

Bradford Level 2 Strategic Flood Risk Assessment - Site E118

Final Draft

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Prepared for:



City of
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METROPOLITAN DISTRICT COUNCIL

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site E118. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2025) and is therefore familiar with the terminology used in this report.

1.1 Site E118

- Location: Beechcliffe, Keighley
- Existing site use: Greenfield, open space and woodland
- Existing site use vulnerability: Water compatible
- Proposed site use: Employment
- Proposed site use vulnerability: Less vulnerable
- Site area: 2.6 hectares
- Proposed development impermeable area: 1.7 hectares
- Watercourse: River Aire (main river)
- Environment Agency (EA) river model: Leeds FAS Kildwick to Esholt 2022
- Summary of requirements from scoping stage:
 - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA
 - Assessment of modelled fluvial flood depths, velocities and hazards
 - Assessment of surface water flood depths and hazards based on the EA's national Risk of Flooding from Surface Water dataset
 - Assessment of all other sources of flood risk
 - Modelling of latest EA climate change allowances for peak river flows and peak rainfall intensities



Figure 1-1: Existing site location boundary



Figure 1-2: Topography



Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning (September 2024) and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.3) or the impacts of climate change (Section 2.2).

Fluvial flood risk to the site comes from the River Aire, a designated main river, to the northeast of the site. Fluvial flooding is modelled to enter the site via the backing up of a series of culverts beneath the A629 road. These culverts connect the River Aire and its floodplain to a small drain located north of the site.

The northeastern corner of the site is within Flood Zone 2 and therefore at medium risk. Flood Zone 2 in this location is not based on modelled data. It is based on the EA's Historic Flood Map (HFM). See Section 2.4. 79% of the site is within Flood Zone 1 and therefore at low risk and developable.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
79	21	0	0



Figure 2-1: Existing risk from rivers to the site

2.1.2 Leeds FAS Kildwick to Esholt 2022 model outputs

Figure 2-2 shows the modelled flood depths for the 0.1% AEP undefended event. Modelled risk to the site is the lesser that shown by Flood Zone 2 (which is based on historic flood outlines), with flooding from the River Aire backing up through the A629 culverts impacting the northern corner of the site. Maximum flood depths within the site are modelled to be > 1.2 m and therefore significant. Modelled flood velocities are generally low across the area at risk (Figure 2-3), with velocity rarely exceeding $0.25 \text{ m}^3/\text{s}$. This is reflected in the modelled flood hazard being largely categorised as 'very low hazard' or 'danger for some' across the area at risk (Figure 2-4). Safe access and escape routes would likely be achievable via either Royd Lane to the west or Royd Ings Avenue (beneath the A629) to the east during a fluvial flood event. Section 2.3.1 discusses the defended model outputs.

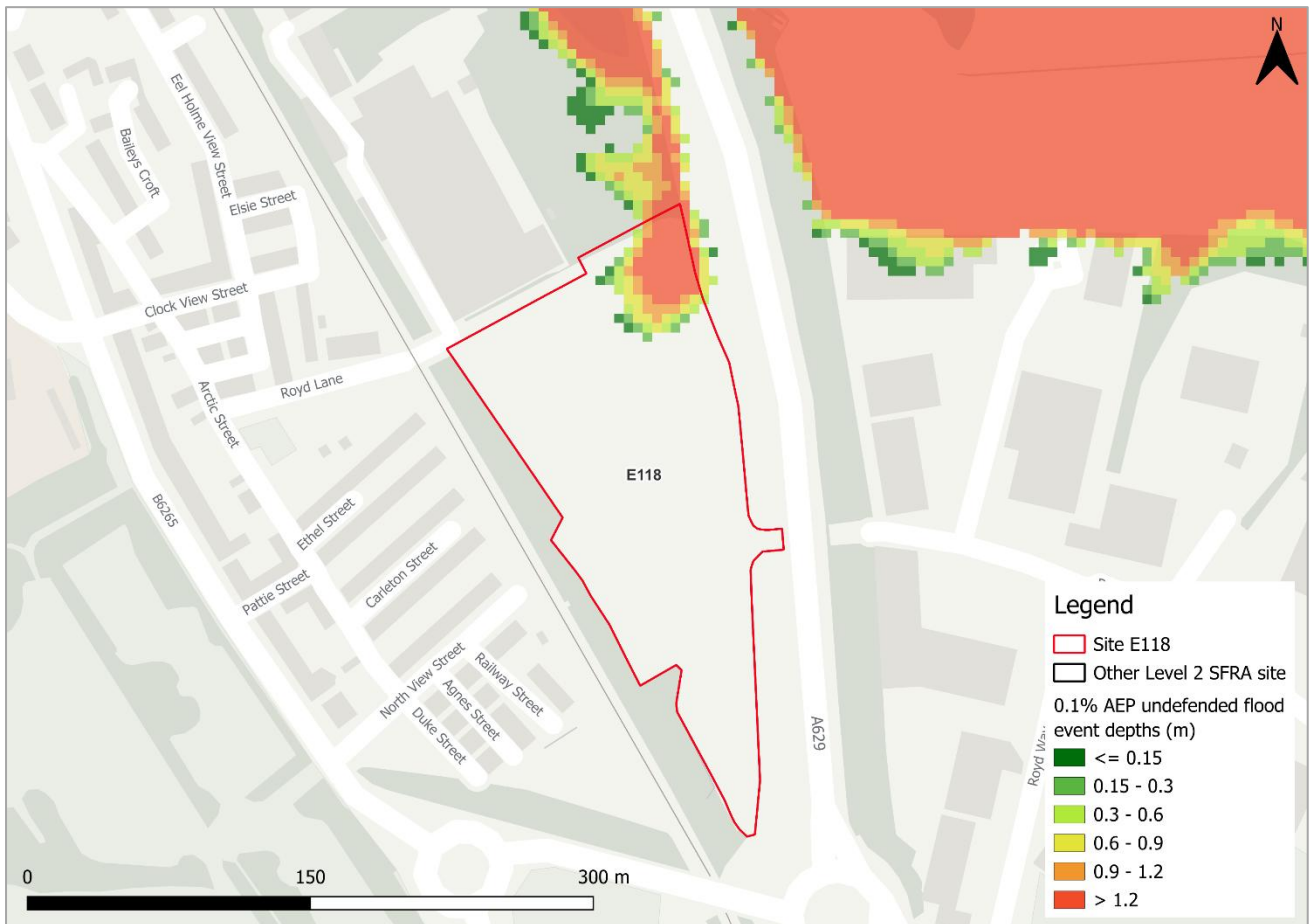


Figure 2-2: Flood depths for 0.1% AEP undefended flood event



Figure 2-3: Flood velocities for 0.1% AEP undefended flood event



Figure 2-4: Flood hazard¹ for 0.1% AEP undefended flood event

2.2 Impacts from climate change

The impacts of climate change on flood risk from the River Aire have been modelled without flood defence infrastructure in place. This allows for direct comparison with the existing risk of the Flood Map for Planning. Section 2.3.1 discusses the defended model outputs.

With consideration of the EA's SFRA guidance, the latest climate change central and higher central allowances have been modelled as shown in Table 2-2.

The EA's SFRA guidance states that SFRAs should assess the central allowance for less, more, and highly vulnerable development, and also water compatible development. The higher central allowance should be assessed for essential infrastructure.

¹ Fluvial hazard ratings based on Table 4 of the SUPPLEMENTARY NOTE ON FLOOD HAZARD RATINGS AND THRESHOLDS FOR DEVELOPMENT PLANNING AND CONTROL PURPOSE – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1. May 2008.

Table 2-2: Modelled climate change allowances for peak river flows for the Aire and Calder Management Catchment

Return period (AEP event)	Central allowance 2080s (% increase)	Higher central allowance 2080s (% increase)	Upper end allowance 2080s (% increase)
3.3% (functional floodplain)	23%	31%	51%
1%	23%	31%	51%

The functional floodplain plus climate change dataset indicates that the site will not be within the functional floodplain in the future.

Figure 2-5 shows the onsite modelled flood depths for the 0.1% AEP undefended event +23% for climate change. Risk is modelled to be almost identical in extent in comparison to present day conditions, with a slightly larger area of significant depths. Maximum depths within the area remain > 1.2 m. Flood velocities are modelled to increase slightly, though maximum velocities remain between 0.25 and 0.5 m³/s (Figure 2-6). The modelled flood hazard within the area at risk is largely categorised as 'danger for some' (Figure 2-7), with some greater areas categorised as 'danger for most'. Safe access and escape routes should remain achievable via either Royd Lane to the west or Royd Ings Avenue (beneath the A629) to the east when accounting for climate change.

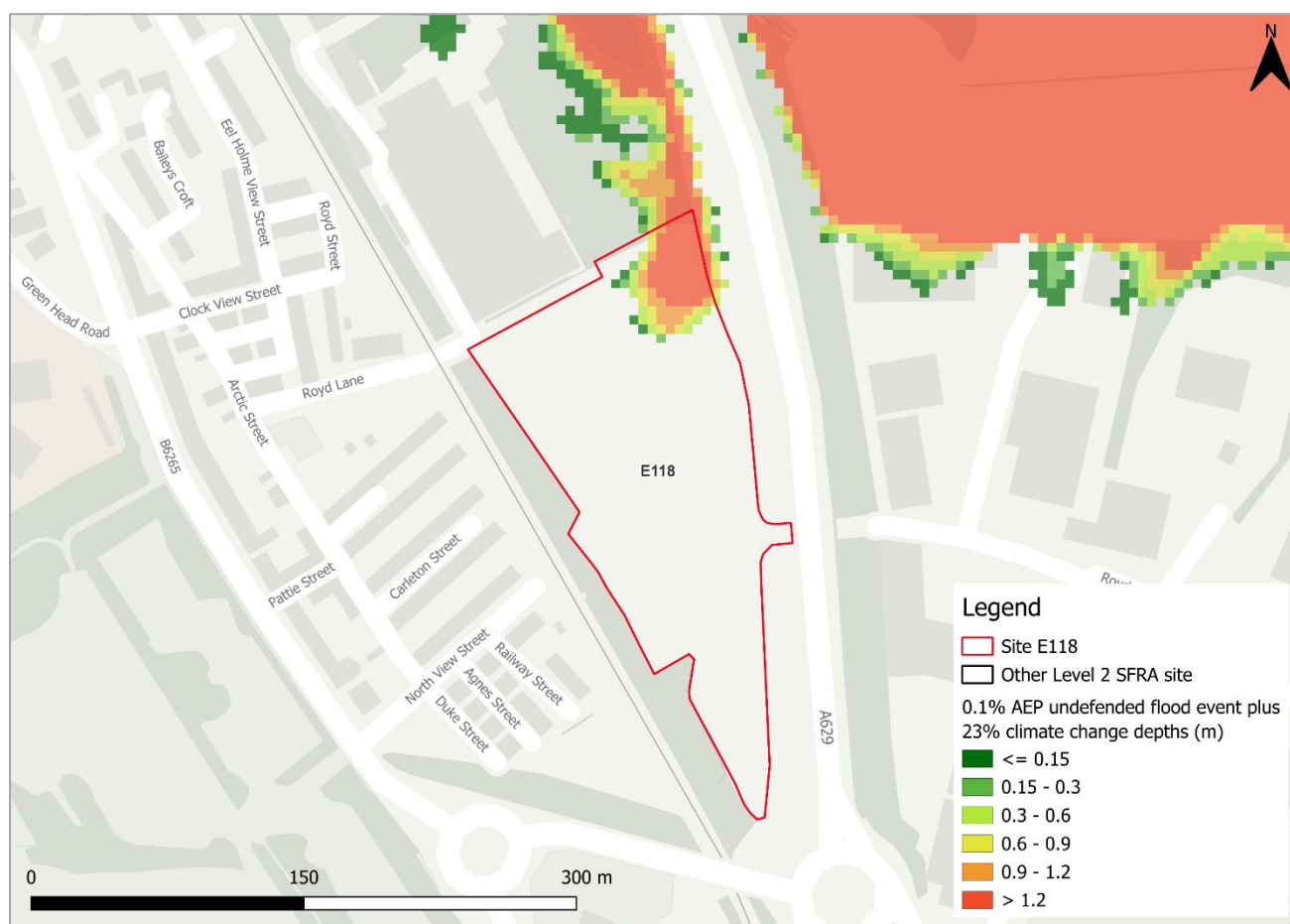


Figure 2-5: Flood depths for 1% AEP undefended flood event +23% (central climate change allowance)

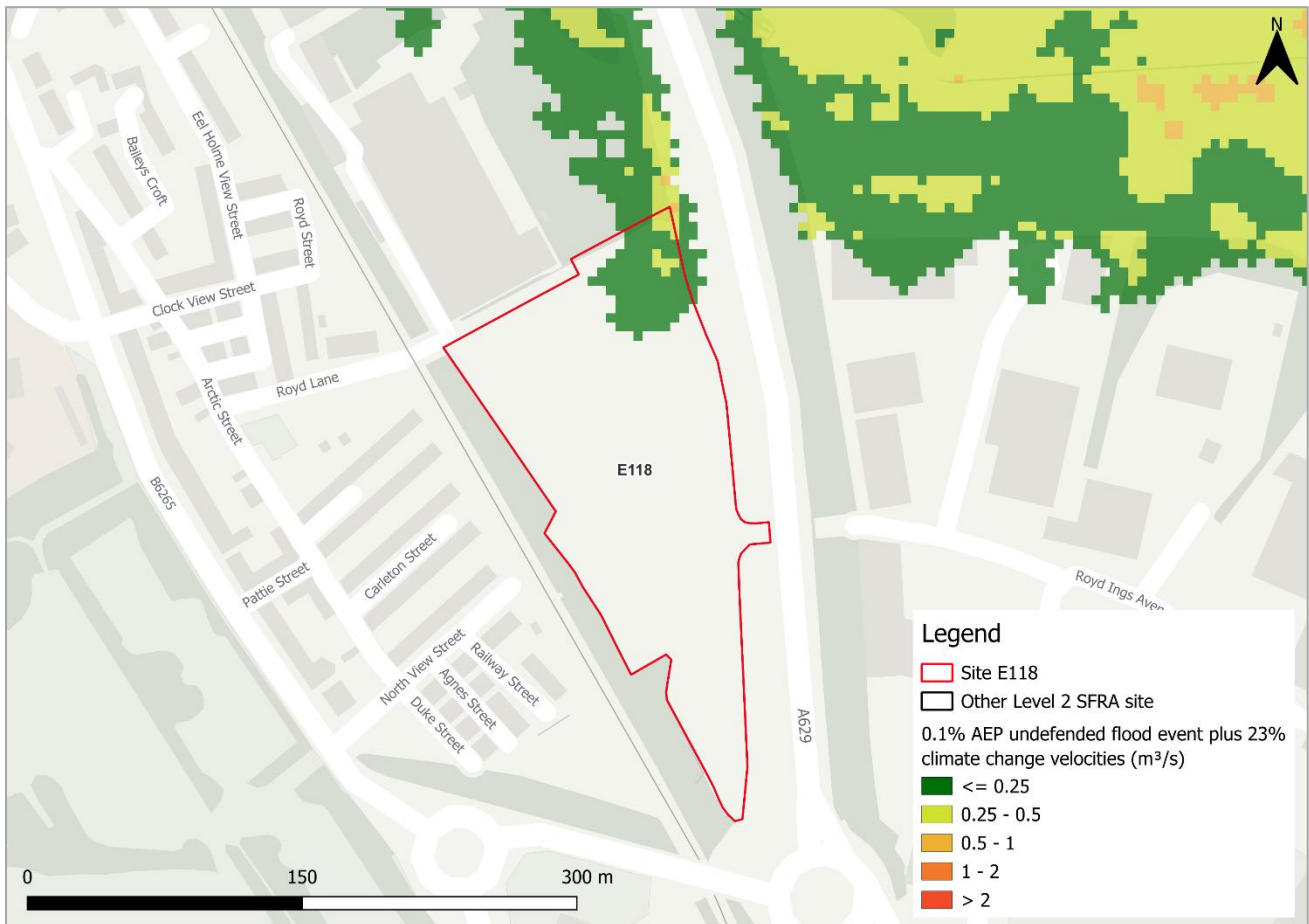


Figure 2-6: Flood velocities for 1% AEP undefended flood event +23% (central climate change allowance)



Figure 2-7: Flood hazard for 1% AEP undefended flood event +23% (central climate change allowance)

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset. This is reflected in the defended modelled flood extent and depths being very similar to the undefended event within the site (Figure 2-8). This is consistent with the modelled climate change events.

There are areas of natural high ground along the banks of the River Aire adjacent to the site.

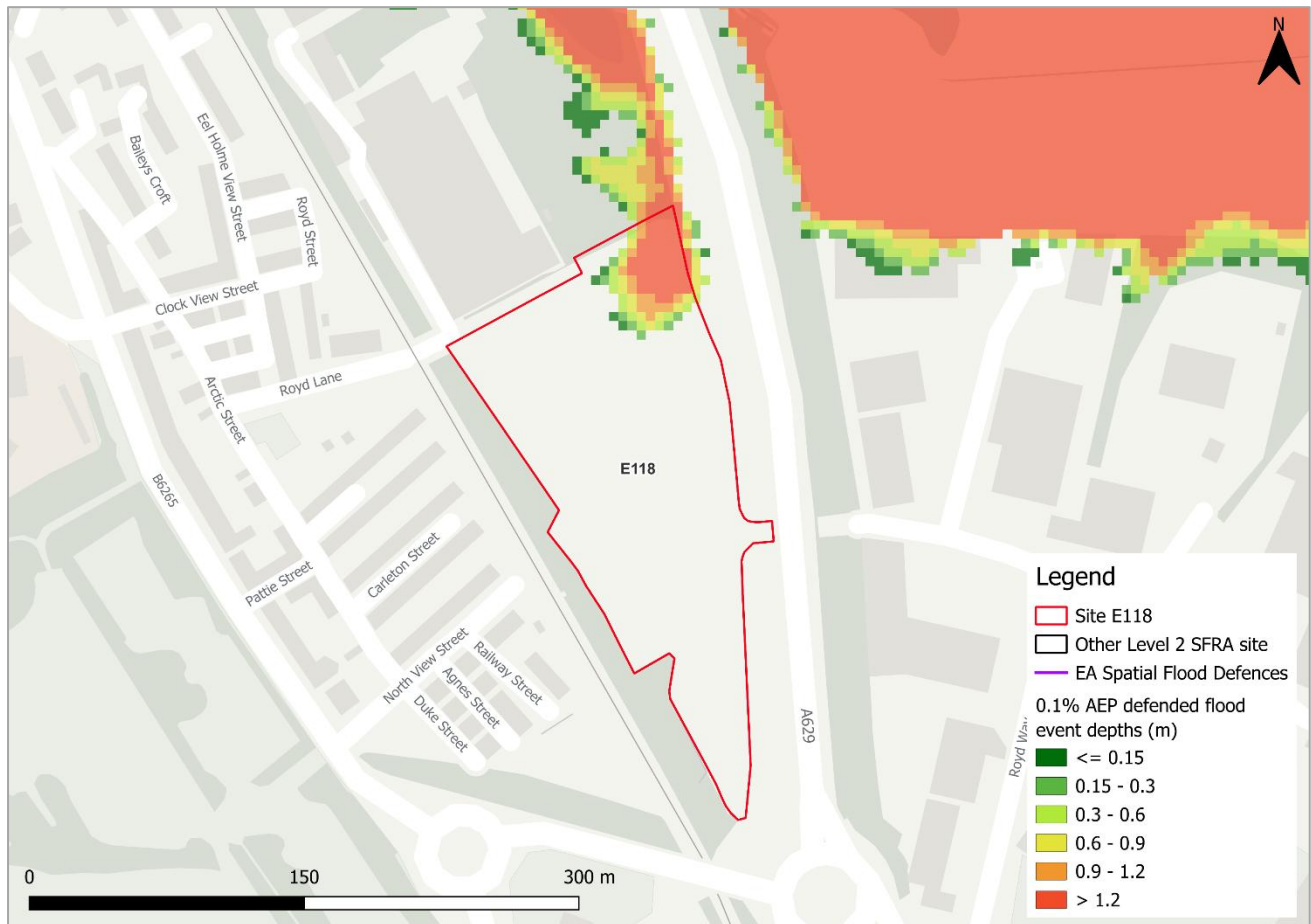


Figure 2-8: Flood depths for 0.1% AEP defended flood event

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) that may help to reduce flood risk to the site and surrounding areas. Upstream of the site, there are opportunities for both riparian and floodplain woodland planting which indicate where tree planting would be effective to attenuate flooding. There is also potential for runoff attenuation features which indicate where it may be possible to temporarily store water and attenuate flooding during high flows. These areas are shown in Figure 2-9. The WwNP mapping is broadscale and indicative. Further investigation is required for any land shown to have potential for WwNP.

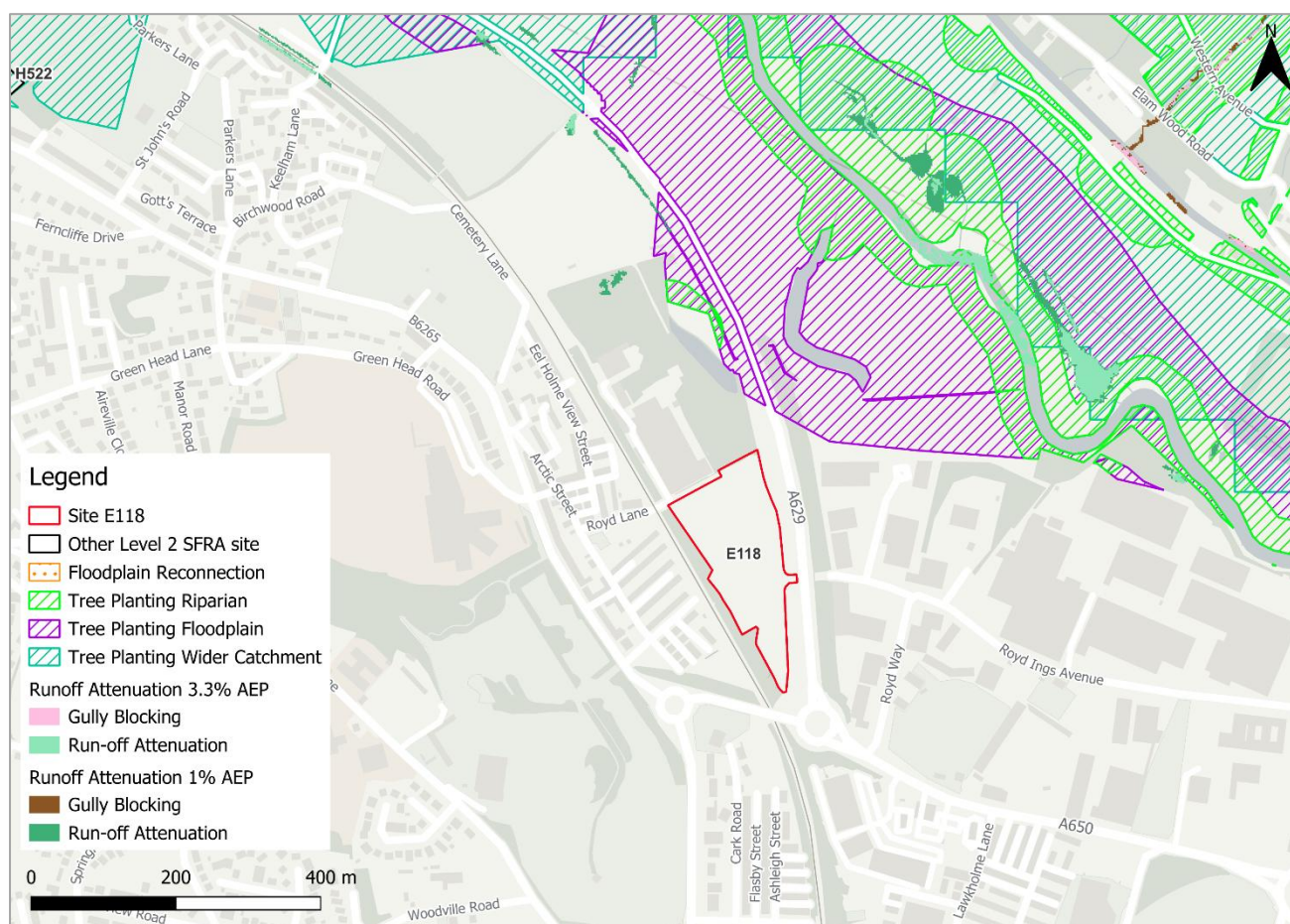


Figure 2-9: Natural Flood Management (NFM) potential mapping

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) has been considered and mapped in Figure 2-10 which shows the northeast of the site has been subject to flooding in the past. The RFO dataset indicates that a historic event occurred as a result of the channel capacity of the River Aire being exceeded in December 2015. Flood Zone 2 of the Flood Map for Planning is based on this event.



Figure 2-10: Recorded historic flood events onsite and around the site

2.5 Flood warning and access and escape routes

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. The site is not located within a FWA.

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. The site is partially located within a FAA, namely 123WAF960 - Upper River Aire catchment.

Based on available information, safe access and escape routes would likely be achievable via Royd Lane, west of the site, or via Royd Ings Avenue (beneath the A629), east of the site during a flood event.



Figure 2-11: EA Flood Warning Areas and Flood Alert Areas

2.6 Observations, mitigation options and site suitability - fluvial

- The proposed development of the site would see a change in the risk classification from water compatible to less vulnerable, according to the NPPF.
- Given the change in use and therefore vulnerability of the site, the FRA must show that the development can be designed to be safe and that there is adequate emergency planning provision (para 014 FRCC-PPG).
- The site is modelled to be within Flood Zone 2 in the north of the site, which is based on the EA's HFM.
- The northern corner of the site is modelled to be at risk from fluvial sources (according to the Leeds FAS Kildwick to Esholt 2022 model) in the 0.1% AEP undefended scenario.
- Fluvial flooding enters the site through the culverts beneath the A629. Opportunities for offsite works to prevent the backing up of floodwater through the culverts should be explored.
- The 1% AEP event with an allowance for climate change is what the EA considers to be the design event for a development to mitigate fluvial flood risk. The site is not modelled to be at risk of flooding during this event.

- Ideally, all built development would be directed to the areas of the site within Flood Zone 1. Were development to proceed within Flood Zone 2, the site-specific FRA must show that appropriate evacuation procedures and flood response infrastructure are in place to manage the fluvial risk associated with the extreme flood event.
- EA flood alerts should continue to be in place to ensure early evacuation of site users before an extreme flood event occurs.

3 Flood risk from surface water

3.1 Existing risk

Based on the EA's national scale Risk of Flooding from Surface Water (RoFSW) map (November 2024), surface water risk to the site is predominantly very low. Approximately 3% of the site is at high surface water risk. A further 9% of the site is at medium risk and a further 21% is at low surface water risk, as shown in Table 3-1.

In the high risk event, surface water risk is largely confined to an area of ponding within a topographic low spot in the northern half of the site. There is also a small amount of ponding at the northwestern corner of the site and at the low spot on Royd Lane (beneath the railway bridge). The areas of ponding onsite are modelled to significantly increase in extent in the medium risk event, with some additional areas of ponding along the southwestern boundary of the site. In the low risk event, surface water flood risk is spread across much of the northern half of the site, the flood depths across the site are significant.

Greatest flood depths within the site in the medium risk event are between 0.9 and 1.2 m (Figure 3-1), however this is confined to a very small area of the site. Modelled flood hazard is largely categorised as significant (Figure 3-2). Safe access and escape routes may be achievable via Royd Ings Avenue (beneath the A629), east of the site in all events.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
67	21	9	3



Figure 3-1: Medium risk event surface water flood depths (Risk of Flooding from Surface Water map)



Figure 3-2: Medium risk event surface water flood hazard² (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

The impact of climate change on surface water flood risk has been modelled. This allows for direct comparison with the RoFSW map. With consideration of the EA's SFRA guidance, the latest climate change allowances have been modelled as shown in Table 3-2.

Table 3-2: Modelled climate change allowances for rainfall for the Aire and Calder management catchment

Return period	Central allowance 2070s (% increase)	Upper end allowance 2070s (% increase)
3.3% (high risk)	25%	40%
1% (medium risk)	30%	45%

Figure 3-3 shows the modelled surface water flood depths for the medium risk event plus 45% climate change. Risk is modelled to be significantly greater than for present day

² Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

conditions, with the medium risk climate change event showing a similar level of risk to the present day low risk event. Maximum depths are modelled to be > 1.2 m, with areas of hazard categorised as extreme (Figure 3-4). Safe access and escape routes may remain achievable via Royd Ings Avenue (beneath the A629) to the east, however flooding to depths of up to between 0.3 and 0.6m is modelled to impact the low spot under the A629 in a small area which may be a barrier to this route.

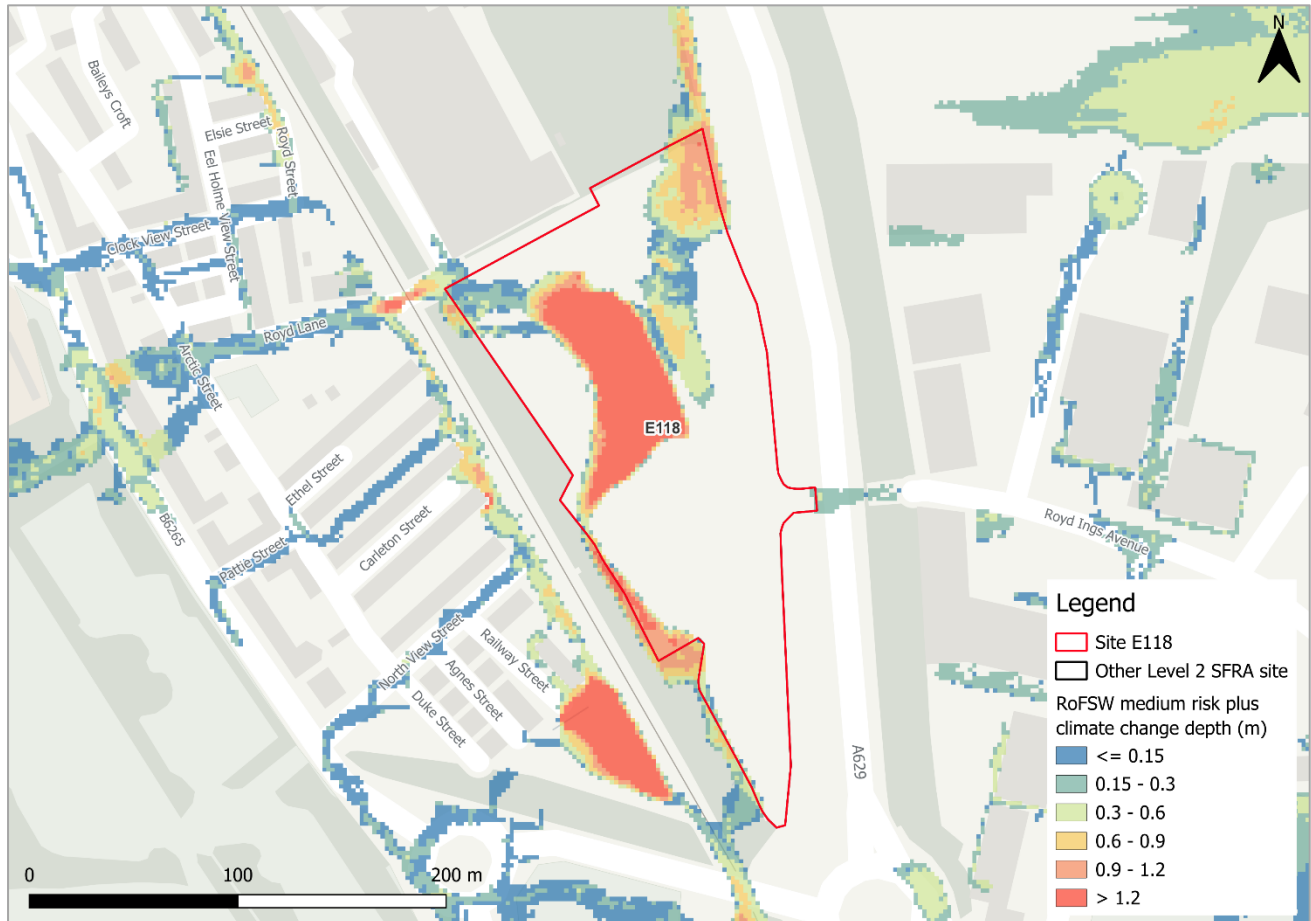


Figure 3-3: Medium risk event surface water flood depths plus 45% climate change (based on Risk of Flooding from Surface Water map)



Figure 3-4: Medium risk event surface water flood hazards plus 45% climate change (based on Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- Current risk is largely confined to the northern half of the site in the medium risk event. However, risk is modelled to increase significantly with climate change.
- Topographic depressions and flow routes should be considered and included in site design and ideally left in place to flood naturally when required. Any regrading of land must include like for like volumes to ensure risk is contained safely onsite for the lifetime of development.
- Safe access and escape routes should be achievable via Royd Ings Avenue (beneath the A629) east of the site in all present day events. When accounting for climate change, there may be depths of up to 0.6m however this is modelled to be in a very small area. Therefore safe access and escape routes should remain achievable.
- A full drainage strategy would be required to ensure there is no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on layout plans and detailed design and full consultation with the LLFA. Runoff volumes must not exceed existing greenfield rates and, if possible, betterment should be achieved.

- Note that the RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide³. Figure 4-1 shows the map covering this site and the surrounding areas and Table 4-1 explains the risk classifications.

The northwest of the site is located within an area where there is no risk of groundwater emergence. Groundwater conditions may therefore be suited to infiltration SuDS in these areas. Within the southeast of the site, there is a risk of groundwater emergence to both surface and subsurface assets. Ground investigations will be required through the site-specific FRA to ascertain groundwater levels and conditions in this area.



Figure 4-1: JBA 5m Groundwater Emergence Map

³ [Strategic flood risk assessment good practice guide. ADEPT. December 2021.](#)

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event. There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

5.1 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. Figure 5-1 shows the RFM in a 'dry day' and 'wet day' scenario. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The site is potentially at risk from two reservoirs, namely; Embsay and Malham Tarn reservoirs, both located within North Yorkshire. Embsay reservoir is operated by Yorkshire Water Services Ltd and Malham Tarn reservoir is operated by the National Trust.

The EA's SFRA guidance states that where a proposed development site is at flood risk from a reservoir, then an assessment into whether the reservoir design or maintenance schedule needs improving should be carried out. Expert advice may be required from an all-reservoirs panel engineer. The Council should consult the relevant reservoir undertaker to ascertain whether the proposed development could affect the reservoir's risk designation, its design category or how it is operated. The Council, as category 1 responders, can access more detailed information about reservoir risk and reservoir owners using the [Resilience Direct](#) system.

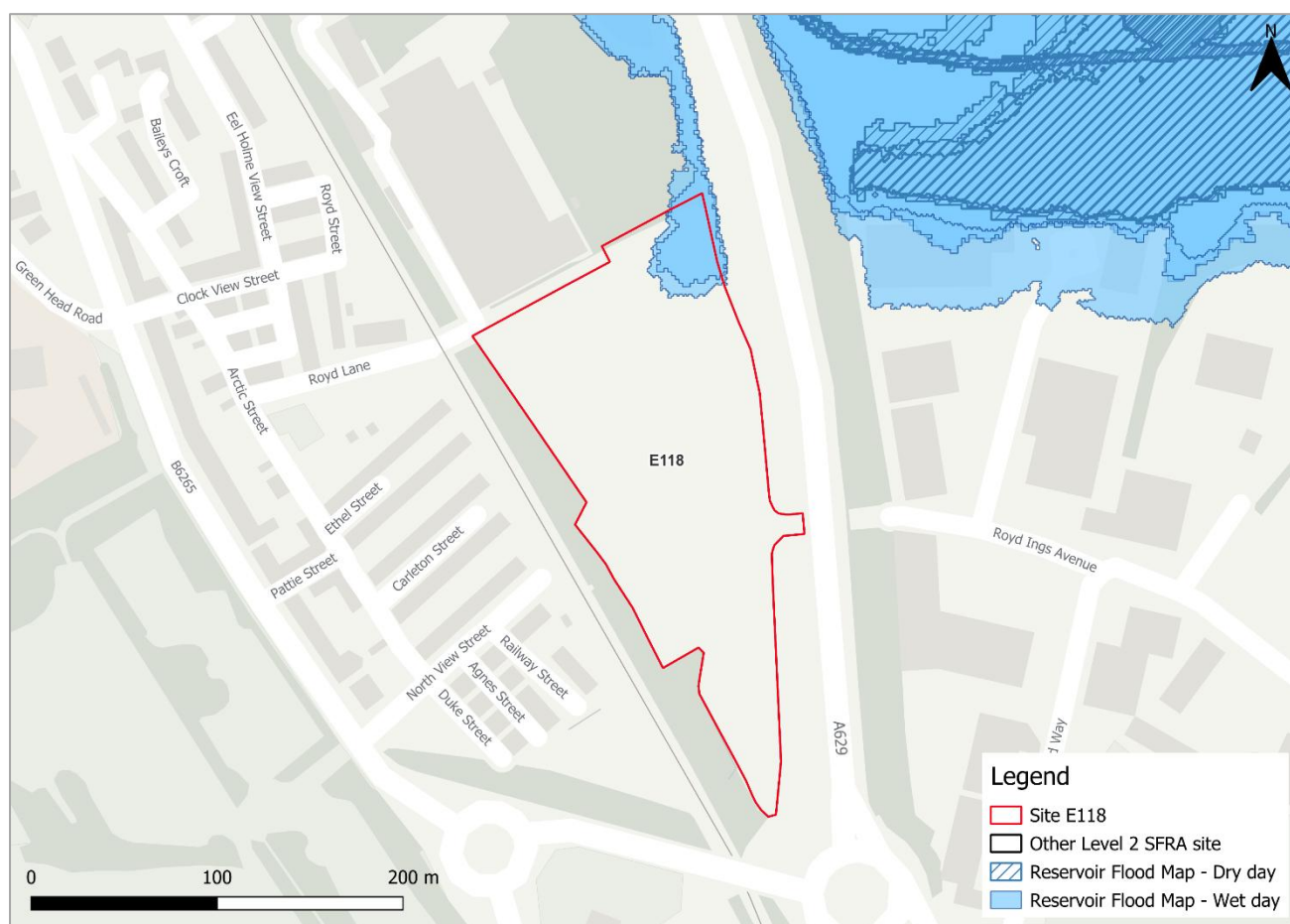


Figure 5-1: Flood risk from reservoirs

5.2 Flood risk from sewers

Flooding from the sewer network can occur when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes overloaded or blocked, or it cannot discharge due to high water levels in the receiving watercourse.

According to Yorkshire Water's records, there have been no incidents of sewer flooding in the area over the last two years.

5.3 Observations, mitigation options and site suitability - residual risk

- The site is at potential residual risk from a breach of two reservoirs. However, these reservoirs are only modelled to impact the site based on the 'wet day' flood extent, which represents a prediction of the credible worst case scenario, therefore it's unlikely that any actual flood would be this large.
- Given the potential reservoir risk to the site, developers should consider⁴:
 - Consulting with the local resilience forum for advice on emergency planning,

⁴ [Reservoir flood maps: when and how to use them | Environment Agency | 2021](#)

- Consulting with relevant reservoir owners to understand the impact development may have on their reservoirs, and
- Using this Level 2 SFRA to understand whether any proposed development will be safe throughout its lifetime.

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site is not required to pass part b) of the exception test⁵, given it is proposed for less vulnerable uses. However, it must still be proven that the development can be safe for its lifetime, which is 75 years for non-residential development.

6.2 Recommendations, FRA requirements, and further work

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

- It should be possible to develop this site for less vulnerable uses.
- Ideally, less vulnerable development would be directed to the area of the site within Flood Zone 1. Were development to proceed within Flood Zone 2, the site-specific FRA must show that appropriate evacuation procedures and flood response infrastructure are in place to manage the fluvial risk associated with the extreme flood event.
- The site is modelled to flood to significant depths and hazards during the medium risk plus climate change event. Topographic depressions and flow routes should be considered and included in site design and ideally left in place to flood naturally when required. Any regrading of land must include like for like volumes to ensure risk is contained safely onsite for the lifetime of development.
- Any FRA should further consider groundwater conditions within the south of the site and include for a detailed drainage strategy.
- Any FRA should consider whether there are any offsite works that could prevent flooding from the River Aire backing up into the site.
- Any FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA guidance; the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority; the lead local flood authority; emergency planning officers; the Environment Agency; Yorkshire Water; the highways authorities; and the emergency services.

⁵ Para 178 National Planning Policy Framework 2024

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