved experience in flood estimation level 2 – senior hydrologist level 3 – senior hydrologist with extensive experience of flood estimation				

Abbreviations

AEP	Annual Exceedance Probability
AMAX	Annual maximum
AREA	Catchment area (km ²)
BFI	Base flow index
BFIHOST	Base flow index derived using the HOST soil classification
BFIHOST19	Base flow index derived using the revised (2019) HOST soil classification
DPLBAR	Mean drainage path length (km)

DPSBAR	Mean drainage path slope (m/km)
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FPEXT	Floodplain extent
HOST	Hydrology of soil types
NRFA	National River Flow Archive
NRW	Natural Resources Wales
POT	Peaks over a threshold
QMED	Median annual maximum flow (with Annual Exceedance Probability of 50% / return period 2 years)
ReFH	Revitalised flood hydrograph method – used for rainfall runoff method
SAAR	Standard average annual rainfall (mm)
SPR	Standard percentage run-off
SPRHOST	Standard percentage run-off derived using the HOST soil classification
Tp	Time to peak
URBAN	Flood Studies Report index of fractional urban extent
URBEXT2000	Revised index of urban extent
WINFAP	Windows Frequency Analysis Package – used for FEH statistical method

1.Method statement

1.1 Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: • purpose of study • names of river/s • location • number of calculation points (and if peak flows or hydrographs) • previous relevant calculations • availability of flood history	The purpose of this study is to review and update the hydrological modelling originally undertaken in 2015 for the 1D/2D ESTRY-TUFLOW Pontardawe Model. This was undertaken in accordance with the Natural Resources Wales (NRW) latest flood estimation technical guidance (GN 008). The model includes an approximate 5.3km reach of the River Tawe and two of its tributaries: Upper Clydach and Cwm Du. Modelling is provided for Pontardawe which is a town located in the Swansea Valley, South Wales. This study is reviewing three calculation points: • Cwm_Du_Upstream_Inflow_001 (referred to in this report as CWM) • Tawe_Upstream_Inflow_001 (referred to in this report as TAW) • Upper_Clydach_Upstream_Inflow_001 (referred to in this report as CLY) The previous peak inflows and hydrographs were provided in the relevant .csv files. This report will provide both peak flows and hydrographs for the following annual exceedance probability (AEP) events: 50%, 20%, 10%, 5%, 3.3%, 2%, 1.3%, 1%, 0.5% and 0.1%. The effects of climate change will be accounted for using the Welsh Government latest climate change allowances. An uplift of 30% (climate change / central estimate) will be

	applied to the 1% AEP peak flow estimates, based on the site's location within the wider West Wales River Basin district. Historical fluvial flooding incidents have been recorded in Pontardawe in the Neat Port Talbot Preliminary Flood Risk Assessment (PFRA) (NPTCBC, 2011). Flooding was recorded across the Tawe and Upper Clydach catchments in 1979, and from the River Tawe and the Swansea Canal in 1998 as a result of heavy rainfall which caused the canal to overtop. Historic flood outline provided by NRW will be used to sense check the hydrological and hydraulic modelling.
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1.2 Overview of catchment

Item	Comments
Brief description of catchment, including key features needing consideration or reference to section in accompanying report. Map/s should be presented here or in section 2.1 of this report.	TAW The River Tawe catchment is a large catchment (151.14km²) shown in Figure 1. The catchment is rural (URBEXT2000 = 0.017) and fairly impermeable (BFIHOST19 = 0.353, SPRHOST = 45.58). British Geological Survey (BGS) Mapping shows the site to predominantly be underlain by bedrock geology of sandstone and siltstone. Soilscape shows the catchment to be predominantly overlain by soils with impeded drainage. The catchment has a wet climate (SARR = 2023) and is steeply sloping (DPSBAR = 141.9).

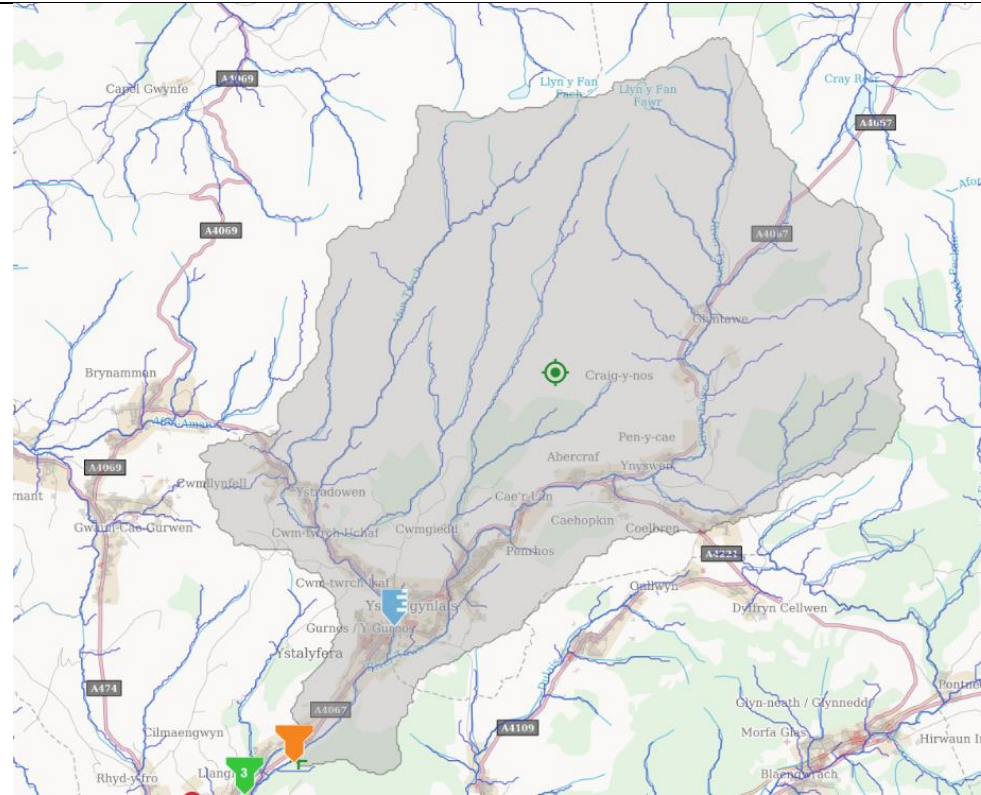


Figure 1. River Tawe FEH Catchment

CWM

The Cwm Du catchment is small (9.57km²), shown in Figure 2. The catchment is rural (URBEXT2000 = 0.001) and fairly impermeable (BFIHOST19 = 0.378, SPRHOST = 41.11). BGS Mapping shows the site to predominantly be underlain by bedrock geology of sandstone and siltstone. Soilsapes shows the catchment to be predominantly overlain by soils with impeded drainage. The catchment has a wet climate (SARR = 1715) and is steeply sloping (ASPBAR = 129).

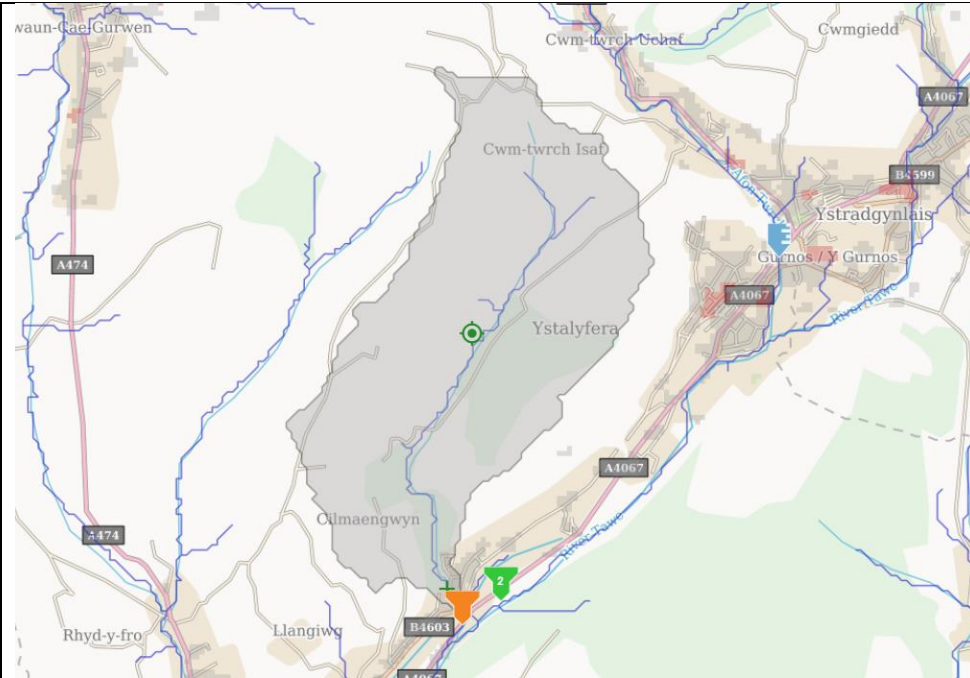


Figure 2. Cwm Du FEH Catchment

CLY

The Upper Clydach catchment is small (18.50km²), shown in Figure 3. The catchment is rural (URBEXT2000 = 0.011) and fairly impermeable (BFIHOST19 = 0.406, SPRHOST = 38.81). BGS Mapping shows the site to predominantly be underlain by bedrock geology of mudstone, sandstone and siltstone. Soilsapes shows the catchment to be overlain by a mixture of soils, some with impeded drainage and some which are freely draining. The catchment has a wet climate (SARR = 1692) and is steeply sloping (ASPBAR = 173).

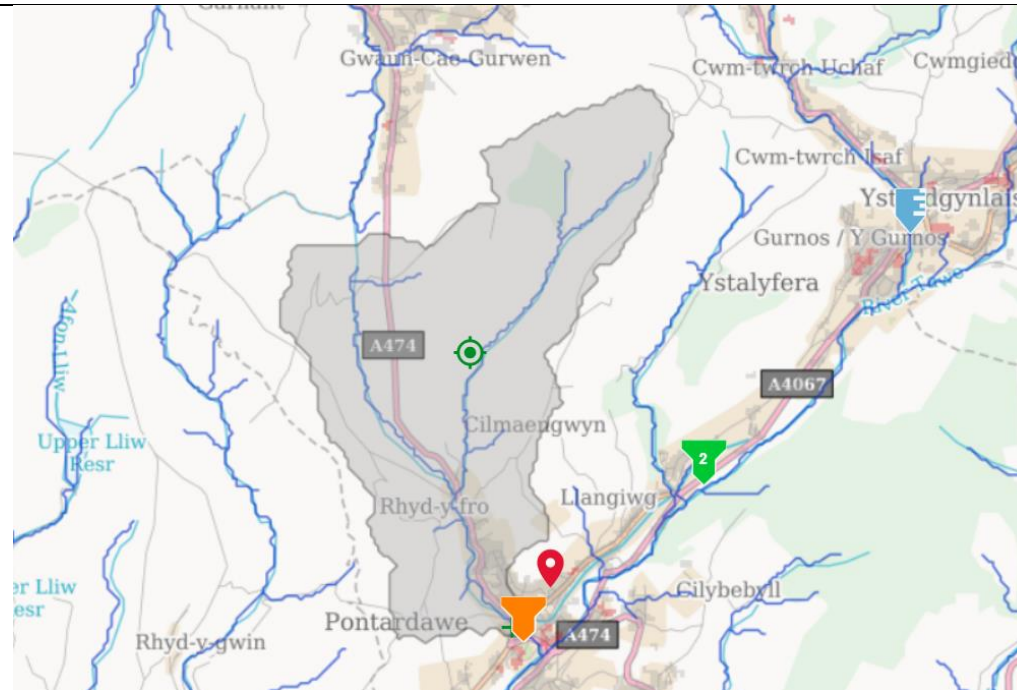


Figure 3. Upper Clydach FEH Catchment

1.3 Source of flood peak data

Item	Comments
Was the NRFA Peak Flows dataset used?	Version 11, released September 2022. This contains data up to water year 2020-21 at most sites.

1.4 Gauging stations (flow or level)

Within, or near to, the study area. Most stations will be included on National River Flow Archive (NRFA), but other station data may also be available.

Watercourse	Station name	NRFA number	Grid reference	Catchment area (km ²)	Location relative to study area (eg, within), note any significant differences in catchments (eg URBEXT)
River Twrch	Gurnos	60017	SN772092	49.9	The gauging station is located at the downstream point of the River Twrch, just north of its confluence with the River Tawe. Its confluence with the River Tawe is located approximately 3.2km upstream of the TAW inflow. The catchment is rural, with a large part of the catchment falling within the Brecon Beacons National Park.
River Tawe	Ynystanglws	59001	SS685997	9.3	The gauging station is located downstream of the site, on the River Tawe. The gauging station is located approximately 5.5km downstream of the TAW inflow. The catchment is mainly rural though has some urban and industrial development at lower levels.

1.5 Data available at each flow gauging station

Station Name	Start and end date on NRFA	Update for this study?	Suitability (Pooling/ QMED/ Neither)?	Data quality check needed?	Comments on data availability and quality e.g. use for Tp calculation, QMED calculation from daily mean flow, trends in flood peaks, outliers
Gurnos	Jan 1995 - Present	NA	Suitable for QMED but not Pooling	No	The site is 60m upstream of the old canal aqueduct and a large weir (~9m drop), which provides the hydraulic control. Flow is contained by the road embankments meaning there is no bypassing/out of bank flow. Low flow rating is calculated from spot gaugings, however the site is not maintained as a low flow station. One peak flow rating across the period of record calculated by hydraulic modelling. Sensitivity analysis shows the modelled rating is generally insensitive to parameter change, suggesting reasonably high confidence in the rating despite the absence of high flow gaugings.
Ynystanglws	October 1956 - Present	NA	Suitable for both	No	Gravel bed provides unstable control. Early record has bypassing above 2.75m not accounted for in rating. Several changes to bank levels have been made over the years: embankments and (lower) concrete side weir (right bank) to control flow to flood plain storage was built in 1973; the side weir was raised by ~1m to match embankment height in April 1998. During low flows (level below 0.448m), well intake pipe often out of water

					due to significant bed erosion. It is unclear when problem started, but results in limited low flow sensitivity; levels adjusted as necessary to be realistic though flow repetitions may occur (e.g. Aug 2006). Since Aug 2010 secondary sensor installed u/s of existing intake pipe to facilitate measurement at low water levels. Multiple peak flow ratings across period of record.
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1.6 Rating equations

Station name	Type of rating e.g. theoretical, empirical, degree of extrapolation	Rating review needed?	Reasons e.g. availability of recent flow gaugings, amount of scatter in the rating
Gurnos	Empirical – velocity-area station	No	Not within the scope of the study and gauging stations lie outside of the hydraulic model extent.
Ynystanglws	Empirical – velocity-area station	No	
Include a link or reference to any rating reviews carried out:		NA	

1.7 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data and licence reference from NRW	Details
Historic flood data – give link to historic review if carried out	Yes	No	PFRA Welsh Government Historic Flood Mapping	Historical fluvial flooding incidents have been recorded in Pontardawe in the Neat Port Talbot Preliminary Flood Risk Assessment (PFRA) (NPTCBC, 2011). Flooding was recorded across the Tawe and Upper Clydach catchments in 1979, and from the River Tawe and the Swansea Canal in 1998 as a result of heavy rainfall which caused the canal to overtop. The Welsh Government Historic Flood Mapping confirms the above-mentioned flood events in Pontardawe however, the site is not shown to have been affected in either event. Historic flood outlines will be used to sense check the hydrological and hydraulic modelling.
Flow data for events (if carrying out Tp or ReFH analysis)	NA			
Rainfall data for events (if carrying out Tp or ReFH analysis)	NA			

Type of data	Data relevant to this study?	Data available?	Source of data and licence reference from NRW	Details
Results from previous studies	Yes	Yes	1D/2D ESTRY-TUFLOW Pontardawe Model NRW Liscence: ATI23790b	Results are available from the previous hydrological assessment undertaken by JBA in 2015 which has provided peak flow estimates and hydrographs which will be compared with the results of this study.
Other data or information e.g. groundwater, tides	NA			

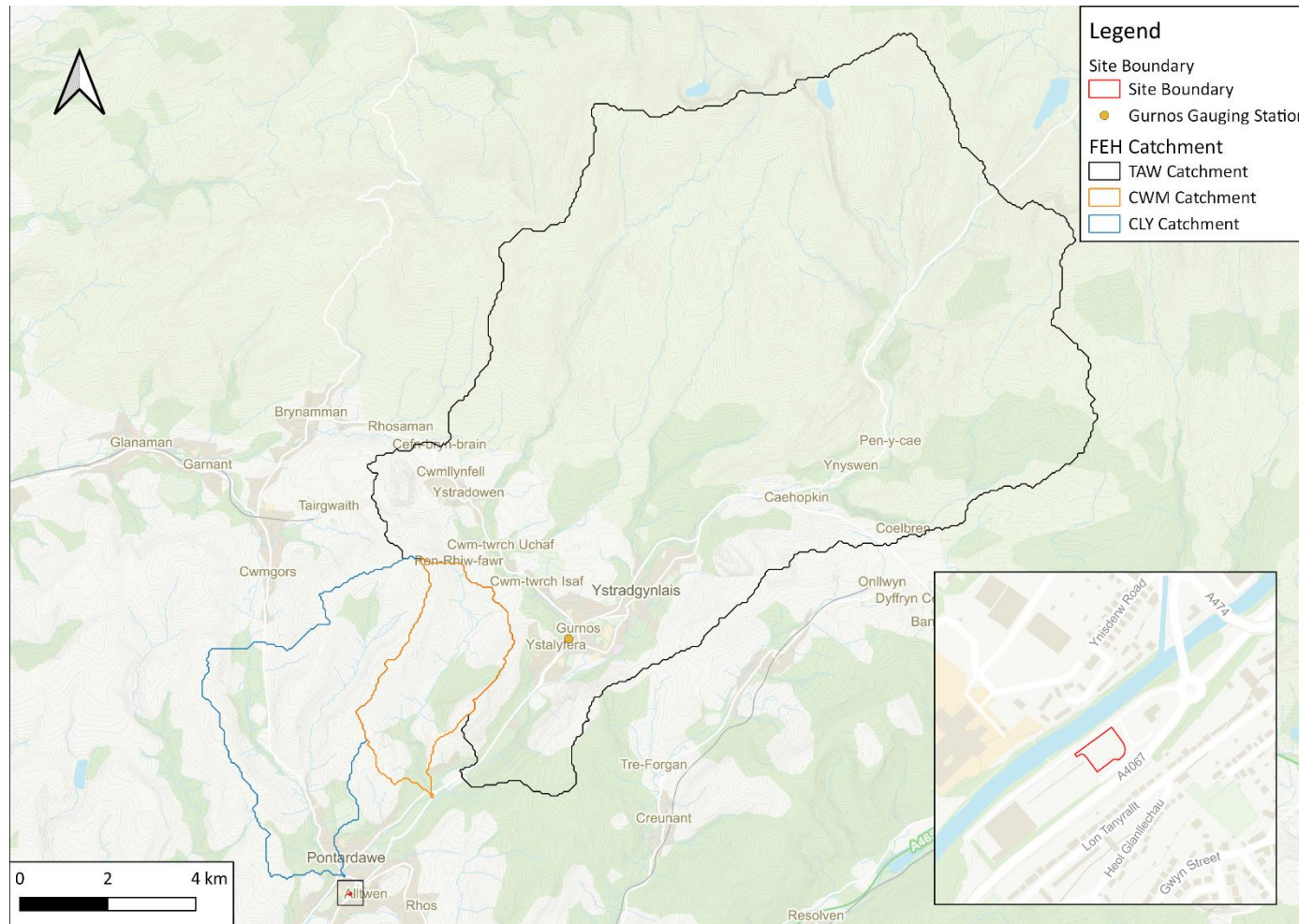
1.8 Initial choice of approach

Item	Comment
Outline the conceptual model. Address questions such as: - Where are the main sites of interest? - What is likely to cause flooding at those locations? (e.g. peak flows, flood volumes, combination of peaks, groundwater, snowmelt, tides) - Might those locations flood from runoff generated on part of the catchment only e.g. downstream of a reservoir?	The main site of interest is the proposed location of a McDonalds site. The site is predominantly at risk of fluvial flooding from the River Tawe, and canal flooding where the tributaries flow into the canal.
Any unusual catchment features to account for? e.g. highly permeable (BFIHOST > 0.65) – consider permeable catchment adjustment for statistical method if SPRHOST < 20%	The CWM and CLY are both small catchments (<40km²) and therefore the use of small catchment pooling method and guidance from the Small Catchment Phase 2 Research (SC090031) was considered.

Item	Comment
• highly urbanised – consider choice of method carefully; consider method that can account for differing sewer and topographic catchments • small catchment (<40 km²) – consider use of small catchment pooling method • pumped watercourse – consider lowland catchment version of rainfall-runoff method • major reservoir influence – consider flood routing • extensive floodplain storage – consider choice of method carefully	There is also potential for interaction between the canal and watercourses.
Initial choice of method(s) and reasons • Are FEH statistical and/or ReFH appropriate? • If not appropriate, describe why and give details of the other methods to be used. • Will the catchment be split into sub-catchments/intervening areas? If so, how will flows for intervening areas be estimated?	FEH and ReFH2 are considered appropriate for this study. Both methods were used in this study. The NRW preferred approach is to estimate peak flows up to the 1% AEP (100-year) event with the FEH Statistical Method, and to estimate peak flows for rarer events using the flood growth curve from ReFH2.
Software to be used (edit as applicable.)	WINFAP [v 5.0.7947 (29986)] ReFH2 [3.2.7650]

2. Locations where flood estimates are required

2.1 Map of study area, including subject site(s) and gauging stations (where applicable).



2.2 Summary of subject sites

The table below lists the locations of subject sites. Use site codes in all subsequent tables to save space.

Site code	Watercourse	Site Name (description)	Easting	Northing	AREA on FEH Web Service (km ²)	Revised AREA if altered (km ²)	Peak flow, hydrograph or both required?
TAW	River Tawe	River Tawe Upstream	274900	206100	151.4	NA	Both
CWM	Cwm Du	Cwm Du Upstream	274150	205700	9.57	NA	Both
CLY	Upper Clydach	Upper Clydach Upstream	272150	203900	18.5	NA	Both

2.3 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	AREA (km ²)	BFIHOST	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	FARL	FPEXT	PROPWET	SAAR (mm)	URBEXT 2000
TAW	151.4	0.374	0.353	15.52	141.9	0.994	0.043	0.62	2023	0.0172
CWM	9.57	0.397	0.378	4.14	142.8	1	0.0347	0.62	1715	0.0014
CLY	18.5	0.444	0.406	5.41	156.8	0.997	0.0201	0.62	1692	0.0105

2.4 Checking catchment descriptors

Item	Comment
Record how catchment boundary was checked • describe any changes • refer to maps if needed	The AREA values of the catchments were checked using OS contour mapping and available LiDAR data. This exercise identified little difference between the FEH catchments and those identified using topographical information. In addition, no obvious cross-catchment flows from watercourses, land drainage ditches, or sewer networks were identified, and as such, the Catchment Descriptors AREA values remain appropriate and were used in these calculations.
Record how other catchment descriptors were checked, especially soils • describe any changes • include a before and after table if necessary	The SPRHOST values were checked using available soil mapping information. This information confirmed that the majority of the TAW and CWM catchments are predominantly overlain by soils with impeded drainage. The CLY catchment is overlain by a mixture of soils, some with impeded drainage and some which are freely draining. This suggests that the underlying ground conditions are relatively impermeable, and as such, the SPRHOST values are considered acceptable.
Method for updating URBEXT / URBAN • Refer to WINFAP Urban Adjustment procedures/guidance	The URBEXT2000 values were checked using the latest OS and aerial mapping, and compared with the FEH Urban Extent 2000 mapping layer. Based on available mapping, no areas of recent development were identified, and as such, the Catchment Descriptors URBEXT2000 value is considered appropriate for all catchments.

3. Statistical method

3.1 Search for donor gauging stations for QMED

Note that donor catchments will usually be rural but may be urban provided the data is deurbanised prior to the adjustment process. Include a map if necessary.

Comment on potential donor sites Mention: • distance from subject site (based on catchment centroid) • whether they are on the same, adjacent or nearby watercourse • features which may impact applicability, eg FARL • quality of flood peak data • length of record	TAW The potential donor gauging stations for QMED are located between 3.7km and 19.2km from the subject site. The Twrch @ Gurnos is located upstream of the subject site on a tributary of the River Tawe, and the Tawe @ Ynystanglws is located downstream of the subject site on the River Tawe. The potential donors were reviewed and all stations have FARL values > 0.9, like the subject site catchment. All potential donors were within +/- 30% of the subject site's SAAR value. Three of the potential donors (Usk @ Trallong, Rhondda Fawr @ Tynewydd and Loughor @ Tir-y-dai) were outside of +/- 20% of the subject site's BFIHOST19 value and were therefore rejected. The potential donors have between 20 and 54 years of data. Three donor stations were selected for QMED estimation – one located on the River Tawe, one on an upstream tributary and the next closest donor. Selecting six donor stations is generally recommended for large catchments however given there are two donors in close proximity to the site and on the same watercourse/tributary to the watercourse, it was considered that three donors are of sufficient quality and proximity to the subject site. CWM The potential donor gauging stations for QMED are located between 4.94km and 24.15km from the subject site. The Twrch @ Gurnos is located on a tributary of the River Tawe, and the Tawe @ Ynystanglws is located downstream of the subject site on the River Tawe. The potential donors were reviewed and all stations have FARL values > 0.9, like the subject site catchment. The Rhondda Fawr @ Tynewydd is outside of +/- 30% of the subject site's SAAR value and was therefore rejected. Two of the potential donors (Rhondda Fawr @ Tynewydd and Melte @ Pontneddfechan) were outside of +/- 20% of the subject site's BFIHOST19 value and were therefore rejected. The potential donors have between 20 and 54 years of data. Small catchment recommendations were used as default.
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	CLY The potential donor gauging stations for QMED are located between 7.66km and 26.61km from the subject site. The Twrch @ Gurnos is located on a tributary of the River Taw, and the Tawe @ Ynystanglws is located downstream of the subject site on the River Taw. The potential donors were reviewed and all stations have FARL values > 0.9, like the subject site catchment. The Rhondda Fawr @ Tynewydd is outside of +/- 30% of the subject site's SAAR value and was therefore rejected. Two of the potential donors (Rhondda Fawr @ Tynewydd and Melte @ Pontneddfechan) were outside of +/- 20% of the subject site's BFIHOST19 value and were therefore rejected. The potential donors have between 20 and 54 years of data. Small catchment recommendations were used as default.
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3.2 Donor stations and QMED adjustment factors

If using WINFAP3 great caution should be taken in urban catchments that are also highly permeable (BFIHOST>0.65). Further details are provided in the EA Flood Estimation Guidelines.

TAW

Station Name	NRFA station number	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged) (m ³ /s)	QMED from flow data with urban influence removed (A) (m ³ /s)	QMEDrural from catchment descriptors (B) (m ³ /s)	Adjustment ratio (A/B)
Twrch @ Gurnos	60017	Chosen due to its location on an upstream tributary of the River Taw, and its hydrologically similar characteristics	27	72.3	71.518	59.86	1.19

Station Name	NRFA station number	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged) (m ³ /s)	QMED from flow data with urban influence removed (A) (m ³ /s)	QMEDrural from catchment descriptors (B) (m ³ /s)	Adjustment ratio (A/B)
Tawe @ Ynstanglws	59001	Chosen due to its location on the same watercourse as the subject site, and its hydrologically similar characteristics	47	257.2	251.455	195.735	1.28
Dulais @ Cilfrew	58008	Chosen due to its hydrologically similar characteristics	49	58.78	57.820	49.25	1.17

CWM

Station Name	NRFA station number	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged) (m ³ /s)	QMED from flow data with urban influence removed (A) (m ³ /s)	QMEDrural from catchment descriptors (B) (m ³ /s)	Adjustment ratio (A/B)
Tawe @ Ynstanglws	59001	The Small Catchment Phase 2 Research (SC090031) recommends that for catchments under	47	257.2	251.455	195.735	1.28

Station Name	NRFA station number	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged) (m ³ /s)	QMED from flow data with urban influence removed (A) (m ³ /s)	QMEDrural from catchment descriptors (B) (m ³ /s)	Adjustment ratio (A/B)
		25km ² , the single closest donor should be used. This donor has hydrologically similar characteristics (SARR, BFIHOST19, FARL).					

CLY

Station Name	NRFA station number	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged) (m ³ /s)	QMED from flow data with urban influence removed (A) (m ³ /s)	QMEDrural from catchment descriptors (B) (m ³ /s)	Adjustment ratio (A/B)
Tawe @ Ynstanglws	59001	The Small Catchment Phase 2 Research (SC090031) recommends that for catchments under 25km ² , the single closest donor should be used. This donor has hydrologically	47	257.2	251.455	195.735	1.28

Station Name	NRFA station number	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged) (m ³ /s)	QMED from flow data with urban influence removed (A) (m ³ /s)	QMEDrural from catchment descriptors (B) (m ³ /s)	Adjustment ratio (A/B)
		similar characteristics (SARR, BFIHOST19, FARL).					

3.3 Overview of estimation of QMED at each subject site

Notes for completing this table

- Methods
 - CD: catchment descriptors alone
 - DT: data transfer
 - BCW: catchment descriptors and bankfull channel width
 - FV: flow variability (using flow duration statistics)
- Urban adjustment procedures should be applied regardless of whether the subject site is rural or urban.
- If using WINFAP3, great caution should be taken in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.65).
- The data transfer procedure is from Science Report SC050050. The QMED adjustment factor A/B for each donor site is given in Table 3.2. This is moderated using the power term, a , which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial estimate from catchment descriptors.
- If more than one donor has been used, use multiple rows for the site and give the weights used in the averaging. Record the weighted average adjustment factor in the table.

				Data transfer		
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Site code	QMEDrural from CDs (m ³ /s)	Method	NRFA numbers for donor site/s used (see 3.2)	Distance between centroids d _{ij} (km)		Moderated QMED adjustment factor (A/B) ^a	If more than one donor		Final estimate of QMEDrural (m ³ /s)	Final estimate of QMEDurban (m ³ /s)
					Power term a		Weight (if WINFAP4 (or later versions) method not used)	Weighted average QMED adjustment factor		
TAW	157.125	DT	60017	3.70		1.155	NA	0.519	181.487	184.341
			59001	4.57				0.480		
			58008	8.73				0.394		
CMW	12.268	DT	59001	4.94		1.124	NA	0.467	13.792	13.801
CLY	19.586	DT	59001	7.66		1.108	NA	0.408	21.695	21.921
Has the Kjeldsen (2014) urban adjustment method (as used in WINFAP4 or later versions) been applied? If not, why?					Yes					
How are the weights derived?					WINAP5					
Are the values of QMED and QMED adjustment factors consistent, for example at successive points along the watercourse and at confluences?					NA					

3.4 Derivation of pooling groups

- Several subject sites may use the same pooling group.
- The composition of pooling groups should be presented in the Annex.
- If Single Site (with or without flood history) was used, add 'N/a' to the last column.

Name of pooling group	Site code from which pooling group was derived	Site codes to which it is applied	Method: Single Site / with History, Enhanced Single Site or Pooled / Small Catchment Pooled? Include reasons for choice of method	Changes made to default pooling group, with reasons. Include any sites that were investigated but retained in the group
River Tawe	TAW	TAW	Pooled	The pooling group was reviewed by checking the L-Skew values, discordancy and flood-frequency curves of the stations. All stations were considered appropriate and the group was shown to be acceptably homogeneous ($H2 = 0.64$). As such, the initial pooling group was accepted.
Cwm Du	CWM	CWM	Pooled	The pooling group was reviewed by checking the L-Skew values, discordancy and flood-frequency curves of the stations. All stations were considered appropriate and the group was shown to be possibly heterogeneous although within the allowable range ($H2 = 1.22$). As such, the initial pooling group was accepted.
Upper Clydach	CLY	CLY	Pooled	The pooling group was reviewed by checking the L-Skew values, discordancy and flood-frequency curves of the stations. All stations were considered appropriate and the group was shown to be acceptably

				homogeneous ($H2 = -0.38$). As such, the initial pooling group was accepted.
URBEXT2000 threshold used to create pooling group(s). Have pooling group growth curves been deurbanised?				0.03

3.5 Derivation of flood growth curves at subject sites

- A pooling group derived at one location can be applied to estimate growth curves at several ungauged sites. However, each site may have a different urban adjustment, and therefore different growth curve parameters.
- Urban adjustments to growth curves should use the latest methodologies in WINFAP
- Any relevant frequency plots from WINFAP, particularly showing any comparisons between single-site and pooled growth curves (including flood peak data on the plot) should be shown here or in an Appendix.

Site code	Pooling group name	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Growth factor for 100-year return period event
TAW	River Taw	Kappa 3 – Best fit	NA	2.247
CWM	Cwm Du	Gen. Logistic – Best fit	NA	2.585
CLY	Upper Clydach	Gen. Logistic – Best fit	NA	2.655

3.6 Flood estimates from the statistical method

	Flood peak (m ³ /s) for the following return periods (in years)									
Site code	2	5	10	20	30	50	75	100	200	1000
TAW	184.314	237.259	274.825	313.649	337.425	368.781	394.925	414.208	463.380	594.366
CWM	13.810	18.251	21.560	25.186	27.522	30.742	33.551	35.695	41.443	58.702
CLY	21.921	29.162	34.607	40.613	44.500	49.880	54.592	58.199	67.908	97.353

4.Revitalised flood hydrograph (ReFH) method for peak flow estimation

This section records calculations for peak flow estimates, if different calculations are subsequently made for hydrographs for modelling, details should be recorded in section 5.

4.1 Parameters for ReFH model for peak flow estimation

If parameters are all estimated from catchment descriptors, they are easily reproducible, so it is not essential to record them here –Just enter ‘all’ under site code and ‘Catchment descriptors’ under method. Where values have been calculated from local data, include catchment descriptor values in brackets, or additional columns.

Site code	Details of method Catchment descriptors Tp data transfer Optimisation (Calibration Utility)	Tp (hours) Time to peak	C _{max} (mm) maximum storage capacity	BL (hours) baseflow lag	BR baseflow recharge
TAW	Catchment Descriptors	3.3	245.65	37.38	0.91
CWM	Catchment Descriptors	1.54	262.14	29.21	1.27
CLY	Catchment Descriptors	1.75	281.91	32.34	1.53
Brief description of any flood event analysis carried out Provide further details either here or give reference to location of documentation		NA			

4.2 Design events for ReFH method for peak flow estimation

Refer to Guidance for latest research regarding choice of summer or winter season based on URBEXT2000, BFIHOST and SAAR. Where values have been calculated from local data, include catchment descriptor values in brackets or additional columns.

Site code	Season of design event (summer or winter)	Recommended Storm duration (hours)	Storm area for ARF (if not catchment area)	Record any adjustment to default parameters
TAW	Winter	9:30	0.91	
CWM	Winter	4:15	0.95	
CLY	Winter	4:45	0.94	
Source of design rainfall statistic (FEH13 or FEH99). If FEH99 has been used provide justification:				

4.3 Peak flow estimates from the ReFH method

Catchment descriptors

		Flood peak (m ³ /s) for the following return periods (in years)										
Site code	Urban/ rural?	2	5	10	20	30	50	75	100	200	1000	100: 1000 ratio

TAW	Urban	150.23	191.03	219.22	247.37	264.80	287.72	307.20	321.94	361.79	501.43	0.64
CWM	Urban	9.71	12.68	14.77	16.88	18.20	19.91	21.37	22.47	25.55	37.49	0.60
CLY	Urban	16.12	20.86	24.12	27.52	29.56	32.28	34.63	36.43	41.42	61.13	0.60

4.4 Calibrated (where relevant)

		Flood peak (m ³ /s) for the following return periods (in years)										
Site code	Urban/ rural?	2	5	10	20	30	50	75	100	200	1000	100: 1000 ratio
NA												

How do peak flows compare to statistical estimates. If catchment descriptor and calibrated calculations were made, which ReFH estimates are preferred and why	The Statistical estimates are significantly larger than the ReFH estimates.
---	---

5.Revitalised flood hydrograph (ReFH) method for model inflow hydrographs

5.1 Parameters for ReFH model for model inflow hydrographs

This section records calculations for model inflow hydrographs, parameters may have been calibrated and storm durations changed.

If parameters are all estimated from catchment descriptors, they are easily reproducible, so it is not essential to record them here –Just enter ‘all’ under site code and ‘Catchment descriptors’ under method. Table can be amended as needed.

Site code	Details of method Catchment descriptors Tp data transfer Optimisation (Calibration Utility)	Tp (hours) Time to peak	C _{max} (mm) maximum storage capacity	BL (hours) baseflow lag	BR baseflow recharge
TAW	Catchment Descriptors	3.3	245.65	37.38	0.91
CWM	Catchment Descriptors – duration changed	1.54	262.14	29.21	1.15
CLY	Catchment Descriptors – duration changed	1.75	281.91	32.34	1.41
Brief description of any flood event analysis carried out Provide further details either here or give reference to location of documentation					

5.2 Design events for ReFH method for model inflow hydrographs

Refer to Guidance for latest research regarding choice of summer or winter season based on URBEXT2000, BFIHOST and SAAR.

Storm duration (hours)	ARF	Source of Storm Duration and ARF	Why Chosen
9:30	0.91	TAW recommended values	The duration of the storm from the TAW catchment was used as this is the dominant catchment. This is in-line with the 2015 Model which used a duration of 9.5 hours using the ReFH calibrated data from Ynystanglws.
Where hydrographs scaled to alternative peak flow estimates? If so, give details			NA

Provide link/reference to location of hydrographs or provide in appendix	G:\TUFLOW Storage-WIP\C - 15297 - McDonalds, Pontardawe\TUFLOW\bc_dbase\R002
--	--

6.Final Peak Flow and Hydrograph Estimates

6.1 Comparison of peak flow estimates from different methods

This table compares peak flows from the ReFH method, FEH Statistical method and any available previous study at each site for two key return periods. Note and explain any significant difference from previous studies.

	QMED (2-year return period)				100-year return period			
Site code	Statistical	ReFH	Previous Study	Comment	Statistical	ReFH	Previous Study	Comment
TAW	184.314	150.23	203.97		414.208	321.94	432.01	
CWM	13.810	9.71	13.78		35.695	22.47	40.69	
CLY	21.921	16.12	21.03		58.199	36.43	64.68	

6.2 Final Peak Flow Estimates

	Flood peak (m ³ /s) for the following return periods (in years)									
Site code	2	5	10	20	30	50	75	100	200	1000
TAW	184.314	237.259	274.825	313.649	337.425	368.781	394.925	414.208	465.479	645.140
CWM	13.810	18.251	21.560	25.186	27.522	30.742	33.551	35.695	40.588	59.555

CLY	21.921	29.162	34.607	40.613	44.500	49.880	54.592	58.199	66.171	97.659
-----	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Choice of method and reasons Include reference to type of study, nature of catchment, and type of data available	In-line with NRW Guidance (GN 008), the preferred approach of estimating peak flows up to and including the 1% AEP (100-year) event using the FEH Statistical Method was used. This provided larger flows and therefore also reduces the risk of under-estimating peak flows. NRW guidance also states that ' <i>peak flows for rarer events should be estimated using the flood growth curve from ReFH2 applied to the 1% AEP estimate</i> '. This guidance was followed for the 200 and 1,000-year events.
--	--

6.3 Hydrographs for Modelling

How were these calculated, for example by scaling ReFH hydrographs to final flow estimates? include link/reference to hydrographs.	The hydrographs were calculated using the Flood Modeller and scaling FEH hydrographs to fit a peak, using the flows calculated in this study.
---	---

How will flows be applied in the model. If intervening areas are used, will hydrographs be adjusted to better match downstream flows, or will best estimate inflows be used and resulting downstream flows accepted?	The flows will be applied in the model using 1d_bc points at the upstream extents of the modelled watercourses.
---	---

6.4 Checks

Are the results consistent, for example at confluences?	NA
What do the results imply regarding the return periods of floods during the period of record?	No recorded gauge data at the site of interest.
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 – 4.0)	For the final flows (FEH Statistical) the 100-year growth factor is: TAW – 2.247 CWM – 2.585 CLY – 2.655 This is within the typical range and is therefore considered realistic.
If 1000-year flows have been derived, what is the range of ratios for the 1000-year flow over 100-year flow?	The 1,000-year flows were derived by applying the growth curve calculated using ReFH2 to the 100-year peak flows calculated using the Statistical Method. The ratio of the 1000-year flow over the 100-year flow for the final peak flows is: TAW – 1.558 CWM – 1.668 CLY – 1.678
What is the range of specific runoffs (l/s/ha)? Are there any inconsistencies?	NA

How did the results compare with those of other studies? Explain any differences and conclude which results should be preferred	This study provided lower estimates than those previously used in the 2015 model. These results should be preferred due to the updated data, methodology and software used in this study.
Are the results compatible with the longer-term flood history?	NA
Describe any other checks on the results	The results of the hydraulic model will be sense checked against recorded flood outlines.

6.5 Assumptions, limitations, and uncertainty

List the main assumptions made specific to the study	• The pooling group used to produce the growth curve in the FEH Statistical Method is representative of the study catchments. This may not be the case for the two smaller catchments which are less represented in the dataset. • The storm duration is appropriate – the previous hydrological study adjusted the storm durations using the ReFH calibrated data from Ynystanglws for the River Tawe node. This is assumed to be appropriate – calculations have not been provided.
Discuss any particular limitations For example, applying methods outside the range of catchment types for which they were developed	• It is not preferable to apply the FEH Statistical method beyond the 1% AEP event. As such, the growth curve from ReFH2 has been applied to the Statistical method 1% AEP peak flow in order to mitigate this issue.

	There is no gauged data or historic flooding information available at the site and therefore, calibration of peak flows is not possible.
Give what information you can on uncertainty in the results For example, using the methods detailed in 'Making better use of local and historic data, and estimating uncertainty in FEH design flood estimation (FEH Local) SC130009	In the FEH Statistical Method, uncertainty arises from uncertainty in the estimation of the index flood, estimation of the growth curve, and the covariance between the two. In line with best practice, data transfer from local gauged donor catchments has been used to reduce the uncertainty associated with estimates of QMED obtained using regression relationships (catchment descriptors alone). The degree of uncertainty in the FEH Statistical Method increases for design flows for longer return periods. As such, the ReFH2 growth curve was applied for peak flows above the 1% AEP event. It is difficult to estimate the uncertainty of design flood estimates produced by ReFH2.
Comment on the suitability of the results for future studies For example, at nearby locations or for different purposes	It is recommended that a review of these results is undertaken if peak flows and hydrographs are required for a different purpose.
Give any other comments on the study For example, suggestions for additional work	NA

Annex – supporting information

Please include details of your pooling group(s)

Pooling group composition

TAW

AM Data		Catchment Descriptors							
	Station	Distance (SDM)	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Discordancy
1	58002 (Neath @ Resolven)	0.340	43	224.000	0.172	0.173	0.301	0.298	1.158
2	79004 (Scar Water @ Capenoch)	0.443	58	140.424	0.122	0.122	0.152	0.152	1.417
3	72015 (Lune @ Lunes Bridge)	0.445	42	198.900	0.153	0.154	0.110	0.110	1.579
4	55026 (Wye @ Ddol Farm)	0.446	52	115.158	0.169	0.169	0.122	0.122	0.409
5	73012 (Kent @ Victoria Bridge)	0.496	42	144.086	0.202	0.203	0.259	0.258	0.346
6	56006 (Usk @ Trallong)	0.503	44	163.600	0.200	0.200	0.183	0.183	1.077
7	60006 (Gwili @ Glangwili)	0.510	53	83.080	0.175	0.176	0.158	0.158	0.324
8	75009 (Greta @ Low Briery)	0.543	45	110.942	0.243	0.243	0.306	0.306	1.300
9	59001 (Tawe @ Ynystanglws)	0.592	47	257.200	0.131	0.133	0.228	0.223	0.915
10	81003 (Luce @ Airyhemming)	0.625	55	132.001	0.132	0.132	0.109	0.109	0.622
11	76004 (Lowther @ Eamont Bridge)	0.635	59	114.406	0.239	0.239	0.168	0.168	1.852
12									
13									
14									
15									

CWM

AM Data

Catchment Descriptors

	Station	Distance (SDM)	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Discordancy
1	71003 (Croasdale Beck @ Croasdale Flu	0.281	37	10.900	0.212	0.212	0.323	0.323	0.358
2	206006 (Annalong @ Recorder)	0.326	48	15.330	0.189	0.189	0.052	0.052	2.204
3	25003 (Trout Beck @ Moor House)	0.331	48	15.142	0.167	0.167	0.291	0.291	0.608
4	106002 (Laxdale @ Laxdale)	0.439	14	17.199	0.097	0.097	0.160	0.160	2.115
5	25011 (Langdon Beck @ Langdon)	0.510	35	15.647	0.226	0.226	0.324	0.324	0.891
6	47022 (Tory Brook @ Newnham Park)	0.635	26	6.649	0.250	0.252	0.149	0.146	1.744
7	49003 (De Lank @ De Lank)	0.661	55	13.671	0.213	0.213	0.165	0.165	0.457
8	28033 (Dove @ Hollinsclough)	0.710	46	4.138	0.223	0.223	0.379	0.379	1.120
9	48009 (St Neot @ Craigshill Wood)	0.782	12	8.465	0.245	0.245	0.373	0.372	0.727
10	25012 (Harwood Beck @ Harwood)	0.784	52	33.426	0.184	0.184	0.223	0.223	0.426
11	27032 (Hebden Beck @ Hebden)	0.843	53	4.052	0.197	0.197	0.202	0.202	0.239
12	46005 (East Dart @ Bellever)	0.880	57	40.116	0.153	0.153	0.047	0.047	1.123
13	48004 (Warleggan @ Trengoffe)	0.911	52	9.957	0.252	0.252	0.258	0.257	0.986
14									
15									
16									
17									

CLY

AM Data Catchment Descriptors									
	Station	Distance (SDM)	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Discordancy
1	49003 (De Lank @ De Lank)	0.165	55	13.671	0.213	0.213	0.165	0.165	1.599
2	206006 (Annalong @ Recorder)	0.197	48	15.330	0.189	0.189	0.052	0.052	2.125
3	25012 (Harwood Beck @ Harwood)	0.302	52	33.426	0.184	0.184	0.223	0.223	0.810
4	48009 (St Neot @ Craigshill Wood)	0.367	12	8.465	0.245	0.245	0.373	0.372	1.037
5	27032 (Hebden Beck @ Hebden)	0.498	53	4.052	0.197	0.197	0.202	0.202	0.278
6	25011 (Langdon Beck @ Langdon)	0.509	35	15.647	0.226	0.226	0.324	0.324	0.949
7	25003 (Trout Beck @ Moor House)	0.512	48	15.142	0.167	0.167	0.291	0.291	1.483
8	48004 (Warleggan @ Trengoffe)	0.515	52	9.957	0.252	0.252	0.258	0.257	1.429
9	71003 (Croasdale Beck @ Croasdale Flu	0.529	37	10.900	0.212	0.212	0.323	0.323	0.704
10	48001 (Fowey @ Trekeivesteps)	0.550	52	17.330	0.216	0.216	0.276	0.275	0.064
11	21017 (Eltrick Water @ Brockhoperig)	0.587	56	59.753	0.175	0.175	0.220	0.220	0.521
12									
13									
14									
15									

Additional supporting information

References

Author	Date	Document
Neath Port Talbot County Borough Council	March 2011	Neath Port Talbot Preliminary Flood Risk Assessment

		(https://www.npt.gov.uk/media/4629/pfra_report_2011.pdf?v=20171123145433)
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Appendix C - Hydraulic Model Results



Notes

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Legend

Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- > 1.25

REVISIONS

P01

P01	FIRST ISSUE EXAMPLE			
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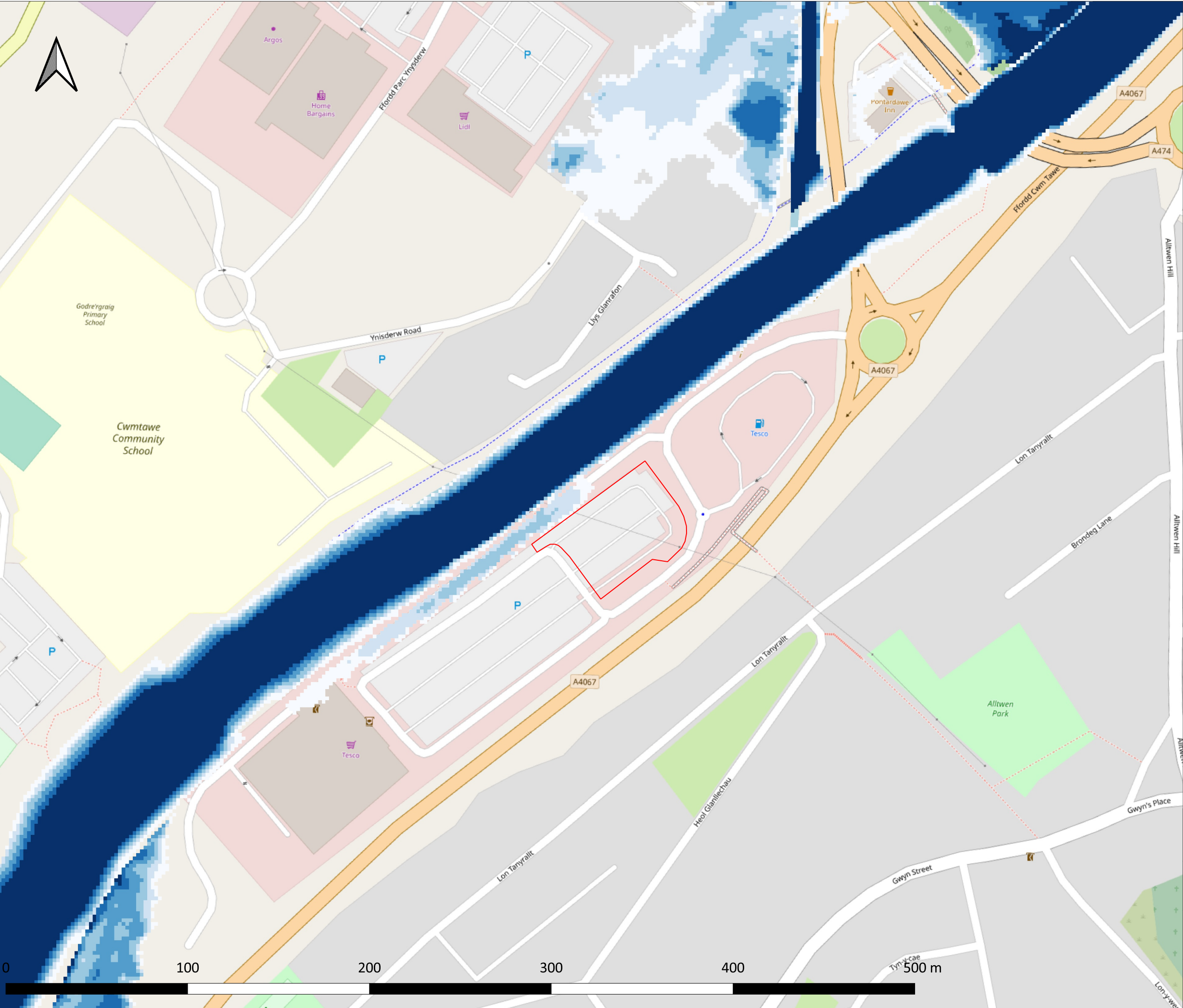
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1 IN 30 YEAR FLOOD DEPTHS

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Legend

Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- > 1.25

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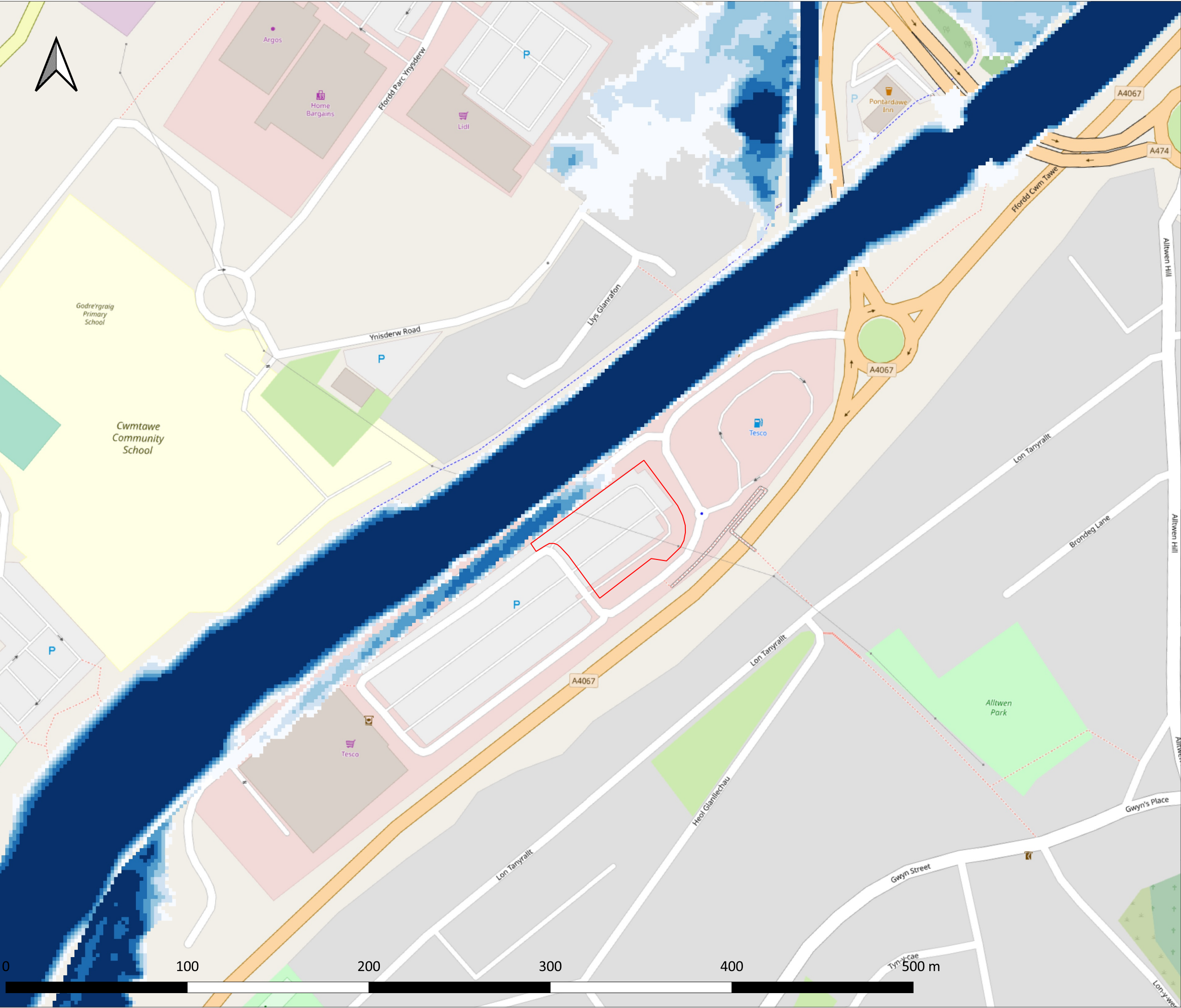
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1 IN 100 YEAR FLOOD DEPTHS

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Legend

Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- > 1.25

REVISIONS

P01

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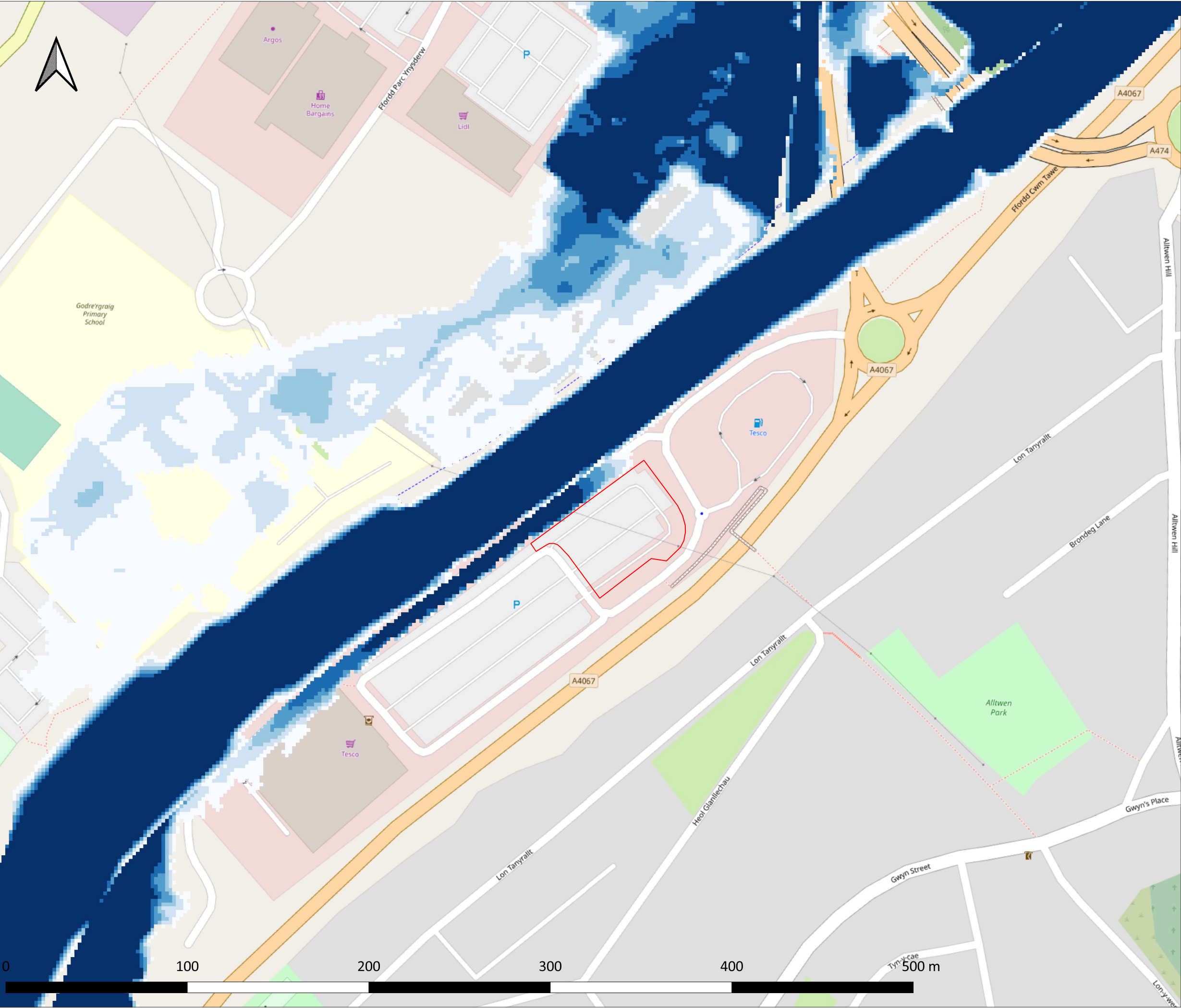
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1 IN 100 YEAR + 30% CC FLOOD DEPTHS

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Notes

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Legend

Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- > 1.25

REVISIONS

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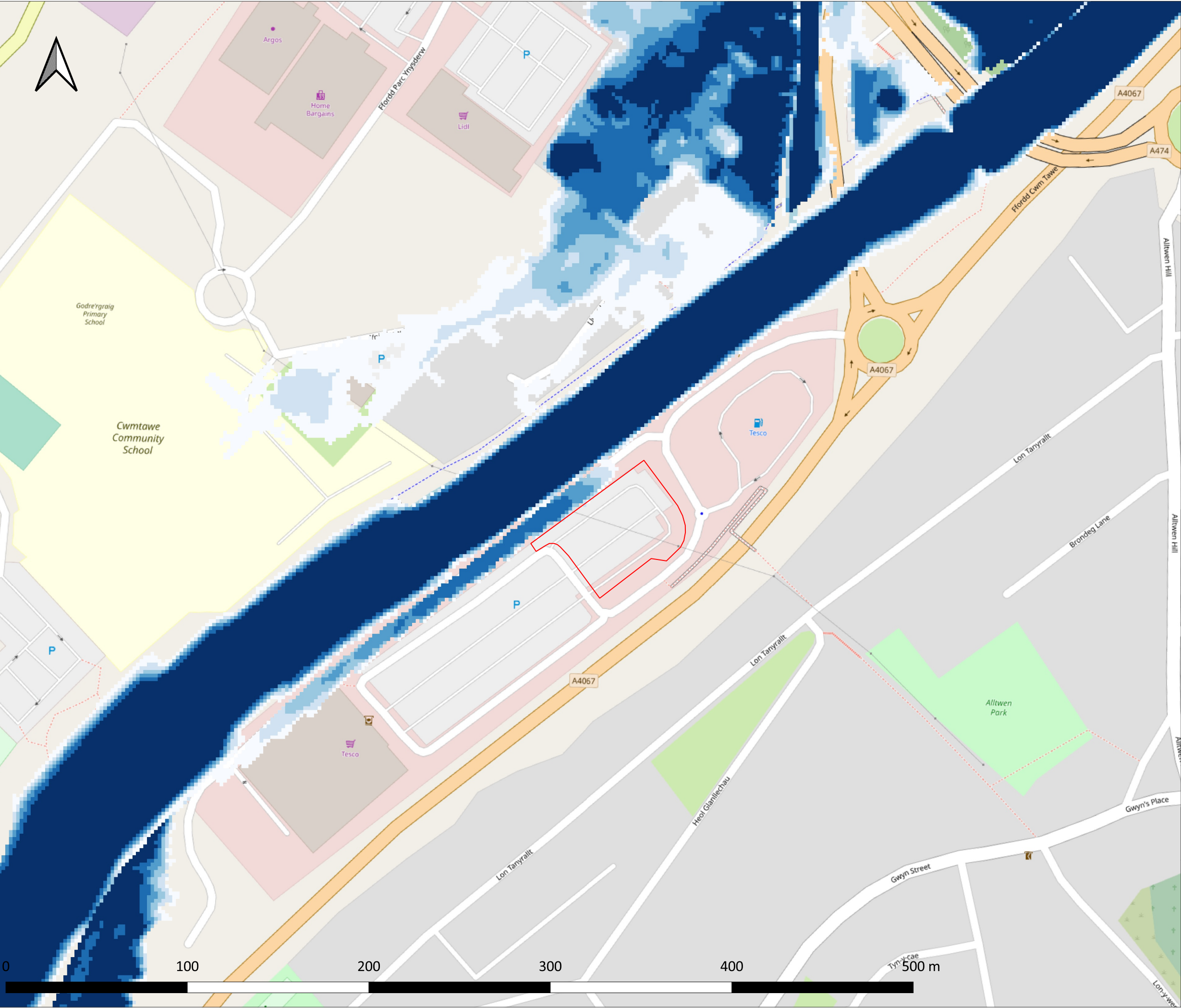
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1 IN 1,000 YEAR FLOOD DEPTHS

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Legend

Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- > 1.25

REVISIONS

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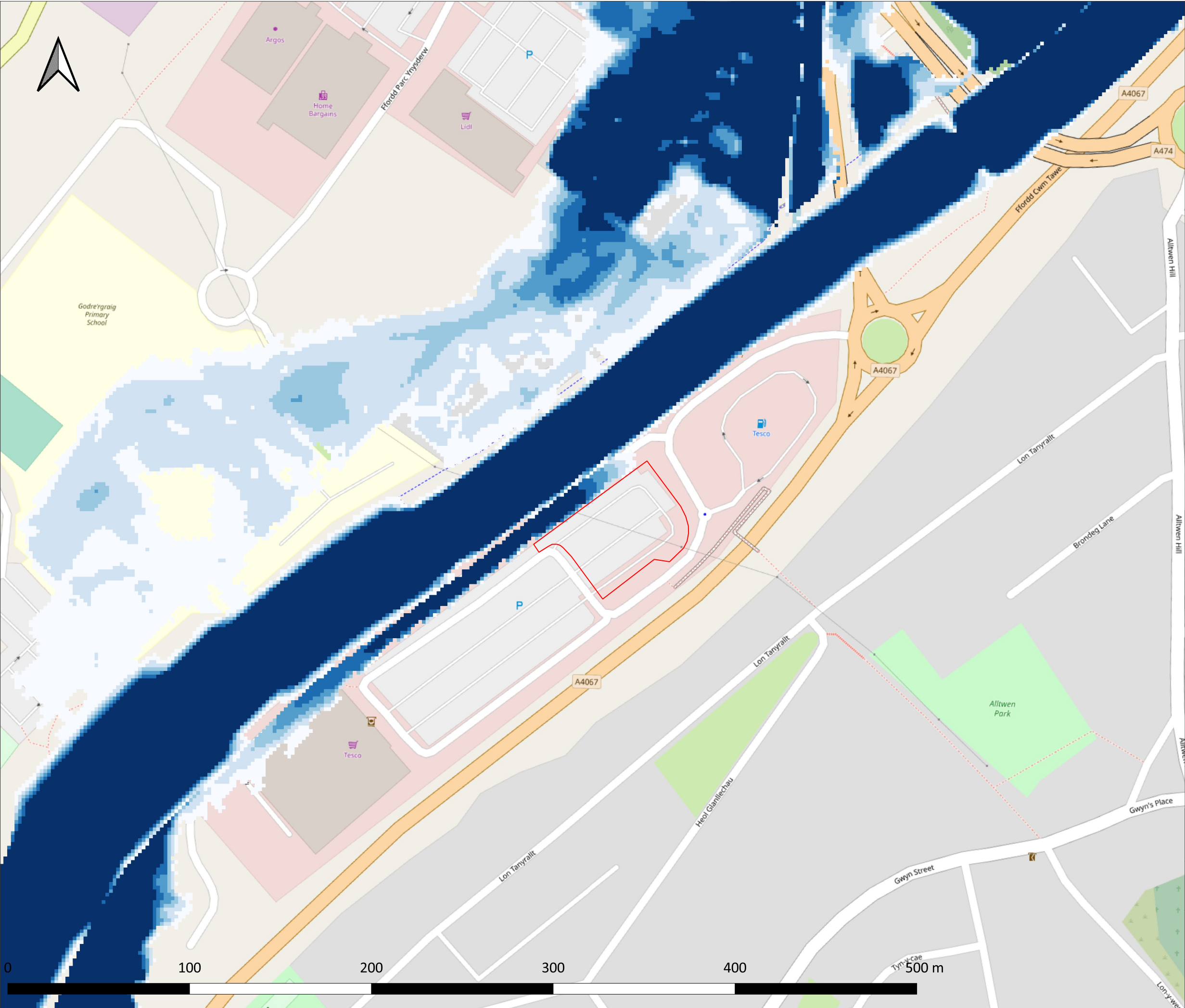
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1 IN 100 YEAR + 30% CC FLOOD DEPTHS - UNDEFENDED SCENARIO

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Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 1.25
- > 1.25

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