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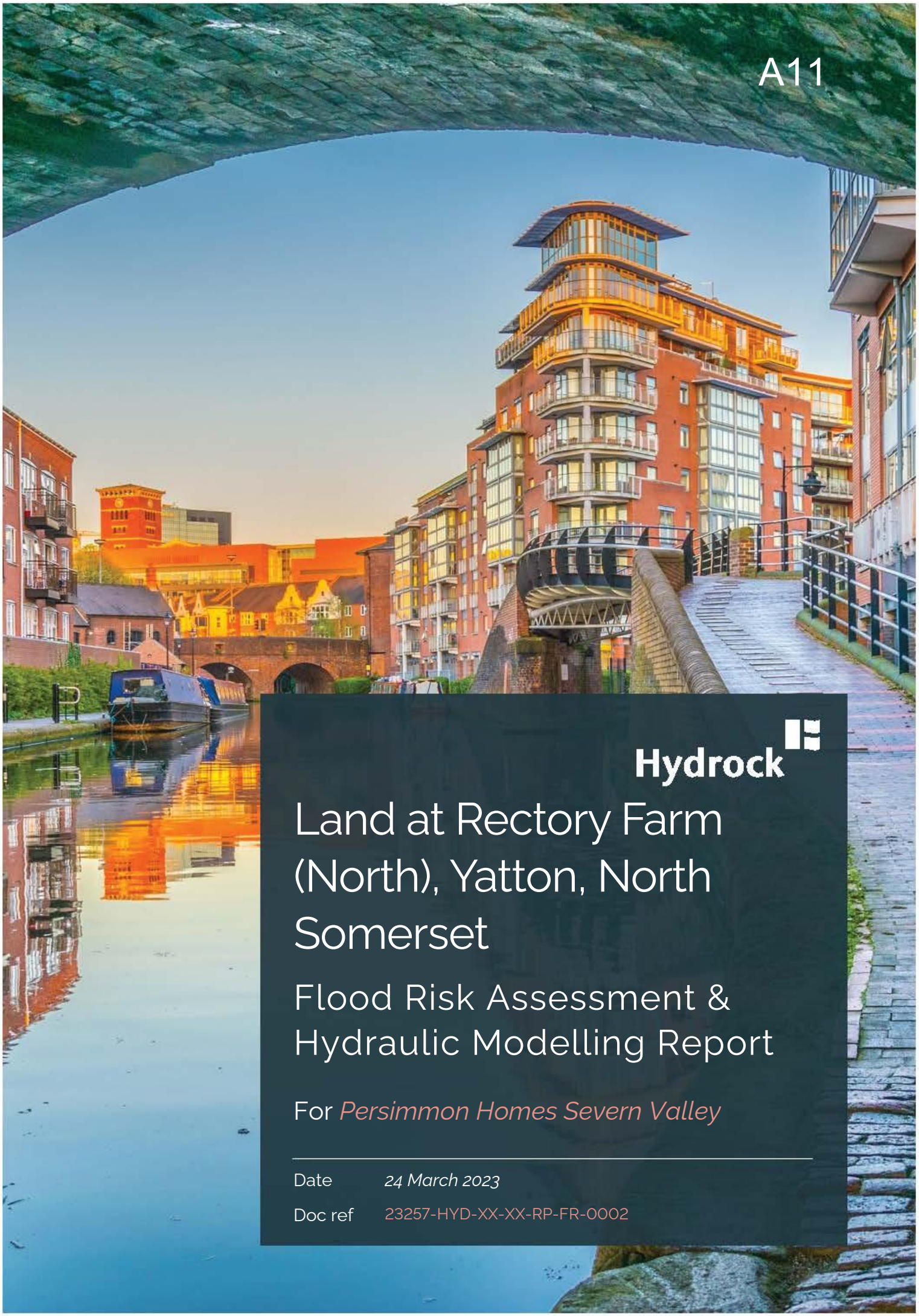

Hydrock

Land at Rectory Farm (North), Yatton, North Somerset

Flood Risk Assessment & Hydraulic Modelling Report

For *Persimmon Homes Severn Valley*

Date	*24 March 2023*
Doc ref	23257-HYD-XX-XX-RP-FR-0002

Document control sheet

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Client	Persimmon Homes Severn Valley	
Project name	Land at Rectory Farm (North), Yatton, North Somerset	
Title	Flood Risk Assessment & Hydraulic Modelling Report	
Doc ref	23257-HYD-XX-XX-RP-FR-0002	
Project number	23257-IOCB	
Status	S2	
Date	24/03/2023	

Document production record		
Issue number	P01	Name
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Document revision record			
Issue number	Status	Date	Revision details
P01	S2	20/03/2023	First Issue - For Comment

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Contents

Tables

Figures

Appendices

1. Introduction

This report has been prepared by Hydrock Consultants Limited (Hydrock) on behalf of our Client Persimmon Homes Severn Valley to support a Planning Application for a residential development on Rectory Farm, Yatton, North Somerset.

Owing to the identified level of risk to the site, and the potential complexities this may cause, a pre-application meeting was held (14th November 2022) with North Somerset in their role as the Lead Local Flood Authority. During this meeting the flood risk to the site and the wider Yatton area was discussed and confirmed that the dominant source of risk in this area was from tidal sources and this should be the main consideration to determine mitigation for any proposed development.

During the meeting it was also explained that there are currently two modelling studies available which include the site. The first of these is the Congresbury Yeo 2015 model. Whilst this model includes tidal downstream boundaries its primary function to model fluvial extents associated within the watercourse. The second model which covers the area is the Woodspring Bay 2020 model and this is a tidal model. Owing to the dominant source of flooding to the site being from tidal sources the LLFA stated that any assessment of risk should be based on the tidal Woodspring Bay model and particularly the impact of a complete failure of the existing defences (i.e. undefended scenario) and the impacts of the latest climate change allowances (policy has been updated since 2020).

Local Planning Authorities are advised by the Government's National Planning Policy Framework (NPPF) to consult the EA and LLFA on development proposals in areas at risk of flooding. For a development of this nature the EA and LLFA normally require a Flood Risk Assessment to be submitted in support of such an application. The report has been prepared to consider the requirements of NPPF through:

- Assessing whether the proposed development is likely to be affected by flooding;
- Assessing whether the proposed development is appropriate in the suggested location; and,
- Detailing measures necessary to mitigate any flood risk identified, to ensure that the proposed development and occupants would be safe, and that flood risk would not be increased elsewhere.

The report considers the requirements for undertaking a Flood Risk Assessment as stipulated in NPPF Technical Guidance. Only those requirements that are appropriate to a development of this nature have been considered in the compilation of this report.

This report has been prepared in accordance with current EA Policy.

2. Site Information

2.1 Location

The site is located on Rectory Farm land to the west of Yatton, North Somerset. Yatton is located approximately 11.5km North East of Weston Super-Mare and approximately 16.5km South West of Bristol. The site is bounded to the North by agricultural fields, to the East by a residential area, to the South by farm buildings (Rectory Farm) and agricultural fields, and to the West by a disused railway line embankment, known as the Strawberry Line, and further agricultural fields beyond.

The site falls within the drainage catchment of the River Yeo (also known as Congresbury Yeo and referred to within this report as such). There are several drainage features / rhynes flowing through the site and in the surrounding area to the west and south. The rhynes within the site and the subject area fall under the North Somerset Levels Internal Drainage Board's (IDBs) Management. Online mapping indicates five named rhynes either within the site boundary or connected to the site, these are: Cookes Rhyne, Williams Rhyne, Branch Rhyne East, Branch Rhyne and Biddlestreet Rhyne (see Figure 1). The rhyne network drains to the Congresbury Yeo located approximately 800m west of the site, flowing in a general north westerly direction towards Woodspring Bay and the Bristol Channel, a further 5.5km downstream.

The approximate site address (Rectory Farm) and Ordnance Survey Grid Reference is provided in Table 1 with the site location and approximate red line boundary shown within Figure 1.

Table 1. Site Referencing Information with the Closest Site Postcode

Site Referencing Information	
Sire Address	Rectory Farm, Chescombe Rd, Yatton, Bristol BS49 4EU
Grid Reference	ST 42501 65501 342501, 165501

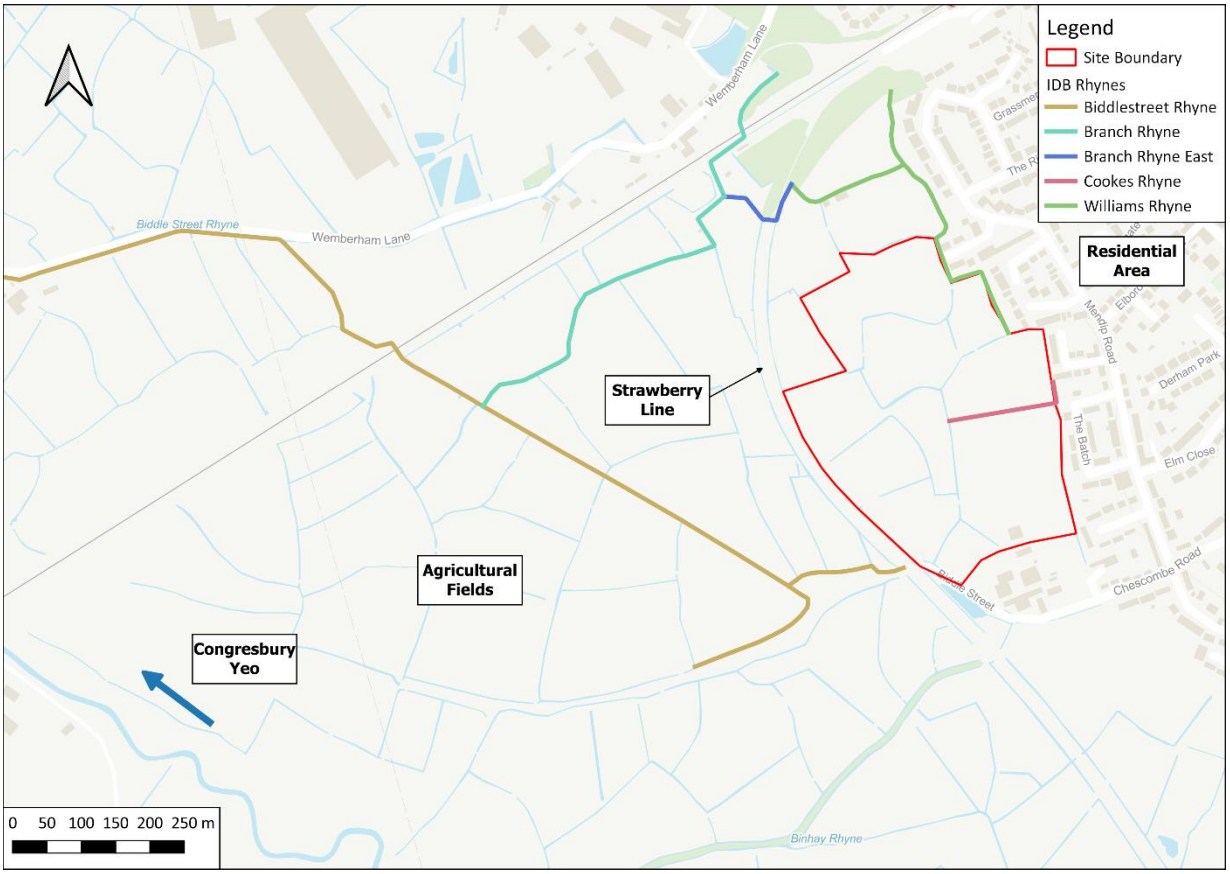

Figure 1. Site Location with Red Line Boundary and Named Rhynes (taken from IDB Online Mapping)

2.2 Topography

A site-specific topographical survey, undertaken in October 2022. is included within Appendix A. The site is 13.79 hectares in area and comprises nine irregular shaped land parcels which are separated by the existing rhyne network (see figure 2).

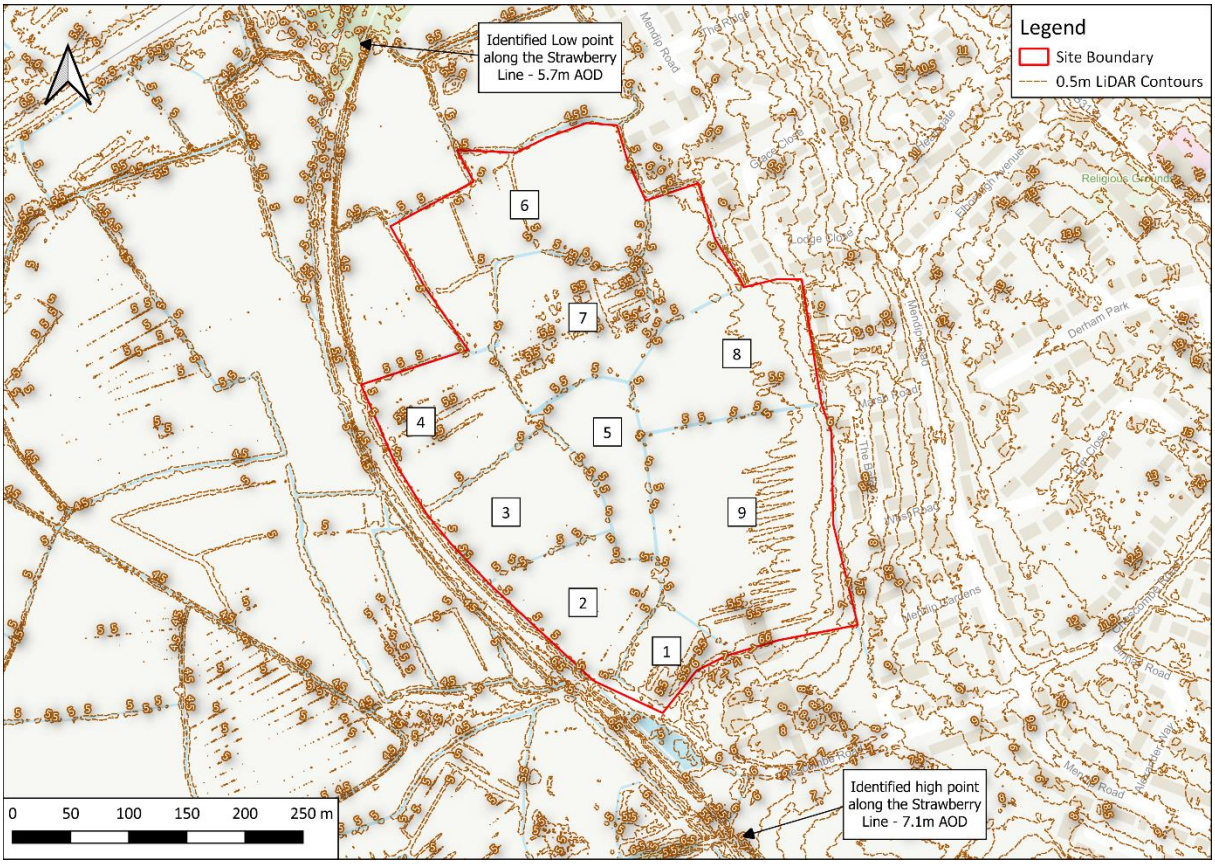

Figure 2. 0.5m Contour Map using EA LiDAR Data.

The topographical survey identifies that the western parcels (1, 2, 3, 4, 5 and 6) show ground levels ranging between 4.89 - 5.5m AOD, and in these parcels no clear and obvious gradients are identified.

However, it should be noted that there is not one consistent fall across the site. One example of this is within the eastern parcels, (7, 8 and 9) where levels increase along the eastern site boundary, Within these parcels levels are shown to rise from a low of 5.03m AOD to a high of 7.54m AOD within Parcel 9. The high points along the eastern boundary with the residential developments range from 6.07m AOD to 7.54m AOD and these increase to the south.

Parcel 3 is shown as being the lowest of the parcels with a low point of 4.89m AOD and a high of 5.3m AOD.

The topographical survey also indicates in some of the parcels to be minor ridge and furrows, with the maximum height of these ridges indicated to be approximately 0.2m higher than adjacent ground levels - so only local fluctuations.

The rhyne network that separates that parcels has also been surveyed and these are generally 4 to 5m wide with depths between 1 - 1.5m.

The topographical survey for the site does not include levels for the Strawberry Line running to the West of the site boundary. In the absence of surveyed information, the EA LiDAR (Figure 2) is considered the best available data. LiDAR data along the Strawberry Line identifies embankment crest levels to fall in a northerly direction from a high point of approximately 7.1m AOD found to the West of the existing Rectory Farm developments, to a low of approximately 5.7m AOD, located approximately 130m north of the site boundary.

Whilst topographical survey data is available for the site, EA LiDAR has been used within the approved Woodspring Bay 2020 model. As such a ground truthing assessment has been carried out by Hydrock to confirm the suitability of this data in comparison to the topographical survey data. On comparison of spot levels across the site, LiDAR levels on the land parcels are shown to have a negligible (0.05m) difference with the surveyed data and is considered acceptable for use. However, around the rhyne network, LiDAR accuracy is indicated to decrease as a result of vegetation coverage and standing water. As such, and as is standard topographical survey on site should be used as this is considered more site specific and the more accurate.

2.3 Current Site Use

The site is currently used for agricultural uses as part of Rectory Farm and is predominantly undeveloped and used for agricultural uses but the existing Poultry House is located towards the South of the site.

2.4 Proposed Development

Outline planning application for the development of up to 190 homes (including 50% affordable homes), 0.13ha of land reserved for Class E uses, allotments, car parking, earthworks to facilitate sustainable drainage systems, open space and all other ancillary infrastructure and enabling works with means of access from Shiners Elms for consideration. All other matters (means of access from Chescombe Road, internal access, scale, layout, appearance and landscaping) reserved for subsequent approval.

3. Sources of Flood Risk

3.1 Fluvial and Tidal Flooding

The site is located within the drainage catchment of the Congresbury Yeo, which is located approximately 800m west of the site and flows in a general westerly direction before discharging into Woodspring Bay and the Bristol Channel approximately 6km north west of the site. The site is included within the Severn River Basin District.

The site and the surrounding areas include a network of land drainage features (rhynes), that drain through a number of culverts, towards the Congresbury Yeo and subsequent Bristol Channel.

For the purposes of the report and based on the EA Flood Map for Planning (FMfP) (Figure 3) this site is classified as being within Flood Zone 3.

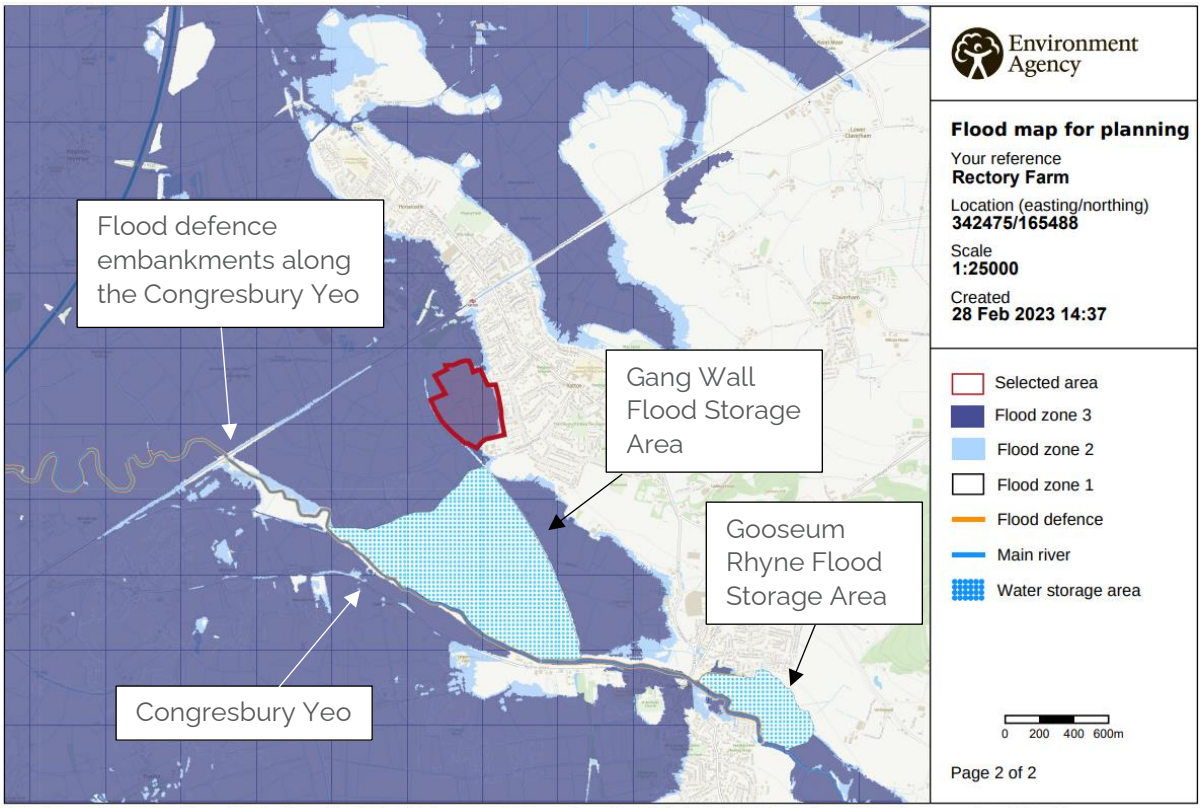

Figure 3. EA Flood Map for Planning

The Environment Agency Flood Zones are defined within Paragraph 078 of the NPPG for Flood Risk and Coastal Change as:

- Flood Zone 1 (Low Risk) comprises land assessed as having a ≤0.1% AEP of fluvial or tidal flooding in any given year, equivalent to the ≥1,000yr return period flood event.
- Flood Zone 2 (Medium Risk) comprises land assessed as having a 0.1-1% AEP of fluvial flooding or 0.1-0.5% AEP of tidal flooding in any given year, equivalent to the 1,000-100yr return period flood event.
- Flood Zone 3a (High Risk) comprises land assessed as having a ≥1% AEP of fluvial flooding or ≥0.5% AEP tidal flooding in any given year, equivalent to the ≤100yr return period flood event.
- Flood Zone 3b (The Functional Floodplain) comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take

account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:

- Land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or
- Land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

A pre-application response from North Somerset Council (ref: 22/P/2451/PR2) is included within Appendix B. The key points from the pre-app response with regards to flood risk are:

- The EA updated Flood Map identifies the northern part of the site to be subject to surface water flooding,
- The whole of the site is located within Strategic Flood Risk Assessment (SFRA) L1 Tidal Flood Zone 3a (Figure 4) and EA Flood Zones 2 and 3 (Figure 3),
- The site is entirely within tidal flood zone 3a as shown on the Council's Strategic Flood Risk Assessment (2020) and this accords with the national Flood Map designation.
- Policies on flooding apply, such as DM1 of the adopted Development Management Policies Plan and CS3 of the Core Strategy that reflect national planning policy with respect to flood risk. Section 5.1 and 5.2 of this report provide full details regarding national and local planning and policy guidance.
- All development must consider its vulnerability to flooding, taking account of all sources of flood risk and the impacts of climate change, up to 100 years ahead on residential, or mixed-use sites.
- It will therefore be necessary to carry out a Sequential Test on a risk-based approach in advance of submitting a planning application for the development of the site.

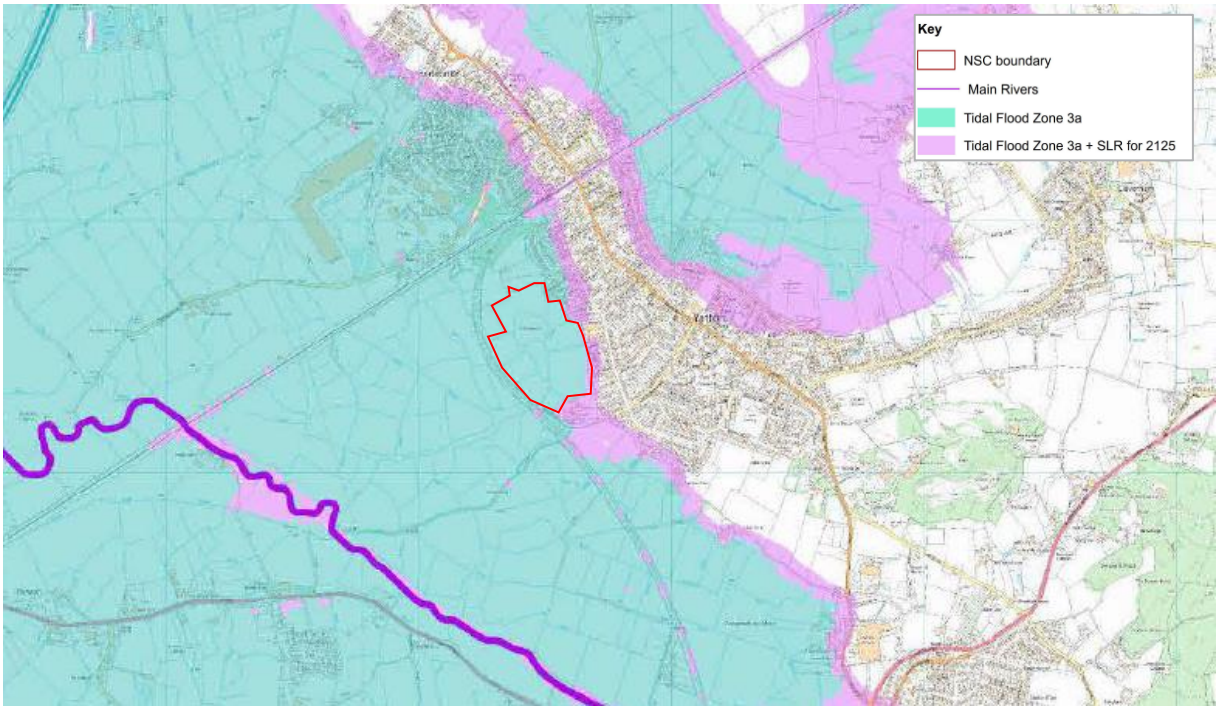

Figure 4. Tidal Flood Zone 3a: Sea Level Rise Allowance - Taken from Fig 045 (Appendix B) within the SFRA

In addition to the pre-application response from North Somerset Council, a meeting has been held with the LLFA. Within this meeting the methodology for assessing the risk to the site was confirmed and the key points are:

- Confirmed tidal sources from the Woodspring Bay area are the biggest risk to the site and the surrounding areas.
- Two EA hydraulic models are currently available for the site "Congresbury Yeo and Hydrology Update 2015" (EA) and the "Woodspring Bay 2020" (JBA). The Woodspring Bay 2020 is the more appropriate for assessing risk and this was requested to be used in this assessment.
- No compensation storage would be required as a result of tidal flooding being the dominant source.
- Agreed to use the existing model and update this to include the uplift for climate change and additional structures not included in the original model (i.e. culverts under Strawberry Line) to provide a more accurate assessment of mechanisms and depths of flooding at the site both now and across the proposed development design life.

3.1.1 Hydraulic Modelling – Existing Models

From discussion with the LLFA during the pre-app meeting (14/11/2022), it was confirmed that there are two EA approved models which include the site within the models' subject areas, the EA's *"Congresbury Yeo and Hydrology Update 2015"* model and the *"Woodspring Bay 2020"* model created by JBA. Within the pre-app meeting the LLFA, Congresbury Yeo 2015 model has a focus on the Congresbury Yeo catchment and the watercourses / rhyne network within it and considers a more fluvially dominant risk. However, the Woodspring Bay 2020 model provides flood risk information for the tidal risk within the Woodspring Bay catchment (including the Congresbury Yeo and surrounding areas) and is also used to define the EA's Flood Zones for the area. Also, the Congresbury Yeo modelling would be considered outdated as it does not use the latest UK Climate Change Projections (UKCP18) and would therefore underestimate the tidal flood risk in the area. As such, the LLFA requested Hydrock undertake this assessment using the Woodspring Bay 2020 model as it is more up to data and a more accurate representation of both current and future climate change risk and aligns with their preference.

The Woodspring Bay 2020 model uses the latest climate change projection based on UKCP18 however, the assessment of hydrology for this model was done in 2018 and as such the hydrographs require uplifting to present day levels, using the EA Sea Level rise allowances for climate change. This was agreed and deemed an acceptable approach to the LLFA during the pre-app meeting. Therefore, as part of this assessment have updated the approved Woodspring Bay 2020 hydraulic model to include the latest climate change information for both the present day (2022) and for the design life (100 years) of the proposed development (2122).

Within the pre-app meeting, it was agreed with the LLFA that the design event for the site would be the 1 in 200 year plus Higher Central climate change allowance up to 2122 and, in line with policy and standard modelling practice, this would assess in the undefended scenario in order to understand the 'worst case' scenario at the site. It should be noted that this doesn't align with local policy but should be used to inform mtigation to provide a robust approach. This meant the all formal defences (i.e. EA assets) were 'removed' from the model. However, informal defences such as motorway embankments and the Strawberry Line embankments would remain as these are deemed more as topographical features rather than a 'defence' per se..

Additionally, and on review, the provided model didn't include culverts on the rhyne networks through the site or under the Strawberry Line. As such, and give the potential importance of these a site walkover was undertaken to identify and measures that and, where not already, these will be included in the updated modelling.

3.1.1.1 *Woodspring Bay 2020 Model*

The Woodspring Bay 2020 model was undertaken by JBA on behalf of the EA to assess coastal flood risk along the north coast in the Bristol Channel and subsequently used to generate the existing EA Zones.

Existing approved outputs from this model are included within the "Woodspring Bay and Severn House Farm Coastal Flood Modelling and Mapping Report" (ref:2018s0923, dated: September 2020). The modelled results for the defended scenario in the present-day flood extents (Figure 5) confirm the Woodspring Bay catchment to benefit from flood defences along the Woodspring Bay frontage and along the Congresbury Yeo, with Figure 5 showing all events other than the 0.1% AEP (1 in 1000-year) event are contained by the defences.

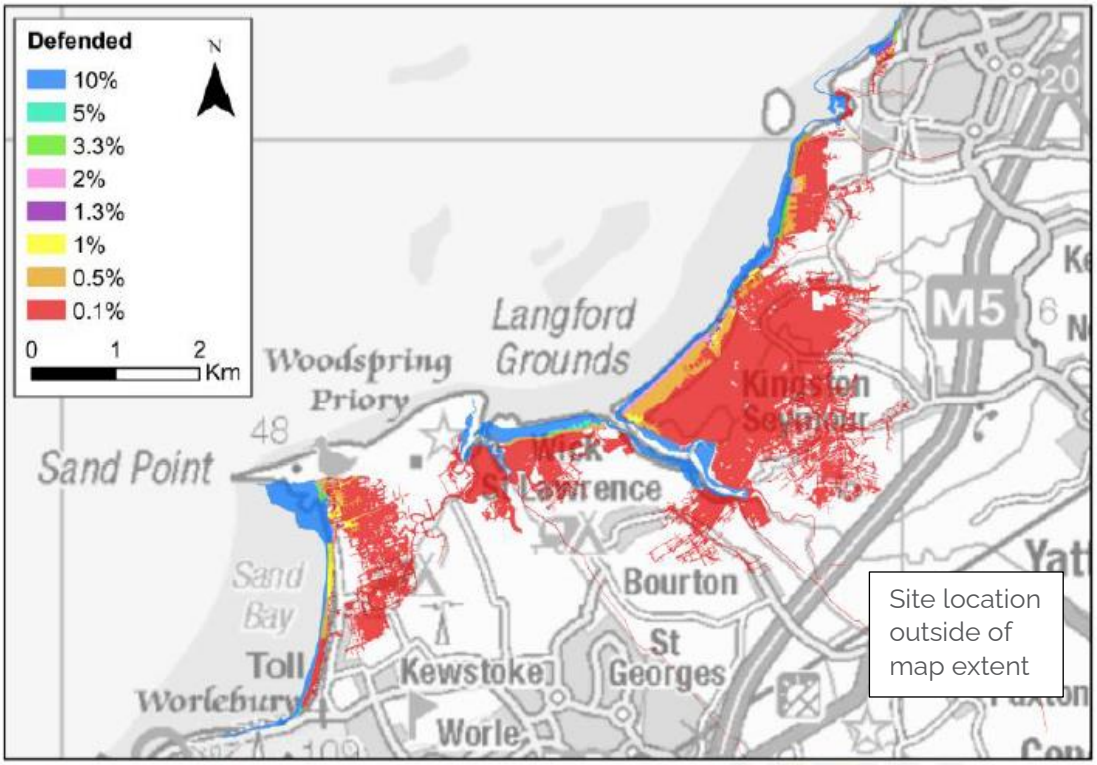

Figure 5. Woodspring Bay Defended scenario present day flood extents – taken from the Woodspring Bay and Severn House Farm Flood Modelling and Mapping Report (JBA, 2020)

However, in the undefended scenario flooding is shown to be significantly more widespread across the study area with all events modelled showing extreme flooded extents (Figure 6). This confirms that the flood issue associated with an extreme and/or undefended (i.e. defence failure or overtopping) event would result in large areas of both Yatton and North Somerset being inundated.

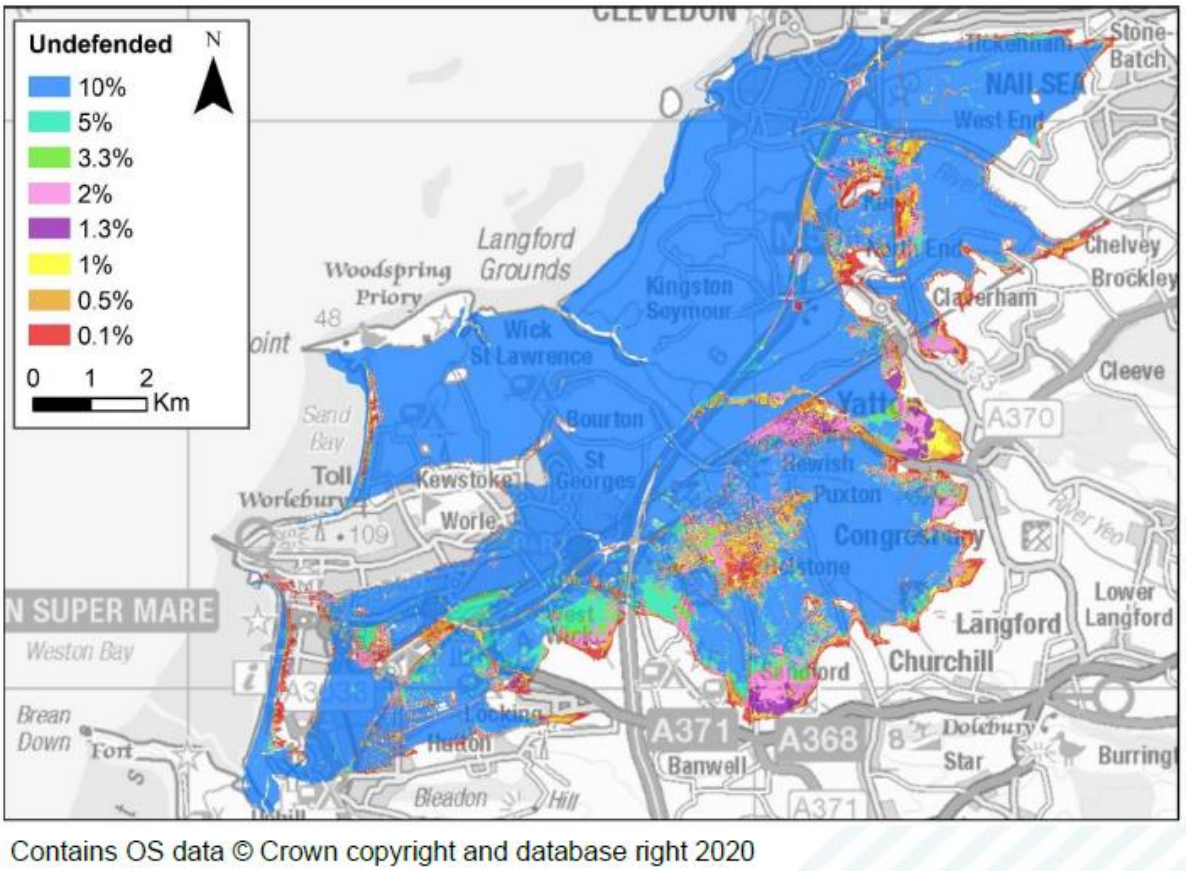

Figure 6. Woodspring Bay Undefended scenario present day flood extents – taken from the Woodspring Bay and Severn House Farm Flood Modelling and Mapping Report (JBA, 2020)

3.1.2 Hydraulic Modelling – Updates and Climate Change

The Woodspring Bay 2020 model has been agreed as being that used to assess the tidal flood risk to the site however, whilst the approved model was deemed appropriate for use some updates to the model were agreed to ensure an accurate assessment of tidal risk to the site as outlined in Section 3.1 above and detailed below.

It should be noted a separate hydraulic modelling report will be provided with the full planning submission.

3.1.2.1 Hydrology Updates

As part of the NPPG for flood risk and coastal change, all Flood Risk Assessments for new development must ensure the proposed development will be safe from all sources of flooding, not and in the future, taking account of the impacts of climate change. To do this, the "design flood" should be assessed which is defined as:

- tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or
- surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year),

plus an appropriate allowance for climate change.

The Woodspring Bay 2020 is a tidal model and includes the latest sea level rise allowances as set out by the EA Guidance for Flood risk assessments: climate change allowances[1]. The allowances within the guidance have been revised in line with the UK Climate Projections 2018 (UKCP18).

The Woodspring Bay 2020 model uses information with regards to climate change however the baseline event is based on 2018. Therefore, to ensure a more accurate representation of baseline (2022 – correct at the undertaking of the modelling) conditions, an uplift based on Table 1 of the Guidance for Flood risk assessments: climate change allowances) was applied. The uplift applied was therefore 4 years of 2000 to 2035 epoch i.e. 20.32mm for the agreed Higher Central allowance for the South West region.

To ensure the impact of climate change across the design life of the development, an uplift for 100-years (residential developments design life) was applied to the 2022 baseline hydrograph. Both the 'Higher Central' and 'Upper End' climate change allowances were applied as is standard practice, these uplifts in total were **1.03m** and **1.39m** respectively

Similarly to the inflow hydrographs, all Initial water level (IWL) shapefiles within the approved model were amended to include the adjustment for climate change although this is not predicted to impact final results and is mainly used for model initialisation.

Table 2. Sea Level Allowances for each epoch in mm for each year (based on a 1981 to 2000 baseline)

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
South west	Higher central	5.8	8.8	11.7	13.1	1.21
South west	Upper end	7	11.4	16	18.4	1.62

3.1.2.2 Model Updates

The provided Woodspring Bay Model is an ESTRY-TUFLOW 1D-2D hydraulic model and has been agreed and granted approval with the EA. The Woodspring Bay model covers approximately 131km^2, therefore given the study undertaken by Hydrock is to assess the risk to site and include additional culverts along the Strawberry Line and within the site, it was deemed appropriate to not deviate from the approved approach.

The model was provided in full by the EA as part of a Product 5 and 7 freedom of information data request.. As above, inflow hydrographs have been updated to account for the climate change uplift and no additional changes, other than those mentioned below, are deemed to have been necessary. A summary of changes made to the model are:

- Uplift of inflow hydrographs using the EA Climate Change allowances
- Addition of culverts under the Strawberry Line and within the site boundary
- Reinforced levels of rhynes within the site boundary from topographical survey data

The only additions that have been included within the model are centred around the site (either within the boundary or in close proximity). Figure 7 shows a model schematic centred on the site of

[1] EA (2016 but updated constantly) Flood risk assessments: climate change allowances - https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

interest showing the locations of all structures (and channels), and the additional features that have been included in the larger strategic model.

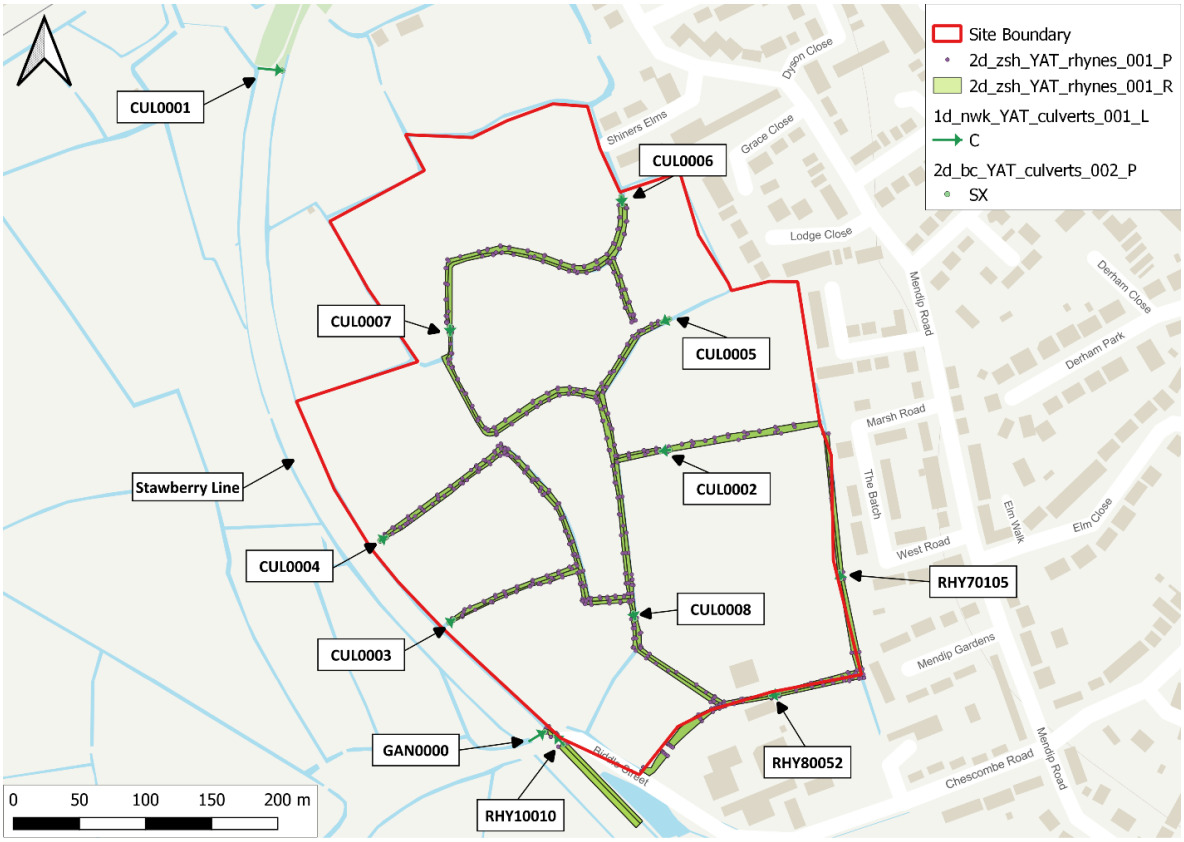

Figure 7. Model schematic centred on the site showing additional features included within the model.

3.1.2.3 *Overview of Modelling Files*

The version of the software that was used is:

- TUFLOW – 2020-10-AE
- The following TUFLOW control files were used to run the models:
- TCF – WSB_~e~_~s~_005_YAT_001.tcf
- TRD – WSB_General_Commands_005_YAT_001.trd
- TEF – WSB_Events_005_HYD.tef
- TGC – WSB_005_YAT_001.tgc
- TBC – WSB_Boundary_Control_005_YAT_001.tbc
- All shapefiles and level data (DTM) are referenced within the TCF, TGC and TBC.

3.1.2.4 *Terrain Data and Topographical Survey*

The sources of data used for this hydraulic modelling study were:

- EA 1m Digital Terrain Model (DTM) LiDAR flown in 2017.
- A comparison check was undertaken with the latest EA LiDAR available at the time (2020) and a negligible difference was found between data sets for the site.
- A site topographical survey undertaken October 2022 (Appendix A).

» A site walkover was undertaken by Hydrock (November 2022) to obtain spot measurements and additional information for the culverts on site and under the Strawberry Line. However, due to dense vegetation some areas and culverts were not possible to access.

3.1.2.5 *Structures*

In the original approved model, no culverts within the site boundary or under the Strawberry Line have been included. The majority of additional structures (1d_nwk_YAT_culverts_001_L.shp) included within the site are farm access culverts connecting the rhyne network under farm tracks. Invert levels for the culverts have been taken from topographical survey data provided by the client (Appendix A).

Where invert levels are not present at the culverts, these were collected following a site walkover or have been interpolated from the nearest known bed level if access was not possible. Where assumptions have been made, a conservative approach has been adopted i.e. choosing the highest bed level and/or lowest bank levels.

Two culverts, CUL0003 and CUL0004 were not possible to access due to dense vegetation at the time of the site walkover. Assumptions have had to be made on these two culvert sizes and owing to the upstream culvert (CUL0008) being 0.6m it has been assumed these are the same size on the basis that inflows and outflows are limited to this capacity - and this is considered an acceptable assumption in the absence of site clearance/more detail survey being practicable. Whilst this is an assumption it should be noted that due to the extreme flood level that occurs across site in the 1 in 200-year present day event (6.12m AOD) the overall impact of these assumptions is considered negligible as these two culverts become surcharged and provide little impact to mitigate onsite flooding. Topographical survey data shows bank top levels around CUL0003 and CUL0004 to be 5.14m AOD and 5.18m AOD respectively and therefore submerged in approximately 1m deep water.

In total, an additional 12 culverts have been included as 1D network lines within the model - 10 farm access culverts (0.3-0.75m diameter) and two larger culverts under the Strawberry Line. All culverts measured were circular pipe culverts.

Table 3. List of additional culverts included within the model and their dimensions

Culvert ID	Inlet / Outlet Dimension (m)	Culvert ID	Inlet / Outlet Dimension (m)
GAN0000	1.2	CUL0003	0.6
RHY10010	0.7	CUL0004	0.6
RHY70105	0.6	CUL0005	0.6
RHY80052	0.3	CUL0006	0.3
CUL0001	0.9	CUL0007	0.75
CUL0002	0.6	CUL0008	0.6

Connecting the sites rhyne network to the wider network south west of the Strawberry Line, two large culverts were measured on a site walkover and included within the model. One culvert to the north of the site (CUL0001) is a 0.9m diameter culvert and one located in the south east corner of the site (GAN0000) was measured at 1.2m diameter pipe. For the smaller culvert (CUL0001) the outlet to the west of the Strawberry Line was located on third-party land to which access was not possible, as such the culvert included in the model was assumed to have a flat gradient. LiDAR in this area of the culvert outlet did not show clear and accurate coverage with levels suggesting a lowest bed level of 4.32m AOD – approximately 0.3m above the inlets measured invert level. A

profile of existing LiDAR at the point of this culvert shows ground levels at the outlet (West – 4.32m AOD) and inlet (East – 4.34m AOD) to have a difference in levels of 0.02m, given this small increase in ground levels onto the site the approach taken is considered to be conservative as the flat gradient will allow easier ingress of potential flood waters onto the site from land to the West of the Strawberry Line.

Figure 8. Inlet for CUL0001

2D boundary conditions points (2d_bc_YAT_culverts_002_P.shp) with type 'SX' have been snapped to the upstream and downstream of each culvert to allow interaction of water between the 1D feature and the 2D domain, see Figure 9. To reinforce culvert invert levels, the SX points have the Z attribute included to adjust DTM levels at the inlets / outlets of the culvert.

Figure 9. Example of the 1d_nwk and 2d_bc points setup within the model.

3.1.2.6 Rhynes Network

LiDAR coverage across the site shows the rhyne network however ground levels picked up on the topographical survey (Appendix A) have been reinforced using 2d Z Shape files (2d_zsh_YAT_rhynes_001_R.shp | 2d_zsh_YAT_rhynes_001_P.shp). These shapefiles have been applied using the topographical survey to determine bank tops (location and heights) and bed levels where possible. This method has been discussed and agreed as acceptable with the LLFA. However, due to access issues, (overgrown plants and barbed wire fencing) not all rhynes were possible to measure on the site walkover or topographical survey and as such those have been kept as LiDAR in the absence of any further data.

3.1.2.7 Roughness - Manning's 'n'

The EA approved Woodspring Bay 2020 model 'materials' layer has been used to represent roughness across the 2D domain and is based on Ordnance Survey MasterMap data across the site and entire model. This has been reviewed against the latest OS Mapping and there are deemed to have been no significant changes since the approved modelling was carried out.

3.1.2.8 Final Model Scenarios

The above has been incorporated into an updated version of the Woodspring Bay 2020 model to assess the impacts of tidal flooding to the site in an "undefended" capacity i.e. all formal defences within the model removed. This does not include removing raised topographical features such as the M5 or specifically to the site the Strawberry Line embankment. Outputs from the original supplied Woodspring Bay 2020 model (Figure 5 and Figure 6),.

The Inclusion of climate change allowances and the removal of all formal defences provides a 'worst-case' assessment of potential tidal flood risk to the site with flooding predicted to enter the site via the culverts under the Strawberry Line and, in the larger events, potentially overtop the embankment causing more widespread flood extents and greater flood levels onsite.

In the undefended scenario, this is the removal of all formal defences and, as stated within the Woodspring Bay and Severn House Farm Coastal Flood Modelling and Mapping Report in this scenario "*almost the entire coastline would be at still water flood risk during extreme sea level events.*"

The final events chosen for the undefended baseline assessment (with the inclusion of climate change and changes outlined) of flood risk are:

- 2022 3.3% AEP (1 in 30-year)
- 2022 0.5% AEP (1 in 200-year)
- 2022 0.1% AEP (1 in 1000-year)
- 2122 0.5% AEP (1 in 200-year) – Higher Central Climate Change Allowances (NPPF) – 1.03m uplift – Design flood for the proposed development
- 2122 0.5% AEP (1 in 200-year) – Upper End Climate Change Allowances (NPPF) – 1.39m uplift

3.1.2.9 Updated Model Results

Maximum on site flood levels are shown in Table 4, due to the tidal nature of the flood events the flooding onsite is shown to be one flat level with negligible (<1cm) variation. Whilst flood levels are shown to be flat, flood depths vary across the site with the deepest parts attributed to the existing rhyne network. Maximum flood depths have also been provided in Table 4.

Maximum flood depth outputs have been provided (Figure 10 and Figure 11) for the smallest modelled event, 3.3% AEP (1in 30-year) present day (2022) event and for the critical design event, 0.5% AEP (1 in 200-year) plus higher central climate change allowance (2122).

Table 4. Maximum Flood Levels for the Modelled Events from the Woodspring Bay 2020 Model

Tidal Event	Maximum Flood Level (m AOD)	Maximum Flood Depth – Land Parcel (m)
2022 3.3% AEP (1 in 30-year)	5.22	0.29
2022 0.5% AEP (1 in 200-year)	6.12	1.17
2022 0.1% AEP (1 in 1000-year)	6.66	1.6
2122 0.5% AEP (1 in 200-year) - Higher Central Climate Change Allowances (NPPF)	7.88	2.73
2122 0.5% AEP (1 in 200-year) - Upper End Climate Change Allowances (NPPF)	8.18	3.12

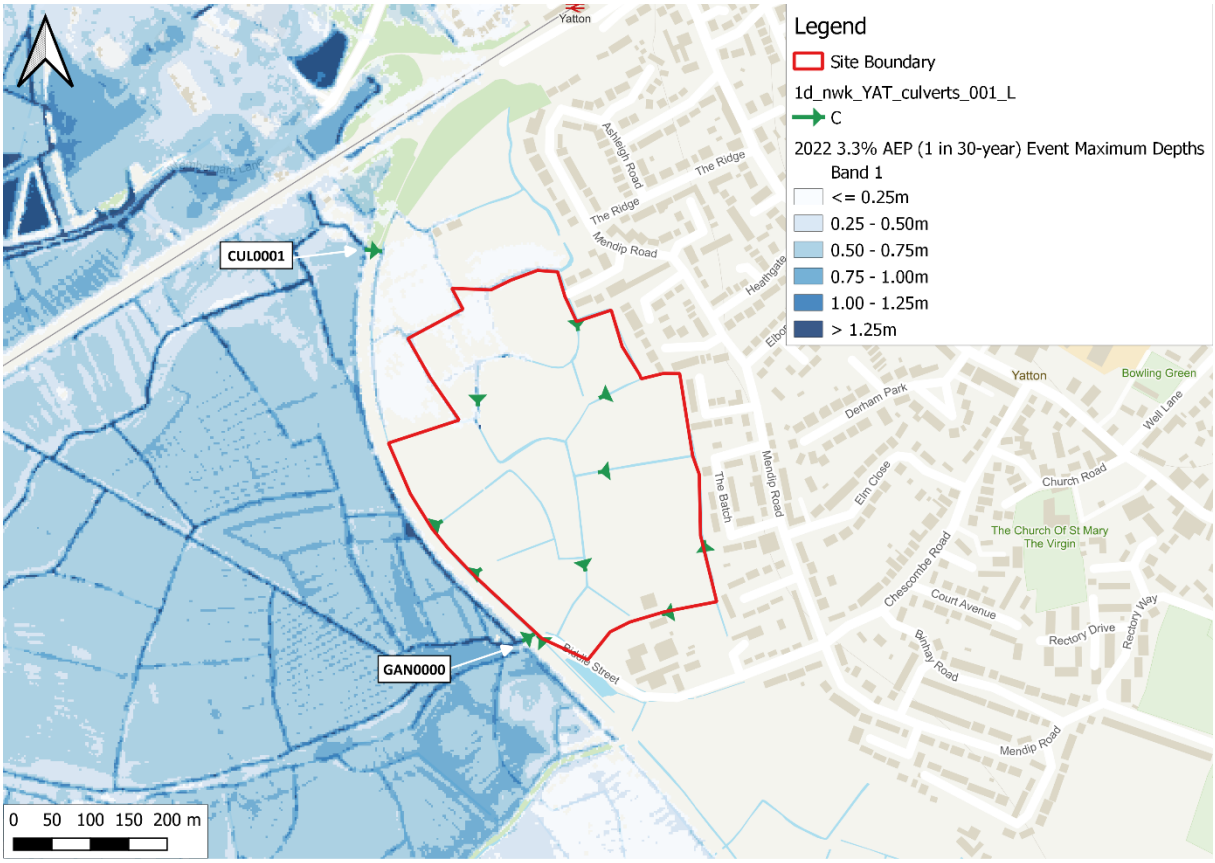

Figure 10. Flood Extents and Depth for the 1 in 30 year (2022) Extreme Tidal Event

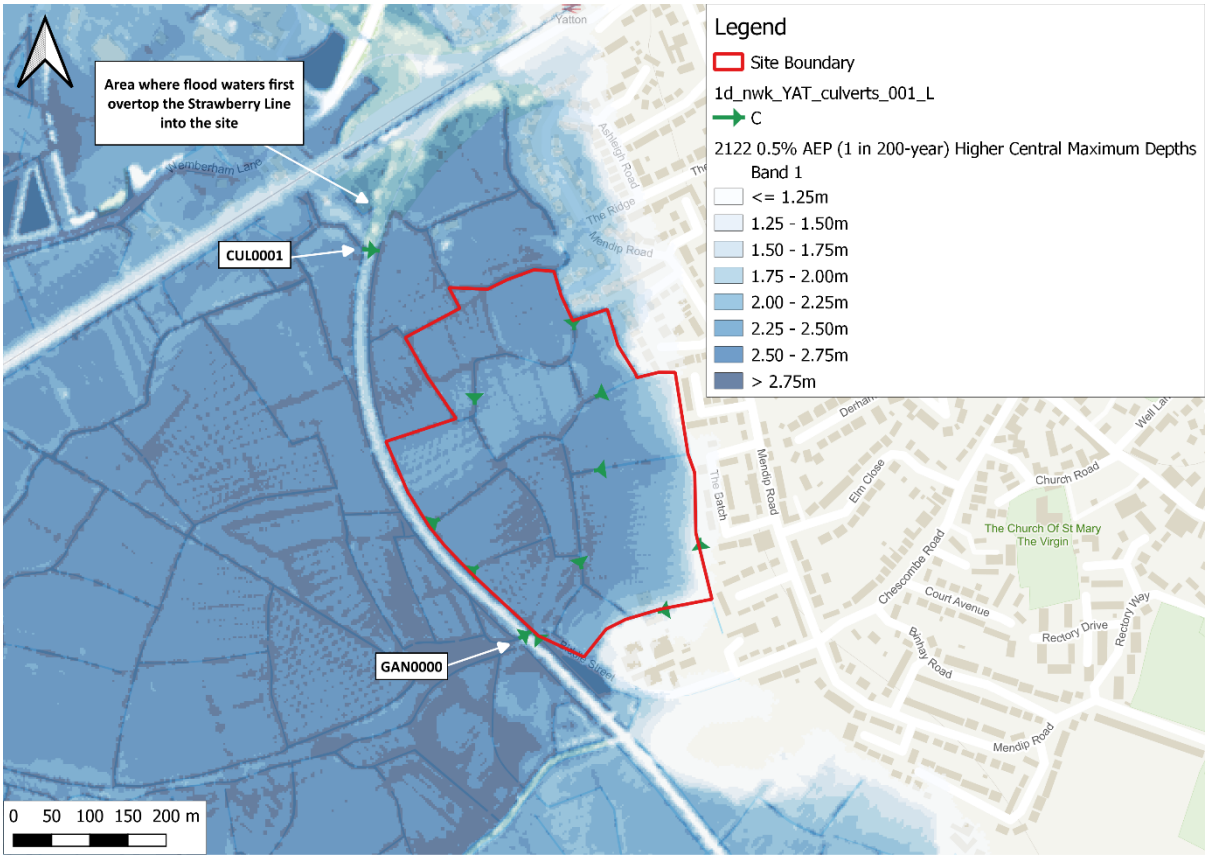

Figure 11. Flood Extents and Depth for the 1 in 200 year (2122) Higher Central Extreme Tidal Event

The results of the modelling confirm the site would be impacted in the event of an extreme tidal event in the undefended scenario, in all events modelled. This again should be considered as worst case and would only occur in the event of a complete failure of all existing defences.

In the smallest event modelled, the 2022 3.3% AEP (1 in 30-year) event (Figure 10), flooding is not predicted to be widespread on the site. Instead flood waters are predicted to flow into the site via the northern culvert (CUL0001) under the Strawberry Line and use the rhyne network as a preferential flow route south into the site. The extent of flooding is predicted to be limited to the northern portion of the site with a maximum flood level of 5.22m AOD and maximum depth 0.29m on the land parcels.

For the larger events the 2022 0.5% AEP (1 in 200-year), 2022 0.1% AEP (1 in 1000-year) and 2122 0.5% AEP (1 in 200-year) plus Higher Central and Upper End climate change events, flooding is first predicted to enter the site through the two culverts under the Strawberry Line (CUL0001 and GAN0000) however, as levels increase flood waters are indicated to overtop the Strawberry Line in the lower areas to the north causing more widespread flood extents across the site. For the largest events modelled. i.e. the two Climate Change events and 2022 0.1% AEP (1 in 1,000 year) event, flood extents show the Strawberry Line along the western boundary of the site to be entirely submerged (as shown in Figure 11).

The results of the 2022 0.5% AEP (1 in 200-year) event, confirms the site to be within the tidal Flood Zone 3a in the present-day undefended scenario with a maximum level of **6.12m AOD** and a maximum depth of **1.17m** on the land parcels and maximum flood extent that are comparable to the existing EA Flood Zone 3 extents (Figure 12).

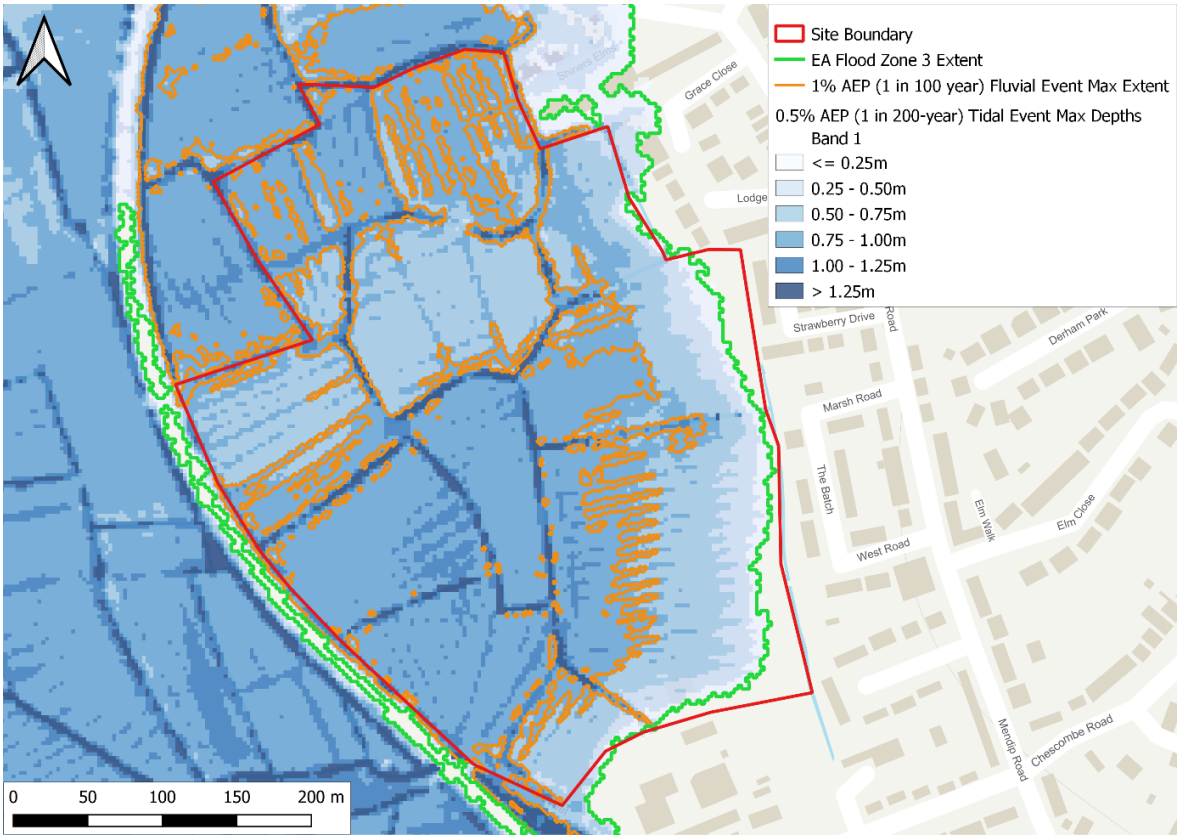

Figure 12. Present Day 0.5% AEP (1 in 200-year) Tidal Event Maximum Depths with 1% AEP (1 in 100-year) Fluvial Event and EA Flood Zone 3 Extents

The 0.5% AEP (1 in 200-year) plus higher central climate change allowance (2122) is the critical design event for this development (100-year design life for residential development). As shown in maximum onsite flood level is **7.88m AOD,** across the entire site with depths up to maximum depths on the land parcels indicated to be **2.73m**. Given the position of the LLFA this event is the design event and is that used to inform potential mitigation required.

As can be seen through the attached plans the site is shown as being at risk from the modelled events and the LLFA requested design event but it should be noted that during such an event the existing defence infrastructure is overtopped and therefore the level of risk is not limited only to the proposed development site and highlights that large areas of both Yatton and the wider North Somerset area would be at risk during any such event. This is shown in Figure 13 below.

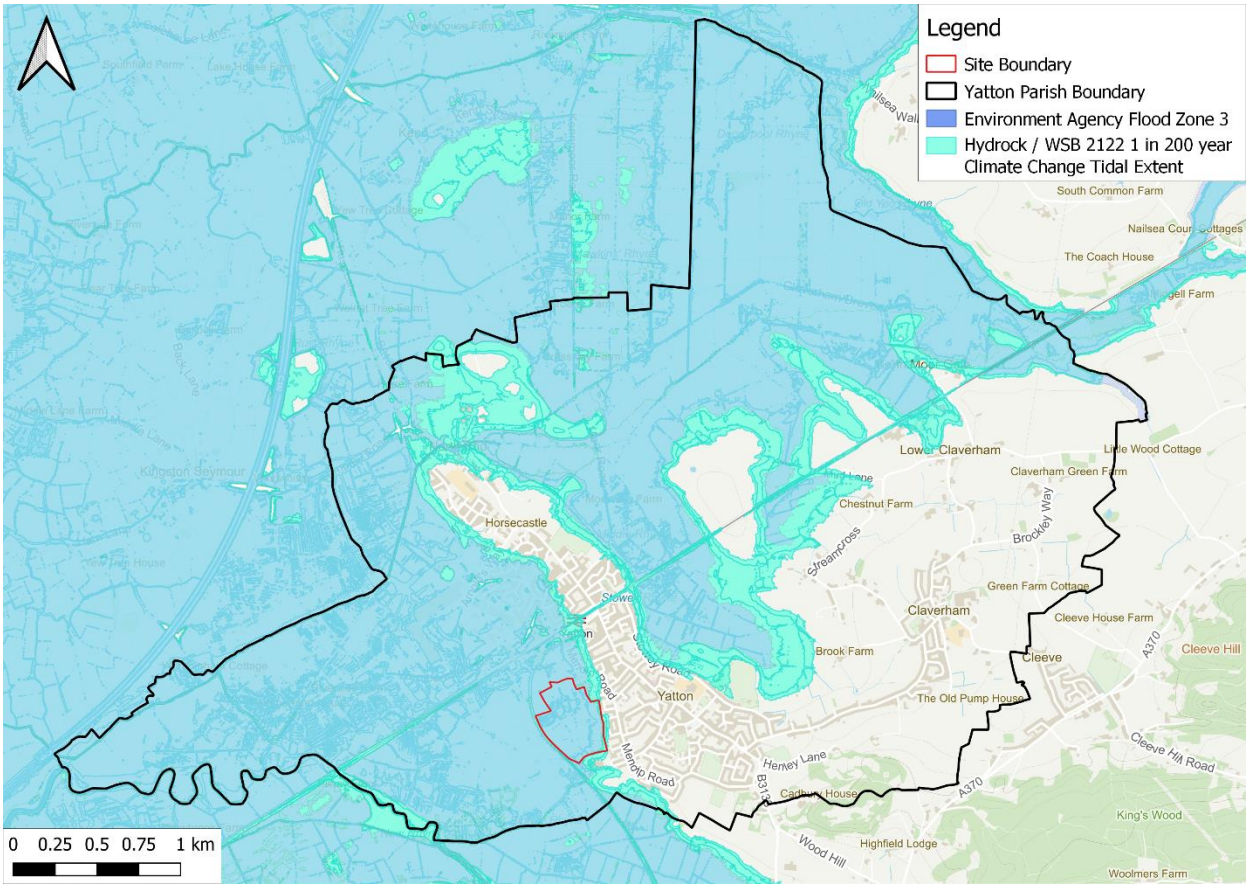

Figure 13. EA Flood Zone 3 and Woodspring Bay 2122 1 in 200 Climate Change Tidal Extent - Yatton Parish

3.1.2.10 *Modelling Summary*

The results of the existing Woodspring Bay 2020 Model and the updated modelling exercise undertaken by Hydrock confirms the site benefits from flood defences up to the 1 in 200-year present day event. However, with the impacts of climate change, these defences are predicted to be overtopped and cause widespread flooding to the Woodspring Bay catchment area in this climate impacts event. The modelling also confirms the site to be impacted by all modelled events in the undefended scenario i.e. removal of all formal defences and that that the LLFA have requested be used to inform worst case risk.

In the all events except the 3.3% AEP (1 in 30-year) present day event, flood waters are not only predicted to enter the site via the culverts under the Strawberry Line but also overtop the disused railway line cause widespread flood extents across the site. For the critical design event, 0.5% AEP (1 in 200-year) with higher central climate change allowances (2122) event, the maximum flood level found on site is 7.88m AOD and maximum depths up to 2.73m on the land parcels but deeper depths associated with the rhyne network up to 3.81m.

Therefore, the majority of the site is confirmed to be within Flood Zone 3a and 2 in the present day but the entire site is predicted to be within this Flood Zone 3a with the effects of climate change.

3.1.2.11 *Updated Modelling*

The updated modelling confirms the site would be impacted by flooding in the undefended 0.5% AEP (1 in 200-year) event for the present day thus confirming the EA Flood Zone 3 extents and the SFRA's Tidal Flood Zone 3a extents. Maximum flood levels for the 1 in 200-year event in the present day are 6.12m AOD, which is a constant level. Maximum depths across the site vary with a maximum of 1.17m on the land parcels (although depths within the rhynes are deeper).

3.1.3 Flood Defences

Figure 14 shows an extract from Figure 040 (included within Appendix B) of the SFRA showing defence types and areas benefitting from defences.

The SFRA states:

"This dataset shows those areas that benefit from the presence of defences in a 1 in 100 (1%) chance of flooding each year from rivers; or 1 in 200 (0.5 %) chance of flooding each year from the sea."

This figure (Figure 14) therefore confirms the site to benefit from the protection of flood defences up to the 1 in 200-year tidal event, with the mapping showing local flood defences running along the Congresbury and Woodspring Bay frontage. This is further confirmed by the EA Flood Map for Planning service which states:

"This location may have a reduced flood risk because of flood defences on a particular river or sea. The flood defences do not remove the risk completely because they can fail."

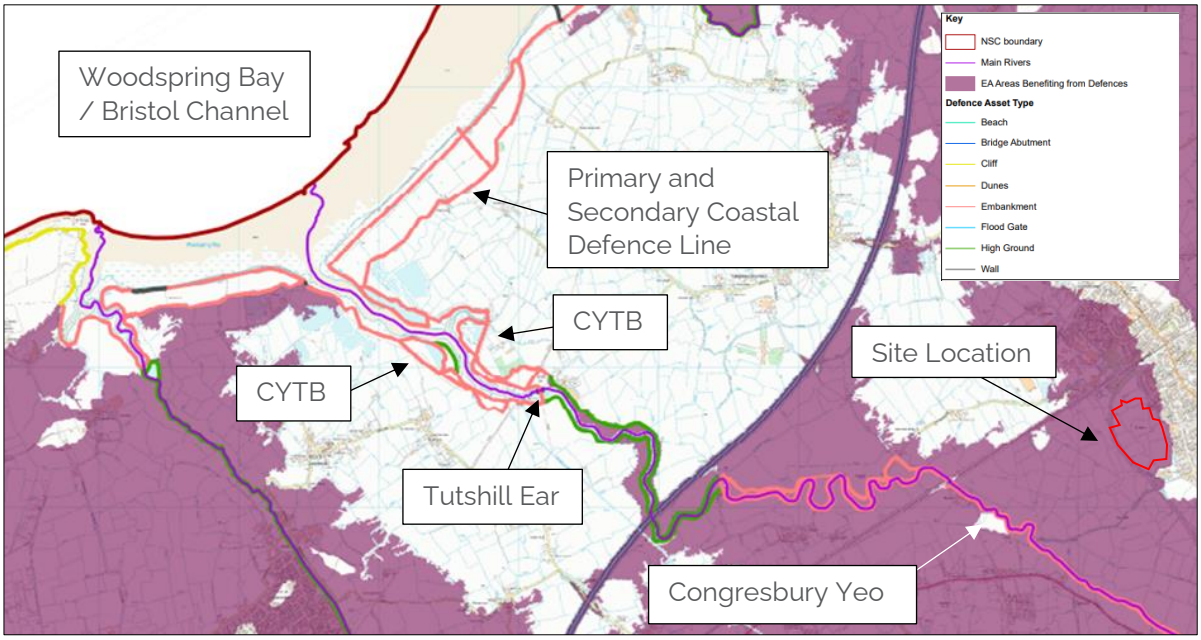

Figure 14. Defence Types and Areas Benefitting from Defences - taken from North Somerset Council Level 1 SFRA Figure 040

The main type of formal flood defence along the Congresbury Yeo are embankments (Figure 14) which run along the left and right bank of the river. EA product 4 (included within Appendix B) data identify the embankments along the right bank of the Congresbury Yeo to have a lowest crest level of 7.33m AOD and a maximum crest level of 7.79m AOD. In comparison to the modelled flood levels, the crest levels of these embankments indicate the site would be protected against flooding in the 0.5% AEP (1 in 200-year) event for the present day (maximum onsite flood level of 6.12m AOD) however, with the inclusion of climate change, the 0.5% AEP (1 in 200-year) for 2122 shows a maximum flood level of 7.88m AOD and therefore above the maximum crest level for the defences along the Congresbury Yeo indicating flood defences will be overtopped with the impacts of climate change - as have been confirmed by the detailed modelling.

The EA FMfP and EA Asset Management Database indicates two water storage areas along the Congresbury Yeo to the south and south east of the site (Figure 3). The SFRA identifies the Gang Wall Flood Storage Area and the Gooseum Rhyne Flood Storage Area are two informal flood storage areas which the SFRA indicate to act as "over-spills" from the Congresbury Yeo and protect Congresbury and Yatton and therefore the site. Whilst the EA Asset Management Database does not give a standard of protection for the areas, the SFRA indicates the two areas to lie within the

functional floodplain (Flood Zone 3b) thus confirming the flood storage areas to be in use during a 1 in 30-year event as a minimums and act as defence for the functional floodplain.

The SFRA states "The Congresbury Yeo was tidal up until 1940 when Phipps Sluice was constructed approximately 6km downstream of the site. The tidal limit was moved further downstream in the 1970s to Tutshill Ear (Figure 14) in order to allow the M5 motorway to be built above high tide level (RH, 2009, Section 3.1.4, pp20)." Whilst this sluice limits the ingress of tidal waters up the river and therefore limiting the interaction between fluvial flows from the Congresbury Yeo and high tidal levels from Woodspring Bay and the Bristol Channel, it does not protect against still water flood risk during extreme sea-level events.

Along the Woodspring Bay frontage at Wick St. Lawrence, approximately 6km north west of the site are a series of embankments, a primary and a secondary defence line (shown in Figure 14 and Appendix B) The smaller primary defence along the coastal frontage acts to break waves before reaching the secondary defence as stated within the Woodspring Bay and Severn House Farm Flood Modelling and Mapping Report (JBA, 2020). The crest levels of these embankments range 7.05 – 9.63m AOD and are away from the site, as indicated within the modelling files of the approved Woodspring Bay 2020 model. Similarly, to the defences along the Congresbury Yeo, the minimum crest level of the embankments along the coastal frontage is above the maximum flood level predicted on site in the 1 in 200-year event for the present day (6.12m AOD) however with the again with the inclusion of climate change, flood levels in the 1 in 200 year event (7.88m AOD) for 2122 confirm defences would be overtopped in some places. This is further identified in Figure 5, which confirms the defences along the Woodspring Bay frontage to protect up to the 0.5% AEP (1 in 200-year) event.

The modelling report also discusses the Congresbury Yeo Tidal Bank Scheme (CYTB) (Figure 14) which is another key piece of coastal defence infrastructure. The report states the CYTB *"…is a tidal defence scheme that was completed to provide improved flood protection for more than 4,100 homes and businesses in North Somerset. The CYTB scheme involved upgrading the existing tidal banks (widening and raising) along the Congresbury Yeo estuary, and the construction of three new sections of bank. The CYTB scheme is located between the towns of Clevedon (to the north) and Weston-super-Mare (to the south)."* The existing embankments were raised to levels of 8.49-9.49m AOD and thus above all flood modelled levels experienced onsite, however, the embankments along the Woodspring Bay frontage are at a lower level and flood waters would still overtop there with the inclusion of climate change allowances. This is further confirmed by results of the original approved Woodspring Bay 2020 model (Figure 5) which shows the defences protecting the subject area (including the site) from extreme tidal events in the present day but are overtopped with the impacts of climate change (Figure 15).

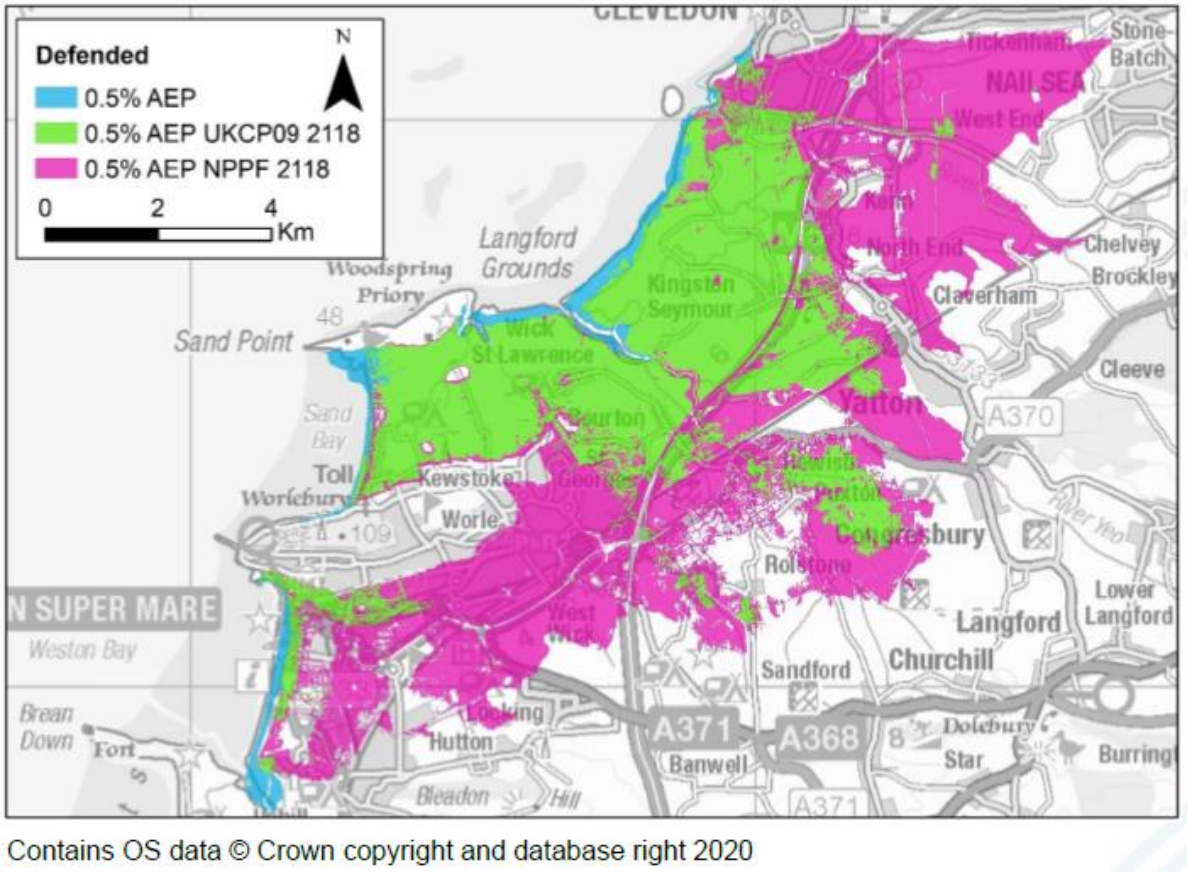

Figure 15. Woodspring Bay Defended scenario 0.5% AEP present day and climate change (2118) comparison – taken from Figure 11-2 of the Woodspring Bay and Severn House Farm Coastal Flood Modelling and Mapping Report (JBA, 2020)

The outputs from the modelling therefore confirms the site to be within the tidal Flood Zone 3a both in the present day and with the inclusion of climate change however, the site is identified to benefit from flood defences up to and include the 1 in 200-year event (Flood Zone 3a) in the present day. With the inclusion of climate change, flood defences are shown to be overtopped and as such the recommended mitigation in Section 4.5 has provided based on the undefended 0.5% (1 in 200-year) plus higher central climate change allowance up to 2122.

3.2 Surface Water Flooding

Surface water flooding occurs as the result of an inability of intense or prolonged rainfall to infiltrate the ground. This often happens when the maximum soil infiltration rate (high intensity rainfall events) or storage capacity is reached i.e. the ground becomes saturated (prolonged period rainfall events). 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.

The EA have produced a risk of flooding from surface water map on behalf of government, to observe how rain water flows and ponds. By using information and input from LLFA's, the maps produced take into account local topography, weather patterns and historical data as stated within the EA Guidance – Flood risk maps for surface water: how to use the map (2013). The available mapping is banded into four levels of flood risk, there are:

- High - each year, the area has a chance of flooding of greater than 1 in 30 (3.3%)
- Medium - each year, the area has a chance of flooding of between 1 in 100 (1%) and 1 in 30
- (3.3%)
- Low - each year, the area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100

» (1%)

» Very low - each year, the area has a chance of flooding of less than 1 in 1000 (0.1%)

The EA's Surface Water Flood Risk Mapping (Figure 16) identifies the majority of the site to be at 'Very Low' risk of surface water flooding. However, the mapping indicates areas of increased risk, up to 'High' risk, associated with the existing rhyne networks. Within the rhynes, the risk is identified to be up to 'High' risk in areas whilst the predicted flood extents that are indicated to extend onto the land parcels is mostly shown to be 'Low' Risk.

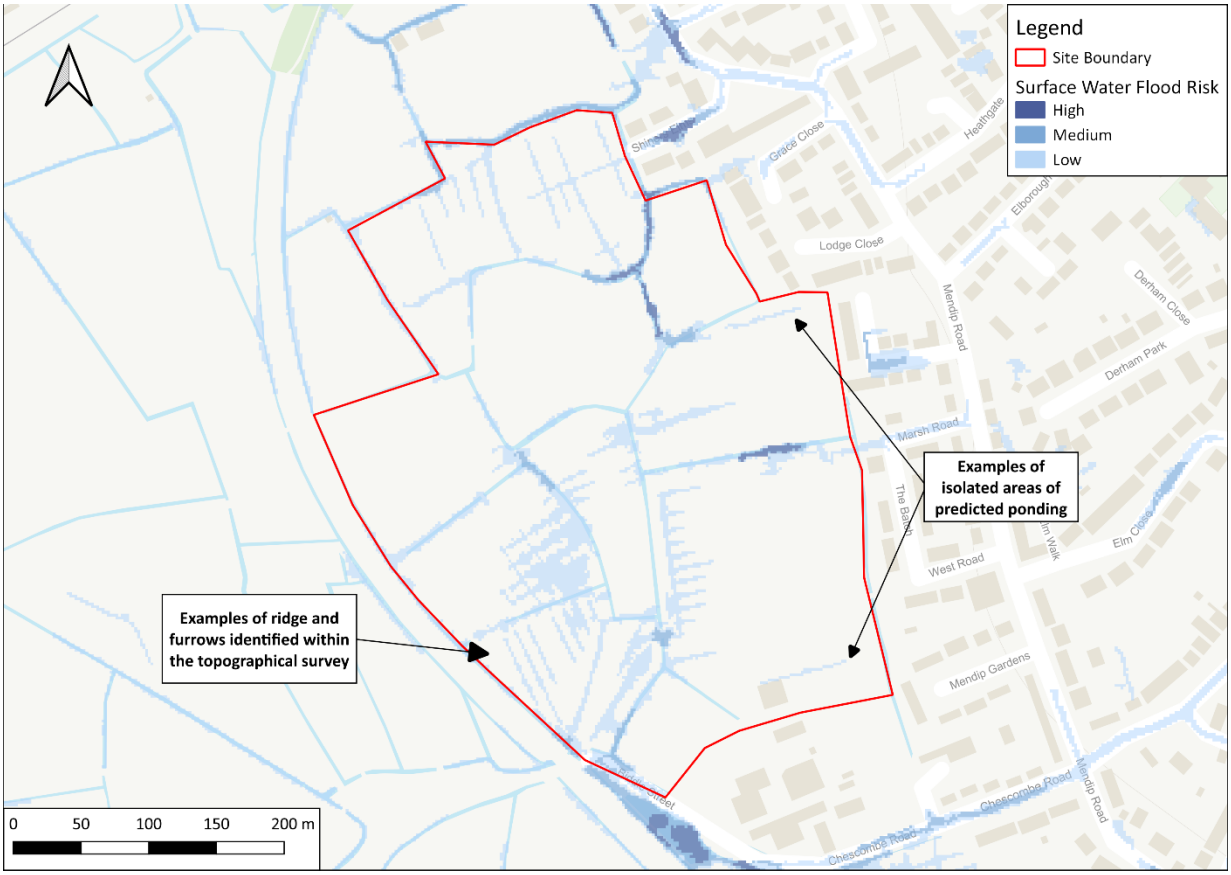

Figure 16. Site Boundary with the EA Surface Water Flood Risk Extents

Based on the extent mapping (Figure 16) the majority of the predicted areas at risk of flooding from surface water show connectivity between the rhyne network and the land parcels however, there are some isolated areas of flooding identified within the site boundary which show no connectivity. The extent mapping also shows examples of the ridge and furrows that were identified within the topographical survey.

Figure 17 taken from EA Long Term Flood Risk Mapping Service[2] shows estimated velocities and predicted flow directions for the onsite flooding. The velocity vector mapping identifies the majority of rhynes within the site boundary to have a general flow towards the western and southern boundaries but also indicate some potential flow north. Mapping identifies that the predicted flooding shown to pond on the land parcels to have a general flow direction into the rhyne network and confirming connectivity i.e. surface water runoff on the land parcels will generally drain towards the existing rhyne network. Although, there are areas of isolated ponding identified within

[2] EA Long Term Flood Risk Service - https://check-long-term-flood-risk.service.gov.uk/map

the site boundary and these are not shown to flow anywhere. The mapping (Figure 17) indicates flows predominantly travel at velocities of below 0.25m/s, although flows exceed 0.25m/s within the rhynes flowing along the northern site boundary and these are therefore a higher risk due. The velocity vectors on the mapping indicate a potential 'off-site' flow route entering the site along the northern boundary originating from the residential developments to the east and also in the south of the site a flow route is identified along Chescombe Road which is also shown to potentially enter the site. Although mapping does not indicate a significant amount of ponding / flood extents as a result of these offsite flows, these will likely contribute to surface water on site and therefore needs to be managed accordingly.

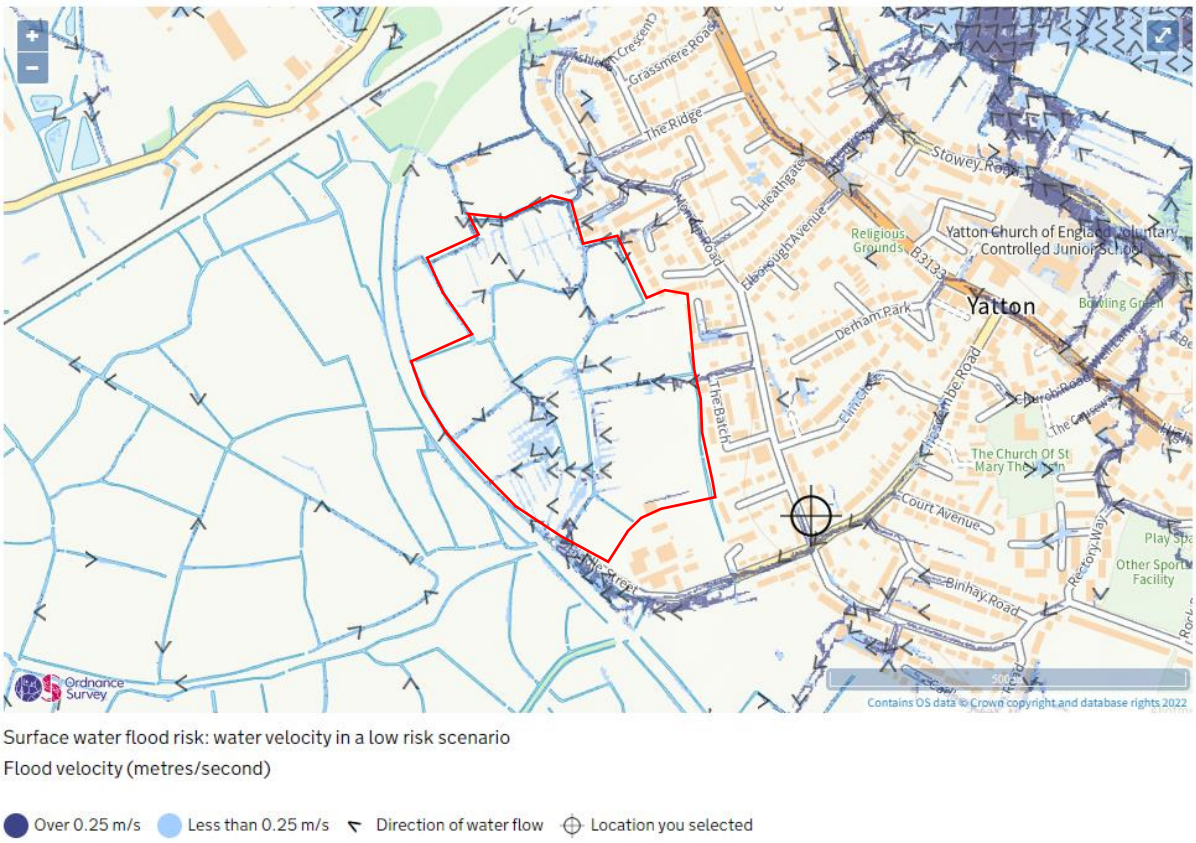

Figure 17. EA Surface Water Flood Risk Velocity Mapping

The Long Term Flood Risk Service also provides predicted flood depths for the identified surface water flood risk (Figure 18). The banding for the depth maps were selected by the EA based on feedback from the LLFA's, the following categories were selected:

Table 5. EA Banding for Flood Water Depth – "What is the Risk of Flooding from Surface Water map?" EA, 2019

Depth (m)	
<0.15	
0.15-0.30	At 0.15m, flooding would: » typically exceed kerb height (standard kerb height is 125mm) » likely exceed the level of a damp-proof course » cause property flooding in some areas
0.30-0.60	At 0.30m flooding is likely to cause property flooding. This is based on average property threshold levels.

0.60-0.90	Property-level flood resilience measures are typically effective up to a water depth of 0.60m above floor level. Above depths of 0.60m these measures are likely to be much less effective and structural damage is more likely to occur. However, as floor levels vary, the maximum flood depth where resilience measures are still effective may be in a range between 0.60m and 0.90m above ground level.
0.90-1.20	Very likely to exceed the maximum flood depth where property-level flood resilience measures are still effective
>1.20	

The published map available to view on the EA Long Term Flood Risk Service as part of the Risk of Flooding from Surface Water map groups these into categories of 'below 300mm', '300 – 900mm' and 'above 900mm'.

The mapping (Figure 18) indicates that the majority of predicted surface water flooding on site, both in the rhynes and on the land parcels to be predominantly below 300mm and would therefore be considered shallow. However, within the rhyne network, the mapping identifies small reaches which are predicted to have deeper depths between 300 – 900mm although these deeper areas are not indicated to extend onto the neighbouring land parcels.

Shallow overland flooding, such as those areas identified on to be at risk on the land parcels, is likely representative of shallow sheet flow and between the ridge and furrow. Sheet flow is defined as shallow overland flow which follows local topographical flow routes. As shown by the vector velocity mapping, the majority of the flooding on the land parcels are shown to flow towards the rhyne network and likely local topography.

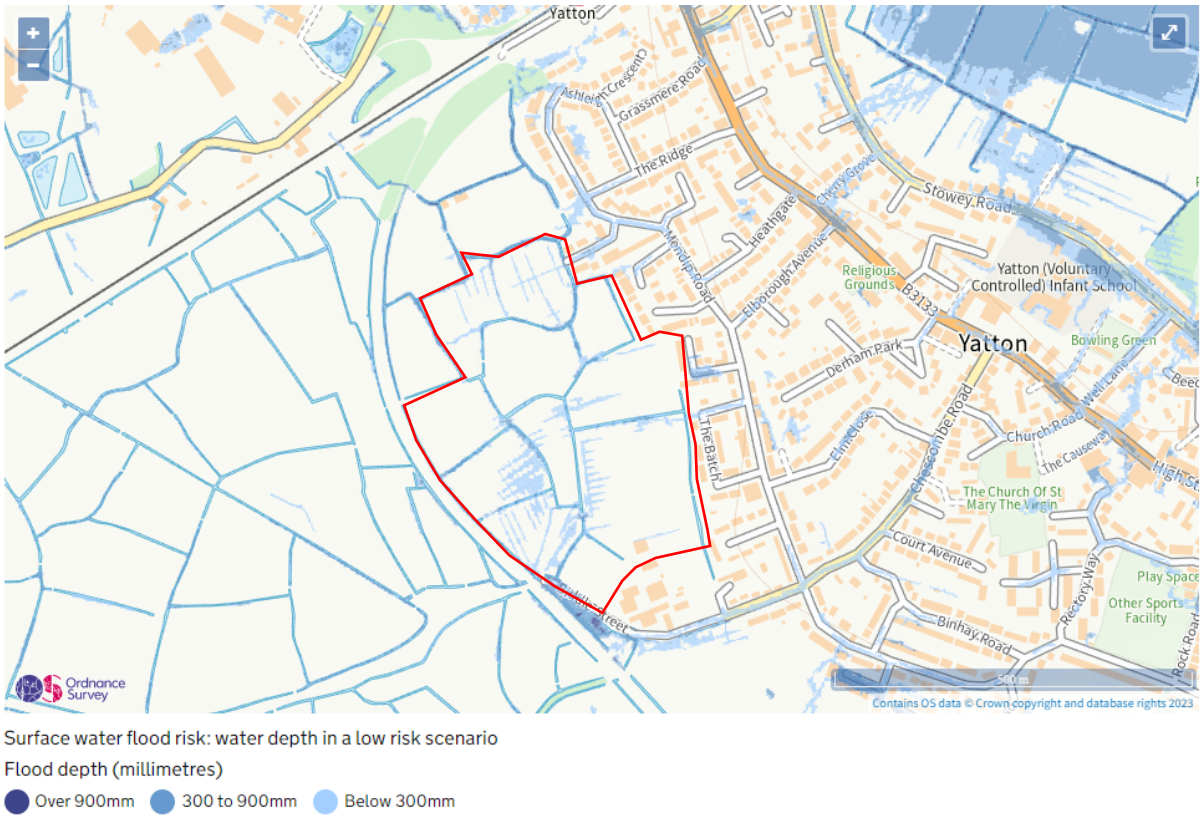

Figure 18. EA Surface Water Flood Risk Depth Mapping

Whilst the EA mapping indicates some areas on site to be at an increased risk, the majority of this is limited to either the rhyne network or is indicated to flow towards the rhyne network rather than

pond on the land parcels. However, whilst this may be so, as the mapping identifies the flooding on the land parcels, it must be managed in accordance with national and local policy.

As stated by Paragraph 059 of the NPPG this report has described the surface water flood risk to the site and identified large portions of the site to be at 'Very Low' risk of flooding with regards to surface water sources but has also identified areas on site, mainly the rhyne network, to be at an increased risk, up to 'High' risk.. However, as identified within this report, offsite flows are indicated to enter the site along the northern and southern boundaries of the site and the proposed development must ensure these flow routes are maintained to ensure no detrimental impact to third party land (i.e. blocking of flow routes through raising of development).

3.3 Groundwater Flooding

The British Geological Survey (BGS) provide an online Geology Viewer[3] for the UK. This mapping indicates the entire site is underlain by bedrock geology of the Mercia Mudstone Group, consisting of mudstone and halite stone. This is overlain by superficial tidal flat deposits, consisting of clay and silt. At the time of writing, a Geophysical Survey report has been completed by Headland Archaeology but no intrusive ground investigation work has yet been undertaken.

It is understood, from a review of readily available information that:

"With little to no superficial geology covering the majority of the site, especially the southern parcel and the nature of the underlaying geology (Mercia Mudstone Group) it can be inferred that the ground conditions are relatively impermeable and clayey resulting in little shallow groundwater. Any shallow ground water that is present is likely to drain south towards the Binhay Rhyne brook. As a result of the potentially low permeability of the subsurface the flux of water is likely to be small".

Whilst the predicted generally low permeability of mudstone type geologies suggests there is limited potential for groundwater emergence, the SFRA shows the north-eastern portion of the site to lie within a *Historic Waterlogged Area*. Figure 19, taken from Figure 035 (included within Appendix B) in the North Somerset SFRA shows the area along the north western boundary which is indicated to be within the *Historic Waterlogged Area*, limited information is available within the SFRA regarding the waterlogged area however the SFRA does identify that the majority of areas where this historic waterlogging has occurred in North Somerset all have mostly clayey soils. The clayey type soils are likely to act as an impermeable layer with water unable to infiltrate through to the bedrock causing waterlogged areas following prolonged periods of rainfall.

[3] BGS Geology Viewer - https://www.bgs.ac.uk/map-viewers/bgs-geology-viewer/

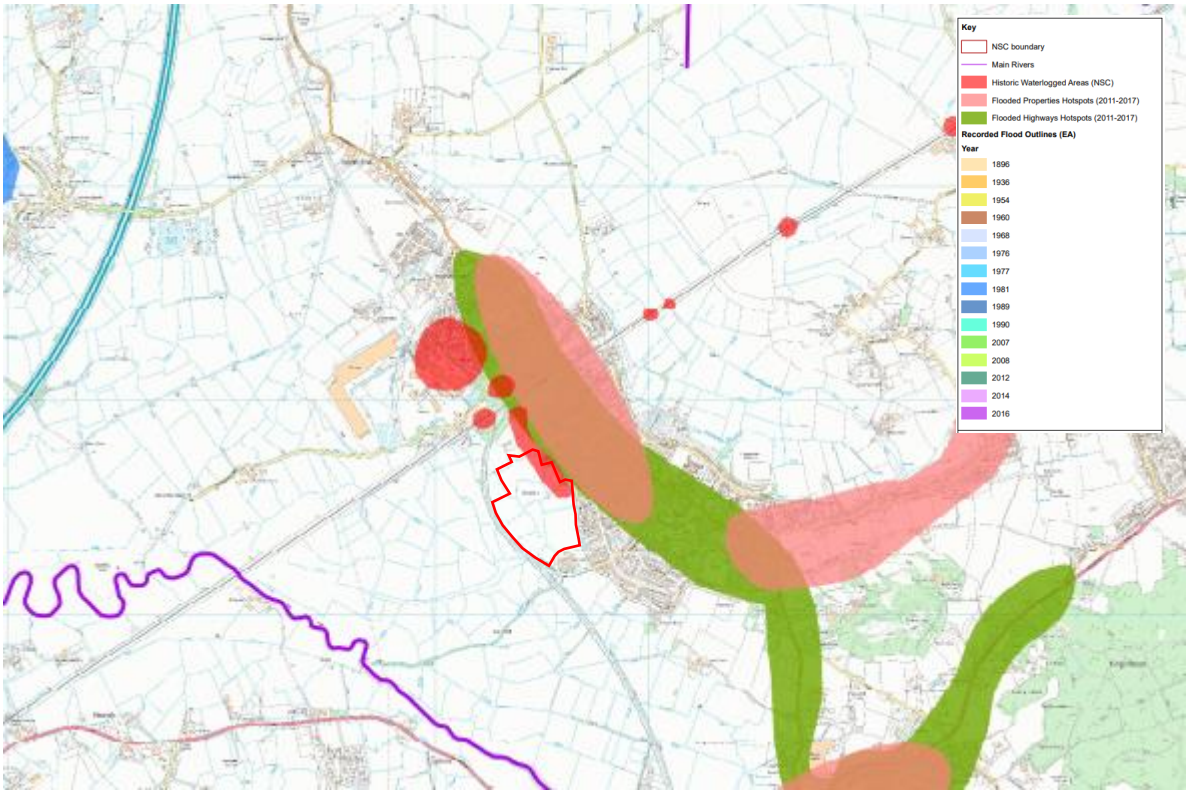

Figure 19. Historic Flood Information - Taken from Fig 035 from the SFRA

Online Soilscapes viewer (Figure 20) from the Cranfield Soil and Agrifood Institute (CSAI), supported by Defra, identifies the site to be overlain by 'loamy and clayey soils of coastal flats with naturally high groundwater'. The drainage type within this soil is identified by this service to be 'naturally wet'. The clayey type soils identified by the Soilscapes viewer therefore align with the information within the SFRA regarding waterlogging areas and having mostly clayey based soils.

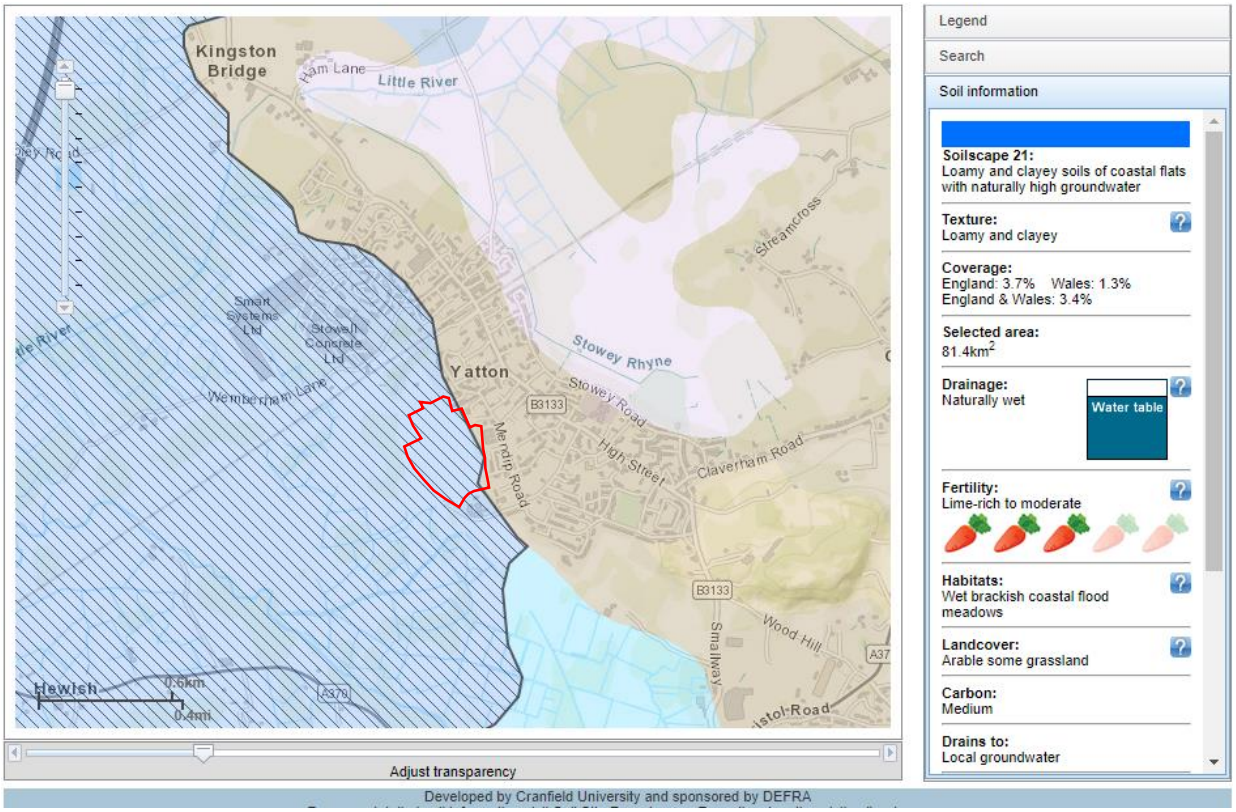

Figure 20. Soilscapes Mapping

As mentioned, there is an extensive rhyne system within the site boundary. It is likely that this rhyne network will be hydraulically linked with any groundwater and act as a natural drawdown point and as such, groundwater is unlikely to get higher than normal channel water levels. Should flood events occur, on site, water levels within the rhynes will likely raise potentially overtopping bank tops and thus causing potential groundwater emergence however, in these scenarios it is likely there would be significant flooding from other sources (e.g. tidal) and as such the recommended mitigation in Section 5.1. would be sufficient in protecting the development.

Nevertheless, given the identified *Historic Waterlogged Area* in the north east of the site and the identified clayey soils from Soilscapes mapping there is potential for high groundwater (subject to confirmation) and therefore potential for groundwater emergence in the *waterlogged* areas.

3.4 Infrastructure Failure Flooding

The developed nature of the surrounding area to the East of the site suggests it is likely that there are drainage systems serving the adjacent development. In the event of surcharging of the sewer network up-catchment of the site, flows will likely be directed towards the existing rhyne network on-site using the road network as a preferential flow route before following local topography on site, as indicated by the EA Surface Water Mapping velocity vectors (Figure 17).

The SFRA identifies the Congresbury and Yatton postcode (BS49) to be amongst the higher risk areas with regards sewer flooding when viewing the total number of properties flooded from sewers. In the sites postcode (BS49 4), Wessex Water Property Sewer Flooding Records indicates one property has reported internal flooding and 15 have reported external flooding, however no specific locations have the properties have been provided. No information is given in the SFRA as to the cause of the flooding incidents however 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'. As above, the Surface Water Mapping velocity vectors suggest any flooding on site (either generated on site or from off-site sources up catchment (Yatton)) will ultimately flow into the existing rhyne network using the

existing road network as a preferential flow route and travel overland before reaching the rhyne network. Flood extents in these areas are not indicated to be significantly larger as a result of the offsite flows.

The EA Long Term Flood Risk Service provides extent mapping for flooding from reservoirs both when river levels are normal and when there is also flooding from rivers. Mapping identifies the site lies within the maximum extent of flooding in the event of a catastrophic failure of Blagdon Lake, located approximately 9.5km south east of the site. Given the monitoring and maintenance requirements for such reservoirs under the Reservoirs Act 1975 in England, which requires reservoir owners to regularly inspect and maintain the reservoirs, the risk of such an occurrence is considered to be very low, and would be considered a 'residual' risk. Whilst no further information is available with regards to the reservoir flooding from Blagdon Lake, EA advice[4] is clear that *"if development is to be considered in an area at risk of reservoir flooding that the developer should contact the reservoir owners to understand the flood risk in more detail and how development could be affected."* As such, at the request of the LLFA via e-mail (28/02/2023 – Appendix B) contact has been made with the reservoir owner (Bristol Water) to establish the risk category for the reservoir and the depth and hazard ratings of the predicted flooding, yet no further information has been received to date.

There is no known risk of flooding from canals or any other artificial sources at the site and as such the site is concluded to be at 'negligible risk' from infrastructure failure flooding.

[4] EA (2021) Reservoir flood maps: when and how to use them - https://www.gov.uk/guidance/reservoir-flood-maps-when-and-how-to-use-them

4. National Planning Policy Framework

4.1 National Policy and Guidance

The following policy documents have been identified as being of relevance to this Planning Application and Flood Risk Assessment:

- NPPF (2021)
- National Planning Practice Guidance for Flood Risk and Coastal Change (2022)
- North Somerset Council (Level 1) Strategic Flood Risk Assessment (SFRA) (2020)
- North Somerset Council Development Management Policies (2016)
- North Somerset Council Core Strategy (2017)

National Planning Policy Framework – Planning and Flood Risk

Paragraph 159 of the NPPF states *'Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.'*

With Paragraph 161 states: *'All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property'*

Paragraph 162 states: *'The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.'*

With regards to the exception test the NPPF states: *'…To pass the exception test it should be demonstrated that:*

a. *the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*
b. *the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.'*

Paragraph 167 states: *'…Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*

c. *within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
d. *the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
e. *it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
f. *any residual risk can be safely managed; and*
g. *safe access and escape routes are included where appropriate, as part of an agreed emergency plan.'*

National Planning Policy Guidance – Flood Risk and Coastal Change

On the 25th August 2022, the National Planning Policy Guidance (NPPG) for flood risk and coastal change was updated to bring it in line with the latest policy position on flood risk introduced in the updates to the National Planning Policy Framework in 2018 and 2021.

The key changes to impact the site within the NPPG are as follows:

Design Flood

Paragraph 002 states: This is a flood event of a given annual flood probability, which is generally taken as:

- river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year); or
- tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or
- surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year),

plus an appropriate allowance for climate change.

Functional Floodplain Definition

The definition of the functional floodplain is now regarded as the 3.3% AEP, or 1 in 30-year event. Previously this was defined as the 5% AEP or the 1 in 20-year event and will need to be considered.

Sequential Test

The Sequential Test ensures that a sequential, risk-based approach is followed to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account. Where it is not possible to locate development in low-risk areas, the Sequential Test should go on to compare reasonably available sites:

- Within medium risk areas; and
- Then, only where there are no reasonably available sites in low and medium risk areas, within high-risk areas

Flood Mitigation

This iteration of the PPG adopts an updated hierarchical approach to flood risk within the guidance. The hierarchy states that (in order of preference) flood risk to development should be reduced through:

- Avoidance of flood risk in plan making, decision making and within sites through sequential allocation.
- Control of flood risk through engagement with flood risk management authorities
- Mitigation of flood risk through use of flood resistance and resilience measures
- Management of residual flood risk through management measures and flood warnings.

Off-Site Impacts

The NPPG specifies that where it is not possible to provide on-site level-per-level compensatory storage, it may be acceptable to provide storage off-site provided it is hydraulically and hydrologically linked.

4.2 Local Policy and Guidance

North Somerset Council (Level 1) Strategic Flood Risk Assessment (SFRA) (2020)

Section 6.1 of the North Somerset Council SFRA (2020) identifies current levels of flood risk. In relation to Yatton and Congresbury it states

"The area partly falls within Tidal and Fluvial Flood Zone 2 and 3, however most of the residential areas lie within Flood Zone 1. There are nearby locations that lie within functional floodplain along the Congresbury Yeo and River Kenn, as well as an informal flood storage area ('Gang Wall') for over-spilling from the Congresbury Yeo. There are also large areas at risk from surface water flooding at Yatton and Claverham, south of the railway, in the Stowey Rhyne catchment and also south of Yatton in the valley of the Congresbury Yeo. The area mostly falls within 1km grid squares with 25% of their area susceptible to groundwater flooding. Part of Congresbury and a small area of Yatton would be at risk of flooding if Blagdon Lake failed. Also, there have been 16 sewer flooding events recorded within Yatton between 2005 and 2015, almost all of them being cases of external flooding. More than 50 sewer flooding events have been recorded in Wrington during the same period."

The site has been identified within the SFRA as lying within the tidal flood zone 3a, with the north eastern boundary of the site being within a *'Historic waterlogged area'*. Development Management Recommendations for sites within Flood Zone 3a within the SFRA state:

"Opportunities should be sought: to reduce overall level of flood risk in the area through layout and form of development and appropriate application of SuDS; to relocate existing inappropriate development to land with lower probability of flooding; and to create space for flooding to occur. All existing 'solid buildings' are considered to be within Zone 3a for planning purposes, together with any other land prevented from flooding in a 5% (1 in 20) annual chance event by the presence of solid buildings and existing infrastructure, unless designed to allow the passage of water (even if in Zone 3b on flood map). Sequential Test required."

Level 2 Strategic Flood Risk Assessment

The site is within Area 4 – Land around Yatton and Congresbury. The summary table for the area suggests that in terms of flood risk *'flooding is extensive but shallow, though risk is relatively high due to low return period of onset'* and in terms of the hazard rating 'Low for land between Yatton and Congresbury. Moderate to the west of Congresbury.'

North Somerset Local Plan

It is understood that North Somerset is in the process of preparing a new Local Plan to take the place of the Core Strategy and Sites and Policies Plan called Local Plan 2038. However, this is not anticipated to be submitted for examination until Autumn 2023, therefore the current guidance at this time is the Core Strategy and Sites and Policies Plan.

Core Strategy

North Somerset Council Core Strategy (2017) was fully readopted in 2017. Within the Core Strategy Yatton has been identified as a Service Village which states:

Vision 6 Service Villages Vision

"By 2026 the Service Villages will become thriving rural communities and a focal point for local housing needs, services and community facilities. They will become more self-contained in terms of providing jobs and serving the local and surrounding community for all their day-to-day needs, whilst protecting their individual character."

Policies relating to flood risk include:

Policy CS3: Environmental Impacts and Flood Risk Assessment

Development that, on its own or cumulatively, would result in air, water or other environmental pollution or harm to amenity, health or safety will only be permitted if the potential adverse effects would be mitigated to an acceptable level by other control regimes, or by measures included in the proposals, by the imposition of planning conditions or through a planning obligation.

Development in zones 2 and 3 of the Environment Agency Flood Map will only be permitted where it is demonstrated that it complies with the sequential test set out in the National Planning Policy Framework and associated technical guidance and, where applicable, the Exception Test, unless it is:

- *development of a category for which National Planning Policy Framework and associated technical guidance makes specific alternative provision; or*
- *development of the same or a similar character and scale as that for which the site is allocated, subject to demonstrating that it will be safe from flooding, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

For the purposes of the Sequential Test:

2. *The area of search for alternative sites will be North Somerset-wide unless:*
   a. *It can be demonstrated with evidence that there is a specific need within a specific area; or*
   b. *The site is located within the settlement boundaries of Weston (including the new development areas), Clevedon, Nailsea and Portishead, where the area of search will be limited to the town within which the site is located. Other Local Development Documents may define more specific requirements.*
3. *A site is considered to be 'reasonably available' if all of the following criteria are met:*
   a. *The site is within the agreed area of search.*
   b. *The site can accommodate the requirements of the proposed development.*
   c. *The site is either: a) owned by the applicant; b) for sale at a fair market value; or c) is publicly-owned land that has been formally declared to be surplus and available for purchase by private treaty.*

Sites are excluded where they have a valid planning permission for development of a similar character and scale and which is likely to be implemented.

North Somerset Council: Sites and Policies Plan Part 1. Development Management Policies

The Sites and Policies Plan brings forward the detailed development plan policies which complement the strategic context set out in the Core Strategy, and was formally adopted in 2015.

The relevant policy in relation to flood risk is DM1, which states:

DM1: Flooding and Drainage

All development must consider its vulnerability to flooding, taking account of all sources of flood risk and the impacts of climate change, up to 100 years ahead on residential or mixed-use sites and 60 years ahead on non-residential sites. Exceptions to national policy on flood risk (as elaborated in national technical guidance and in Policy CS3 of the North Somerset Core Strategy) will not be permitted.

All development that would increase the rate of discharge of surface water from the site must consider its implications for the wider area, including revised or amended proposals. Sustainable drainage systems are expected; alternatives will only be permitted where sustainable drainage is impractical and the alternative does not conflict with national or local planning policy. If discharge of surface water to a public sewer is proposed, the applicant must demonstrate that capacity exists, otherwise,

how excess surface water will be managed into the long-term. Essential flood prevention and drainage works for developments that include new housing must be completed prior to first residential occupation, except in the case of phased developments where alternative arrangements are agreed.

Open areas, including highways, within developments must be designed to optimise drainage and reduce run-off, while protecting groundwater resources and quality.

Land is safeguarded for a strategic flood solution at the former Weston Airfield and to the south of the Cross Rhyne, and for flood management infrastructure along the River Banwell as shown on the Proposals Map.

Yatton Neighbourhood Plan (2017-2026)

The Yatton Neighbourhood Plan was developed under the NPPF to reflect the needs and priorities of the community. The relevant policy in relation to flood risk is HO 2, which states:

HO 2. To avoid any increase in the risk of flooding in Yatton as a result of new house developments

4.3 Sequential Test

The NPPF Sequential Test requires that a sequential approach is followed to steer new development to areas with the lowest probability of flooding (i.e., Flood Zone 1, then 2, then 3).

This assessment has demonstrated that the site is currently on land designated as Flood Zone 2 and 3a by the EA's Flood Zone Mapping. The assessment has also shown the site to benefit from significant flood defences however it is not classified by the EA as being 'defended' on their mapping. As such, and based on this assessment, the site is considered for the purpose of this assessment as entirely within Flood Zone 3a.

Whilst the modelling identifies the site to be impacted by the 3.3% AEP (1 in 30-year) event (FZ3b) in the undefended scenario, the site is not predicted to be impacted by any tidal flooding up to and including the 0.5 % AEP (1 in 200-year) event due to the presence of defences (when considered). Whilst the LLFA has requested that an undefended scenario be unertaken it is considered this is to inform suitable mitigation to adopt a design for exceedance approach. It should be noted that within the SFRA, North Somerset Council delineates Flood Zone 3b *"…where the risk of flooding is predicted to be 1 in 20 (5%) AEP or greater, taking into account the presence of defences."*. In line with this, the site is concluded as being within Flood Zone 3a due to 3b being defended both present day and development design life.

With the inclusion of climate change based on the latest EA sea level rise allowances, the 1 in 200-year event (FZ3a) up to 2122 for the developments design life shows the entire site would be within Flood Zone 3a as a result.

The specific site is not allocated within the local plan, however Yatton (including the site) has been identified within the North Somerset Council Core Strategy (2017) as a Service Village which states: *Vision 6 Service Villages Vision - "By 2026 the Service Villages will become thriving rural communities and a focal point for local housing needs, services and community facilities. They will become more self-contained in terms of providing jobs and serving the local and surrounding community for all their day-to-day needs, whilst protecting their individual character."*

In line with NPPF, NPPG and Local Policy CS3 from the North Somerset Core Strategy (2017) development in Flood Zones 2 and 3a must demonstrate that it complies with the Sequential Test as set out in the NPPF. As such, it is recommended the Planning Consultant undertake the Sequential Test in anticipation of the planning submission to confirm site suitability but the current allocation should add weight to the acceptability of residential development in this location..

4.4 Exception Test

Outline planning application for the development of up to 190 homes (including 50% affordable homes), 0.13ha of land reserved for Class E uses, allotments, car parking, earthworks to facilitate sustainable drainage systems, open space and all other ancillary infrastructure and enabling works with means of access from Shiners Elms for consideration. All other matters (means of access from Chescombe Road, internal access, scale, layout, appearance and landscaping) reserved for subsequent approval

The residential units and Doctors surgery fall under the category of 'more vulnerable' development in accordance with Table 2 of the Flood Risk and Coastal Change National Planning Practice Guidance (NPPG).

Table 6 (taken from Table 2, Paragraph 079 of NPPG) shows that more vulnerable developments are suitable in Flood Zone 1 and 2 however should any developments be located within Flood Zone 3a, an Exception Test would be required to be passed in order for development to be permitted.

Table 6: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception Test required	✓	✓
Flood Zone 3a	Exception Test required	✓	X	Exception Test required	✓
Flood Zone 3b	Exception Test required	✓	X	X	X

Where ✓ means development is appropriate and X means development should not be permitted

Paragraph 031 of the NPPG states that as part of the Exception Test, two elements must be *"satisfied before allowing development to be allocated or permitted situations where suitable sites at lower risk of flooding are not available following application of the sequential test. It should be demonstrated that:*

a. *development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk; and*
b. *the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."*

This flood risk assessment demonstrates part b, that the recommended mitigation will ensure the development will be safe for its lifetime without increasing flood risk elsewhere however evidence supporting a planning application should demonstrate 'part a' can be passed following the application of the Sequential Test.

4.1 Mitigation Measures

Whilst an Exception Test is to be undertaken (as noted above), the following section details measures recommended to mitigate any 'residual' flood risks, to ensure that the proposed development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, akin to the requirements of section 'b' of the Exception Test, as outlined in the NPPF.

4.1.1 Level Raising

As discussed earlier in this report, the development is to be located in the areas of site with the predicted shallowest flood depths in the present-day scenario in the eastern portions. However, for the developments design life (100 years) the inclusion of climate change to the Woodspring Bay 2020 model indicates the entirety of site to be inundated with a maximum flood level of 7.88m AOD in 2122 0.5% AEP (1 in 200-year) plus Higher Central climate change tidal event. In accordance with local and national policy, and through a combination of ground raising and setting of finished floor levels (FFLs) all proposed dwellings are recommended to be set to include a 600mm freeboard above the 1 in 200-year plus climate change event. This means the FFLs should be set to a minimum level of **8.48mAOD**.

4.1.2 Safe Access and Egress

The latest site layout plan indicates there are two proposed access and egress routes for the proposed development, one in the north leading onto the existing Shiners Elms and another in the south leading onto the existing Chescombe Road. Existing Flood Zone mapping shows the northern site entrance to be within present day Flood Zone 2 and 3 and this is further confirmed from outputs of the Woodspring Bay 2020 model. However, the southern access point onto Chescombe Road is shown to be within Flood Zone 1 and therefore predicted lowest risk of fluvial and tidal flooding in the present day and as such would be a safe access and egress route in the event of a flood event. With the impact of climate change however, the 1 in 200 year plus Higher Central allowance shows the access point onto Chescombe Road would be pushed into Flood Zone 3a, although at the very limit of flooding where flood waters are predicted to be much shallower than those experienced on site with maximum depths up to 1m on the access road (Figure 21).

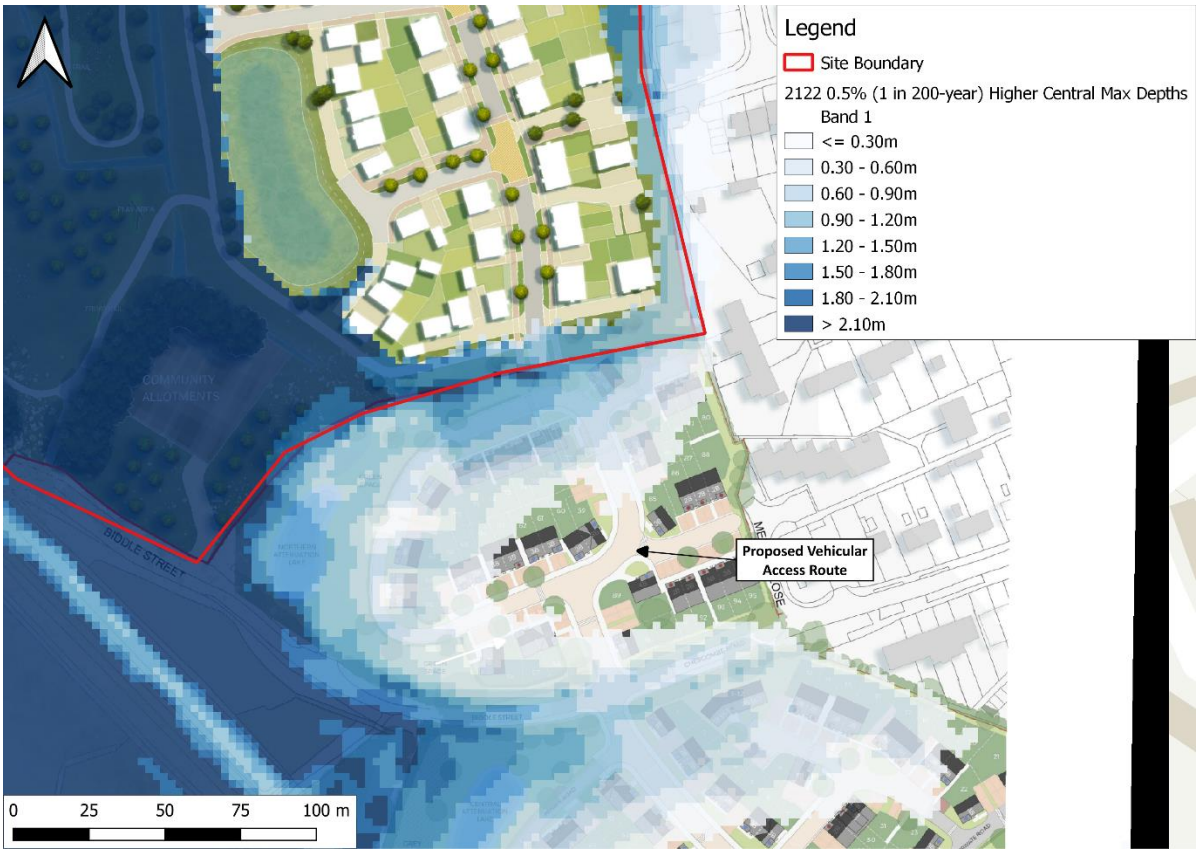

Figure 21. Maximum flood depths for the southern vehicular access route - 0.5% (1 in 200-year) AEP Higher Central Event (this figure includes proposed ground raising with plots)

Modelling outputs have also identified areas of lowest hazard in accordance with Defra *'Framework and Guidance for Assessing and Managing Flood Risk for New Development'* (FD2320/TR2). This guidance assesses the threshold for flood hazard ratings and classifies them as:

- *Low (Hazard) - Caution - "Flood zone with shallow flowing water or deep standing water"*
- *Moderate (Hazard) - Dangerous for some (i.e. children) - "Danger: Flood zone with deep or fast flowing water"*
- *Significant (Hazard) - Dangerous for most people - "Danger: flood zone with deep fast flowing water"*
- *Extreme (Hazard) - Dangerous for all - "Extreme danger: flood zone with deep fast flowing water"*

The results of the modelling (Figure 22) show the site to be classified as an Extreme degree of flood hazard however the southern vehicular access is shown to pass through areas identified as lower hazard ratings, with part of it shown to be outside of the flooding extent entirely.

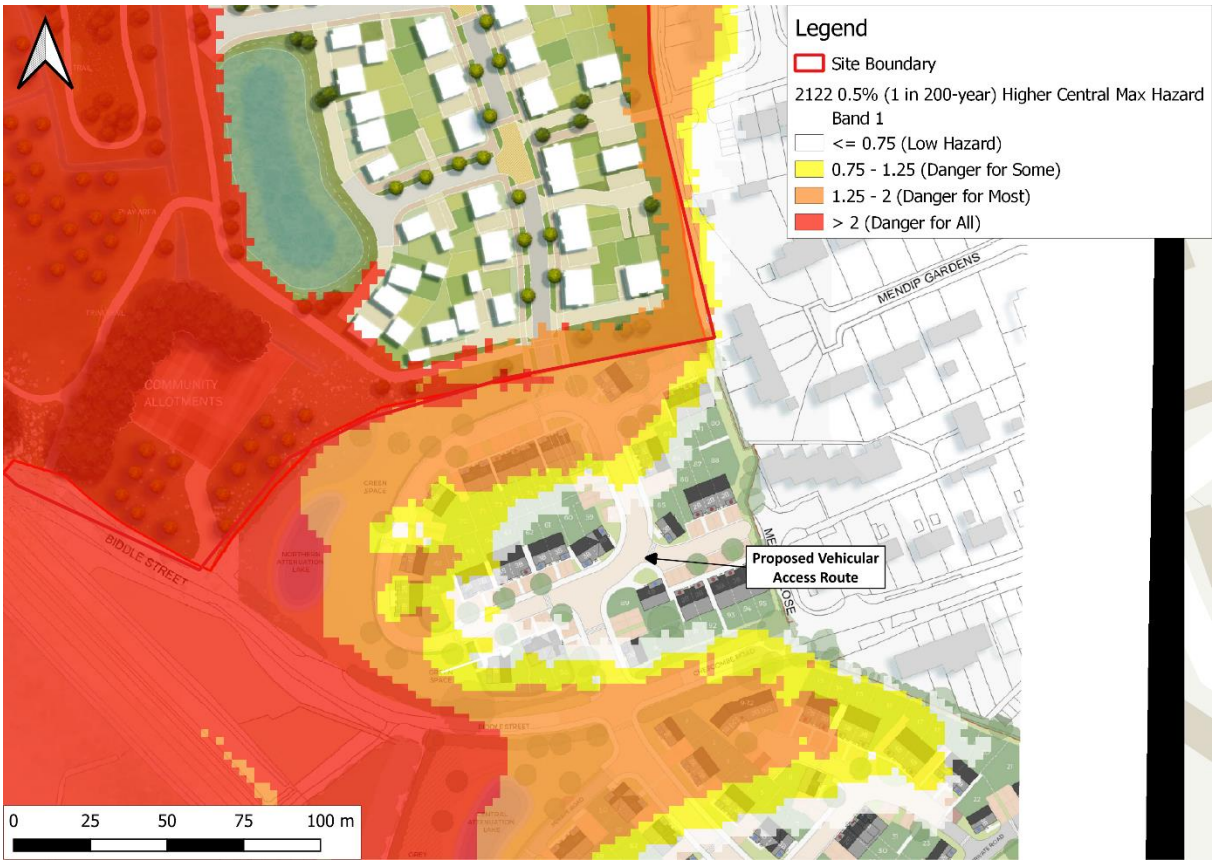

Figure 22. Maximum hazard ratings for the southern vehicular access route - 0.5% (1 in 200-year) AEP Higher Central Event (this figure includes proposed ground raising with plots)

Therefore, to address safe access and egress onto the site, it is recommended that this be addressed through a Flood Warning and Evacuation Plan (FWEP). The proposed FWEP should make residents and visitors aware of the potential risks to site and what to do should an extreme tidal flood occur, showing access and egress routes off the site. The recommended mitigation also ensures that in the event residents cannot leave the site during a flood event, there will be an area for safe refuge in the properties where residents can remain until flood waters recede.

It should be noted that whilst sections of the site and access are shown as being at increase hazards this is at the very peak of the modelling tidal event and the above figures do not show the reaction to the event. Given the dominant source is tidal this is a very predicted mechanism of flooding with high tides being predicted a long way into the future (i.e. weeks) so as to ensure

suitable warnings and measures can be implemented (i.e. evacuation etc). Further to this the modelling has been used to determine the length of time from first out of bank flooding occurring to this impacting the site. The modelling (and as shown in Figure 23 below) shows that flooding first occurs within the site **15hours** after the first out of bank flows occur north of the M5 Motorway / Mouth of the Congresbury Yeo and some 4.5km north west of the site. Water levels on the site then continue to increase throughout the site with maximum flood levels and hazards as shown on Figure 24. Given the minimum lead in time of 15hours on a predictable event it is considered that through preparation of a Flood Warning and Evacuation Plan suitable measures will have time to be implemented such that access and egress can be achieved safely through the site.

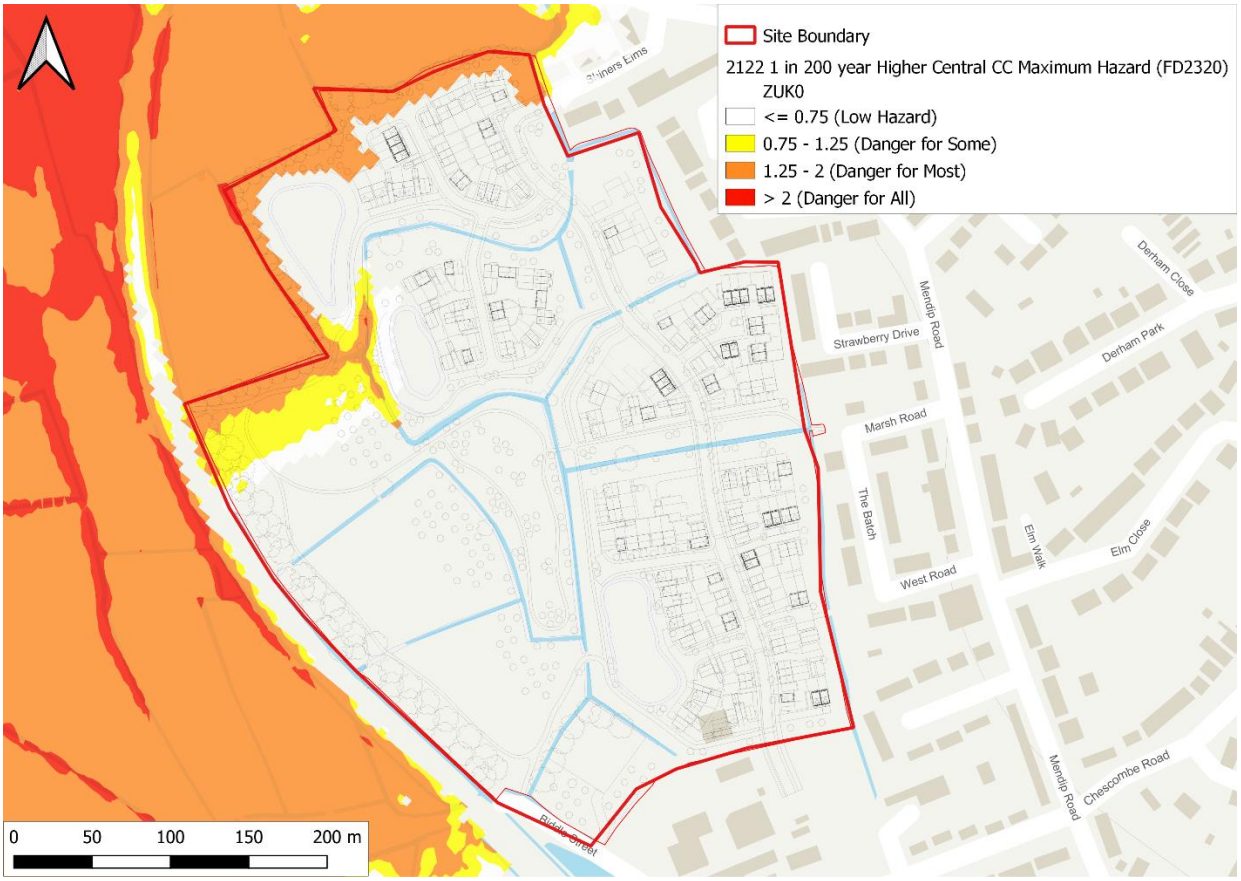

Figure 23. Hazard Mapping for the 2122 0.5% (1 in 200-year) AEP Higher Central Tidal Event - Initial onsite flooding

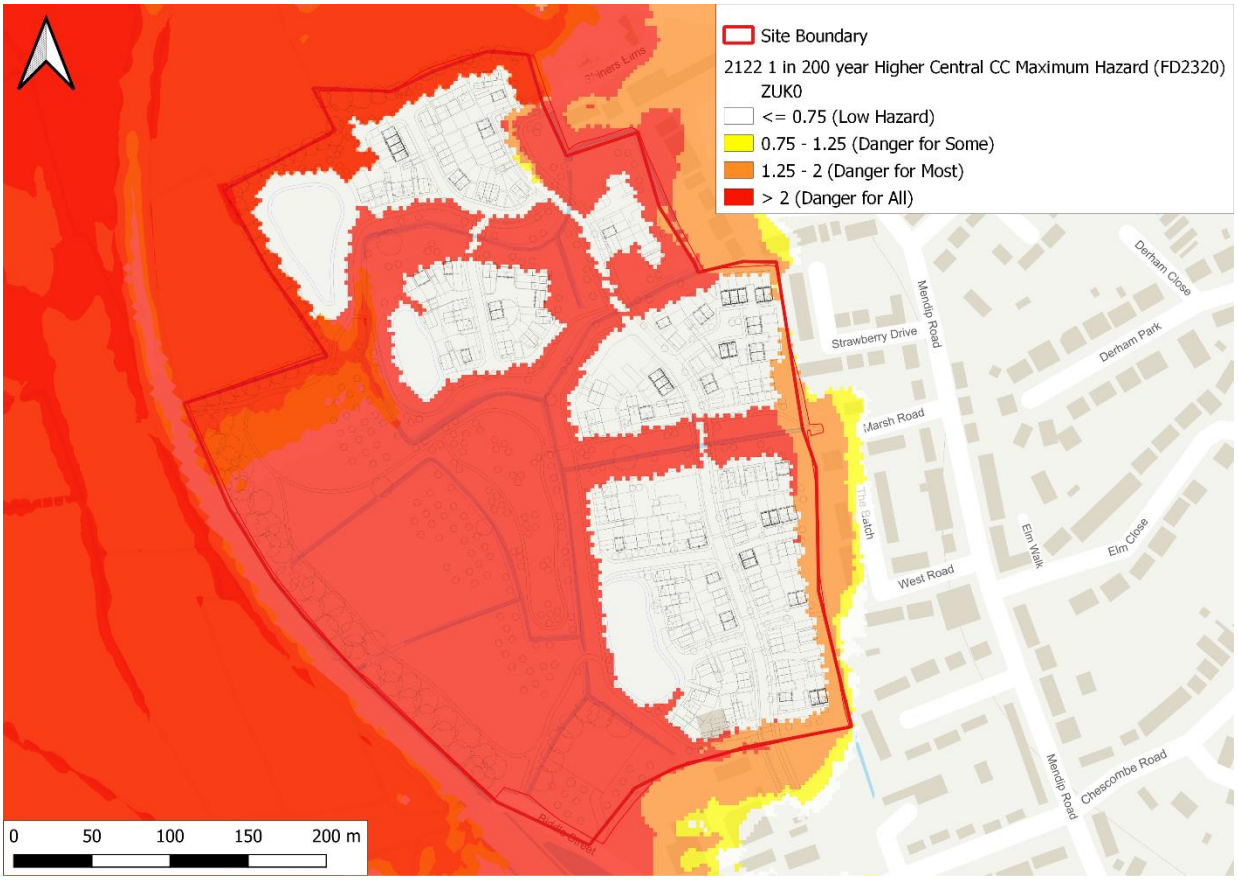

Figure 24. Maximum Hazard Mapping for the 2122 0.5% (1 in 200-year) AEP Higher Central Tidal Event.

4.1.3 *Floodplain Storage and Cumulative Impacts*

This report has confirmed the dominant source of flood risk to the site is from tidal sources in the undefended scenario. Tidal extents are often much larger than fluvial flood events and as a result do not require compensation storage as a result of proposed development. The Paragraph 049 of the NPPG states: "*The loss of floodplain storage is less likely to be a concern in areas benefitting from appropriate flood risk management infrastructure or where the source of flood risk is solely tidal.*" Therefore, no compensatory storage is required for the tidal flooding as discussed and agreed with the LLFA.

With regards to surface water compensatory storage, the EA Surface Water Flood Risk Map (Figure 16) identifies all areas of 'High' risk classified as *"each year, the area has a chance of flooding of greater than 1 in 30 (3.3%)" and* 'Medium' risk classified as *"each year, the area has a chance of flooding of between 1 in 100 (1%) and 1 in 20 (3.3%)"* to be located in the rhynes and are not predicted to extend out into the floodplains. As development will be restricted to the land parcels, there will be no loss of floodplain storage for these areas of risk and as such no compensatory storage is required for surface water.

5. Summary

This Flood Risk Assessment (FRA) report has been prepared by Hydrock on behalf of Persimmon Homes Severn Valley to support a planning application for a proposed residential development of Rectory Farm (North) , Yatton.

A detailed assessment of flood risk has identified that the site is located within the present-day Flood Zone 1, 2 and 3a (Low, Medium and High Risk) with tidal sources being the dominant risk to the site. The site was also shown to be at 'low' or 'negligible' risk of flooding from surface water, groundwater, and artificial infrastructure sources. Although it is recommended groundwater monitoring be undertaken as part of the ground investigation works, which are yet to start, to assess the level of groundwater on site.

At a pre-app meeting with the LLFA, Hydrock were instructed to use the "Woodspring Bay 2020" hydraulic model created by JBA to assess the risk of tidal flooding to the site. The hydraulic model was updated to include climate change uplifts and additional structures on site which were not present in the original JBA model. Hydraulic modelling confirmed the site to be at high risk of flooding in the present day 1 in 200-year extreme tidal event but benefits from significant flood defences along the Woodspring Bay frontage and along the Congresbury Yeo. With the impacts of climate change, the existing defences are predicted to be overwhelmed. In the undefended 2122 0.5% AEP (1 in 200-year) plus Higher Central climate change allowance design event, the site is predicted to be completely inundated with flood waters with a maximum flood level of 7.88m AOD and maximum depths up to 2.73m on the land parcels and 3.81m within the rhyne network.

The proposed residential led development is classified as 'more vulnerable' in accordance with the NPPG and on the basis that the site is indicated to be within Flood Zone 3a in the present day and in the future, it is recommended a Sequential Test be undertaken by the Planning Consultant to confirm site suitability. Following this, an Exception Test should also be carried out, with this report satisfying part 'b' of the Exception Test, providing recommended mitigation to ensure the site will be safe from flooding across its design life.

Given the predicted impacts of climate change it is recommended that building FFLs be raised as high as practically possible to a minimum level of 8.48m AOD (600mm freeboard above the 2122 0.5% AEP (1 in 200-year) Higher Central tidal level), to ensure a significant freeboard above any potential flooding and a safe refuge area is provided. This approach is in line with both local and national policy.

The proposed site access roads are shown to be at risk of flooding from tidal sources in the future. As such, a Flood Warning and Evacuation Plan is recommended to highlight the flood risk to visitors and details the procedures to follow in the event of a Flood Warning from the EA being issued for the area.

Given the dominant source of flooding to the site is tidal, raising the ground is less likely to impact on maximum water levels from tidal sea flooding. As such, flood compensation storage is not deemed necessary.

This report therefore demonstrates that, in respect of flood risk the residential development of the site:

- Is suitable in the location proposed.
- Will be adequately flood resistant and resilient.
- Will not place additional persons at risk of flooding, and will offer a safe means of access and egress or provide a Flood Evacuation plan where applicable.
- Will not increase flood risk elsewhere as a result of the proposed development through the loss of floodplain storage or impedance of flood flows.

» Will put in place measures to ensure surface water is appropriately managed.

As such, the development would meet the flood risk requirements of the NPPF and other relevant planning requirements..

Hydrock Consultants Limited

6. References

Author	Date	Title
Jacobs	June 2020	North Somerset Council Level 1 Strategic Flood Risk Assessment (https://www.n-somerset.gov.uk/sites/default/files/2020-12/North%20Somerset%20Council%20Level%201%20SFRA%20-%20acc.pdf)
JBA	September 2020	Woodspring Bay and Severn House Farm Flood Modelling and Mapping Report
EA	2015	Congresbury Yeo and Hydrology Update 2015
GOV.UK	Updated July 2021	National Planning Policy Framework (NPPF), 14. Meeting the challenge of climate change, flooding and coastal change) (https://www.gov.uk/government/publications/national-planning-policy-framework--2)
GOV.UK	Released 15/04/15, now evolving online guidelines	Planning Practice Guidance, Flood Risk and Coastal Change (http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/)
GOV.UK	Released 19/02/16, now evolving online with latest projections	Environment Agency, Flood Risk Assessments: Climate Change Allowances (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)
North Somerset Council	July 2016	North Somerset Council Development Management Policies (2016)
North Somerset Council	January 2017	North Somerset Council Core Strategy (2017)

Appendix A

Topographical Survey

Reference	Title
23257-TS01 Rev B	Land at Rectory Farm – Topographical Survey

Appendix B

Relevant Flood Risk Information

Reference	Title
22/P/2451/PR2	Delegated Report Pre-Application Advice
176927	EA Product 4
67946CH-L1-SFRA-FIG-045	Tidal Flood Zone 3a: Sea Level Rise Allowance
67946CH-L1-SFRA-FIG-040	Defence Types and Areas Benefitting from Defences
67946CH-L1-SFRA-FIG-035	Historic Flood Information
67946CH-L1-SFRA-FIG-038	Areas Susceptible to Groundwater Flooding
-	LLFA Email - Reservoirs