MOTT MACDONALD

Eign Wastewater Treatment Works

Flood Risk Assessment

March 2024

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Eign Wastewater Treatment Works

Flood Risk Assessment

March 2024

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Executive summary

Mott MacDonald has been appointed by Mott MacDonald Bentley to undertake a Flood Risk Assessment (FRA) on behalf of the applicant, Dwr Cymru Welsh Water (DCWW) at Eign Wastewater Treatment Works, Hereford.

Flood risk from multiple sources has been assessed in accordance with the National Planning Policy Framework and associated Planning Practice Guidance. The Site is shown to be within Flood Zone 3, with fluvial flooding being the primary source of flooding. Table 1.1 gives a summary of flood risk from various sources pre and post development of the Site.

Table 1.1: Summary of flood risk at the Site

Flood Risk Source	Pre-development flood risk	Post development flood risk
Fluvial	High	High
Tidal	Low	Low
Surface water	Low	Low
Groundwater	Low	Low
Sewer	Low	Low
Reservoirs/Artificial sources	Low	Low

New fluvial hydraulic modelling has been carried out by Mott MacDonald to support this FRA. Model results indicate that installing a proposed containment wall results in negligible change to modelled flood extent and depth. No new receptors are at increased risk of flooding resulting from the proposed development with negligible change to existing receptors.

Based on the findings of this FRA the following conclusions are drawn:

- The proposed containment wall is “water compatible”, which is appropriate for allocation in any Flood Zone. The development cannot be relocated to a lower-risk Flood Zone. The exception test is not required for water compatible developments.
- The proposed development is in Flood Zone 2 and 3a, indicating a “high” (>1% AEP) risk of fluvial flooding.
- Tidal flooding is not considered a significant risk.
- Localised areas of the Site are susceptible to surface water flooding at “medium” (3.3% - 1% AEP) risk. The area for proposed development itself is at “very low” (<0.1% AEP) risk of surface water flooding.
- The Site is not located on a principal aquifer, so groundwater flooding should not be considered a significant risk.
- No artificial sources of flooding have been identified at the Site.
- There are numerous reservoirs in the River Wye catchment that would result in flooding if the reservoirs were to fail. Under the Reservoirs Act 1975, the Environment Agency and Natural Resources Wales ensures that reservoirs are inspected regularly by reservoir safety panel engineers and that essential safety works are carried out. This means the overall risk of reservoir failure is low.

1 Introduction

1.1 Background and scope

Mott MacDonald (MM) has been appointed by Mott MacDonald Bentley (MMB) to undertake a Flood Risk Assessment (FRA) on behalf of the applicant, Dwr Cymru Welsh Water (DCWW). The proposed development is located at the existing Eign Wastewater Treatment Works (WwTW), Hereford, Herefordshire, National Grid Reference (NGR) SO 52069 38779 (hereafter 'the Site').

Operational improvement works are required at Eign WwTW to implement the necessary secondary containment to bring the site in line with the Industrial Emissions Directive (IED) as outlined in Best Available Techniques (BAT) 19 and CIRIA 736. This scheme is to make the necessary improvements at the site to avoid potential pollution to adjacent land and River Wye / Afon Gwy. The works will have no impact on any process parameters e.g. no expected changes of the outfall into the river.

The scope of work includes the construction of secondary containment around the existing sludge treatment units so that in case of a potential failure, the sludge gets contained within the provided containment. The scope of work is split into two zones and the detailed scope of works is provided in section 1.3- Proposed Development.

As the Site is in Flood Zone 3, the permitted development requires a site-specific FRA. This FRA is intended to inform the design of the proposed assets by improving resilience to flood risk and to provide flood risk evidence for those elements of the works which fall under permitted development.

This FRA has been carried out in accordance with the National Planning Policy Framework (NPPF)[1] and associated Planning Practice Guidance (PPG)[2].

This FRA assesses the risk of flooding to the Site from all sources and the possible impact of the proposed development on flood risk elsewhere. The scale and nature of the FRA is considered appropriate for the proposed development.

Information presented within this report is dependent upon the accuracy and reliability of the supplied information, correspondence, and data available to Mott MacDonald, at the time of the assessment. Any party developing a detailed design should not rely on assumptions made in this report but should satisfy themselves in that regard.

Mott MacDonald has followed accepted procedure in providing the services but, given the residual risk associated with any prediction and the variability that can be experienced in flood conditions, Mott MacDonald takes no liability for and gives no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This report has been prepared for the purposes of supporting a permitted development only. Mott MacDonald accepts no responsibility or liability for this document to any party other than by whom it was commissioned.

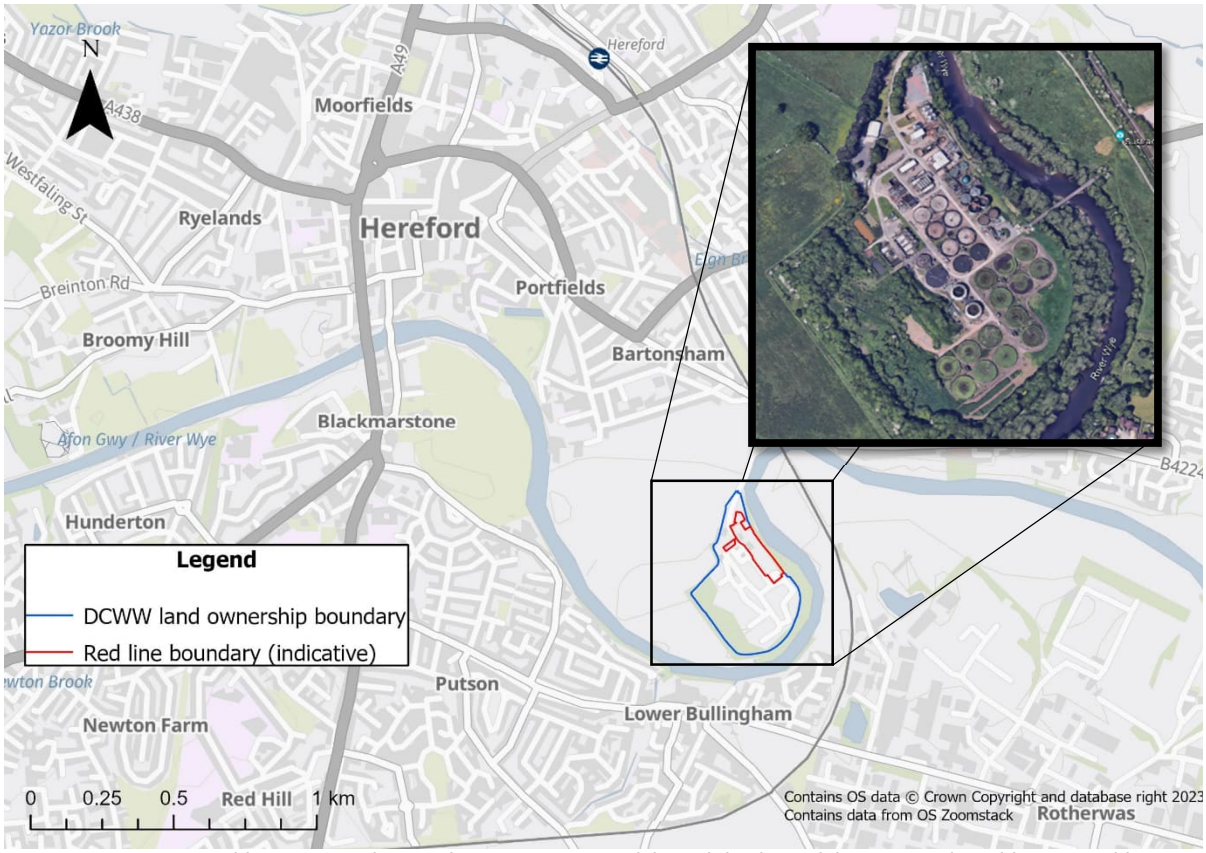
1.2 Site description

A map showing the location of the Site and area of proposed development is provided in Figure 1.1. The Site is defined by the red line boundary being used for the permitted development.

[1] Department for Communities and Local Government, 2023. National Planning Policy Framework.

[2] Department for Communities and Local Government, 2014. Planning Practice Guidance. Available at: http://planningguidance.communities.gov.uk [Accessed 19/03/2024]

Figure 1.1: Site Location



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

The Site is approximately 0.1km^2 in area and comprises an existing WwTW that largely comprises hardstanding, with some areas of grass, wastewater treatment tanks and associated infrastructure. The Site is bounded by mature trees and is accessed from Outfall Works Road in the north.

The River Wye (a 'Main River') flows from west to east through Hereford and meanders around the south of the Site. At the closest point, the river is approximately 20m to the east of the Site.

LIDAR[3] shows that the Site has an elevation of between 50-55mAOD, and is elevated in relation to the surrounding grassland which has an elevation in the region of 49mAOD.

1.3 Proposed development

The Eign Wastewater Treatment Works (WwTW) currently does not meet the requirements outlined in the Industrial Emissions Directive (IED). To rectify this, necessary improvements must be made to the site to make the site IED compliant. The work is categorized into two zones, and the following tasks will be undertaken.

- All permeable areas covered under IED zone 1 and 2 to be made impermeable.

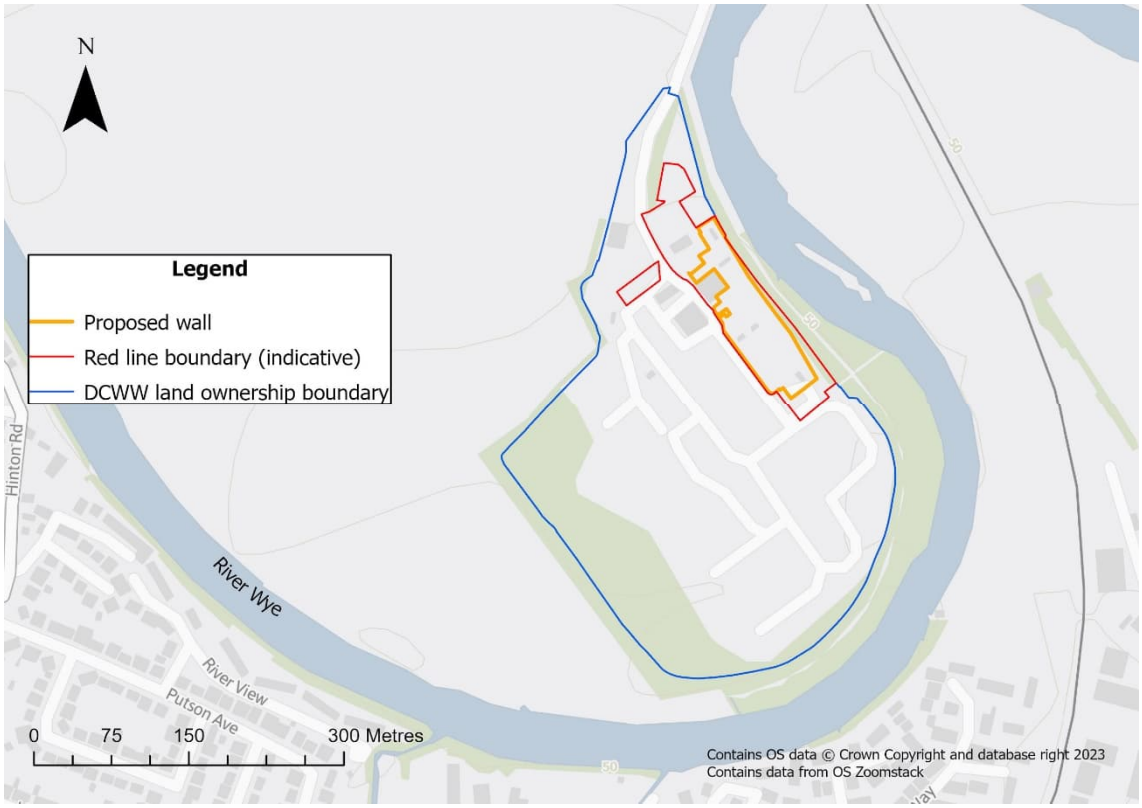
[3] Department for Environment Food & Rural Affairs (Defra), 2022. LIDAR data. Available at: https://environment.data.gov.uk/survey [Accessed 26/02/2024]

- Providing secondary containment around the sludge treatment/storage units to contain sludge in case of failure. Containment is attained by constructing walls around the zones based on hydraulic modelling (height varies from 0.55m to 2.25m).
- Existing hardstanding/impermeable areas, concrete tanks, and joints within the IED zones to be sealed.
- New pumping station and rising mains to return the stormwater from the secondary containment to the inlet.
- Proposed drainage arrangement to cater the site returns within Zone 1
- Vehicular impact protection to assets adjacent to the road

Figure 1.2 depicts the location of the proposed secondary containment wall within the Site boundary, which encloses an area of 7,321m^2.

The proposed works fall under permitted development, as they are situated within the existing operational area owned by DCWW.

Figure 1.2: Proposed development – Containment wall



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

2 Policy Frameworks

2.1 National Planning Policy

This section provides an overview of the flood risk specific planning context that all new developments must adhere too.

2.1.1 National Planning Policy Framework (NPPF)

The NPPF sets out the Government's planning policies for England and defines how these are expected to be applied. The associated PPG on flood risk provides additional guidance to local planning authorities to ensure the effective implementation of the planning policy set out in the NPPF, on development in areas at risk of flooding.

As set out in the NPPF, inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. For the purposes of applying the NPPF:

- "Areas at risk of flooding" means land within Flood Zones 2 and 3; or land within Flood Zone 1, which the Environment Agency (EA) has notified the local planning authority as having critical drainage problems; and
- "Flood risk" means a combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers, and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

The stated overall aim of the NPPF is to steer new development to Flood Zone 1. If following application of the Sequential Test, it is not possible for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if deemed appropriate.

2.1.2 The Sequential Test

The NPPF (Section 127) requests a sequential, risk-based approach should be applied to all plans. This should also consider the current and future impacts of climate change. The aim of the sequential test is to steer new developments to locations in Flood Zone 1, where flood risk is lowest.

When developments cannot be moved, the vulnerability classification shown in Table 2.1 should be used to identify any tests that are required.

The Site is situated within Flood Zones 2 & 3a (refer to Section 3.1.2) indicating a "high" risk of fluvial flooding.

The purpose of the proposed development is to prevent spillage from the sludge treatment tanks into the River Wye, hence its location cannot be moved. As the proposed development is intended to operate in flood events, it is considered 'water compatible'. Water compatible developments are considered appropriate in any flood zone, so the Exception Test will not be applied.

Table 2.1: Flood risk vulnerability classification

Flood Zones	Flood risk vulnerability classification				
	Essential infrastructure	**Highly Vulnerable**	**More vulnerable**	**Less vulnerable**	**Water compatible**
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception test required	✓	✓	✓
Zone 3a	Exception test required	x	Exception test required	✓	✓
Zone 3b	Exception test required	x	x	x	✓

Source: Environment Agency. 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf

Key:

✓ Development is appropriate
x Development should not be permitted

2.1.3 The Exception Test

Where required, the Exception Test must demonstrate that sustainability benefits of the development outweigh the flood risk. Details of how flood risk will be managed throughout its lifetime must be stated, as well as showing that flood risk won't increase elsewhere as a result of its development.

2.1.4 Climate change guidance

The NPPF requires that climate change is considered. With respect to the application of climate change allowances, the proposed development has a 20-year design horizon up to 2050.

Climate change is predicted to warm the atmosphere, increase the moisture which can be held in the air and cause more extreme flooding. To model the impact of future climate change scenarios the peak flows for flood events were increased. The climate change allowances used in the modelling have been calculated using the EA guidance on the peak river flow allowances for schemes[4]. The Site and study area is within the Wye MC Management Catchment. Peak river flow allowances for this catchment are shown in Table 2.2.

Table 2.2: UKCP18 peak river flow allowances for the River Wye

Epoch	Central	Higher	Upper
2020s (2015-2039)	14%	19%	29%
2050s (2040-2069)	20%	27%	47%
2080s (2070-2115)	37%	49%	80%

Source: Environment Agency. 2024. Available online from: https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow?mgtmcatid=3117

EA guidance[5] is to use the central and higher central allowances as the design allowance for the 2050s epoch. Therefore, peak flows in the new hydraulic modelling have been uplifted by +20% and +27%.

[4] Environment Agency, 2022. Peak river flow allowances - GOV.UK (www.gov.uk). [Accessed 28/02/2024]

[5] Environment Agency, 2022. Using peak river flow allowances for flood risk assessments. Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk). [Accessed 22/02/2024]

2.2 Local Planning Policy

2.2.1 Lead Local Flood Authority Plan

Herefordshire Council is the Lead Local Flood Authority (LLFA) for Eign WwTW. The Flood and Water Management Act 2010[6] gives LLFAs powers and duties for flood risk management. Herefordshire Council has a Strategic Flood Risk Assessment (SFRA)[7] that aims to explain how they will engage in the management of flood risk from surface water, ground water, and ordinary watercourses within its administrative area, now and in the future.

2.2.2 Local development plan

Local planning policies are set out in the adopted Local Plan. This document sets out a vision and a framework for the future development of an area, addressing needs and opportunities in relation to housing, the economy, community facilities, and infrastructure. It is a basis for safeguarding the environment, adapting to climate change, and securing good design.

- The Herefordshire Local Plan[8] was adopted in October 2015 and provides the overall vision, strategic objectives, spatial strategy, and strategic planning policies for the county until 2031.
- The key policy relevant to the proposed development is:
    - Policy SD3 Sustainable water management and water resources:
- This policy seeks to reduce flood risk and avoid inappropriate development in areas at risk of flooding. Development is directed away from high-risk areas in accordance with the Sequential Test and Exception Tests (where appropriate).
- Development must be designed to be safe in times of flood and measures should be taken to reduce flood risk and manage surface water runoff.
- Appropriate Sustainable Drainage System (SuDS) techniques are to be considered and incorporated into the design of the site.
- Proposals should not adversely affect water quality either directly through unacceptable pollution of surface water or groundwater, or indirectly through overloading of Wastewater Treatment Works.

2.2.3 Strategic Flood Risk Assessment

The Hereford City Strategic Flood Risk Assessment Level 1[9] has been developed in accordance with the NPPF. Relevant information from the SFRA has been incorporated into this FRA and has been considered in application of the Sequential Test.

[6] Flood and Water Management Act 2010. Available at: https://www.legislation.gov.uk/ukpga/2010/29/introduction [Accessed on: 23/02/2024]

[7] Herefordshire Council, 2020. Strategic Flood Risk Assessment Level 2. Available at: https://www.herefordshire.gov.uk/directory-record/2111/strategic-flood-risk-assessment [Accessed 28/02/2024]

[8] Herefordshire Council, 2015. Herefordshire Local Plan. Available at: https://www.herefordshire.gov.uk/downloads/file/1788/core-strategy-sections-combined [Accessed 28/02/2024]

[9] Herefordshire Council, 2019. Strategic Flood Risk Assessment Level 1. Available at: https://www.herefordshire.gov.uk/downloads/download/1997/strategic_flood_risk_assessment_2019 [Accessed 28/02/2024]

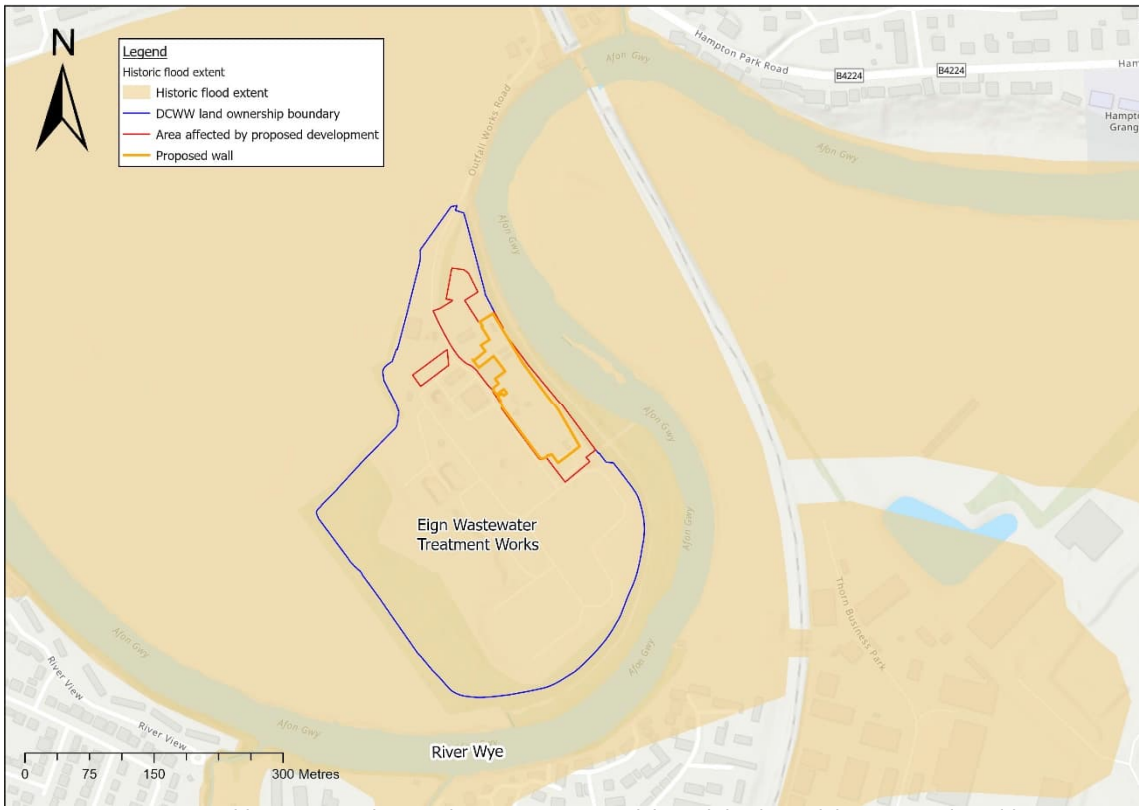
3 Assessment of flood risk

3.1 Existing flood risk to the Site

3.1.1 Flood history

The EA 'Historic Flood Map[10]' dataset shows the maximum extent of various recorded fluvial flood events since 1946. Figure 3.1 shows that the entirety of the Site falls within the recorded historic flood map extent. The flood mapping does not provide a date or source of the flood extent, but it is highly likely that flooding is fluvially sourced from the River Wye.

Figure 3.1: Historic Flood Map



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

3.1.2 Fluvial flood risk

3.1.2.1 EA Flood zones

The EA publishes floodplain extents for all main rivers throughout England. These extents, displayed on the "Risk of Flooding from Rivers and Sea[11]" flood map, are available online to the

[10] Environment Agency, 2024. Historic Flood Map (Defra Data Services Platform).Available at: https://environment.data.gov.uk/explore/889885c0-d465-11e4-9507-f0def148f590 [Accessed 29/02/2024].

[11] Environment Agency, 2023. Risk Of Flooding from Rivers and Sea (Defra Data Services Platform) Available at: https://environment.data.gov.uk/explore/8d57464f-d465-11e4-8790-f0def148f590 [Accessed 29/02/2023]

public and are the primary source of publicly available flood risk information. The EA also provides the “Flood Map for Planning” which displays “Flood Zones”.

Table 3.1 provides definitions of the Flood Zones as stated in Table 1 of the PPG. It should be noted that the boundaries given on the flood map are only indicative and do not necessarily account for any man-made structures such as railway embankments, roads, or flood defences.

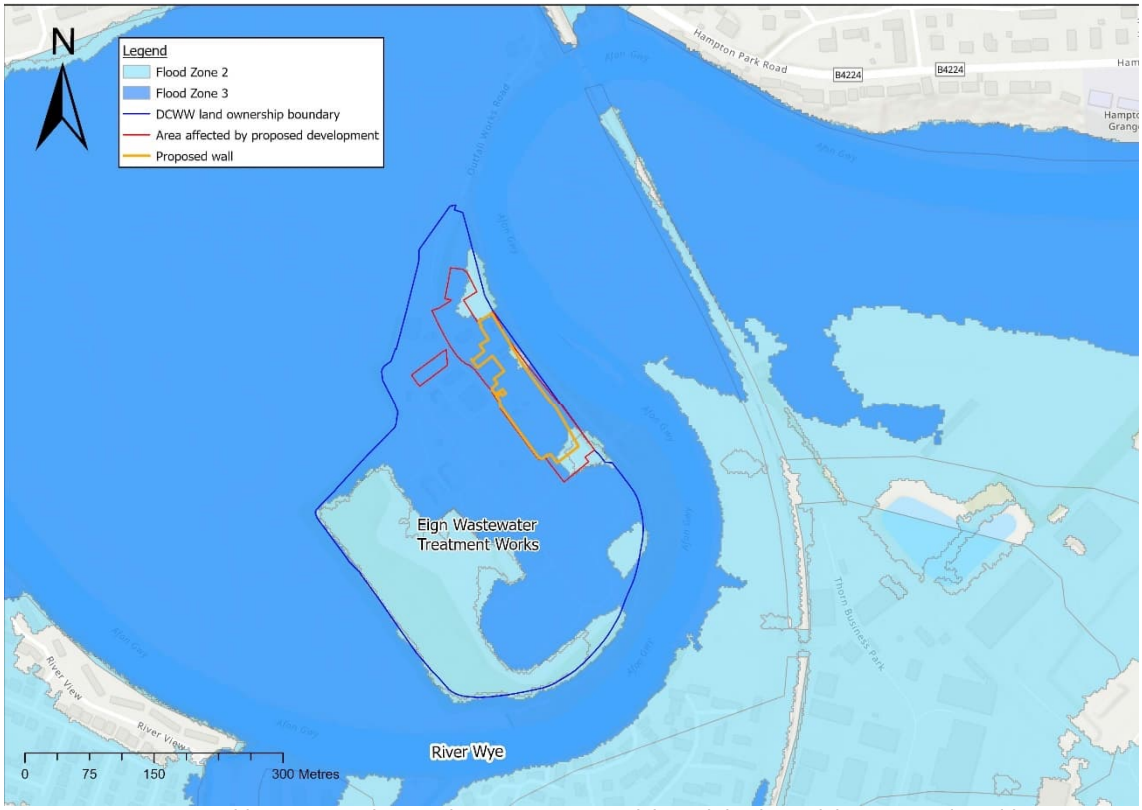
Table 3.1: Flood Zones

Flood Zone	Description	Annual Exceedance Probability (AEP)
Flood Zone 1 – Low Probability	Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year	< 0.1% (1 in 1000 year) sea or river flooding
Flood Zone 2 – Medium Probability	Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding, or between a 1 in 200 and 1 in 1000 annual probability of sea flooding in any year	1% - 0.1% (1 in 100 – 1 in 1000 year) river flooding 0.5%-0.1% (1 in 200 – 1 in 1000 year) sea flooding
Flood Zone 3a – High Probability	Land assessed as having a 1 in 100 or greater annual probability of river flooding, or a 1 in 200 or greater annual probability of flooding from the sea in any year.	> 1% (greater than 1 in 100 year) river flooding > 0.5% (greater than 1 in 200 year) sea flooding
Flood Zone 3b – The Functional Floodplain	Land where water must flow or be stored.	Identified in the Strategic Flood Risk Assessment

Source: Department for Communities and Local Government (2014) Planning Practice Guidance

The primary source of fluvial flooding to the Site is from the River Wye. Adopting the EA’s flood map for planning, Figure 3.2 depicts the Site, and location of the proposed containment wall, falling within Flood Zone 3, assessed as having >1% annual exceedance probability (AEP) of fluvial flooding. The Site does not benefit from any flood defences.

Figure 3.2: Designated EA flood zone of proposed development

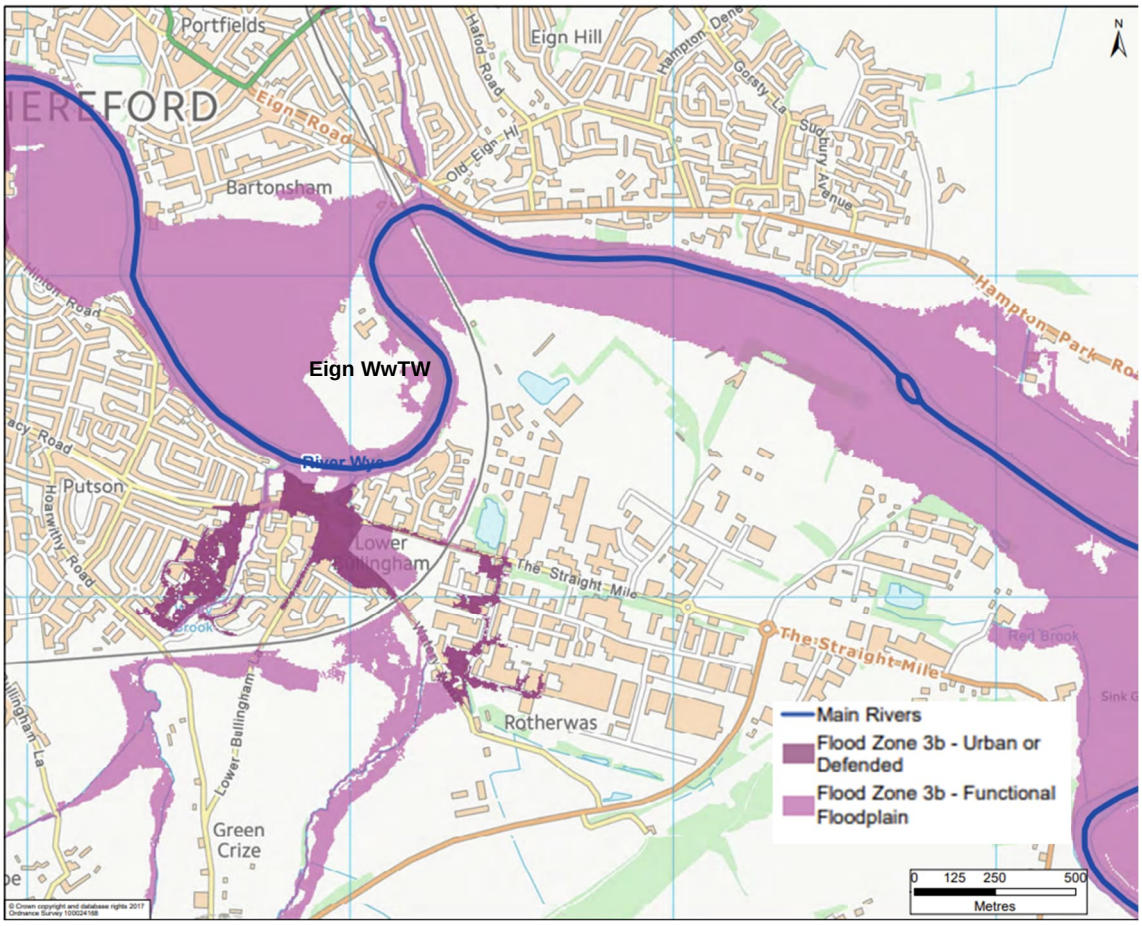


Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024. Environment Agency Flood Map for Planning 2024

3.1.2.2 SFRA Mapping

Figure 3.3 shows the Flood Zone 3b outlines provided by Herefordshire Council. A comparison with the EA designated flood zone mapping in Figure 3.2 shows the Site is predominantly located in Flood Zone 3a, with small sections of the Site, including the Outfall Works Access Road, as well as the surrounding floodplain being within the functional floodplain (Flood Zone 3b).

Figure 3.3: SFRA Flood zone 3b mapping



Source: Herefordshire Council (2019) Strategic Flood Risk Assessment Appendix E-1C

3.1.2.3 Updated fluvial modelling and mapping

New hydraulic modelling has been carried out by Mott MacDonald on behalf of MMB for DCWW, consisting of a detailed 1D-2D hydraulic model of the River Wye in 2024 (hereafter the 'MM updated model'), using Flood Modeller (FM) and TUFLOW software packages. The modelling report is provided in Appendix A.

The modelled reach is limited to the main river reaches of the River Wye including its tributaries; the River Frome and the River Lugg. For the purposes of this study, reaches downstream of the railway bridge adjacent to Outfall Works Road serve only as a downstream boundary to the study area and remain unchanged from the model supplied by the EA. The upstream and downstream extents of the model are given in Table 3.2.

Table 3.2: MM updated model reaches

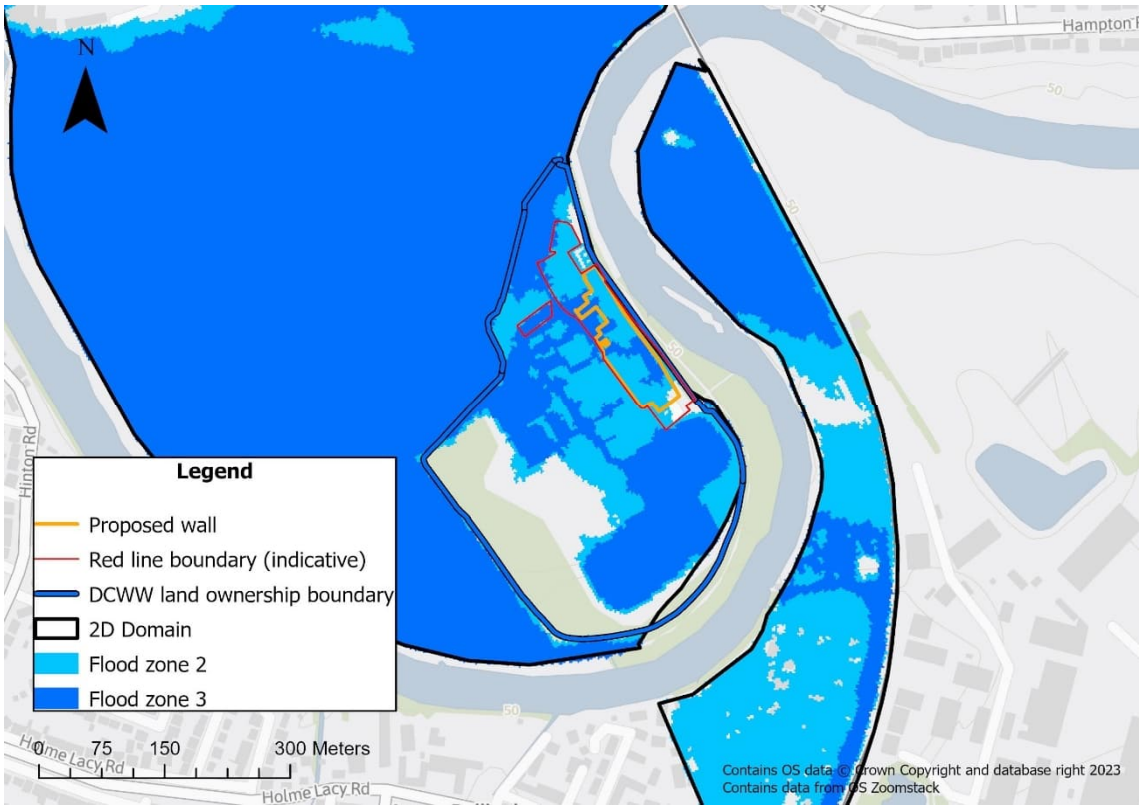
Watercourse	Length (km)	Upstream limit	Downstream limit
River Wye	72	SO 4709 3954	SO 3560 2158
River Frome	1	SO 5656 3923	SO 3565 2392
River Lugg	6	SO 5461 4068	SO 3546 2406

The MM updated model includes a baseline scenario from which updated Flood Zones can be extracted (Figure 3.4). A 2D approach provides more realistic, site-specific detail of flood

mechanisms and extents, compared with the 1D broadscale approach used to generate the EA flood zones.

The area intended to be contained by the proposed wall is seen to be flooded during both the 1% and 0.1% AEP event, with water entering from the west. Hence the development is considered to be situated in Flood Zones 2 and 3. As the Site does not form part of the Functional Floodplain, it sits within the sub-category Flood Zone 3a.

Figure 3.4: MM modelled flood zones within the Site (excludes river channel)

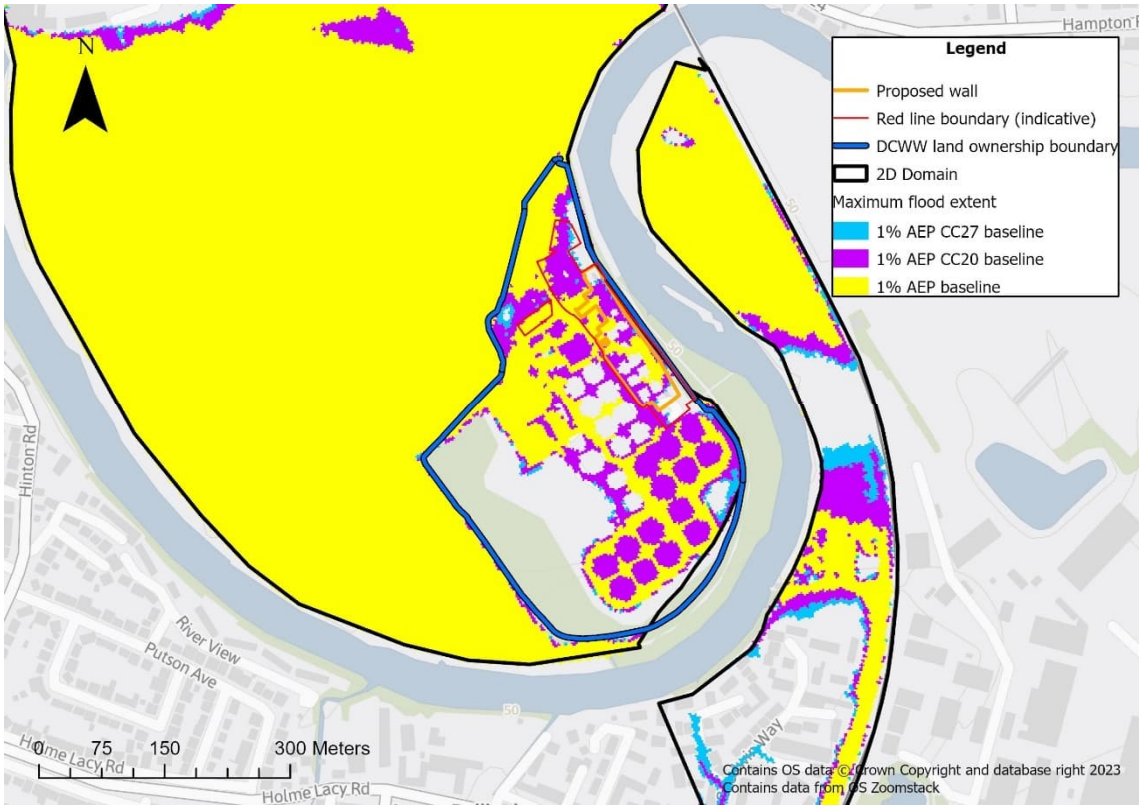


Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

Climate change allowances have been considered in the implementation of the updated MM model. Following EA guidance[5], the central (+20%) and higher central (+27%) allowances relating to the 2050s epoch have been used.

The 1% AEP baseline event showed significant increases in flood extent when the climate change allowances were applied. Figure 3.5 depicts these differences. The 20% uplift significantly increases flooding within the boundary of the proposed development, with all but the southeastern corner of the area inundated. The model results show that most of the Site would flood during the 1% AEP event when using the central climate change allowance.

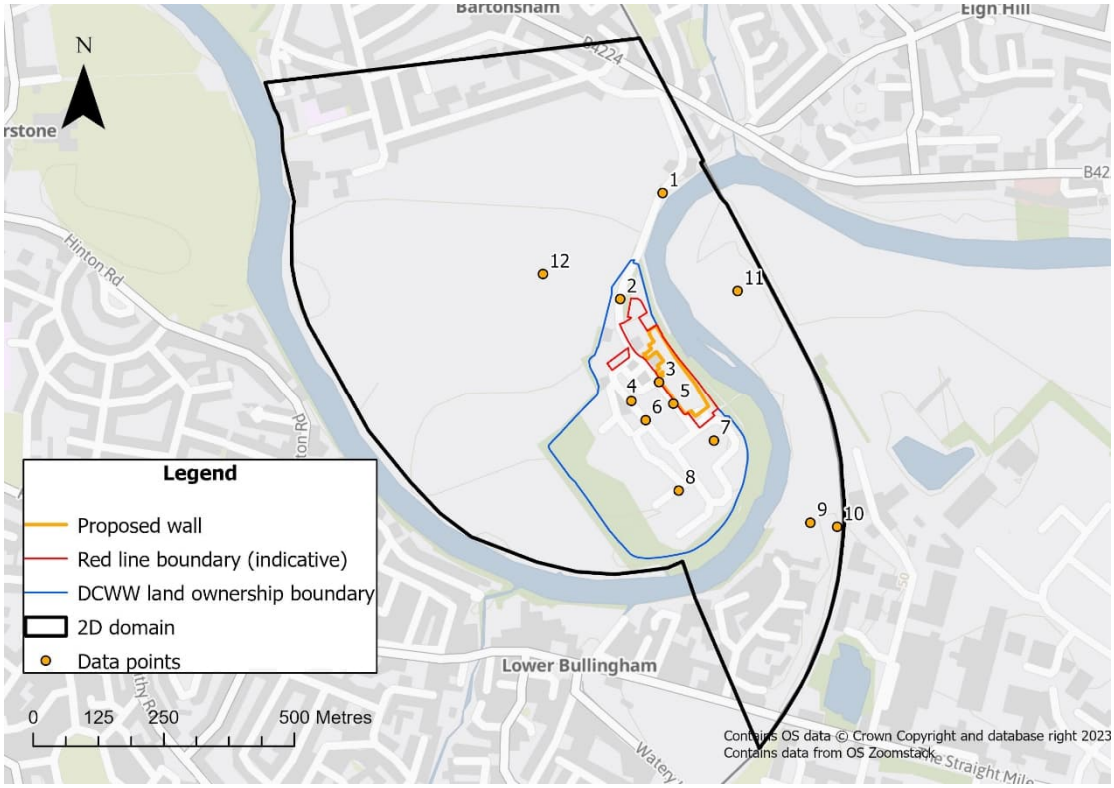
Figure 3.5: 1% AEP event flood extents including climate change allowance for baseline scenario



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

To enable the assessment of changes in modelled parameters at, and surrounding the site, resulting from the proposed containment wall, 12 data points in and around the Site (point locations shown in Figure 3.6 have been used. Table 3.3 contains the resulting flood levels for the 50%, 10%, 5%, 2% and 1.3% AEP baseline events at the data points.

Figure 3.6: Points analysed for water level change



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024**.**

The access road to the Site, Outfall Works Road, leaves the Site to the north. A section of the road is shown to lie in Flood Zone 3a. The access road is represented by data points 1 and 2 which, respectively, become inundated in the 10% and 5% AEP event.

The first area to flood along the access road is a small car park, approximately 130m northeast of the Site boundary. Floodwater reaches this area via the floodplain to the west, bypassing the meander in the channel in the south. The extent to which the road is inundated progressively increases with decreasing AEP, with the road being completely submerged during the 0.1% AEP and 1% AEP events.

As such, it is essential that evacuation plans are put into place in case of fluvial flooding.

Table 3.3: Baseline water levels for 50% - 1.3% AEP events

Points					Water level (mAOD) / Water Depth (m)				
AEP (%)	50	10	5	2	1.3	1	1+20%CC	1+27%CC	0.1
1	dry	50.04 /0.07	50.38 /0.43	50.38 /0.43	50.70 /0.82	50.75/0.89	51.2/1.16	51.36/1.26	51.39/1.52
2	dry	dry	50.69 /0.05	50.69 /0.05	51.19 /0.55	51.29/0.65	51.64/1.00	51.75/1.11	52.04/1.40
3	dry	dry	dry	dry	dry	dry	51.56/0.28	51.65/0.38	51.92/0.64
4	dry	dry	dry	dry	51.17 /0.08	51.17/0.26	51.63/0.72	51.75/0.84	52.04/1.13
5	dry	dry	dry	dry	dry	dry	51.52/0.37	51.61/0.46	51.89/0.74
6	dry	dry	dry	dry	50.98 /0.43	51.15/0.61	51.61/0.30	51.73/1.18	52.03/1.48
7	dry	dry	50.27 /0.64	50.27 /0.64	50.74 /1.11	50.85/1.22	51.34/1.71	51.48/1.85	51.86/2.23
8	dry	dry	50.27 /0.27	50.27 /0.28	50.74 /0.74	50.85/0.86	51.35/1.35	51.49/1.49	51.87/1.88
9	dry	dry	dry	dry	50.83 /0.39	50.93/0.49	51.32/0.88	51.48/1.04	51.87/1.40
10	dry	dry	50.37 /1.54	50.38 /1.54	50.83 /2.00	50.93/2.10	51.33/2.50	51.48/2.65	51.87/3.04
11	dry	49.80 /1.06	50.10 /1.36	50.10 /1.37	50.61 /1.88	50.73/2.00	51.22/2.48	51.39/2.65	51.80/3.06
12	dry	50.31 /1.32	50.69 /1.70	50.69 /1.70	51.19 /2.20	51.29/2.30	51.65/2.65	51.76/2.77	52.06/3.10

Source: Mott MacDonald (2024)

3.1.2.4 Summary

Prioritising the more detailed 2D flood zone mapping, we henceforth consider the proposed development to sit in Flood Zone 3a, with the Outfall Works Road Access sitting in Flood Zone 3b. The 2D modelling results provide more refined Flood Zone outlines, but overall confirm the EA and SFRA Flood Zone mapping. A high level of fluvial flood risk is associated with this location, defined as having a 1% - 0.1% AEP of river flooding.

3.1.3 Tidal flood risk

Whilst Flood Zone 3 is characterised as having a > 0.5% AEP of tidal flooding, the tidal extent of the River Wye reaches Bigsweir, approximately 44km downstream of Hereford. It is therefore concluded there is very low risk of flooding from tidal sources or tidal influence on fluvial flooding.

3.1.4 Surface water flood risk

The online EA 'Long term flood risk' map includes information regarding the risk of flooding from surface water. The 'Flood risk from surface water' mapping indicates areas with a 'High', 'Medium', 'Low' and 'Very low' surface water flood risk. These are defined in Table 3.4.

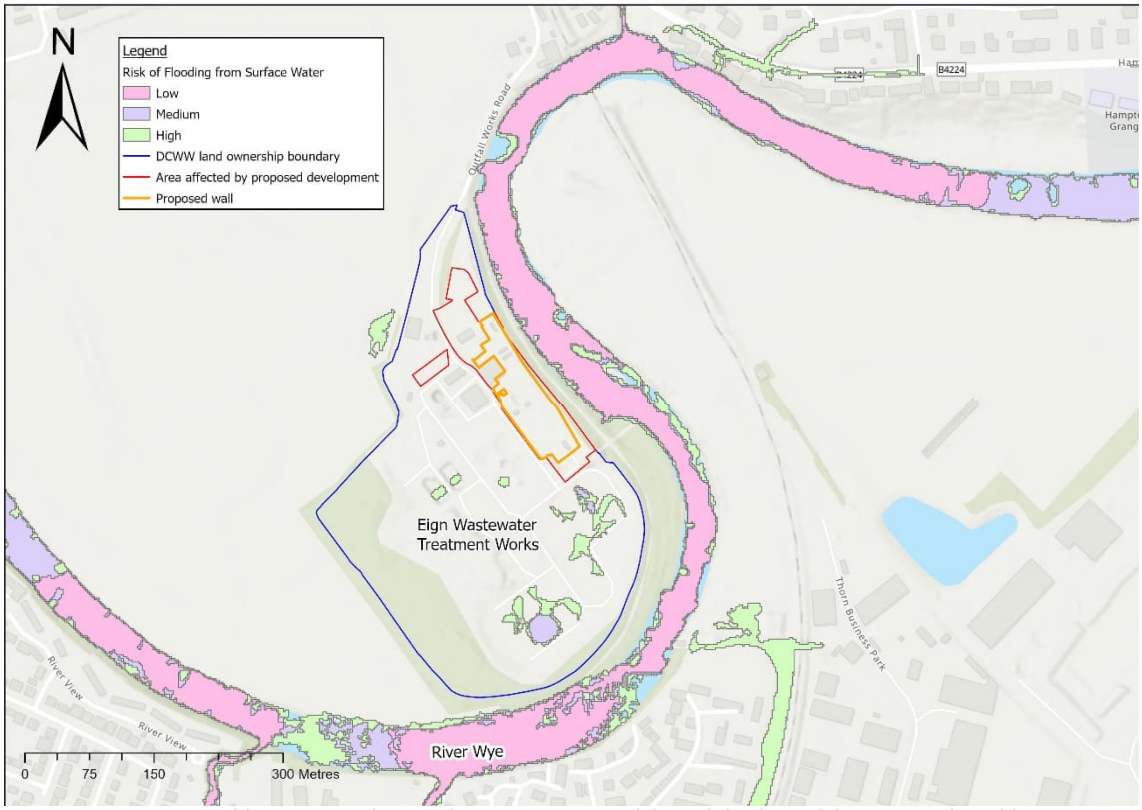
Despite small areas of the Site being at 'medium and high' risk of flooding, the area within the proposed containment wall is at 'very low' risk of surface water flooding as shown in Figure 3.7**Error! Reference source not found.** No surface water overland flow pathways are shown to pass through the location of the containment wall.

Table 3.4: Flood risk from surface water

Flood risk	Description	Annual Exceedance Probability
Very low risk	Each year the area has a chance of surface water flooding of less than 0.1%.	<0.1% (1 in 1000 year) of surface water flooding
Low risk	Each year the area has a chance of surface water flooding of between 0.1 and 1%.	1% - 0.1% (1 in 100 – 1 in 1000 year) surface water flooding
Medium risk	Each year the area has a chance of surface water flooding of between 1 and 3.3%.	3.3 – 1% (1 in 75 -1 in 100 year) surface water flooding
High risk	Each year the area has a chance of surface water flooding of greater than 3.3%.	>3.3% (up to 1 in 75 year) surface water flooding

Sourceource: Environment Agency (2023) Flood Warning Information Service: Long term flood risk information.

Figure 3.7: Surface water flood map



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

3.1.5 Sewer Flooding

Flooding could occur if the sewer network capacity became exceeded or blocked, leading to surface water flooding.

As an existing, functioning WwTW, the Site is designed to capture, treat and pump water away from the Site. As such the risk from sewer flooding is low, except in asset failure conditions. The likelihood of asset failure is also low, as it is assumed DCWW maintain their assets to a legal standard.

3.1.6 Groundwater flooding

Groundwater flooding occurs when water levels in the ground rise above surface elevations and is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). The Site is underlain by Raglan Mudstone Formation bedrock geology, which is interbedded siltstone and mudstone. This is overlain by superficial deposits of alluvium, and artificial made ground. The bedrock is not designated a principal aquifer.

The raised elevation of the site, compared to surrounding land, and close proximity of the site to the River Wye, means that the risk of groundwater flooding is low.

The EA 'Check long term flood risk' online service assesses that flooding from groundwater is unlikely.[12] As such, groundwater flood risk is considered negligible.

[12] Environment Agency (2024) Check long term flood risk. Available at: https://check-long-term-flood-risk.service.gov.uk/risk [Accessed 04/03/2024]

3.1.7 Reservoir, canal and other sources of Artificial Flooding

3.1.7.1 EA Mapping

The EA 'Check long term flood risk' online service[12] assesses that the Site is unlikely to experience flooding from reservoirs.

There are no canals in the vicinity of the Site, so canal flood risk is negligible. No other sources of artificial flooding have been identified in the vicinity of the Site.

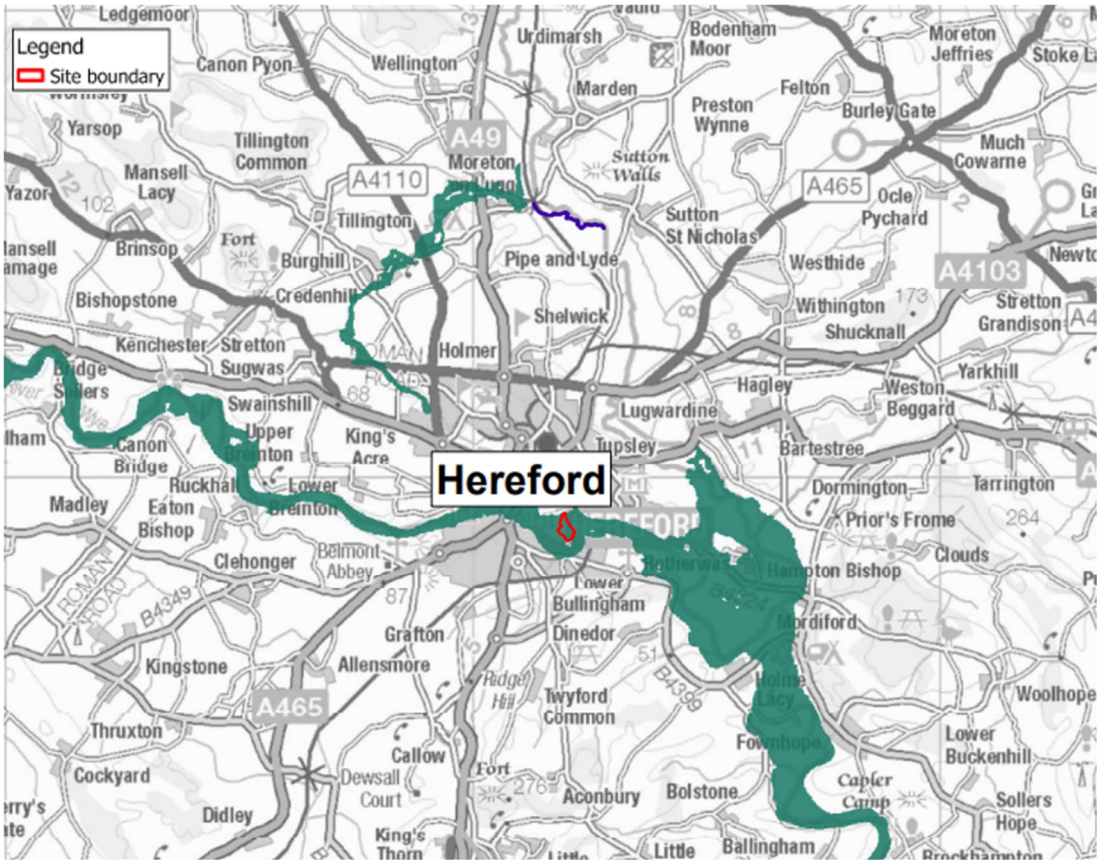
3.1.7.2 Herefordshire Council Mapping

Herefordshire Council have potential plans to restore a 55km stretch of the Herefordshire and Gloucester canal[13]. The proposed new canal terminus would sit in the centre of Hereford approximately 2km north west from the Site, and the canal would have a north-easterly orientation away from Hereford. Any floodwater associated with canal failure would likely flow towards Little Lugg, downstream of the Site. The canal is broadly located within a local valley with no mechanism for floodwaters to reach the Site. The Herefordshire and Gloucestershire Canal Trust will be directly responsible for management of flood risk; therefore, risk of asset failure is low and thus presents a low risk to the Site.

The 2019 SFRA "Reservoir flooding in Herefordshire map"[9] indicates a floodplain surrounding the River Wye as it conveys through the south of Hereford. Figure 3.8 provides an extract from this map, with flood extent highlighted in green. The Site lies within this depicted flood extent.

[13] Herefordshire Council (2023) Hereford City Master Plan. Available at: https://councillors.herefordshire.gov.uk/documents/s50108560/ [Accessed 05/03/2024]

Figure 3.8: Reservoir flood extent in Herefordshire Figure



Source: Herefordshire Council Strategic Flood Risk Assessment 2019

3.1.7.3 Other sources of information

- The Flood Estimation Handbook (FEH) Service[14] has been used to assess the presence of additional waterbodies, including lakes and reservoirs. The River Wye catchment upstream of the Site has an area of 1966km^2 and contains the following waterbodies:
- Caban Coch Reservoir
- Penygarreg Reservoir
- Claerwen Reservoir
- Craig Goch Reservoir
- Llangorse Lake
- Llanbwchllyn Lake
- Pencerrig Lake

[14] Flood Estimation Handbook Web Service (2024) Available at: Map - FEH Web Service (ceh.ac.uk) [Accessed 05/03/24]

Under the Reservoirs Act 1975, the EA and Natural Resources Wales (NRW) ensure that reservoirs are inspected regularly by reservoir safety panel engineers and that essential safety works are carried out. This means the overall risk of reservoir failure is very low.

3.1.7.4 Summary

A number of reservoirs and waterbodies have been identified within the River Wye catchment upstream of the Site which could result in inundation of the Site if a breach was to occur. However, these reservoirs are inspected regularly by reservoir safety panel engineers and meet legal standards. This means the overall risk of flooding from reservoirs in the catchment to the Site is very low.

Currently no other artificial sources of flooding exist within the catchment hence risk of flooding from all artificial sources is very low.

3.2 Management of risk during construction

It is recommended that during the construction phase, care is taken to ensure that materials are not washed into the existing drainage system causing blockages which could lead to localised flooding.

Operatives on site should be aware of possible fluvial and surface water flooding during red and amber weather alerts. They should sign up to the EA flood alert and warning service[15] for the Site.

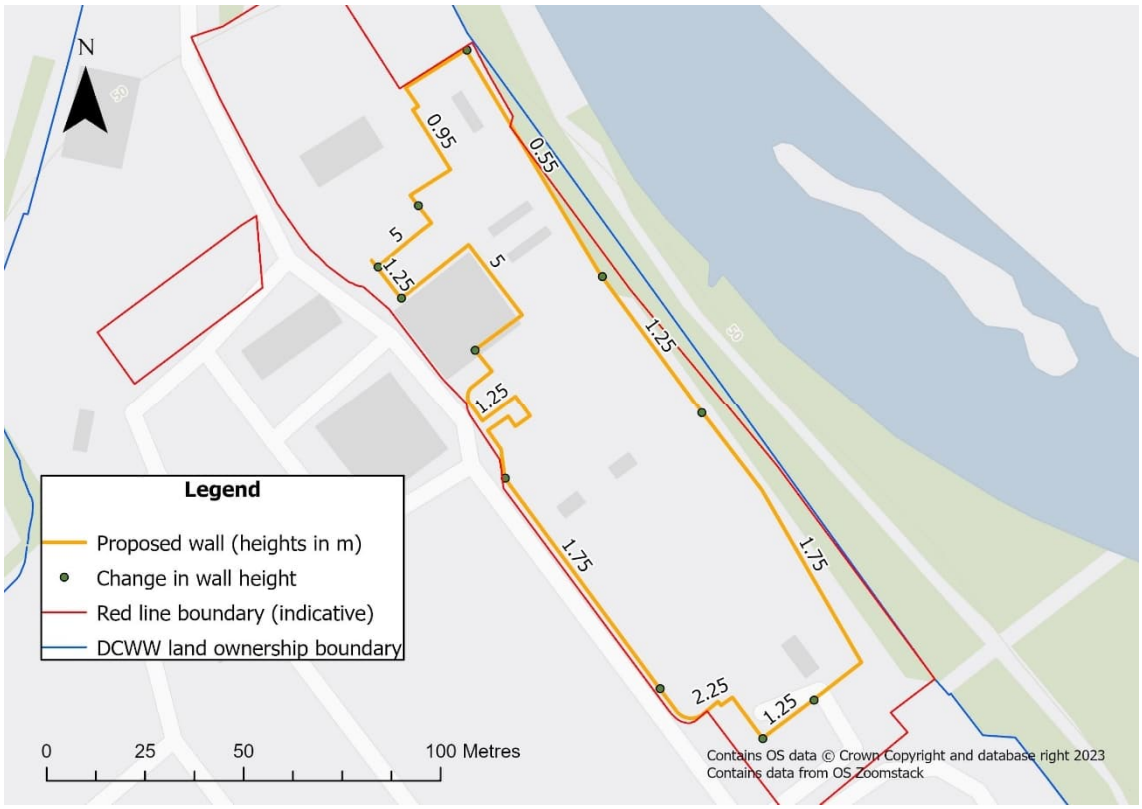
Additionally, as modelling has shown that the Site access road (Outfall Works Road) becomes flooded during the 10% - 0.1% AEP baseline modelled events, it is essential that plans to safely evacuate and access the Site be put in place.

3.3 Risk of flooding resulting from the proposed development

A new development has the potential to exacerbate flood risk to third parties through failure to properly account for the potential impact it may have on local flood risk. As part of the proposed development, a containment wall will be constructed to prevent potential sludge leakage beyond the red-line boundary. An outline of the proposed development, including the heights of each wall section (containment wall) is shown in Figure 3.9. This section of the report demonstrates that the proposed development does not increase flood risk elsewhere, as required by the NPPF.

[15] Environment Agency (2024) Sign up for flood warnings. Available at: Sign up for flood warnings - GOV.UK (www.gov.uk) [accessed 04/03/2024]

Figure 3.9: Proposed containment wall



Source: Mott MacDonald 2024

3.3.1 Fluvial flood risk

To investigate the risk of fluvial flooding to third parties, resulting from the proposed development, hydraulic model runs inclusive of the proposed containment wall were undertaken (hereafter the 'scheme model')

The scheme model simulated floods with AEPs between 1% and 0.1%, inclusive of climate change allowances, as shown in Table 3.5.

Table 3.5: Design events simulated in the Scheme model

Purpose	Epoch	Climate change uplift	1% (100)	0.1% (1000)
Proposed design	Present	0%	✓	✓
	2050s	20%	✓	
	2050s	27%	✓	

The design lifetime is intended to last until the 2050s. Modelled flood extent drawings displaying the change in flood extent resulting from the proposed scheme for the 1%, 1% + 27CC and 0.1% events are provided in Appendix B.

The resulting flood levels at the 12 modelled data points (see Figure 3.6) for the modelled design events are shown in Table 3.6.

The results show no significant increase in flood level outside of the Site boundary, with the maximum increase in flood level on third party land being 10mm, during the 1% AEP + 27% CC and 0.1% AEP events. Site access via Outfall Works Road also showed no increase in maximum flood level.

Figure 3.10 shows the difference between the baseline and post-development water levels for the 0.1% AEP event, which represents the worst-case scenario of the modelled events. While there is a minor increase (<0.1m) in flood level within the Site boundary, third-party land surrounding the site does not experience significant increased flood levels (<10mm).

The lowest elevation of the area enclosed by the proposed containment wall is 50.7mAOD. In a modelled baseline 0.1% AEP fluvial flood, the maximum water level recorded at the wall's perimeter (referring to points 3 and 5 in Table 3.6) was 51.92mAOD. Using this measurement as a conservative estimate of the flood level throughout the wall's interior, we can provide an estimate of the volume of flood water displaced in a 0.1% AEP event as 8932m^3. In such a design event, this increase is considered negligible, with any increased flood levels exceeding 10mm being contained within the DCWW land ownership boundary (Figure 3.10).

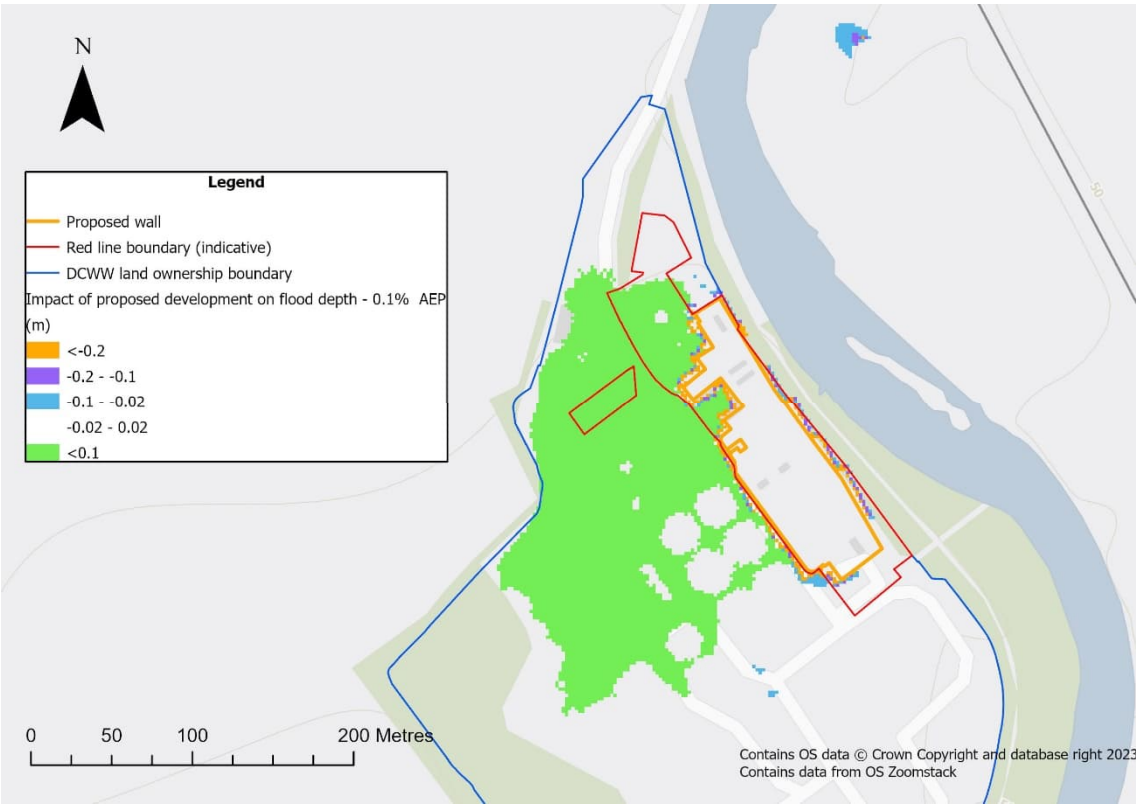
It is therefore considered that there will be no significant increase in fluvial or tidal flooding to third parties as a result of the proposed development.

Table 3.6: Comparison of baseline and post-development maximum water levels for 1% - 0.1% AEP events

Points	**Water level (mAOD)**											
AEP (%)	1			1+20CC			1+27CC			0.1		
	Baseline	Scheme	Difference	Baseline	Scheme	Difference	Baseline	Scheme	Difference	Baseline	Scheme	Difference
1	50.75	50.75	0.00	51.26	51.26	0.00	51.36	51.37	0.00	51.39	51.40	0.00
2*	51.29	51.29	0.00	51.64	51.64	0.00	51.75	51.76	0.00	52.04	52.06	0.02
3*	dry	dry	0.00	51.56	51.64	0.08	51.65	51.76	0.11	51.92	52.07	0.16
4*	51.17	51.17	0.00	51.63	51.64	0.01	51.75	51.77	0.02	52.04	52.08	0.03
5*	dry	51.16	0.00	51.52	51.60	0.08	51.61	51.71	0.10	51.89	52.01	0.12
6*	51.15	51.15	0.00	51.61	51.63	0.02	51.73	51.75	0.02	52.03	52.06	0.03
7*	50.85	50.85	0.00	51.34	51.33	-0.01	51.48	51.47	-0.01	51.86	51.85	-0.01
8	50.85	50.86	0.00	51.35	51.34	-0.01	51.49	51.48	-0.01	51.87	51.87	-0.01
9	50.93	50.93	0.00	51.32	51.32	0.00	51.48	51.47	-0.01	51.87	51.86	-0.01
10	50.93	50.93	0.00	51.33	51.33	0.00	51.48	51.48	-0.01	51.87	51.86	-0.01
11	50.73	50.74	0.00	51.22	51.22	0.00	51.39	51.38	0.00	51.80	51.79	-0.01
12	51.29	51.29	0.00	51.65	51.65	0.00	51.76	51.77	0.01	52.06	52.08	0.02

*Within DCWW land ownership boundary

Figure 3.10: 0.1% AEP difference in water level for baseline vs post- development



Source: Mott MacDonald 2024. Contains OS data © Crown Copyright and database right 2024. Esri World Topographic Map imagery 2024.

For all modelled events, the containment wall prevented flooding within its boundary, there is no change to flood extents and there is no flood level increase outside of the blue-line boundary.

3.3.2 Surface water flood risk

All new developments have the potential to cause an increase in downstream flood risk due to increased runoff rates and volumes occurring from a development. The proposed development within the Site consists of a simple brick wall, situated on existing operational land.

The section of the Site dedicated to the new development is currently at very low risk of surface water flooding. As such no flow paths will be diverted, but there may be minimal increase in run off due to an increase in impermeable ground within the red line boundary, with the entire area within this boundary being converted to hardstanding.

3.3.2.1 Management of surface water flood risk during operation

The strategy for management of risk during construction should be continued during active operation of the site. This comprises action resulting from the receipt of weather warnings, flood alerts/warnings and activation of evacuation plans. Additionally, the damage to land should be assessed following construction and restoration drainage should be installed to aid with rejuvenation of the soil structure. A drainage strategy for Zone 1 containment bund is outlined, dividing the area into three catchment regions. The plan includes:

- New gullies and manholes for one catchment area, directing surface water to the proposed site return pumping station, from which is pumped to the existing manhole (SW3), and finally through existing drains to the inlet works by gravity.
- A mix of new and existing gullies and manholes for the second catchment area, collecting surface water to an existing return pumping station, from which is pumped to the existing manhole (SW3), and similarly through existing drains to the inlet works by gravity.
- The third catchment area encompasses existing gullies and manholes around key assets like the thickener building, MCC kiosk CHP room and digester feed tank, with collected surface water directed to manholes no 7 or no 13. An actuated valve system downstream controls drainage flow as needed, with water draining to the inlet works via gravity.

This arrangement is detailed in the General arrangement for the proposed site drainage arrangement for Zone 1 (B16564-123532-ZZ-BG-DR-CA-CI1005).

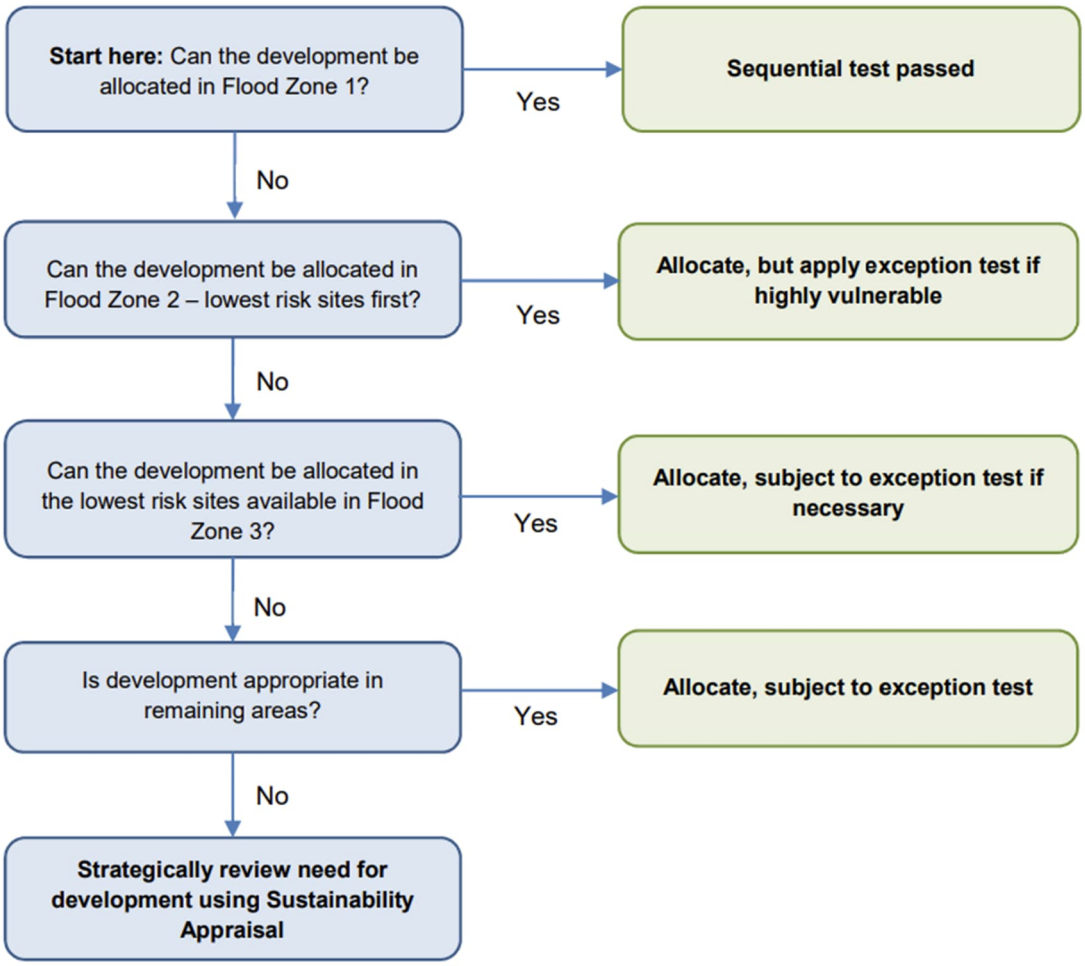
3.4 NPPF and the Sequential test results

The Site is located within Flood Zone 3a. Following the sequential test the Site is deemed to be “water compatible” and therefore the exception test is not required.

3.4.1 Sequential test

Figure 3.11 shows the process of the sequential test, required for all proposed developments to guide development to the lowest flood risk areas. The proposed development (containment wall) is located within Flood Zone 3a, designating it at “high” risk of fluvial flooding. However, it is imperative that the proposed location is not moved as the wall is intended to prevent effluent runoff from the tanks contained within its perimeter.

Figure 3.11: Application of the Sequential Test



Source: Herefordshire City SFRA (August 2020)[7]

The proposed wall falls under the 'water compatible' category as it will be expected to operate during a flood event. According to Table 2.1, this type of development is appropriate in Flood Zone 3a under NPPF flood risk policy, and no further testing is required.

4 Flood risk management

4.1 Access road flooding

As the modelling results show the access road to the Site is inundated during events less frequent than, and including the 10% AEP, it is essential to the safe operation of the site for the development of a flooding action plan. Table 4.1 shows the flood hazard matrix used for the assessment of flood hazard around the Site.

Table 4.1: Environment agency flood hazard rating matrix

Thresholds for Flood Hazard Rating – FD2321 **H=d x (v+0.5) + DF**	**Degree of Flood Hazard**	**Description**
<0.75	Low	**Caution -** "Flood zone with shallow flowing water or deep standing water"
0.75-1.25	Moderate	**Dangerous for some (i.e. children) -** "Danger: Flood zone with deep or fast flowing water"
1.25-2.5	Significant	**Dangerous for most people -** "Danger: flood zone with deep fast flowing water"
>2.5	Extreme	**Dangerous for all** - "Extreme danger: flood zone with deep fast flowing water"

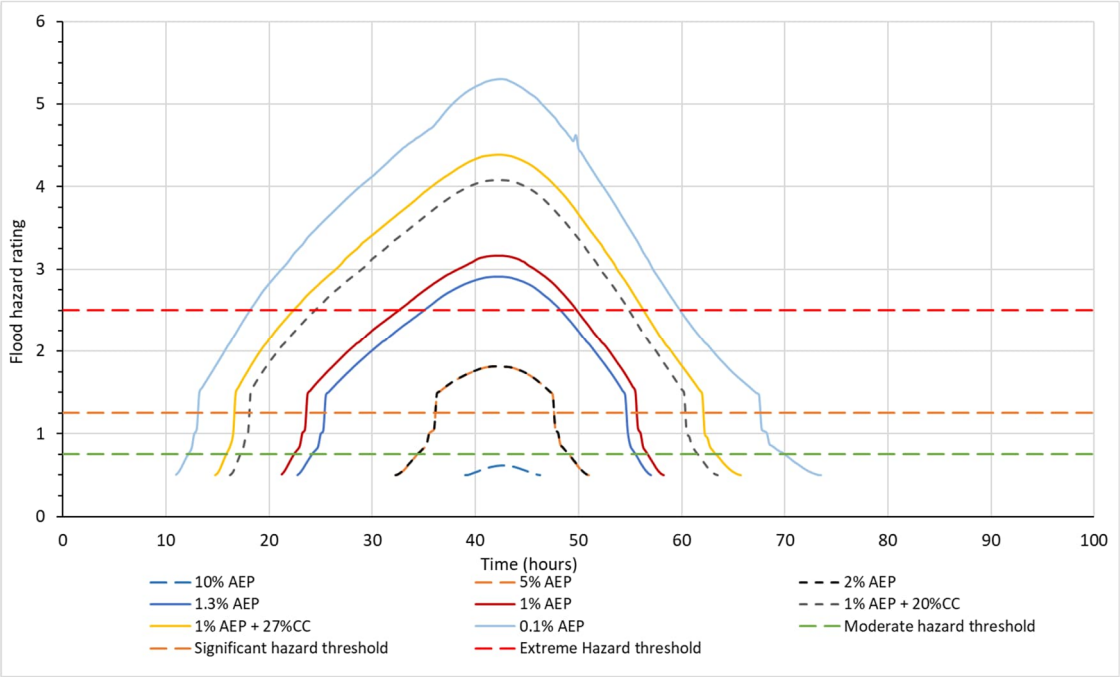
Source: Environment Agency 2008 Supplementary Note on Flood Hazard Ratings and Thresholds For Development Planning and Control Purpose [Accessed 20/03/2024]

Figure 4.1 shows the flood hazard rating[16] (HR) throughout every AEP event that caused flooding at Outfall Works Road, thus restricting access to the Site. The time series represents the worst-case flood hazard along the access road (data point 1, Figure 3.6). While the road floods during the 10% AEP event, the HR is low throughout the event, with the EA guidance stating caution should be observed. The 5% AEP and 2% AEP events have an 11-hour period where the HR is significant, presenting a 'danger for most'. The 1.3% AEP and 1% AEP events have a duration of 29 hours and 31.5 hours respectively, where flooding is over the significant hazard threshold, meaning there is a 'danger to most'. Of these time periods there are 16.5 hours (1.3% AEP), and 18 hours (1% AEP) where the HR is extreme, meaning during these periods there is an extreme danger to all. There is a HR exceeding the extreme threshold for 42 hours during the 0.1% AEP event, demonstrating the importance of an effective flooding action plan during such an event.

During a period of danger to most, site operatives would not be able to access or exit the Site via Outfall Works Road and during a period of Danger for All, the site would be inaccessible to emergency services.

[16] Environment Agency (2008) Supplementary note on flood hazard ratings and thresholds for development planning and control purpose Available at: FLOOD HAZARD RATINGS AND THRESHOLDS [Accessed 08/03/2024]

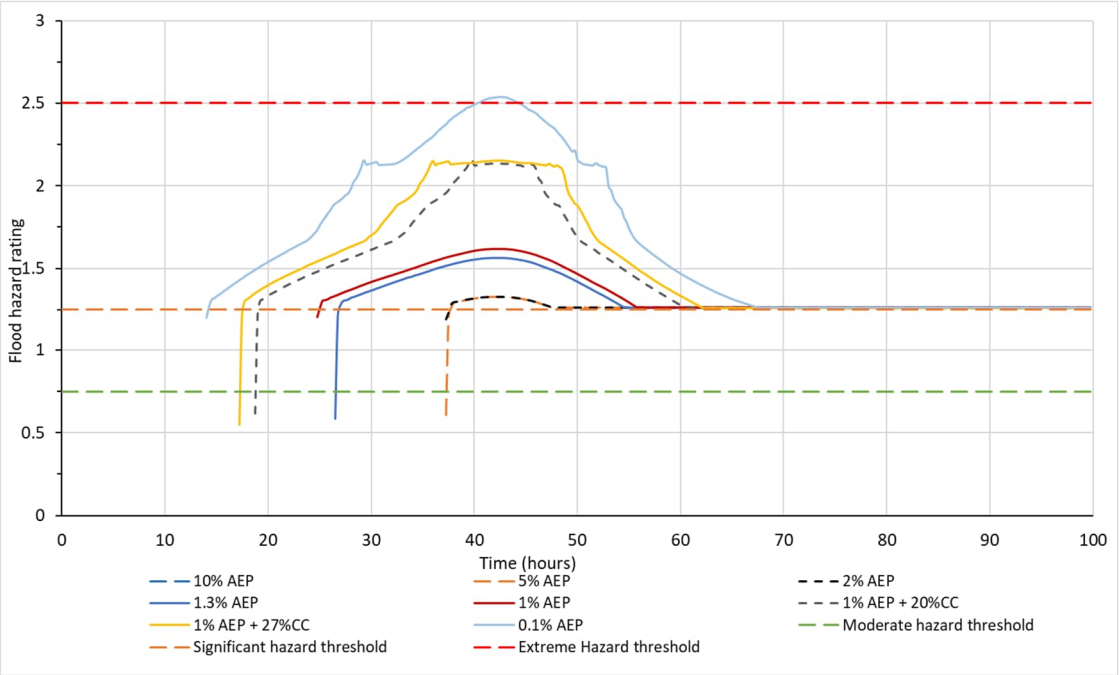
Figure 4.1: Flood hazard at Outfall Works Road (Site Access)



Source: Mott MacDonald 2024

Figure 4.2 presents the worst-case HR within the Site boundary for the modelled events where flooding was observed. The time series were read from data point 7 (Figure 3.6) in the southeast of the Site boundary. Data point 7 represents the area of greatest flooding within the Site boundary. The HR for each event shows that any flooding in the site quickly presents a significant hazard, where there is a danger to most, with the 0.1% AEP event presenting a short period of extreme danger to all. The figure suggests the HR does not reduce beyond the significant hazard threshold once initial flooding takes place, however this is due to the lack of representation of site drainage in the flood model, with the period of significant hazard likely to be overestimated during the period of flood recession.

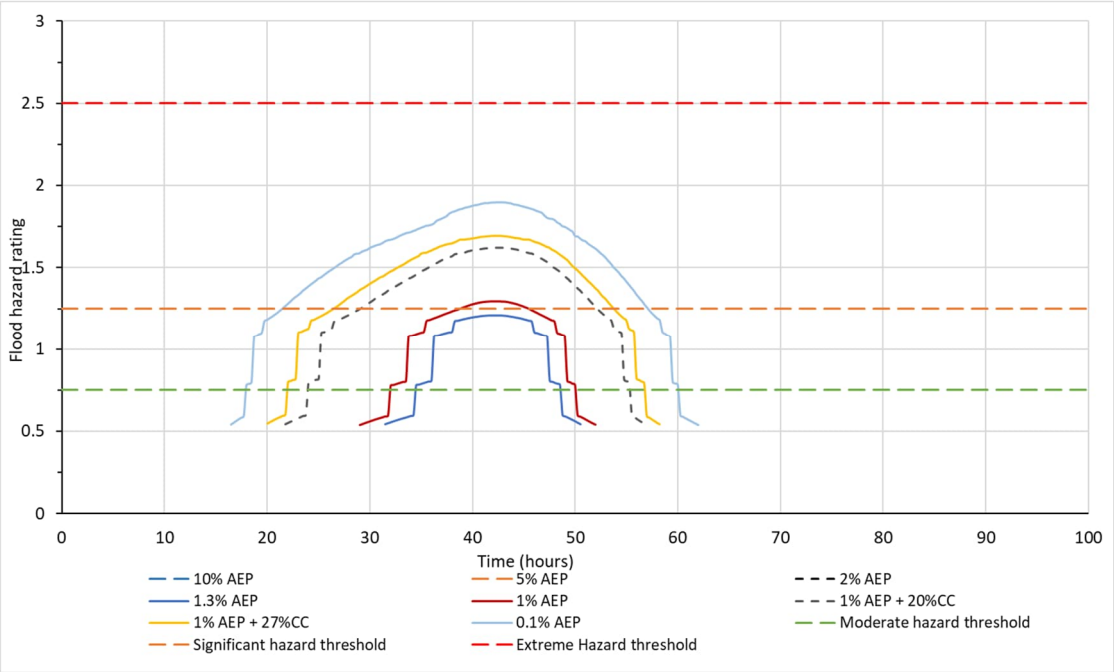
Figure 4.2: Worst case flood hazard within Site boundary



Source: Mott MacDonald 2024

A footbridge located to the southeast of the Site, which connects the Site to the River Wye right hand bank floodplain, is an alternative pedestrian evacuation route via the housing development to the south. Figure 4.3 shows the HR at data point 9 (Figure 3.6) which represents the worst-case HR along this potential evacuation route. This route is free from flooding during 10% AEP, 5% AEP and 2% AEP events (events which prevent access via Outfall Works Road). The HR for the 1.3% AEP, 1% AEP and 0.1% AEP events is also lower than those for Outfall Works Road, however significant hazard is shown for a period of 36 hours during the 0.1% AEP event which would prevent pedestrian access for site operatives but would still provide access for emergency services.

Figure 4.3: Worst case flood hazard for southeastern access route



Source: Mott MacDonald 2024

5 Conclusions

5.1 Summary

5.1.1 Flood risk to the proposed development

Based on the findings of this FRA the following conclusions are drawn:

- The proposed wall is “water compatible”, which is appropriate for allocation in any Flood Zone. The development cannot be relocated to a lower-risk Flood Zone due to its purpose of containing failure of existing tanks. The exception test is not required for water compatible developments.
- The proposed development is in Flood Zone 2 and 3a, indicating a “high” (>1% AEP) risk of fluvial flooding.
- Tidal flooding is not considered a significant risk.
- Localised areas of the Site are susceptible to surface water flooding at “medium” (3.3% - 1% AEP) risk. The area for proposed development itself is at “very low” (<0.1% AEP) risk of surface water flooding.
- The Site is not located on a principal aquifer, so groundwater flooding should not be considered a significant risk.
- No sources of artificial canal flooding have been identified at the Site.
- There are numerous reservoirs in the River Wye catchment that would result in flooding if the asset failed. Under the Reservoirs Act 1975, the EA and NRW ensures that reservoirs are inspected regularly by reservoir safety panel engineers and that essential safety works are carried out. This means the overall risk of reservoir failure is low.

Table 5.1 gives a summary of the flood risk pre and post development at the Site.

Table 5.1: Summary of flood risk at the Site

Flood Risk Source	Pre-development flood risk	Post development flood risk
Fluvial	High	High
Tidal	Low	Low
Surface water	Low	Low
Groundwater	Low	Low
Sewer	Low	Low
Reservoirs/Artificial sources	Low	Low

5.1.2 Flood risk resulting from the proposed development

The updated MM hydraulic model recorded a maximum increase of 10mm on third-party land during the 1% AEP + 27% CC allowance and 0.1% AEP events with no increase in flood extent. Site access also showed no significant increase in maximum flood level. Consequently, it is considered that the proposed development will not increase fluvial flood risk in 3rd party land.

Further, given that the Site is currently at ‘very low’ risk of surface water flooding, the decreased permeability produced by conversion of the area within the red line boundary to 100% hardstanding will have little effect on the diversion of flow paths and will be managed through an updated drainage strategy. A negligible increase of run off is envisaged but to such a small extent that it would not affect any downstream receptors.

Appendices

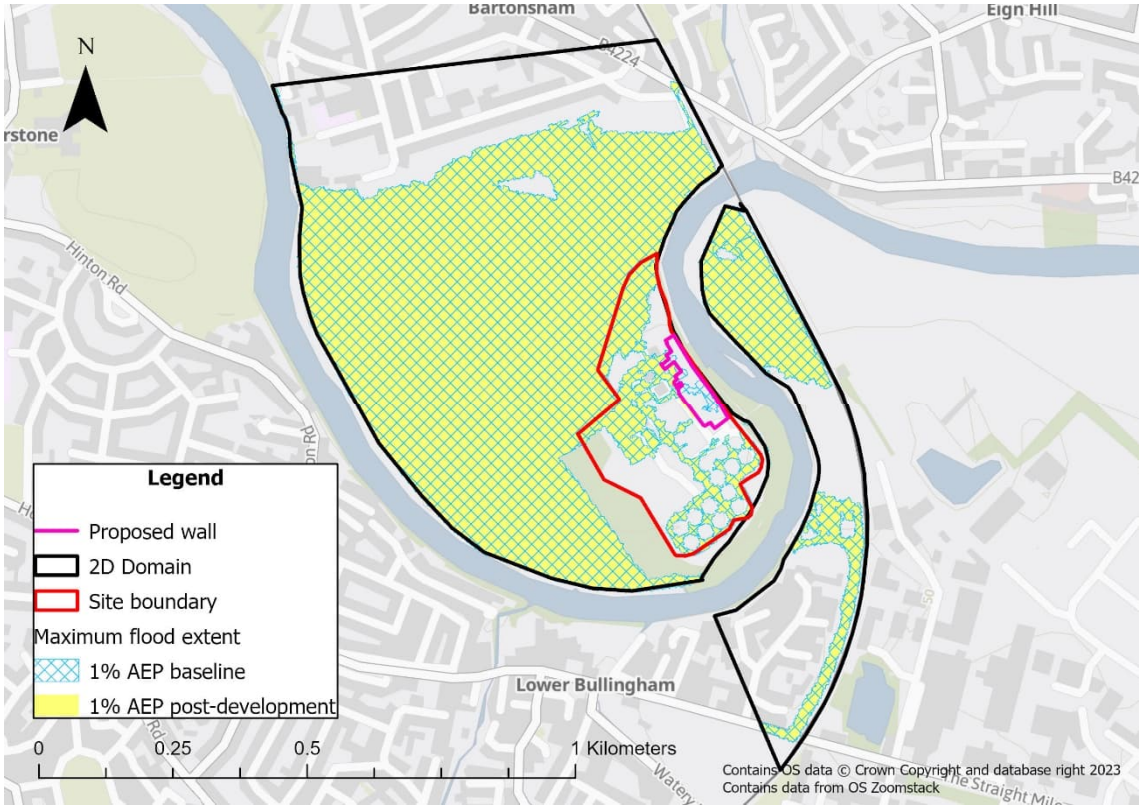
A. Hydraulic modelling report

Please note this is provided as a digital appendix.

B. Modelled flood extent drawings

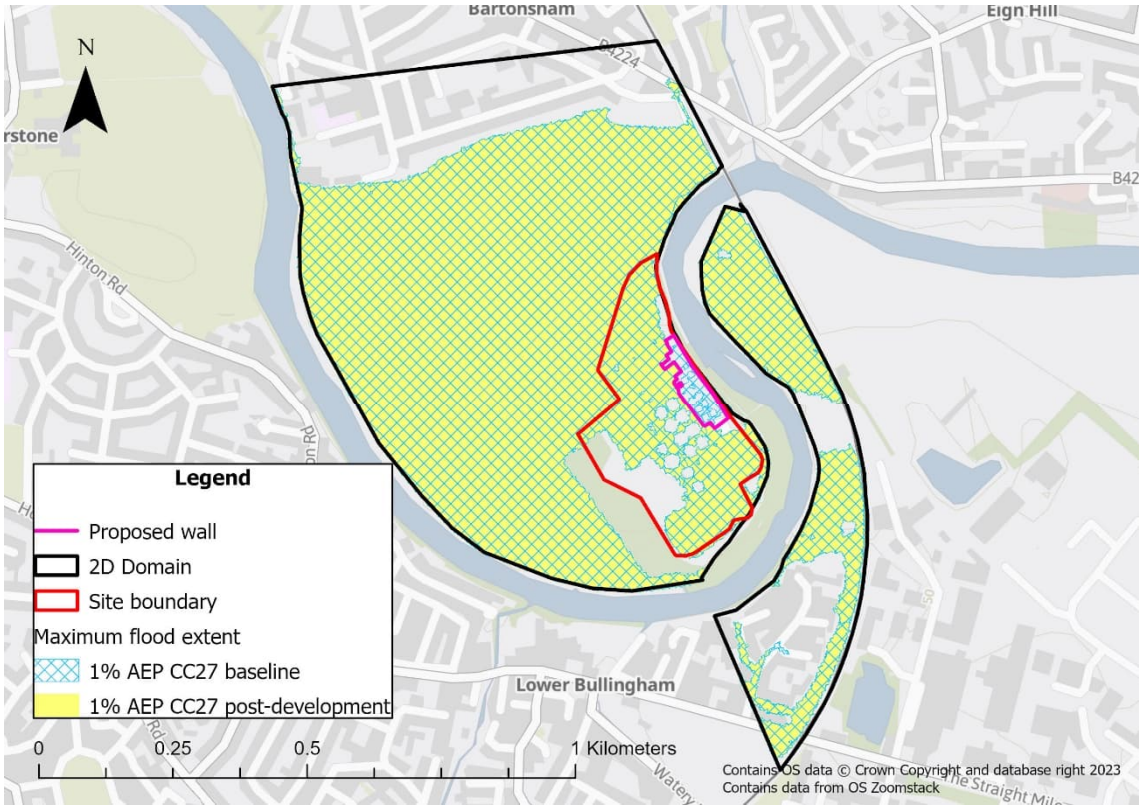
Figures comparing the flood extents for the baseline and options scenarios are included below.

Figure B.1: 1% AEP Flood Outline Comparison (Baseline and Scheme)



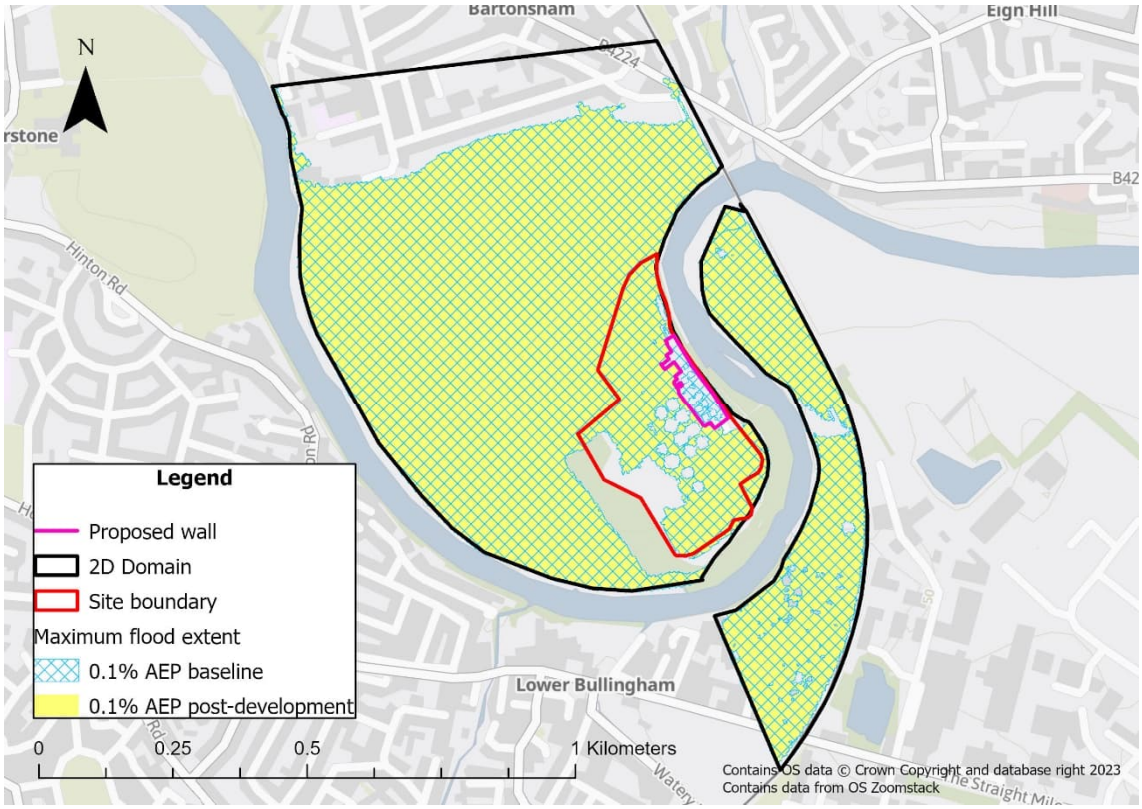
Source: Mott MacDonald

Figure B.2: 1% + 27CC AEP Flood Outline Comparison (Baseline and Scheme)



Source: Mott MacDonald

Figure B.3: 0.1% AEP Flood Outline Comparison (Baseline and Scheme)



Source: Mott MacDonald