

**Calderdale Metropolitan
Borough Council**

**Level 2 Strategic Flood Risk
Assessment - Site Screening**

September 2018

Final Report

Calderdale MBC
Town Hall
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Contract

This report describes work commissioned by Jason Morris, on behalf of Calderdale Metropolitan Borough Council, by email dated 22 November 2017. Rachel Bryan and Mike Williamson of JBA Consulting carried out this work.

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Purpose

This document has been prepared as a Screening Report for Calderdale Metropolitan Borough Council. Potential Development Sites identified for inclusion follow development of the Calder Catchment Level 1 Strategic Flood Risk Assessment and Calderdale Site Screening Assessment. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

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Contents

1	Local Plan Potential Development Site Screening	1
1.1	Introduction	1
2	Site Summary Table	2
3	Potential Site Appraisal Tables.....	8
3.1	1088 West Vale Works, Stainland Road, West Vale, Elland	8
3.2	1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge	14
A	Surface water runoff requirements	20
B	Sites not taken forward owing to flood risk	21
B.1	0152 Land adjacent to 81, Hunter Hill Road, Halifax.....	21
B.2	0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland	26
B.3	0327 Land off Halifax Road, Todmorden	31
B.4	0573 Land adjacent Mill Royd Street, Brighouse	38
B.5	0649 Former Adamroyd Mill, Victoria Road, Todmorden	45
B.6	0915 Callis Mill, Halifax Road, Hebden Bridge.....	51
B.7	1068 Land at, Hollins Mill Lane, Sowerby Lane	57
B.8	1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge.....	63
B.9	1556 Land at Rowan House, Scout Road, Mytholmroyd.....	69
B.10	1628 Riverside House, Gas Works Lane, Elland	74

1 Local Plan Potential Development Site Screening

1.1 Introduction

To inform the Sequential Approach to the allocation of development through Calderdale Metropolitan Borough Council's (CMBC) upcoming Local Plan, a Level 1 SFRA was completed¹. Following various site selection processes, aided by two further site screening flood risk assessments, 12 potential development sites were identified where further, more detailed site-specific assessment, was required to confirm the potential suitability of the potential development sites with respect to flood risk.

This report provides a summary table for each Level 2 site and incorporates the following:

- Screening FRA;
- Outline drainage strategy;
- Level 2 site screening assessment.

Each assessment table describes the likely fluvial, groundwater, canal, reservoir and surface water (both offsite impacts and runoff generated by development) flood risks, where applicable. Climate change is also taken into account. In addition, flood risk mitigation options, including requirements for further assessment are provided.

Based on available flood modelling data, each summary table includes updated recommendations for the Local Planning Authority (LPA) as to the likely suitability of each potential development site in terms of flood risk.

Hazard and depth mapping are provided for each site in the supporting documentation.

The National Planning Policy Guidance² (NPPF) and the accompanying Flood Risk and Coastal Change Planning Practice Guidance³ (FRCC-PPG) are consulted throughout this assessment.

After consultation with the EA, LLFA and LPA, the Council have agreed on the following recommendations as stated in the site summary table (Section 2). Section 3 details the site assessments for sites where development may be proposed, as agreed by CMBC, based on the majority of the sites footprint being located within Flood Zone 1. Appendix B states the sites that the Council have decided not to take forward in the Local Plan owing to flood risk.

1 Calder Catchment Level 1 Strategic Flood Risk Assessment. JBA Consulting. 2016

2 <https://www.gov.uk/guidance/national-planning-policy-framework>

3 <https://www.gov.uk/guidance/flood-risk-and-coastal-change>

2 Site Summary Table

Site	Recommendation	Modelling Availability	% in Flood Zones		EA Response	JBA Review following EA initial comments 30/07/2018	Council Decision
			% Flood Zone 2	% Flood Zone 3		Updated recommendation for LLFA consideration	
0152 Land adjacent to 81, Hunter Hill Road, Halifax	The site is relatively small, and it is recommended that the northern area of the site only is considered for development due to potential surface water flood risk. This site is required to be modelled for 100% within Flood Zone 1 and as part of a site specific FRA to assess surface water flooding.	The site has not been modelled (100% within Flood Zone 1).	0.00	0.00	As this site is in Flood Zone 1 and not in proximity to a main river, we have no reasons, from a fluvial flood risk perspective, why this site should not be allocated. Fluvial flood risk issues aside, a Site Specific FRA will be required to assess Surface Water Flooding, overland flow routes, and possible mitigation measures, before the site is confirmed for allocation. The LLFA should be consulted with regard to these issues and whether the site is suitable for allocation.	Following review of EA comments and based on available information: Recommendation for allocation in the northern area of the site based on FZ1. The developer will need to appraise all sources of flood risk as part of a detailed FRA. It is noted that the EA have included wording "before the site is confirmed for allocation" The Council will need to review this requirement with the EA as individual site specific modelling would usually fall to the developer to undertake and fund once site specific development proposals have been finalised. This level of detail does not usually form part of a level 2 assessment. Development of models for all identified sites is likely to be both a time consuming and costly process for the LLFA.	Site filtered and has not been taken forward in the Local Plan.
0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland	It is recommended that Area 'A' is only considered for development and a detailed FRA for site specific proposal is required. Area 'B' will not be available for development without alternate access to the B6144. Allocation within Flood Zone 3 should be avoided unless detailed assessment supports it. Hydraulic model of Black Brook and hydrological assessment of Sunny	No detailed model available. Black Brook should be remodelled as part of a detailed FRA to understand the distribution of risk on the site.	0.96	20.19	In line with JBA comments, further assessment will be needed before this site is committed for an allocation. Allocation within Flood Zone 3 should be avoided unless detailed assessment supports it. At this stage, insufficient information has been provided to be able to apply the Exception Test, where relevant. A detailed site specific FRA will be required to understand the distribution of risk on site.	Following review of EA comments and based on available information: Recommendation for allocation based on avoiding FZ2 and 3. The developer will need to appraise all sources of flood risk as part of a detailed FRA. It is noted that the EA have included wording "in line with JBA comments...before the site is committed for allocation" The Council will need to review this requirement with the EA as individual site specific modelling would usually fall to the developer to undertake and fund once site specific development proposals have been finalised.	Site filtered and has not been taken forward in the Local Plan.

	Bank Clough is required.					JBA's recommendation did not make this part of the requirement for allocation of the site. This level of detail does not usually form part of a level 2 assessment. There is scope to avoid high risk areas in terms of development. Development of models for all identified sites is likely to be both a time consuming and costly process for the LLFA.	
0327 Land off Halifax Road, Todmorden	Access cannot be achieved as a result of fluvial flood risk and therefore we recommend removal of allocation for this site. There has also been drainage water flood issues reported as a result of gully blockage. Detailed modelling will be required as part of any FRA to confirm flood extents and depths.	No detailed model available.	0.00	100	We agree with JBA findings and recommend that this site is not brought forward for allocation on the basis of being 100% within flood zone 3. If detailed modelling provides a different flood risk picture, then views may change.	Following review of EA comments and based on available information: Recommendation for removal based on FZ3. Alternatively the council may need to consider development of a new model to confirm flood risks at this site. Development of models for all identified sites is likely to be both a time consuming and costly process for the LLFA.	Site filtered and has not been taken forward in the Local Plan.
0573 Land Adjacent Mill Royd Street, Brighouse	Owing to significant fluvial risk based on flood depths and surface water flood risk based on hazards, the recommendation would be to remove the allocation of this site.	Detailed model available. 2015 Calder and Canals Brighouse Model.	17.43	82.56	We agree with JBA findings and recommend that this site is not brought forward for allocation. It may be appropriate to revisit the suitability of this site for allocation if future planned flood alleviation schemes go ahead. This isn't likely until around 2020, however.	Following review of EA comments and based on available information: Recommendation for removal based on FZ3. Alternatively the council may need to consider potential implications of future flood alleviation scheme.	Site filtered and has not been taken forward in the Local Plan.
0649 Former Adamroyd Mill, Victoria Road, Todmorden	The recommendation for this site is to either remove allocation or restrict development objectives to higher areas of land within the site. Detailed modelling will be required as part of any FRA to confirm flood extents and depths as there is insufficient	No detailed model available. Site required to be modelled as part of a FRA.	17.23	81.27	Insufficient information is currently available to determine which parts of this site are suitable for development and therefore allocation. Site specific FRA will be needed to confirm flood extents and depths and the areas to be allocated should be updated accordingly. There is a potential future flood defence scheme in pipeline for	Following review of EA comments and based on available information: Recommendation for removal or allocation to higher areas of land within the site based on FZ3. The council may need to consider development of a new model to confirm flood risks at this site if allocated. The developer will need to appraise all sources of	Site filtered and has not been taken forward in the Local Plan.

	information currently available to determine which sites are suitable for development.				Oak Hill Clough, but this should not be accounted for in allocating this site, due to uncertainty.	flood risk as part of a detailed FRA. Development of models for all identified sites is likely to be both a time consuming and costly process for the LLFA.	
0915 Callis Mill, Halifax Road, Hebden Bridge	More Vulnerable development may be considered based on first floor development or land raising which will only be acceptable if it does not cause increases in risk offsite by displacing flood storage and flows. The impact of development will need to be considered further through a site specific FRA.	Detailed model available. 2015 Calder and Canals Hebden Model.	0.00	100	Based on the 100% Flood Zone 3 coverage, we don't consider this site suitable for allocation. JBAs recommendation that more vulnerable development may be considered at first floor or through land raising needs to be heavily caveated with the fact that it will only be acceptable if it does not cause increases in risk offsite by displacing flood storage and flows. Further detailed assessment would be needed in order to facilitate the exception test and allocation would only be considered appropriate if detailed modelling provides a different flood risk picture	Following review of EA comments and based on available information: Recommendation for more vulnerable first floor development and land raising based on FZ3, which will only be acceptable if it does not cause increases in risk offsite by displacing flood storage and flows. A site specific FRA will be needed to determine the impact of development. The developer will need to appraise all sources of flood risk as part of a detailed FRA.	Site filtered and has not been taken forward in the Local Plan.
1068 Land at, Hollins Mill Lane, Sowerby Lane	Owing to access restrictions, flood depths and hazards the recommendation for this site is to remove allocation.	Detailed model available. 2015 Calder and Canals Sowerby Model.	46.62	53.36	We consider allocation of this site would need to be supported by more detailed assessment. At this stage, there isn't enough information to be able to apply the exception test, therefore it isn't clear whether this site should be allocated.	Following review of EA comments and based on available information: Recommendation for removal based on FZ3. Allocation would need to be supported by more detailed assessment according to the EA. This level of detail does not usually form part of a level 2 assessment.	Site filtered and has not been taken forward in the Local Plan.
1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge	Owing to access restrictions, flood depths and hazards the recommendation for this site is to remove allocation.	Detailed model available. 2015 Calder and Canals Sowerby Model.	38.38	61.61	We consider allocation of this site would need to be supported by more detailed assessment. At this stage, there isn't enough information to be able to apply the exception test, therefore it isn't clear whether this site should be allocated.	Following review of EA comments and based on available information: Recommendation for removal based on FZ3. Allocation would need to be supported by more detailed assessment according to the EA. This level of detail does not usually form part of a level 2 assessment.	Site filtered and has not been taken forward in the Local Plan.
1088 West Vale Works, Stainland Road, West	Avoidance of development in Flood Zones 2 and 3 is	No detailed model available.	6.30	12.70	Allocation outside of flood zones is preferential for this site. We consider allocation of parts of this	Following review of EA comments and based on available information: Recommendation for removal based on avoiding FZ2	The majority of the site is located in

Vale, Elland	recommended for this site. Detailed modelling will be required as part of any FRA to confirm flood extents and depths.				site within FZ2 and FZ3 would need to be supported by more detailed assessment. At this stage, there isn't enough information to be able to apply the exception test, therefore it isn't clear whether this site should be allocated.	and 3. The developer will need to appraise all sources of flood risk as part of a detailed FRA. The council may need to consider development of a new model to confirm flood risks at this site if allocated. Development of models for all identified sites is likely to be both a time consuming and costly process for the LLFA. This level of detail does not usually form part of a level 2 assessment.	Flood zone 1 (81%) with approximately 6% in Flood Zone 2 and 13% in Flood Zone 3a. Given the large extent of the site in Flood Zone 1, it is considered that the principle of development is acceptable at the site provided it avoids Flood Zones 2 and 3. Further modelling work should be carried out once the scheme layout is known and if development is proposed in the higher Flood Zones.
1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge	Avoidance of development in Flood Zones 2 and 3 is recommended for this site. Detailed modelling will be required as part of any FRA to confirm flood extents and depths.	No detailed model available.	8.00	14.49	Allocation outside of flood zones is preferential for this site. We consider allocation of parts of this site within FZ2 and FZ3 would need to be supported by more detailed assessment. At this stage, there isn't enough information to be able to apply the exception test, therefore it isn't clear whether this site should be allocated.	Following review of EA comments and based on available information: Recommendation for removal based on avoiding FZ2 and 3. The developer will need to appraise all sources of flood risk as part of a detailed FRA. The council may need to consider development of a new model to confirm flood risks at this site if allocated. Development of models for all identified sites is likely	The majority of the site is located in Flood zone 1 (78%) with approximately 8% in Flood Zone 2 and 14% in Flood Zone 3a. Given the large extent of

						to be both a time consuming and costly process for the LLFA. This level of detail does not usually form part of a level 2 assessment.	the site in Flood Zone 1, it is considered that the principle of development is acceptable at the site provided it avoids Flood Zones 2 and 3. Further modelling work should be carried out once the scheme layout is known and if development is proposed in the higher Flood Zones.
1556 Land at Rowan House, Scout Road, Mytholmroyd	The recommendation is that the suitability of the site for development is to be reconsidered. Due to flood depths, residential development is considered unsuitable within Flood Zone 3. A more detailed FRA will be required.	Detailed model available. 2015 Calder and Canals Hebden Model.	72.71	27.3	We agree that allocation for residential uses should be avoided in Flood Zone 3 where possible and if allocation is to be considered appropriate on this site, detailed FRA will be required to justify it, by showing that the exception test could be passed. A flood defence scheme is currently in the planning stage, which could benefit this site. This should not be taken into account for allocation purposes until it is in place.	Following review of EA comments and based on available information: Recommendation for removal based on avoiding residential development within FZ3. Suitability of the site for development is to be reconsidered overall. All sources of flood risk as part of a detailed FRA to justify if allocation is considered appropriate.	Site filtered and has not been taken forward in the Local Plan.
1628 Riverside House, Gas Works Lane, Elland	CMBC to reconsider suitability for this site for development owing to estimated Flood Zone 3 depths, climate change Flood Zone 2 proxy	No detailed model available.	49.62	50.39	We agree with JBA that on the basis of the information available, this site is unsuitable for the allocation of more vulnerable uses. Detailed site specific FRA may alter this perception, but only if it	Following review of EA comments and based on available information: Recommendation to reconsider suitability for this site based on FZ2 and FZ3. More vulnerable development is unsuitable for this site.	Site filtered and has not been taken forward in the Local Plan.

	outlines which inundate the site and potential bridge blockage which could increase the flood risk and access issues. Detailed modelling will be required as part of any FRA to confirm flood extents and depths.				presents a significantly different flood risk picture compared to what is already available.	All sources of flood risk as part of a detailed FRA to justify if allocation is considered appropriate. The council may need to consider development of a new model to confirm flood risks at this site if allocated. Development of models for all identified sites is likely to be both a time consuming and costly process for the LLFA. This level of detail does not usually form part of a level 2 assessment.	
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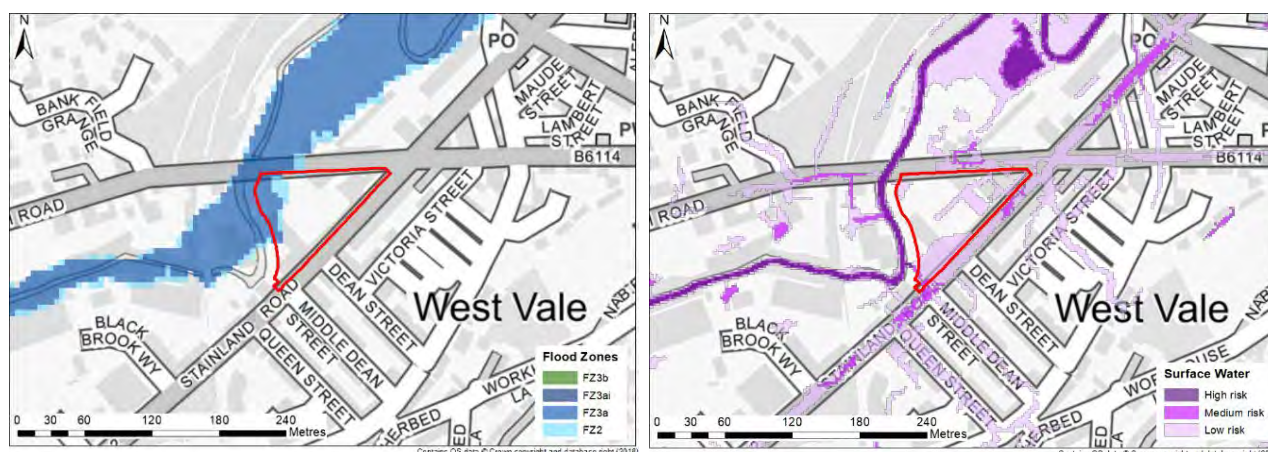
3 Potential Site Appraisal Tables

3.1 1088 West Vale Works, Stainland Road, West Vale, Elland

1088 West Vale Works, Stainland Road, West Vale, Elland

Site area	0.65 Ha
Existing use	Brownfield with small greenfield area
Proposed use	Mixed Use
Proposed development flood risk vulnerability classification	More Vulnerable and Less Vulnerable uses
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.52 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a brownfield site that is identified as mixed use by CMBC, however may be used for residential allocations. There is potential for 'More Vulnerable' and 'Less Vulnerable' development, as per Table 2 of the FRCC-PPG.
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The western boundary of this site is located along Black Brook.
- An 8m buffer is also required along the western boundary (adjacent to Black Brook) where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse for maintenance purposes.
- There are a number of assets that are located close to the site, these include; Wall Gabion (asset ID:0061/58), on the River Calder with a condition of 5 (Very Good), a Bridge (asset ID: 0061/60), the pipe support to the bridge on the River Calder with a condition assessment of 3 (Fair), and an outfall (asset ID: 0061/59) closer to the site for the River Calder with a condition assessment of 4 (Good).
- The site generally slopes from the east to north west with ground levels dropping from around 77.3m AOD to 72.5m AOD as the land slopes down to Black Brook on the western of the site.
- 100% of the site is within the Elland and Brighouse CDA, drafted through the Level 1 SFRA.
- Approximately 81% of the site is located within Flood Zone 1, and is therefore, considered suitable for redevelopment. An additional 6% is located within Flood Zone 2 and may also be considered suitable.
- The Council should site all residential redevelopment outside of the identified fluvial flood risk areas, otherwise a more detailed FRA will be required, and this will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. The Flood Zone 3a areas

1088 West Vale Works, Stainland Road, West Vale, Elland

should be left as open space for storage of flood water, therefore with reference to the EA Flood Map for Planning, the north west area of the site appears to be unsuitable for redevelopment, although less vulnerable development may be considered but will be subject to flood risk. Bridge blockage scenarios have not been modelled and could therefore also increase the flood risk to the site.

- The site currently has less vulnerable development, by introducing More Vulnerable and potentially residential development into fluvial flood risk areas with average depths approximately 0.3m for the 1% AEP event, and 0.65m under the 0.1% AEP event, increases the flood risk and vulnerability to the north west area of the site. Properties would also potentially have difficulties in gaining flood insurance based on fluvial flood information provided. Therefore, avoidance of development in Flood Zones 2 and 3 is recommended in this instance.
- Flood mapping in this instance is based on EA strategic mapping and no climate change outlines are available (other than Flood Zone 2 approximation). These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific FRAs. It is recommended that detailed modelling will be required as part of any FRA to confirm flood extents and depths.
- Approximately 10% of the site is currently located within Flood Zone 3 with an additional 6% within Flood Zone 2, as can be seen on the previous figure showing the Flood Map for Planning. This therefore shows that the effects of climate change on the likely level of risk to the site. This will need to be confirmed through detailed modelling as part of a site specific FRA.
- Surface water flooding appears widespread only for the low risk (0.1% AEP event) and could, therefore, impact on the redevelopment. However, localised redevelopment areas will need to consider surface water based on location. A drainage water flood issue has been reported due to gully blockage and flooding from a natural spring in an area of Saddleworth Road.
- The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates low surface water flood risk and localised areas of medium flood risk to Saddleworth Road surrounding the site. There is a potentially suitable access west of Saddleworth Road, although there are localised areas of low flood risk.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided that due to the majority of the site footprint being located within Flood Zone 1 (81%), it is considered that the principle of development is acceptable at the site providing it avoids Flood Zones 2 and 3. Further modelling would should be carried out once the scheme layout is known and if development is proposed in the higher Flood Zones.

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	6.30	12.70	No detailed model available. To be confirmed through an FRA
Flood Zone depth based on estimated lidar levels and published flood zones (m)	Max: 0.9 Average: 0.65	Max: 0.6 Average 0.3	N/A
Flood Zone hazard	Unknown based on strategic model	Unknown based on strategic model	N/A
Climate change	There is no climate change model for this area. In the absence of detailed modelling, Flood Zone 2 will be used as a proxy for the extent of Flood Zone 3 in 100 years' time to assess climate change impacts. Although this is a pragmatic approach to predicting climate change, the approach is consistent with other SFRAs and reflects professional modelling experience. It is often the case the Flood Zone 3 including allowance for climate change can be similar to the Flood Zone 2 outline. Approximately 10% of the site is currently located within Flood Zone 3 with an additional 6% within Flood Zone 2, as can be seen on the previous figure showing		

1088 West Vale Works, Stainland Road, West Vale, Elland

	the Flood Map for Planning. This therefore shows that the effects of climate change on the level of risk to the site would likely be limited.
Historic flooding	The site is just outside of the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.
Defended	No known defence infrastructure present on Black Brook.
Flood Warning Area	No
Mitigation options & site suitability	• Ideally 'More Vulnerable' development should be directed to the areas outside of higher risk Flood Zones. Approximately 81% (Flood Zone 1) of the site would be considered suitable for redevelopment. • The risk is confined to the north western boundary of the site. The remaining area within Flood Zone 3 should be left as open space as possibly a green corridor along Black Brook for Flood Risk Management. • Due to LiDAR depths of flooding within Flood Zone 2 (average 0.65m) and Flood Zone 3 (average 0.3), residential development is inappropriate for north west boundary of the site, owing to current flood risk and future implications of climate change (using Flood Zone 2 as a proxy). Less vulnerable uses may be considered however they will remain at risk of flooding. A more detailed FRA will be required as part of the development strategy to reflect site specific development proposals (in Flood Zone 1) and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. Avoidance of development in Flood Zones 2 and 3 is recommended in this instance. • More detailed modelling and provision for climate change should be made in the site specific FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Bridge blockage scenarios have not been modelled and could therefore also increase the flood risk to the site. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • Access (including emergency access) across the site will need to take account of future flood levels, however with depths from the site to Saddleworth Road approximately on average 0.3m according to EA Flood Mapping and LiDAR data, it appears that suitable access is available from Flood Zone 1 areas and therefore supports the recommendation for locating development outside of fluvial flood zones. • CMBC agrees with JBA's recommendation and has decided that development will be considered provided it avoids Flood Zones 2 and 3. Further modelling work should be carried out once the scheme layout is known and if development is proposed in the higher Flood Zones.

Flood Source: Groundwater

Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 25\%$ $< 50\%$. LiDAR indicates a slight fall across the site from east to north west, which indicates that ponding if encountered is likely to be minimal and localised as water will tend to flow towards Black Brook, which is parallel to the western boundary of the site.
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Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates 100% of the site is indicated to be at risk from Reservoir flooding. The RFM shows that this area has depths with a banding of $> 2\text{m}$ and flood velocity of mainly $> 2\text{m/s}$. The proximity of the closest reservoir to the site is approximately 6 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to this site.
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Flood Source: Infrastructure Failure – Canals

1088 West Vale Works, Stainland Road, West Vale, Elland

Flood risk: canal No canalised watercourses in area. No flood risk identified.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.00	1.14	60.23
Surface water flooding depths (m)	N/A	Max: 0.31m Average: 0.19m	Max: 0.77m Average: 0.27m
Surface water hazards	N/A	Max: Moderate Average: Low	Max: Significant Average: Low
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	There is surface water risk to north eastern and southern corner of the site for the Low Risk event, and a small 1% of the southern corner for the 1% event (Medium Risk). Overall, over 60% of the site is at some level of risk from surface water flooding, although the majority is low risk. In the Medium Risk (1% AEP) event the southern area is shown to experience surface water flooding with localised depths on average 0.19m reaching a maximum of 0.31m. The hazard is generally low, with some very localised areas indicating a Moderate hazard. In the Low Risk (0.1% AEP event), flood depths average 0.27m and reach a maximum of 0.77m. The hazard rating is generally low with localised areas of moderate and significant hazards, predominantly within the north east corner of the site. Surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure and these extents are likely to change if the site layout is changed. Development must not reduce the area available for surface water storage as this would result in displacement of surface water towards adjacent development areas. The flood mapping indicates some potential for surface water flooding entering the site from adjacent areas, including from Stainland Road in the southern corner of the site. However, drainage routes from the site should be assessed as part of the FRA. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a number of alternative routes, west of Saddleworth Road which has localised areas of low risk of surface water flooding, and therefore off-site impacts on access and egress appear manageable.		
Surface water: mitigation options & site suitability	- Surface water flooding appears widespread for the 0.1% AEP event and could likely impact on the redevelopment potential across site defined by the surface water flood map. However, localised redevelopment areas will need to consider surface water based on location. As parts of the site are subject to a significant flood hazard under the 0.1% AEP event, a site specific detailed surface water assessments and drainage strategy will be required as part of any FRAs for redevelopment in this area. The FRAs will need to mitigate climate change impacts across the lifetime of the development. - Areas at risk from surface water flooding, certainly areas of medium risk, should ideally be kept free from redevelopment or alternatively flows should be redirected using appropriate SuDS if practical. - The FRAs should assess the potential for offsite surface water impacts on		

1088 West Vale Works, Stainland Road, West Vale, Elland

proposed redevelopments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes.

- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.
- Any FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield* - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.	3.33% AEP: 3.01l/s 1% AEP: 3.58l/s QBAR: 1.72l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s
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Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	8.5	395	110	290	22.7	Revised attenuation volume 345m ³ (assuming outflow volume of 55 m ³)
1% AEP Rainfall+30%	10.75	530	135	400 (110m ³ of exceedance storage)	31.4	Revised attenuation volume 467.5m ³ (assuming outflow volume of 55m ³) (122.5m ³ of exceedance storage)

Climate change Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.

Surface water: flood risk impacts from development site & mitigation

80% development represents a significant increase in development of this site.

In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment.

It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above.

To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual redevelopment site areas at detailed design.

Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.

An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from

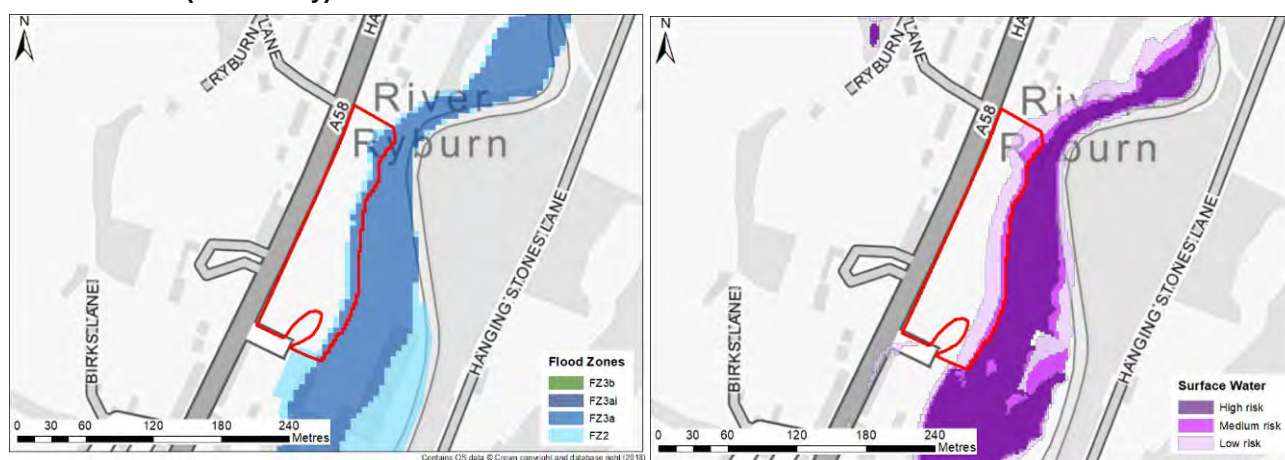
1088 West Vale Works, Stainland Road, West Vale, Elland

oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage.

3.2 1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge

1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge	
Site area	1.12 Ha
Existing use	Greenfield
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total developable area (Agreed by CMBC) 0.9 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG.
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development opportunities have been identified by the Council at this stage.
- The eastern boundary of this site is located adjacent to the River Ryburn and generally slopes from the west to the east with ground levels dropping from 124m AOD to 112 m AOD as the land slopes down towards the River Ryburn on the eastern boundary of the site.
- Approximately 10% of the site is within the Ripponden CDA, drafted through the Level 1 SFRA. The site is half a mile away from the Capital Programme FRM scheme of Elland Road, Ripponden.
- Approximately 80% of the developable site is located in Flood Zone 1 and is, therefore, considered suitable for development. An additional 8% is located within Flood Zone 2 and approximately 15% in Flood Zone 3. The associated depth and hazard rating vary with topography.
- The Council should locate all residential, More Vulnerable development outside of the identified fluvial flood risk areas otherwise a more detailed site specific FRA will be required and this will have to show that the second part of the Exception test has been satisfied in order for development to proceed.
- As the fluvial risk is confined to the eastern boundary of the site, adjacent to the River Ryburn, and flood depths are on average significant under the 0.1% AEP event (1.62m) and moderate under the 1% AEP event (0.9m), the vulnerability of development in the flood zone extents is high and therefore development should be avoided in Flood Zone 2 and 3.
- Flood mapping in this instance is based on EA strategic mapping and no climate change outlines are available (other than Flood Zone 2 approximation). Under climate change Flood Zone 2 proxy outlines the site will be particularly susceptible to climate induced inundation owing to the finite capacity of the River Ryburn. These proxy climate change outlines may not be suitable to support development

1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge

proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific FRAs. It is also recommended that detailed modelling will be required as part of any FRA to confirm flood extents and depths.

- The Flood Zone 3 areas should therefore be left as open space for storage of flood water, as a high-density development is likely to impede flood flows at the open development site. With reference to the EA Flood Map for Planning, the eastern boundary of the site is unsuitable for residential development owing to flood depths which were based on estimated LiDAR levels and published flood zones. It is recommended that detailed modelling will be required as part of any FRA to confirm flood extents and depths.
- An 8m buffer is also required along the eastern boundary (adjacent to the River Ryburn) where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse and associated defences for maintenance purposes. This may reduce the available developable area, as will maintenance easements for the site.
- Surface water flood risk appears localised to the surface water flow route along the eastern boundary adjacent to the River Ryburn, entering the site from upstream. The medium risk and low risk surface water flood outlines are contained within Flood Zone 3.
- Due to the potential fluvial and surface water flood risk, a detailed model is required as part of a FRA to confirm the flood extent and depths as over 20% of the site exists within Flood Zone 2 and 3 of the River Ryburn.
- Therefore, avoidance of development in Flood Zones 2 and 3 is recommended for this site.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided that due to the majority of the site footprint being located within Flood Zone 1 (78%), it is considered that the principle of development is acceptable at the site providing it avoids Flood Zones 2 and 3. Further modelling should be carried out once the scheme layout is known and if development is proposed in the higher Flood Zones.

Flood Source: Fluvial

Flood Zones (%) (of developable area)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	8.00	14.49	No detailed model available. To be confirmed through an FRA
Flood Zone depth based on estimated lidar levels and published flood zones (m)	Max: 2.5 Average: 1.62	Max: 1.3 Average: 0.9	N/A
Flood Zone 3 hazard	Unknown based on strategic model	Unknown based on strategic model	N/A
Climate change	There is no climate change model for this area. In the absence of detailed modelling, Flood Zone 2 will be used as a proxy for the extent of Flood Zone 3 in 100 years' time to assess climate change impacts. Although this is a pragmatic approach to predicting climate change, the approach is consistent with other SFRA's and reflects professional modelling experience. It is often the case the Flood Zone 3 plus allowance for climate change can be similar to the Flood Zone 2 outline. Approximately 15% of the site is currently located within Flood Zone 3 with only an additional 8% within Flood Zone 2, and the majority (77.51%) within Flood Zone 1, as can be seen on the previous figure showing the Flood Map for Planning. This therefore shows that the effects of climate change on the level of risk to the site would likely be limited.		
Historic flooding	A small proportion of the southern boundary of the site is contained within the Environment Agency Historic Flood Map (HFM) outline. The remainder of the site is outside of the HFM outline and from available data there are no records of other historic flood events.		
Defended	No known defence infrastructure present on the River Ryburn at this		

1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge

	location.
Flood Warning Area	No
Mitigation options & site suitability	• Ideally 'More Vulnerable' development should be directed to the areas outside of higher risk Flood Zones. Approximately 77% (Flood Zone 1) of the site would be considered suitable for redevelopment. • Due to the level of risk and estimated depth of flooding across parts of this site (Flood Zone 2, and 3) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is residential and has therefore been classified as More Vulnerable and is within Flood Zone 3, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Flood Zone 3 should be left as open space as possibly a green corridor along the River Ryburn for Flood Risk Management. This should be possible given the fact that the fluvial flood risk area is localised. • The majority of the surface water risk is within the fluvial flood extents, there is only a small buffer of low surface water risk that exceeds the fluvial flood extents and therefore should not require additional mitigation. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed modelling and provision for climate change should be made in the site specific FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Bridge blockage scenarios have not been modelled and could therefore also increase the flood risk to the site. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available at A58/Halifax Road. • CMBC have decided that given the large extent of the site in Flood Zone 1, it is considered that the principle of development is acceptable at the site provided it avoids Flood Zones 2 and 3. • Further modelling work should be carried out once the scheme layout is known and if development is proposed in the higher flood zones.
Flood Source: Groundwater	
Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of <25%. Based on a review of LiDAR, there is a fall in level across the areas in a northern direction, indicating that if encountered, ponding is likely to be minimal and localised as water will follow topography towards the River Ryburn.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates that 100% of the site is indicated to be at risk from Reservoir flooding. The RFM shows that this area has depths with a banding of >2m and flood velocity of mainly >2m/s. The proximity of the closest reservoir to the site is approximately 4 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to this site.
Flood Source: Infrastructure Failure – Canals	

1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge

Flood risk: canal No canalised watercourses in area. No flood risk identified.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%) (of developable area)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.00	9.75	24.54
Surface water flooding depths (m)	N/A	Max: 0.28m Average: 0.13m	Max: 0.97m Average: 0.4m
Surface water hazards	N/A	Max: Moderate Average: Low	Max: Extreme Average: Moderate
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	Overall, approximately 35% of the site area is at some level of surface water flood risk, however the majority of the mapped surface water flooding is localised. There is approximately 25% of surface water flood risk for the 0.1% AEP (Low Risk) event and in the medium risk event, less than 10% of the developable site is impacted. Whilst the maximum hazards are extreme in very localised areas for the 0.1% AEP event, the majority of hazards are generally moderate or significant across the southern boundary of the site, adjacent to the River Ryburn. With reference to the mapping the southern area appears to be a natural lower catchment and is likely to be less suitable for development. The majority of the surface water flood risk appears to follow topography as the ground levels drop from 124 m AOD to 112m AOD to meet the River Ryburn. As the site is generally flat overland surface water flows appear minimal, only causing a risk on the eastern boundary. Depths are low for the 1% AEP event, 0.13m on average, and 0.4m for the 0.1% AEP event. Hazard ratings are low with very localised areas with moderate flood hazards for the 1% AEP event, and generally moderate - significant for the 0.1% AEP event, with more localised areas presenting an extreme hazard, located in the south west corner of the site. Mapping indicates significant surface water flows entering the site from the adjacent areas, as the site is located within a surface water flow route. However, drainage routes from the site should be assessed as part of the FRA. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates if any, little localised highway flooding for any event. Therefore, off-site impacts on access and egress appear manageable, and will not impact on the development potential of the site.		
Surface water: mitigation options & site suitability	Surface water flood risk appears localised to the eastern boundary and should not impact significantly on the development potential across the majority of the site, were flooding to occur. However, localised development areas will need to consider surface water based on location. Areas of the site are subject to localised surface water flood risk and a site / development specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to any existing drainage routes and ponding areas. The FRA will need to mitigate climate change impacts		

1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge

across the lifetime of the development.

- Areas at risk from surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using appropriate SuDS.
- Development should not prevent the natural flow of surface water and any mitigation or SuDS facilities should be located outside of the surface water flow route. This may limit the available land for development at this site.
- Whilst they appear to be minimal, the FRA should assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes.
- Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates if any, there is a little highway flooding for any event. Therefore, off-site impacts on access and egress appear available for development in Flood Zone 1, which supports the Council's recommendation for development provided it avoids Flood Zone 2 and 3.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate:
Greenfield - FEH Methodology

3.33% AEP 6.33l/s
1% AEP: 7.53l/s
QBAR: 5.34l/s
CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s
Greenfield runoff rate for this site for all events up to and including the 1 % AEP + 30% CC = 5l/s

Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1 % AEP (m ³)
3.33% AEP Rainfall+30%	23	950	290	660	52.4	Revised attenuation volume 805m ³ (assuming outflow volume of 145m ³)
1% AEP Rainfall+30%	36	1365	450	910 (250m ³ of exceedance storage)	72.1	Revised attenuation volume 1135m ³ (assuming outflow volume of 225m ³) (330m ³ of exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development	To illustrate the potential attenuation and storage for site, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. This figure will need to be proportioned to actual					

1224 Land North of Meadowcroft Lane, Halifax Road, Sowerby Bridge

**site &
mitigation**

development site areas at detailed design.

Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.

An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from a conventional piped surface water drainage system including a combination of oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. Attenuation would need to be provided at locations outside of the surface water flow route.

Appendices

A Surface water runoff requirements

Requirements for greenfield runoff rates are as follows;

- Surface water discharge, to a watercourse or a sewer, is to be limited to the Greenfield runoff rate of 2l/s/ha, in lieu of detailed calculations, for up to and including the 1 in 100 year storm event plus 30% allowance for climate change. The minimum discharge from the site is to be 5l/s.
- If surface water disposal to the watercourse is proposed the impact on the watercourse and downstream systems needs to be considered.
- A new connection to a watercourse for discharge of surface water is to be limited to the Greenfield runoff rate of 2l/s/ha, in lieu of detailed calculations, minus 50% for up to and including the 1 in 100 year storm event. Where the watercourse can be proven hydraulically and structurally adequate to the nearest open outfall then surface water discharge rate is to be limited to the Greenfield runoff rate of 2l/s/ha, in lieu of detailed calculations, minus 30% for up to and including the 1 in 100 year storm event. The minimum discharge rate from the site for surface water is to be 5l/s.

For Brownfield;

- A new connection to a watercourse for discharge of surface water is to be limited to the Greenfield runoff rate of 2l/s/ha, in lieu of detailed calculations, minus 50% for up to and including the 1 in 100 year storm event. Where the watercourse can be proven hydraulically and structurally adequate to the nearest open outfall then surface water discharge rate is to be limited to the Greenfield runoff rate of 2l/s/ha, in lieu of detailed calculations, minus 30% for up to and including the 1 in 100 year storm event. The minimum discharge rate from the site for surface water is to be 5l/s.
- Surface water discharge to a public sewer should be limited to the existing 1 in 1 year storm event rate minus 30% for all storm events up to and including the 1 in 30 year storm event plus 30% allowance for climate change.

For all sites

Any drainage system will need to accommodate the following design parameters:

- a. No system surcharge during a 1 in 2 year storm plus 30% for climate change.
- b. No surface flooding during a 1 in 30 year storm plus 30% for climate change
- c. No internal flooding to property including access and egress areas during a 1 in 100 year storm plus 30% for climate change.

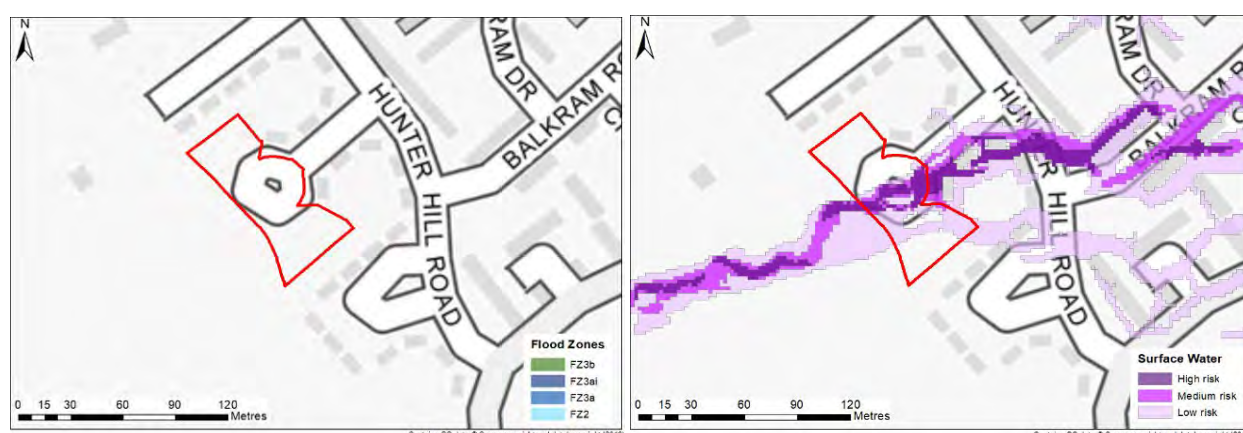
B Sites not taken forward owing to flood risk

B.1 0152 Land adjacent to 81, Hunter Hill Road, Halifax

0152 Land adjacent to 81, Hunter Hill Road, Halifax

Site area	0.35 Ha
Existing use	Greenfield
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed with CMBC) 0.28 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a greenfield site which is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG.
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The site is currently not at risk of fluvial flooding, according to the EA Flood Map for planning, with 100% of the site being located within Flood Zone 1. The primary and significant flood risk at this site is surface water. Drainage water flood issue reported in an area of Hunter Hill Road.
- The site generally slopes from the north west to the south east corner with ground levels dropping from around 294m AOD to 286m AOD. Overall, there is a difference of 12m AOD in ground level across the site.
- The Detailed River Network (DRN) indicates that there are two ditches north of the site that enter into culverts which outfall into Hebble Brook. The capacity and structural condition of these culverts has not been confirmed as part of this assessment. There is no available modelling for these culverts so therefore no blockage scenarios have been tested however, the culverts are unrelated to the site due to indicative alignment.
- 100% of the site is within the Halifax CDA, drafted through the Level 1 SFRA.
- This site has potential surface water flooding and required to be modelled for 100% within Flood Zone 1.
- There is no detailed model for this site. Flood mapping in this instance is based on EA strategic mapping, and no climate change outlines are available. The site is 100% within Flood Zone 1 and is therefore not perceived to be at risk of fluvial inundation during climate change events.
- Surface water appears localised to the main flow route. High risk and medium risk surface water flood outlines are located through the centre of the site, which is likely to impede access to the southern half of the site and may limit the development potential of the southern area of the site. Any development

0152 Land adjacent to 81, Hunter Hill Road, Halifax

proposals within this site will need to consider surface water based on location. Development must not reduce the area available for surface water storage or flows as this would result in displacement of surface water towards adjacent development areas. Development may impede existing surface water flow routes. Existing communities may perceive new development to increase risk if existing surface water flow routes are not maintained following development.

- Any surface water attenuation strategies for the site will need to be designed to manage runoff from new development without being overwhelmed by offsite runoff flowing through the development.
- Access to and from the site during a surface water flood event may be impeded with areas of high risk and moderate hazards, with smaller areas with significant hazards along the access route. Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected if practical. There is potential for development north of the surface water flow route which has an accessible exit route.
- There is a significant pluvial flow route and development may cause runoff to be diverted towards existing communities. The presence of any local culverts, upstream of this flow route, needs to be confirmed as this may impact the surface water flood extents. Development should not prevent the natural flow of surface water and any mitigation or SuDS facilities should be located outside of the surface water flow route. This may limit the available land for development at this site.
- Future development will need to take safe access and egress into consideration (including emergency routes). The southern area of the site has restricted routes during significant rainfall events although the northern area of the site has safe access onto Hunter Hill Road. The available area of the site for development should exclude areas of significant surface water flooding.
- The site is relatively small and it is recommended that the northern area of the site is only considered for development. Surface water flow routes will need to be managed and a site specific detailed surface water assessment and drainage strategy will be required as part of any FRA.
- After consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	0.00	0.00	0.00
Flood Zone depth (m)	N/A (Flood Zone 1)	N/A (Flood Zone 1)	N/A (Flood Zone 1)
Flood Zone hazard	N/A (Flood Zone 1)	N/A (Flood Zone 1)	N/A (Flood Zone 1)
Climate change	The site has not been modelled for climate change. As 100% of the site is currently location within Flood Zone 1, the site is not considered to be at risk of flooding during climate change scenarios.		
Historic flooding	The site is just outside of the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.		
Defended	No known defence infrastructure present at the site.		
Flood Warning Area	No.		
Mitigation options & site suitability	As the proposed use is residential, development should be directed to the areas outside of higher risk Flood Zones. As 100% of the site is within Flood Zone 1, the site would be considered suitable for development owing to current fluvial flood risk. However, surface water flood risk is a significant constraint and, therefore, needs to be considered.		

Flood Source: Groundwater

Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of <25%. Comparison with LiDAR data indicates a fall in levels across the site. Ponding, if encountered, is likely to be minimal over much of the site as water will tend to follow topography.
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0152 Land adjacent to 81, Hunter Hill Road, Halifax

Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir	The site is not within Reservoir flood mapping extents.
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Flood Source: Infrastructure Failure – Canals

Flood risk: canal	No canalised watercourses in area. No flood risk identified.
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Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	10.55	4.54	23.51
Surface water flooding depths	Max: 0.39m Average: 0.14m	Max: 0.44m Average: 0.15m	Max: 0.61m Average: 0.16m
Surface water hazards	Max: Significant Average: Low	Max: Significant Average: Low	Max: Significant Average: Moderate
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	Surface water follows a natural flow route through existing urban areas via the road network and topography. Any existing land drainage culvert in this area would need to be confirmed as this may impact the surface water flood extents. There is surface water flood risk to the area up to the 0.1% AEP (Low Risk) event. Overall approximately 38% of the site area is at some level of surface water flood risk, however the majority of the mapped surface water is within the 0.1% AEP (Low Risk) event and is localised to the centre and south of site which is located in a surface water flood path. There is significant surface water risk below the 0.1% AEP (Low Risk) event with 15.1% of the site at medium or high risk of surface water flooding. Whilst the maximum hazards are significant in very localised areas, the majority of hazards are generally moderate or low across the risk area for the 1% AEP event, and low for the 3.33% AEP event. There is a localised area of the site that is classified as having a 'significant' hazard for the 3.33% AEP event, which increases for the 1% AEP and 0.1% AEP events. Average depths are between 0.14 to 0.61m. To get to the southern part of the site, the flow route would have to be crossed or diverted, however, it is not clear how this could be achieved without increasing risk elsewhere. The RoFSW appears to identify overland surface water flow routes from adjacent areas, however, drainage routes from the site should be assessed as part of the FRA. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. OS Mapping indicates low, medium and high flood risk to Clough Lane, Hambleton Crescent, Balkram Road and Hunter Hill Road and therefore may cause problems on access and egress to the site.		

0152 Land adjacent to 81, Hunter Hill Road, Halifax

Surface water: mitigation options & site suitability

- Surface water flooding appears localised to the main flow route, which includes areas with a high risk of surface water flooding and therefore is likely to impact significantly on the development potential across the areas of the site defined by the surface water map. Localised development areas will need to consider surface water based on location.
- The development area is generally subject to a low risk of surface water flood hazards, although dispersed across the majority of the area, which are most significant in the centre of the site. This area is likely to be less suitable for development.
- Areas at risk from surface water flooding, certainly areas at high or medium risk, should ideally be kept free from development and manage offsite impacts.
- Future development will need to take safe access and egress into consideration (including emergency routes). Surface water mapping indicates a high - medium flood risk for Hunter Hill Road, to the east of the site and therefore off-site impacts on access and egress appear problematic. The southern area of the site has restricted routes to Hunter Hill Road during significant rainfall events with average depths of 0.23m under the 1% AEP event (Medium Risk) and 0.36m under the 0.1% AEP event (Low Risk). The northern area of the site has available safe access routes onto Hunter Hill Road. The available area of the site for development should exclude areas of significant surface water flooding.
- Therefore, recommendation for this site is to only develop in the northern area of the site, as the southern area is unsuitable for development owing to surface water flood risk.
- The FRA should assess the potential for offsite surface water impacts on proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes.
- Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site, based on surface water flood risk.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield* - FEH Methodology				3.33% AEP: 4.31l/s 1% AEP: 5.12l/s QBAR: 2.46l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s		
Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	6.25	196	56	140	15.5	Revised attenuation volume 168 m ³ (assuming outflow volume of 28 m ³)
1% AEP Rainfall+30%	7.75	270	70	200 (60m ³ of exceedance)	22.2	Revised attenuation volume 235 m ³

0152 Land adjacent to 81, Hunter Hill Road, Halifax

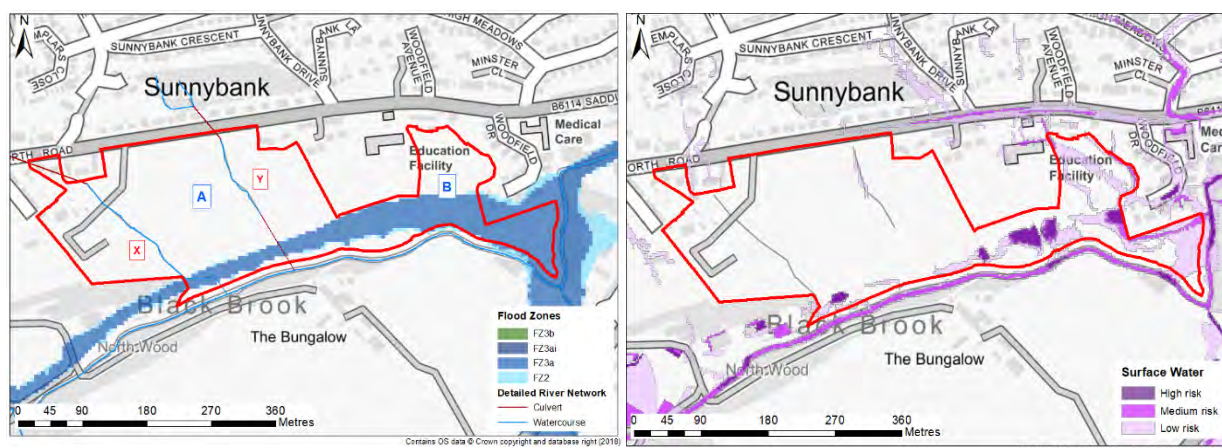
				storage)		(assuming outflow volume of 35 m ³) (67m³ of exceedance storage)
Climate change	Application of the central (30%) potential change for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development site & mitigation	To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. This figure will need to be proportioned to actual development site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to river then the sewer network, subject to detailed design ranging from a conventional piped surface water draining system including oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. Attenuation would need to be provided at locations outside of the surface water flow route.					

B.2 0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland

0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland

Site area	9.32 Ha
Existing use	Primarily Greenfield including a small brownfield area
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed with CMBC) 7.46 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG.
- Environment Agency flood mapping indicates that the floodplain and surface water extents flow north of Black Brook potentially reducing developable area. More detailed modelling may be required as part of any FRA to confirm any modelling interactions and climate change impacts. There is no available EA model of Black Brook and the flood extent is based on strategic mapping techniques. The Black Brook model will need updating based on the possible disparity between the location of the flood zones and Black Brook when comparing the EA Flood Map for Planning and OS Open Data Map. More detailed modelling would be required as part of any subsequent FRA to confirm flood extents.
- Drainage water flood issue is reported in an area of Ellistones for the spring water coming from the ground and surface water flooding because of blockage of Black Brook within Woodfield Drive area.
- Hydraulic model of Black Brook and hydrological assessment of Sunny Bank Clough is required.
- Area 'A' is defined by the red line boundary and the flood zone extent. Area 'B' is isolated by the flood zones extents as can be seen on the figure above. On this basis, area 'B' will not be available for development without alternate access to the B6144. However, area 'A' will be available for development and a detailed FRA for site specific proposal is required.
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- An 8m buffer is also required along the southern boundary (adjacent to Black Brook) where development is prohibited. This is an Environment Agency requirement to allow access to the watercourse for maintenance purposes, limiting access to the eastern parts of the site and further reduces the developable area.
- The site generally slopes from the north west to south east with ground levels dropping from around 118.5m AOD to 75.5m AOD as the land slopes down to Black Brook on the southern boundary of the site.

0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland

- The Detailed River Network (DRN) indicates that there are two drainage ditches within the site. Ditch 'Y' is culverted where it enters the site before opening up and then entering a further culverted section under the on-site road before flowing towards Black Brook. Ditch 'X' is also culverted where it enters the site, although opens up and flows towards Black Brook. To ensure road crossing across the site, the capacity of the ditches must be maintained. The capacity and structural condition of these culverts has not been confirmed as part of this assessment and will need to be fully appraised as part of the FRA.
- The two unnamed watercourses should be left free from development. Modelling should assess the risk from each watercourse, including the culverted sections. Any development should not impede the capacity of drainage ditches.
- 100% of the site is within the Elland and Brighouse CDA, drafted through the Level 1 SFRA.
- Approximately 79% of the site is currently located in Flood Zone 1 and is, therefore, potentially suitable for development.
- The Council should locate all residential development outside of the identified fluvial flood risk areas, and this will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. The Flood Zone 3 areas should be left as open space for storage and flood conveyance.
- Based on current flood extents area 'B' appears to be unsuitable for development as it will be isolated during design flood events.
- Flood Zones 2 and 3 of the EA Flood Map for Planning when compared to the OS Open Data Map indicates a disparity between the location of the flood zones and the Black Brook watercourse. The Flood Zone map does not align with Black Brook, this indicates a flood zone within the site boundary. The extent of this flood zone is supported by the surface water mapping which is based on 2 m LIDAR and uses topography to define flood extents. The strategic modelling of Black Brook was undertaken in 2011 as part of the National Generalised Modelling (NGM) study. The modelled flood outlines (MFO) produced from this generalised study are not as accurate or robust as those developed from detailed river modelling.
- Depth and hazard information is also not available for Black Brook. It is recommended that Black Brook should be remodelled as part of the FRA.
- Access to and from the site during a flood event should not be an issue with Saddleworth Road along the northern boundary at very low risk for the majority of its length.
- After consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	0.96	20.19	No detailed model available. To be confirmed through an FRA
Flood Zone depth based on estimated lidar levels and published flood zones (m)	Unknown based on strategic model	Unknown based on strategic model	Unknown based on strategic model
Flood Zone hazard	Unknown based on strategic model	Unknown based on strategic model	Unknown based on strategic model
Climate change	Black Brook has not been modelled for climate change therefore, climate change impacts have been assessed by using Flood Zone 2 as a proxy for the extent of Flood Zone 3 in 100 years' time. A hydraulic model of Black Brook and hydrological assessment of Sunny Bank Clough is required. Approximately 20% of the site is currently located within Flood Zone 3 with only an additional 1% within Flood Zone 2, as can be seen on the previous figure showing the Flood Map for Planning. This therefore shows that the effects of climate change on the level of risk to the site would likely be limited.		
Historic flooding	The site is just outside of the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood		

0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland	
	events.
Defended	No known defence infrastructure present on Black Brook.
Flood Warning Area	No.
Mitigation options & site suitability	• 'More Vulnerable' development should be directed to the areas outside of higher risk Flood Zones. Assuming development of 60% of area 'A' is achievable as the risk is confined to the southern boundary of the site, area 'B' is potentially unsuitable for development due to the level of flood risk and restricted access and egress routes. The remaining area within Flood Zone 3 (including nominal Flood Zone 2 area) should be left as open space for Flood Risk Management. • The majority of the surface water risk is within the fluvial flood extents and therefore should not require additional mitigation. • It is recommended that the FRA for the site should include remodelling of Black Brook. It may be that the flood zones will show a shift closer to Black Brook thus increasing the area of land within Flood Zone 1 and therefore impacting less on housing yields. Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. A hydrological assessment of Sunny Bank Clough will also be required. • The two drainage ditches within the site should be assessed to estimate current and future risk and should be left free of development. The possibility of culvert removal on the site should be investigated with a view to opening up the ditches. • An 8m buffer is also required along the southern boundary (adjacent to Black Brook) where development is prohibited. This is an Environment Agency requirement to allow access to the watercourse for maintenance purposes. • Access (including emergency access) across the site will need to take account of future flood levels. There is suitable access and egress routes for area 'A' north onto Saddleworth Road and will therefore be available for development and a detailed FRA for site specific proposal is required for this area. However, there are no available access routes for area 'B' owing to current flood risk, therefore this area of the site may be unsuitable for development without alternate access to existing highways. • Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site.
Flood Source: Groundwater	
Flood risk: groundwater	100% of the site indicated as having a susceptibility to groundwater emergence of > 50% < 75%. Comparison with LiDAR data indicates a fall in levels across the site in a southerly direction, indicating that groundwater is likely to flow in this direction and that ponding, if encountered, is likely to be minimal over much of the site as water will tend to flow across the site following the topography. It is identified that if it occurs, ponding will potentially correspond with the lower areas to the south identified as being at higher risk of surface water flooding.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates approximately 50% of the southern part of the site would be at risk. The RFM indicates flood depths within a banding of 0.3-2m and flood velocity <0.5m/s. It is worth noting however that reservoirs in the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925. The nearest reservoir is approximately 4.2 miles away, therefore flood depths are unlikely to be representative at this site.
Flood Source: Infrastructure Failure – Canals	

0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland

Flood risk: canal No canalised watercourses in area. No flood risk identified.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	1.82	1.69	18.94
Surface water flooding depths	Max: 0.5m Average: 0.24m	Max: 0.53m Average: 0.23m	Max: 0.82m Average: 0.22m
Surface water hazards	Max: Significant Average: Low	Max: Significant Average: Moderate	Max: Significant Average: Low
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	There is surface water flood risk to the southern and eastern part of the site up to the 0.1% AEP (Low Risk) event. Overall approximately 24% of the site area is at some level of surface water flood risk, however the majority of the mapped surface water flooding is localised. There is limited surface water risk below the 0.1% AEP (Low Risk) event with only 3.5% of the site at medium or high risk of surface water flooding. Whilst the maximum hazards are significant in very localised areas, the majority of hazards are generally moderate or low across the risk area. There is only a very small area within the site that is categorised as having a 'significant' hazard for the 3.33% AEP event. With reference to the mapping the southern area appears to be a natural lower catchment and is likely to be less suitable for development. Surface water flood risk appears mainly localised to the southern boundary next to Black Brook. The high risk and medium risk surface water flood outlines are contained within Flood Zone 3 and so should not, therefore, impact significantly on the development potential. The impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes) need to be considered. Surface water mapping indicates little / low surface water flood risk to Saddleworth Road to the west of the site which provides a potentially suitable access. There is however, low - medium flood risk on this access route to the east of the site which could impact on the development potential. To gain access to the eastern boundary of the site, you would have to pass through the Flood Zone and therefore we would recommend avoidance for this access route. The RoFSW does not appear to identify overland surface water flow routes into the site from adjacent areas, however drainage routes from the site should be assessed as part of the FRA.		
Surface water: mitigation options & site suitability	- Surface water flood risk appears localised in several small depressions and so should not impact significantly on the development potential across the majority of the site, were flooding to occur. However, localised development areas will need to consider surface water based on location. - The development area is subject to low risk of surface water flooding across the southern part of the site with localised areas of low to moderate surface water flood hazards, which is most significant in the eastern area. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to any existing drainage routes and ponding areas. Existing drainage ditches would need to be maintained or modified in such a way to not increase surface water flood risk. Any requirement for new culverts will need to ensure surface water		

0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland

flood risk is managed. The FRA will need to mitigate climate change impacts across the lifetime of the development.

- The area upstream of ditch 'Y' has low surface water risk. In the case of the 0.1% AEP event, there will also be a low hazard risk in this area.
- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. However, provided there is no development within Flood Zones 2 and 3 then surface water flooding is considered manageable.
- Areas at risk from surface water flooding, certainly areas at high or medium risk, should ideally be kept free from development or alternatively flows should be redirected across the site using appropriate SuDS.
- The Council have decided to remove allocation of this site based on flood risk to the site, as stated in the site summary table (Section 2).

**Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield - FEH Methodology	3.33% AEP: 63.4l/s 1% AEP: 85.8l/s QBAR: 36.2l/s CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 18.64
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Design flood event (including climate change)	Assumed Critical* storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	24	7690	1130	6500	140*	Revised attenuation volume 7065m ³ (assuming outflow volume of 565 m ³)
1% AEP Rainfall+30%	24	9590	1130	8500 (2000m ³ of exceedance storage)	180	Revised attenuation volume 9065m ³ (assuming outflow volume of 565 m ³) (2000 m ³ of exceedance storage)

Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.
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Surface water: flood risk impacts from development site & mitigation	It is recognised that this site includes a small area of existing development and specific proposals for development will need to be provided as part of any FRA. This will need to take into account CMBC's requirements. To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent run off rates are applied. CMBC agreed that 80% of each site area would be most representative. This figure will need to be proportioned to actual development site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts, attenuation storage will be required, both for the design drainage and exceedance events. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the sewer network, subject to detailed design ranging from a conventional
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0177 Land adjacent to Ellistones Place, Saddleworth Road, Elland

piped surface water drainage system including a combination of storage tanks or oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage.

*The limiting greenfield runoff rate results in a design event exceeding 24hrs for the purpose of this appraisal, a critical storm duration of 24hrs has been assumed.

B.3 0327 Land off Halifax Road, Todmorden

0327 Land off Halifax Road, Todmorden

Site area	0.33 Ha
Existing use	Brownfield / Urbanised including car park
Proposed use	Mixed Use
Proposed development flood risk vulnerability classification	More Vulnerable and Less Vulnerable uses
Proposed development impermeable area	80% of total developable area (Agreed by CMBC) 0.26 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a brownfield site that is identified as mixed use by CMBC, however may be used for residential allocations. There is potential for 'More Vulnerable' and 'Less Vulnerable' development, as per Table 2 of the FRCC-PPG.
- The council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The northern boundary of this site is located along the River Calder. There is also the Rochdale Canal to the south of the site. An 8m buffer is, therefore, also required along the northern boundary (adjacent to the River Calder) where development is prohibited. This is an Environment Agency requirement to allow access to the watercourse, associated defences and the Walsden Water culvert for maintenance purposes.
- Drainage water flood issues are reported as a result of gully blockage in areas of Brook Street and Cambridge Place.
- The aspiration for 80% More Vulnerable development is unlikely to be realised. 100% of the site is located within Flood Zone 3 and is at significant fluvial flood risk with maximum depths approximately 2.1m based on LiDAR data, as there is no detailed model for this site. The site currently has less vulnerable uses and introducing More Vulnerable and potentially residential development into a

0327 Land off Halifax Road, Todmorden

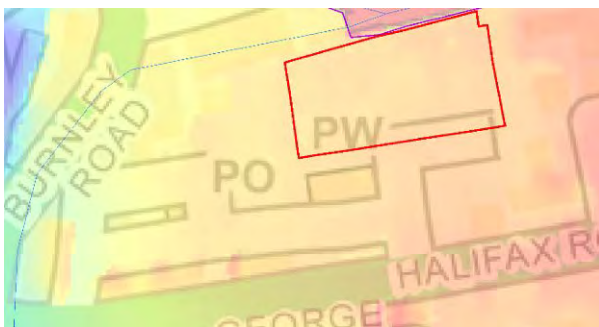
significant fluvial flood risk area (100% in Flood Zone 3) with average flood depths approximately 0.7m AOD under the 1% AEP event, and 3.2m AOD under the 0.1% AEP event, increases the flood risk and vulnerability to the site. Properties would also potentially have difficulties in gaining flood insurance based on fluvial flood information provided.

- There are also a number of flood assets close to the site; a flood wall (asset ID: 171197), along the River Calder in the north end of the site, with a condition assessment grade of 4 (Poor), and a culvert (asset ID: 162041) in the west of the site, with a condition of 3 (Fair). These are likely to implicate the flood risk and vulnerability to the site, due to the low condition grades.
- On this basis it is recommended that the site is not allocated for residential development, unless development is raised above flood levels and safe access can be achieved.
- The site is relatively level and generally slopes from west to east with ground levels dropping from around 125.4m AOD to 124.8m AOD.
- The Detailed River Network indicates that there is a culvert 'X' north west of the site boundary, as can be seen from the figure above, which outfalls into the River Calder which is located adjacent to the development site. The capacity and structural condition of the culvert has not been confirmed as part of this assessment and will need to be fully appraised as part of the FRA.
- Approximately 40% of the site is located within the Todmorden CDA.
- This site is considered unsuitable for residential development owing to current flood risk, depths, maintenance easements and unavailable access and egress routes as flood risk cannot be effectively managed as part of the development proposal. Opportunities for mixed use may be considered provided that safe access and egress can be demonstrated.
- Less Vulnerable development will remain at significant risk of flooding at considerable depths. This may result in insurability issues.
- Any proposed new development at this site would need to include consideration of compensatory storage to prevent increase in flood risk elsewhere.
- Flood mapping in this instance is based on EA strategic mapping and no climate change outlines are available (other than Flood Zone 2 approximation). These proxy climate change outlines may not be suitable to support development proposals, depending on site specific redevelopment aspirations. It is recommended that detailed modelling will be required as part of any FRA to confirm flood extents and depths.
- Under climate change conditions the site will be particularly susceptible to climate induced inundation, with Flood Zone 3 extents likely to increase the fluvial flood risk to the site. The Flood Zone 3 areas should be left as open space for storage of flood water.
- Surface water flood risk appears widespread across the majority of the site and is most significant in the eastern area. There is no surface water risk around the perimeter of the existing building, however if there was no development in this area, the risk extent would most likely extend further.
- There are impacts of fluvial and surface water flood risk on access and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates high surface water flood risk to Halifax Road to the south of the site which could possibly impact on the redevelopment potential to the site, similarly there are no available access routes under fluvial flood outlines which further supports the recommendation to remove this site.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%) (of developable area)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	0.00	100	No detailed model available. To be confirmed through an FRA
Flood Zone depth based on estimated lidar levels and published flood zones (m)	Maximum: 2.1 Average: 1.3	Maximum: 2.1 Average: 0.7	Unknown based on strategic model
Flood Zone hazard	Unknown based on	Unknown based on	Unknown based on

0327 Land off Halifax Road, Todmorden

	strategic model	strategic model	strategic model
Climate change	There is no climate change model for this area. In the absence of any detailed modelling then Flood Zone 2 will be used as a proxy for the extent of Flood Zone 3 in 100 years' time to assess climate change impacts. Although this is a pragmatic approach to predicting climate change, the approach is consistent with other SFRAs and reflects professional modelling experience. It is often the case that Flood Zone 3 including allowance for climate change can be similar to the Flood Zone 2 outline. 100% of the site is located within Flood Zone 3, as can be seen on the previous figure showing the Flood Map for Planning. This therefore shows that the effects of climate on the level of risk to the site would likely be significant.		
Historic flooding	The site is just outside of the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.		
Defended	Environment Agency records indicate that the site is protected by fluvial flood wall assets along the River Calder which all have 'Good' conditions according to the EA's Condition Assessment Manual (CAM), which flows adjacent to the northern border of the site. Adjacent to the west of the site, the Walsden Water appears to enter a culverted section which flows beneath Burnley Road. There are however, no areas surrounding the site which are reported to be an Area Benefiting from Defences, according to EA data. Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.		
Flood Warning Area	100% of the site is within River Calder at Central Todmorden Flood Warning Area		
Flood Risk	According to the EA Flood Map for Planning, Flood Zone 2 transitions into Flood Zone 3 as the culvert enters the River Calder. If this culvert was to fail or block, the flood outlines could detail a different extent. The River Calder has not been modelled in this area, therefore flood zone depths were not provided. As a proxy, LiDAR data has been used to depict flood depths at the site.  Contains OS data © Crown copyright and database right (2018) Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right The figure above indicates the LiDAR ground levels surrounding the site. The site is generally level, with a slight fall in an eastwards direction from 125.4m AOD to 124.8m AOD. There is little difference in LiDAR on Halifax Road, directly south of the site, where the land reaches 127.2m AOD which provides 2.1m of flood depth under the 1% AEP event (100-year). Based on information provided from LiDAR, the depth can exceed 2.1m under the 0.1% AEP event (1000-year), just before the junction of Halifax Road and Burnley Road, as the land reaches to 128.9m. This will cause approximate depths of 3.6m which further supports the recommendation for removal of the site, specifically for		

0327 Land off Halifax Road, Todmorden

	residential More Vulnerable development. Flood risk at this site is significant, however, FZ3 extents under climate change will result in areas of the site being inundated, at notable depths. Residential redevelopment would be prohibited for ground floor use, therefore first floor and upwards would be more beneficial although this unlikely to be suitable due to safety concerns. Residents would be restricted, and emergency and egress routes would be obstructed by flood water. Business and/or residential properties would also potentially have difficulties in gaining flood insurance based on fluvial flood information provided.
Mitigation options & site suitability	• With reference to mapping, the site appears to be unsuitable for redevelopment due to current flood risk. • There are significant depths of flooding and therefore residential development is inappropriate for this site, owing to current flood risk and future implications of climate change, using FZ2 as a proxy to determine climate change as flood risk cannot be effectively managed over the lifetime of the residential development without increasing risk elsewhere. The site is located 100% within Flood Zone 3. Maintenance easement will also reduce the available developable area. Less vulnerable uses may be considered however they will remain at significant risk of flooding and development may not be achievable across the site. • Any increases in the developable area may result in increased risk to local community. Opportunities to land raise would need to be offset by the provision of compensatory storage so as not to increase the risk of flooding to existing communities. • Ideally, any potential residential, and therefore 'More Vulnerable' redevelopment within this site should be directed to the areas outside of higher risk Flood Zones. The level of flood risk makes this site at an unacceptable level of risk. • The recommendation for this site is to remove allocation. Additional modelling and a site-specific FRA will be required. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • Detailed assessments and provision for climate change, using Flood Zone 2 as a proxy, should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Climate change scenarios have not been modelled and depending on development proposals, further investigation may be required. • Surface water risk is within the fluvial flood extents and mitigation will need to demonstrate that surface water is effectively managed under design conditions. • The FRA for the site should include remodelling of the River Calder in Todmorden, as it was last modelled in 2011. • An 8m buffer is also required along the northern boundary (adjacent to the River Calder) where residential redevelopment is prohibited at this site, this will also reduce the available developable area. This is an Environment Agency requirement to allow access to the watercourse, associated defences and the Walsden Water culvert for maintenance purposes. • Access (including emergency access) across the site will need to take account of future flood levels. With depths from the site to Halifax Road ranging from 0.6m - 2.1m AOD, safe access and egress is unavailable and therefore reiterates the recommendation for removal of the site. • Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site.

0327 Land off Halifax Road, Todmorden

Flood Source: Ground Water

Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 50\% < 75\%$. In comparison to fluvial flood risk, groundwater flood risk is a lesser, potentially more frequent flood risk which supports the recommendation to remove allocation of this site. There is a fluvial flood wall asset, owned and maintained by the EA, parallel to the northern boundary of the site. Ground water flooding may accumulate on the dry side of any raised flood defence, which if it occurs, could potentially increase the risk of groundwater to the northern boundary of the site. Comparison with LiDAR data indicates a slight fall in levels across the site, although relatively level, in an easterly direction, indicating that groundwater is likely to flow in this direction and that ponding, if encountered, is likely to be minimal over much of the site as water will tend to flow across the site following the topography. It is identified that if it occurs, ponding will potentially correspond with the areas to the west identified as being at medium risk of surface water flooding.
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Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates 100% of the site is indicated to be at risk from reservoir flooding. However, the reservoir has depths with a banding of $>2\text{m}$ and flood velocity $0.5\text{--}2\text{m/s}$ and is approximately 8.5 miles away, flood depths are unlikely to be representative at this site.
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Flood Source: Infrastructure Failure – Canals

Flood risk: canal	The Published EA canal mapping indicates that to the south of the site, there is a raised canalised watercourse, the River Calder, also located within Flood Zone 3.
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Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)**Surface Water Flood Risk to Proposed Development Site**

Existing development risk of flooding from surface water (%) (of developable area)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.90	21.12	41.30
Surface water flooding max depths	Max: 0.09m Average: 0.07m	Max: 0.33m Average: 0.18m	Max: 1.13m Average: 0.77m
Surface water max hazards	Max: Low Average: Low	Max: Moderate Average: Low	Max: Extreme Average: Significant
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	There is substantial surface water flooding around the perimeter and to the east of the site up to the 0.1% AEP (Low Risk), with approximately 65% of the site at some level of surface water flood risk. There is moderate surface water flood risk below the 0.1% AEP event with 22% of the site at medium or high risk of surface water flooding, however, as shown in the table above, there is less than 1% of the site at a high risk of surface water. The areas of surface water ponding are potentially associated with the hardstanding profile or potential issues with existing drainage. Surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure and these extents are likely to change if the site layout is changed. Depths are low, 0.07-0.77m across all events on average. During the 1% event, depths appear manageable ranging from 0.18-0.33m and during the 0.1% event depth increase to 0.77-1.13m. Hazard ratings in areas indicating flooding are low and locally moderate. However, for the 0.1% AEP		

0327 Land off Halifax Road, Todmorden

	event, there is a significant portion of the site that is classified as being an 'extreme' hazard. The northern boundary of the site runs adjacent to the River Calder channel and Walsden Water culvert. There are likely surface water cross connections to the culvert and the watercourse that will enable emergent flood water via the drainage system, which is not currently presented in the mapping. There is no surface water risk around the perimeter of the existing building, however the risk extent could be shown to extend further if there was no development present.
Surface water: mitigation options & site suitability	• Surface water flood risk appears widespread and could therefore impact significantly on the redevelopment potential across the majority of the site. The redevelopment area will need to consider surface water based on location. The site is subject to low risk of surface water flooding around the perimeter and east of the site, with a small localised area to the west of the development area. The site also has localised areas of moderate and high surface water flood risk, particularly around the perimeter of the site. The majority of the site, within the 3.33% AEP (High Risk) event, is free from surface water flood hazards, with only a very localised area on the southern boundary of the site. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Areas at risk from surface water flooding, certainly areas at high or medium risk, should ideally be kept free from development or alternatively flows should be redirected across the site using appropriate SuDS if practical. This accounts for 60% of the site and therefore based on this, only 40% of the site is available for development owing to surface water flood risk although there is significant fluvial food risk to this site. • The FRA should also assess the potential for offsite surface water impacts on the proposed development if less vulnerable development is to be achieved, although subject to significant risk of flooding. This will need to include consideration of inflows from adjacent sites. • The FRA should consider any existing or proposed discharges to the River Calder and if these discharge routes are proven, impacts on outfall capacity during high flows will need to be assessed. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, as mapping indicates high fluvial and surface water flood risk to the main highway (Halifax Road) and surrounding roads and therefore off-site impacts on access and egress appear problematic and reiterate the recommendation for site removal. The council agree with this recommendation and have removed the site allocation.

**Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

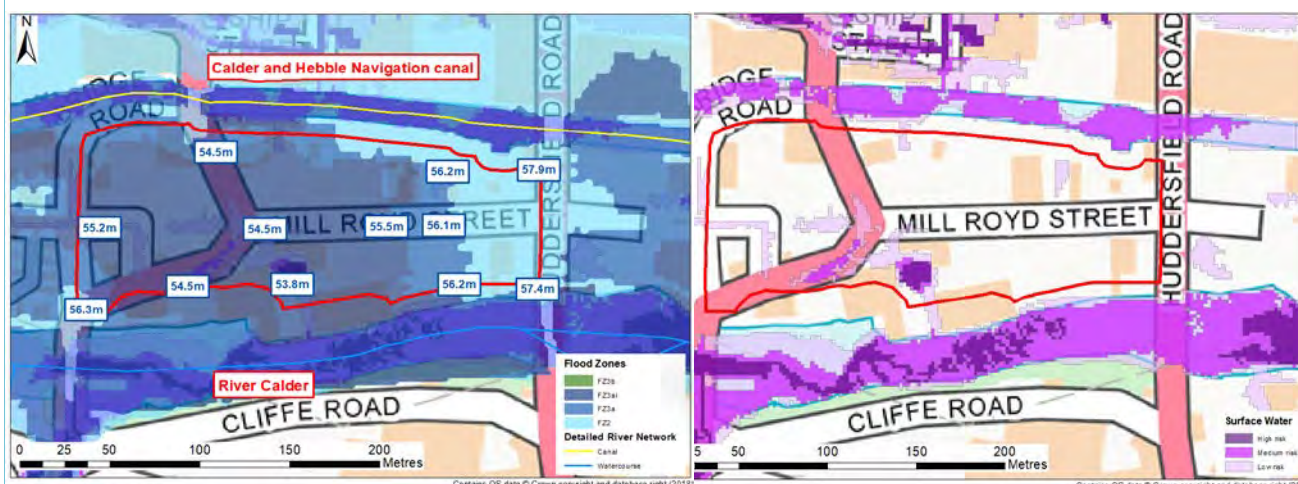
Proposed development limiting runoff rate: Greenfield* - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.				3.33% AEP: 7.7l/s 1% AEP: 9.5l/s QBAR: 4.4l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s		
Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)

0327 Land off Halifax Road, Todmorden						
3.33% AEP Rainfall+30 %	7	195	65	130	14.5	Revised attenuation volume 162.5m ³ (assuming outflow volume of 32.5 m ³)
1% AEP Rainfall+30 %	9.25	270	85	190 (60 m ³ exceedance storage)	20.7	Revised attenuation volume 232.5m ³ (assuming outflow volume of 42.5 m ³) (70 m ³ of exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development site & mitigation	In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment. It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above. To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual development site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. The attenuation will be located in its entirety within flood zone 3. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.					

B.4 0573 Land adjacent Mill Royd Street, Brighouse

0573 Land Adjacent Mill Royd Street, Brighouse	
Site area	2.22 Ha
Existing use	Brownfield / urbanised including commercial / retail
Proposed use	Mixed Use
Proposed development flood risk vulnerability classification	More Vulnerable and Less Vulnerable uses
Proposed development impermeable area	80% of total area (Agreed by CMBC) 1.78 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a brownfield site that has commercial / retail uses. The site is identified as mixed use by CMBC, however, as this may include residential allocations, there is potential for 'More Vulnerable' and 'Less Vulnerable' development, as per Table 2 of the FRCC-PPG.
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The site is located in the middle of two watercourses with the River Calder to the south and the Calder and Hebble Navigation canal to the north. The site is also adjacent to two bridges under Huddersfield Road, as can be seen from the figure above.
- All areas of the site remain at significant flood risk during current flood events.
- There is a slight fall in level across the site in a westerly direction, and also a small depression in the centre of the southern boundary of the site, where ground levels drop to 53.8m AOD, as can be seen from the figure above, as the land slopes down to the River Calder. Based on available modelling, the depth of flooding during the 1% AEP event ranges from 0-2.2m, with an average depth of 1m.
- Approximately 17% of the site is located within Flood Zone 2 and therefore, over 82% of the site is located within Flood Zone 3 and may be unsuitable for development owing to significant depths of flooding.
- Climate change models for the 2015 Calder and Canals Brighouse model show the increase in flood risk to the east of the site for the 1% AEP event (including an allowance for climate change). No blockage scenarios have been tested however, these are likely to result in increased flood risk. The model increases Flood Zone 3 by approximately 10%.
- 100% of the site is located within the Elland and Brighouse CDA, drafted through the Level 1 SFRA. It is also located within the Brighouse FAS area (site is closer to Bethel Street).
- The average depth of flooding during the 1% AEP event is 1m, with maximum flood depths reaching

0573 Land Adjacent Mill Royd Street, Brighouse

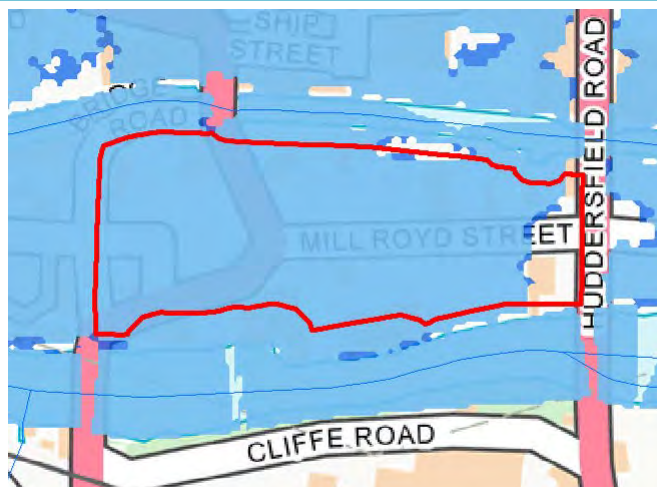
2.2m. This depth of flooding precludes residential development unless development is raised above design levels and emergency access can be achieved. However, based on Flood Zone 2 levels, fluvial flood depths are extreme with maximum depths at 3.7m with an average of 2.1m, therefore even first floor residential development cannot be built within 17% of the site.

- It is noted that the site currently has commercial / retail uses, opportunities for less vulnerable development will remain at significant risk of inundation and it is highly unlikely that businesses will be able to get insurance. Redevelopment of the site based on an 80% assumed developable area may be significant barrier to flood flows and has the potential to increase flood flows significantly. Compensatory flood storage will be required as mitigation of loss of any flood storage.
- Residential development is considered inappropriate for this site, and less vulnerable development will remain at risk from significant depths of flooding.
- Under climate change conditions the site will be particularly susceptible to climate induced inundation owing to the finite capacity of the River Calder and the Calder and Hebble Navigation canal.
- The Flood Zone 3 areas should ideally be left as open space for storage of flood water.
- Surface water flood risk appears mainly localised in a small depression in the centre of the southern boundary of the site, next to the River Calder, and has low risk of surface water flooding in the south west of the site, with depths ranging from 0.06m - 0.63m. The high risk and medium risk surface water flood outlines are contained within Flood Zone 3 and so should therefore not impact significantly on the development potential across the majority of the site. However localised development areas will need to consider surface water based on location. There has however, been a drainage water flood issue reported due to a burst pipe and gully blockage within an area of Mill Royd Street.
- Fluvial flood risk to the site holds more of a significant risk than surface water, owing to flood depths provided from the 2015 Calder and Canals Brighouse Model.
- Future development will need to take safe access and egress both within and outside (including emergency routes) into consideration. The frequency of surface water inundation is unknown and there is a risk of repeated incidents of low level flooding. There is extensive fluvial flood risk in this area, however problems with access could arise if any bridge blockage north and south of the site on Huddersfield Road were to occur.
- There are low surface water flood depths under the 1% AEP event, with average depths of 0.25m. However, any bridge blockages are likely to impede surface water flood risk on Huddersfield Road. The average hazard rating for this event is significant, with maximum 'extreme' values. Access based on current levels is therefore unavailable.
- Owing to significant fluvial risk based on flood depths and surface water flood risk based on hazards, the recommendation would be to remove the allocation of this site.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	17.43	82.56	Not defined (as currently developed)
Flood Zone depth (m)	Max: 3.7 Mean: 2.1	Max: 2.2 Mean: 1.0	Not applicable
Flood Zone hazard	Max: Extreme Mean: Extreme	Max: Extreme Mean: Significant	Not applicable
Climate change	Climate change impacts have been assessed by updating the existing model for the 1% AEP event, increasing the flow by 50% to represent the upper end climate change flows for the Humber basin. Based on the defended model the increase in depths on average are 0.5m and maximum 0.63m. The increase in depths for the undefended model on average is 0.6m and maximum 0.9m. Any bridge blockage will also increase flood risk.		

0573 Land Adjacent Mill Royd Street, Brighouse



Indicative Flood Extents for 1% AEP Defended and Undefended Climate Change Scenarios

Based on the 2015 Calder and Canals Brighouse model

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The site is currently 100% within Flood Zones 2 and 3.

Available modelling indicates under climate change the extents of Flood Zone 3 will increase to approximately 95%. These will extend to the east of the site and there will also be an increase in the area inundated to the north of the Calder and Hebble Navigation North Cut Canal.

Historic flooding

The site is contained within the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.

Defended

Environment Agency records indicate the area is protected from fluvial flooding from the River Calder by concrete and masonry flood wall assets across the southern boundary of the site. The condition of these flood walls ranges between Condition Grade 2 - 3, which is considered as 'Good / Fair' according to the EA's Condition Assessment Manual (CAM).

There are however, no areas surrounding the site which are reported to be an Area Benefiting from Defences, according to EA data.

Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.

Flood Warning Area

100% of the site is within **River Calder at Brighouse** Flood Warning Area

Mitigation options & site suitability

- Due to the level of risk and significant depth of flooding across this site (Flood Zone 2 and 3), residential development is considered inappropriate for this site. Less vulnerable development may be considered however will remain at significant risk of flooding, and extreme risk of flooding owing to flood depths under the 0.1% AEP event.
- A new high-density development is likely to impede flood flows which could be a significant issue requiring compensatory storage.
- Any increases in the developable area may result in increased risk to the local community. Flood risk cannot be effectively managed over the lifetime of the development due to significant fluvial risk to the site which is likely to increase.
- Climate change and culvert blockage will result in increased flood risk, approximately 95% of the site will be inundated according to available

0573 Land Adjacent Mill Royd Street, Brighouse

modelling.

- The recommendation for this site is to either remove allocation or restrict development objectives to higher areas of land within the site within Flood Zone 3. A site-specific FRA will be required.
- Based on level of flood risk, CMBC should reconsider the suitability of this site for redevelopment owing to current flood risk and future implications of climate change, as the site is predominantly located within Flood Zone 3. CMBC will have to provide strategic justification for inclusion of this site because the flood risk is too high.
- Redevelopment in areas covered by Flood Zone 3 may be difficult and land raising may result in a reduction in available flood storage.
- Ideally, 'More Vulnerable' redevelopment should be directed to the areas outside of higher risk Flood Zones. However, as 100% of the site is within Flood Zones 2 and 3, the redevelopment potential of the site will be significantly impacted, which reiterates our recommendation for site removal.
- Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated.
- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.
- Future flood levels may continue to impact access (including emergency access) across the site, with areas adjacent to Huddersfield Road becoming inundated, bridge blockage could increase the flood risk and further restrict this road which is the only potential access route.

Flood Source: Groundwater
Flood risk: ground water

100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 25\% < 50\%$. In comparison to fluvial flood risk, groundwater flood risk is a lesser, potentially more frequent flood risk which supports the recommendation to remove allocation of this site.

LiDAR data indicates that there is a slight fall in level across the site in a westerly direction, and also in the centre of the southern boundary of the site, indicating that ponding, if encountered, is likely to be minimal as water will tend to flow across the site following topography.

There is a concrete flood wall and masonry wall assets, owned and maintained by the EA, parallel to the southern boundary of the site. Ground water flooding may accumulate on the dry side of any raised flood defence, which if it occurs, could potentially increase the risk of groundwater to the southern boundary of the site.

Flood Source: Infrastructure Failure – Reservoirs
Flood risk: Reservoir

The Reservoir Flood Map (RFM) indicates approximately 98% of the site is indicated to be at risk from Reservoir flooding. However, the reservoir has depths with a banding of mainly $>2\text{m}$ and flood velocity $0.5\text{--}2\text{m/s}$. The proximity of the closest reservoir to the site is 6.75 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to the site.

Flood Source: Infrastructure Failure – Canals
Flood risk: canal

The Published EA canal mapping indicates that to the north of the site, the Calder Canal is located.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)
Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water

High Risk
(3.33% AEP)

Medium Risk
(1% AEP outline)

Low Risk
(0.1% AEP outline)

0573 Land Adjacent Mill Royd Street, Brighouse

(%)	outline)		
	0.95	1.15	6.46
Surface water flooding depths	Max: 0.40m Average: 0.26m	Max: 0.47m Average: 0.25m	Max: 0.63m Average: 0.23m
Surface water hazards	Max: Moderate Average: Low	Max: Moderate Average: Low	Max: Significant Average: Low
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	There is minimal and only localised surface water flood risk to the majority of the site below the 0.1% (Low Risk) event, with only just over 2% of the site at medium or high risk of surface water flooding. Overall approximately 9% of the site area is at some level of surface risk. The mapping indicates a central southern area of surface water flooding (depths in this area are 0.16-0.40m) highlighted under the 3.33 % AEP. There is a further area of localised surface water flooding indicated under the 0.1% AEP (Low Risk) event adjacent to the south west of Mill Royd Street, with depths 0.1-0.63m. The remaining areas of surface water flood risk are localised and likely to relate to local topography. Surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure and these extents are likely to change if the site layout is changed. The average localised hazard rating is low, rising to significant in the 0.1% AEP event. The RoFSW does not appear to identify overland surface water flow routes into the site from adjacent areas, however drainage routes from the site should be assessed as part of the FRA. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress.		
Surface water: mitigation options & site suitability	• Surface water flooding appears localised in small depressions and so should not impact significantly on the redevelopment potential across the majority of the site, were flooding to occur. However, localised redevelopment areas will need to consider surface water based on location. The redevelopment area is generally subject to a relatively low surface water flood hazard across the south western part of the site, with localised areas of moderate - significant hazards, primarily associated with the existing drainage network. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to any existing drainage routes and ponding areas. The FRA will need to mitigate climate change impacts across the lifetime of the development. Existing drainage ditches would need to be maintained or modified in such a way to not increase surface water flood risk. • Areas at risk from surface water flooding, certainly areas at high or medium risk, should ideally be kept free from redevelopment. SuDS potential is limited due to significant fluvial flood risk. • The FRA should also assess the potential for offsite surface water impacts on the proposed redevelopment. This will need to include consideration of inflows from adjacent sites. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • If additional discharge to the River Calder/ Calder and Hebble Navigation North Cut Canal is proposed the FRA will need to consider outfall capacity during high flows. • Surface water flooding of the surrounding highways will need to be taken into consideration for emergency access and egress. Mapping		

0573 Land Adjacent Mill Royd Street, Brighouse

indicates a medium - high flood risk to A643/Bramston Street, however flood risk to Mill Royd Street appears if any, to be low, and a medium surface water flood risk to A641/Huddersfield Road, which could increase if any bridge blockages were to occur and therefore this may cause off-site impacts on access and egress, specifically with fluvial flood risk being more significant than surface water.

- Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield* - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.	3.33% AEP: 23.57l/s 1% AEP: 28.02l/s QBAR: 13.47l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s
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Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30 %	11	1385	370	1010	29.7	Revised attenuation volume 1195 (assuming outflow volume of 185 m ³)
1% AEP Rainfall+30 %	13	1840	440	1400 (390 m ³ exceedance storage)	41.1	Revised attenuation volume 1620 (assuming outflow volume of 220 m ³) (425 m ³ exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development site & mitigation	In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment. It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above. To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual development site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP					

0573 Land Adjacent Mill Royd Street, Brighouse

(standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.

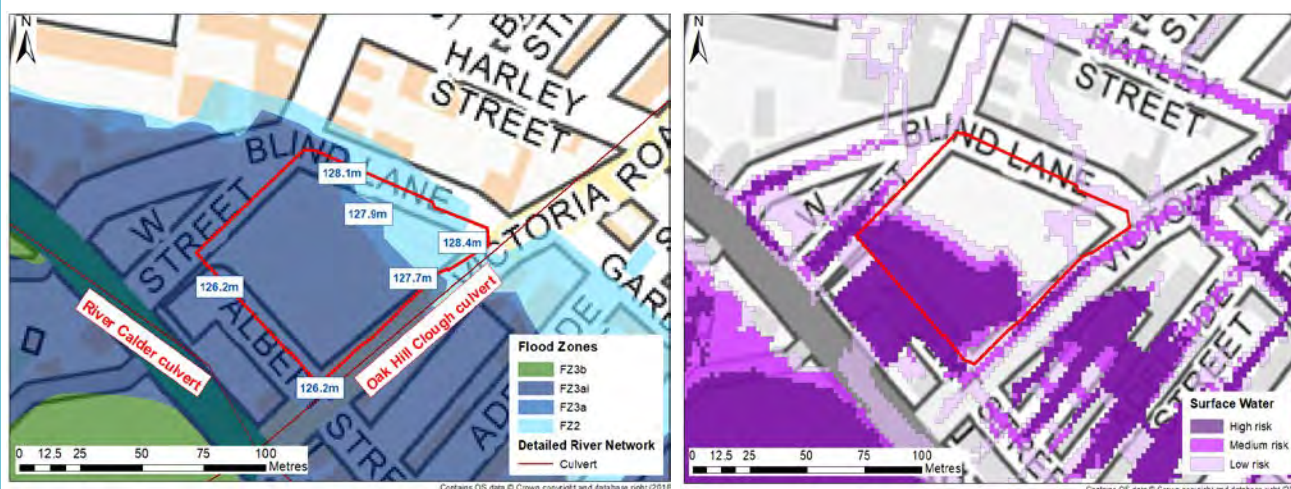
An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river and then sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.

B.5 0649 Former Adamroyd Mill, Victoria Road, Todmorden

0649 Former Adamroyd Mill, Victoria Road, Todmorden

Site area	0.57 Ha
Existing use	Brownfield
Proposed use	Mixed Use
Proposed development flood risk vulnerability classification	More Vulnerable and Less Vulnerable uses
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.46 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a brownfield site that has an industrial use. The site is identified as mixed use by CMBC, however, as this may include residential allocations, there is a potential for 'More Vulnerable' and 'Less Vulnerable' development, as per Table 2 of the FRCC-PPG.
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- Based on level of flood risk, CMBC should reconsider the suitability of this site for redevelopment owing to current flood risk and future implications of climate change, as the site is predominantly located within Flood Zone 3. CMBC will have to provide strategic justification for inclusion of this site because the flood risk is too high.
- The site is located adjacent to two culverts, the River Calder culvert and the Oak Hill Clough culvert. There is no available modelling for these culverts, so no blockage scenarios have been tested however, these are likely to result in localised increases in flood risk. Drainage water flood issues have been reported in areas of Blind Lane and West Street because of gully blockage.
- All areas of the site remain at significant flood risk during current flood events.
- The site generally slopes from the north east to south west with ground levels dropping from around 128.4 m AOD to 126.2 m AOD as the land slopes down to Albert Street and the River Calder as shown in the fluvial flood outline figure above. Based on available mapping and LiDAR data, the depth of flooding during the 1% AEP event ranges from 0-1.9m with an average depth of approximately 1.2m.
- The River Calder enters a culvert to the south west of the site. The culvert adjacent to the south eastern boundary of the site flows into Oak Hill Clough further downstream (asset ID: 101152) and has a condition assessment grade of 5 (Very Poor). There second culvert close to this site is located on West Street along the River Calder (asset ID: 101332) with a condition grade of 3 - (Fair). If the culverts were to fail/block, the flood outlines could detail a different extent and cause additional fluvial flood risk to the site.
- 100% of the site is within the Todmorden CDA, drafted through the Level 1 SFRA. The site is also

0649 Former Adamroyd Mill, Victoria Road, Todmorden

closer to the Capital Programme FRM scheme of Asquith Hall Care Home, Burnley Road, Todmorden.

- Approximately 20% of the site is located within Flood Zones 1 and 2 and, therefore 80% of the site is located in Flood Zone 3 and may be unsuitable for redevelopment owing to significant depths of flooding.
- The average depth of flooding during the 1% AEP event is estimated to be 1.2m. This depth of flooding precludes residential development unless development is raised above design levels and emergency access can be achieved. It is noted that the site currently has industrial uses, opportunities for less vulnerable development will remain at significant risk of inundation and insurability issues will need to be considered. Redevelopment of the site based on an 80% assumed developable area will result in a significant volume of flood storage that will need to be mitigated to ensure that risk to existing communities is not increased. Significant depths of flooding may restrict residential development to first floor level only. However, this is dependent on safe egress that avoids areas of significant flood risk. A detailed FRA will still be required to support the planning application at the site.
- Under climate change conditions the site will be particularly susceptible to climate induced inundation owing to the finite capacity of the River Calder and Oak Hill Clough culvert.
- Ideally Flood Zone 3 extents are likely to increase the overall fluvial flood risk to the site. The Flood Zone 3 areas should ideally be left as open space for storage of flood water.
- There is no detailed model for this site. Flood mapping in this instance is based on EA strategic mapping and no climate change outlines are available (other than Flood Zone 2 approximation). These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific FRAs. It is recommended that detailed modelling will be required as part of any FRA to confirm flood extents and depths as site is within Flood Zone 2 and 3 of the River Calder and Oak Hill Clough.
- Surface water flood risk appears significant, although mainly localised to the south western boundary adjacent to the River Calder culvert. The frequency of surface water inundation is unknown and there is a risk of repeated incidents of low level flooding.
- Future redevelopment will need to take safe access and egress into consideration. There is extensive flood risk in this area, with all exit routes south of the site inundated, however there is one egress route available, from the eastern corner of the site travelling north up Victoria Road. However, residential development on the first floor would need a safe exit route to Victoria Road, which is within Flood Zone 2.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	17.23	81.27	Not defined (as currently developed)
Flood Zone depth based on estimated lidar levels and published flood zones (m)	Max: 0.7 Mean: 0.35	Max: 1.9 Mean: 1.2	N/A
Flood Zone hazard	Unavailable based on strategic model	Unavailable based on strategic model	N/A
Climate change	The site has not been modelled for climate change. Climate change impacts have therefore been assessed using Flood Zone 2 as a proxy for the extent of Flood Zone 3 in 100 years' time. Although this is a pragmatic approach to predicting climate change, the approach is consistent with other SFRAs and reflects professional modelling experience. It is often the case that Flood Zone 3 including allowance for climate change can be similar to the Flood Zone 2 outline. Further modelling could be undertaken to assess the impacts of climate change and culvert blockage however based on the estimated depths of		

0649 Former Adamroyd Mill, Victoria Road, Todmorden

	flooding at this location it is unlikely to result in a significant reduction in flood depths. Approximately 80% of the site is currently located within Flood Zone 3 and 17% within Flood Zone 2, as can be seen on the previous figure showing the Flood Map for Planning. This therefore shows that the effects of climate on the level of risk to the site would likely be significant.
Historic flooding	The southern corner of the site is contained within the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.
Defended	The Environment Agency does not own or maintain any flood defence assets along the site and is therefore, not identified to be protected on the EA's Flood Map for Planning. Environment Agency records indicate that the River Calder enters a culvert upstream of the site (Burnley Road / Blind Lane). This area is undefended with high ground either side. This watercourse appears to enter the culvert beneath the access road (Burnley Road) to the junction of Wellington Road and Burnley Road. The capacity and structural condition of the culvert has not been confirmed as part of this assessment.
Flood Warning Area	100% of the site is within River Calder at Todmorden - Patmos Burnley Road Flood Warning Area
Mitigation options & site suitability	• There are significant depths of flooding and therefore residential development is inappropriate for this site. Less vulnerable uses may be considered however they will remain at significant risk of flooding. • Any increases in the developable area may result in increased risk to local community. Opportunities to land raise would need to be offset by the provision of compensatory storage so as not to increase the risk of flooding to existing communities. • Climate change and culvert blockage is likely to result in increased flood risk. Surface water flooding is likely to be significant across 50% of the site. • The recommendation for this site is to either remove allocation or restrict development objectives to higher areas of land within the site. Additional modelling and a site-specific FRA will be required. • Based on level of flood risk, CMBC should reconsider the suitability of this site for redevelopment owing to current flood risk and future implications of climate change, as the site is predominantly located within Flood Zone 3. CMBC will have to provide strategic justification for inclusion of this site because the flood risk is too high. • Redevelopment in areas covered by Flood Zone 3 may be difficult and land raising may result in a reduction in available flood storage. • Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • Future redevelopment will need to take safe access and egress into consideration. There is extensive flood risk in this area, with all exit routes south of the site inundated, however there is one available egress route available, from the eastern corner of the site travelling north up Victoria Road. However, residential development on the first floor would need a safe exit route to Victoria Road, which is within Flood Zone 2. • Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, based on 100% Flood Zone 3 coverage.

Flood Source: Groundwater

0649 Former Adamroyd Mill, Victoria Road, Todmorden

Flood risk: ground water	LIDAR mapping indicates a slight fall in level across the area in a south-westerly direction, indicating that ponding, if encountered, is likely to be minimal as water will tend to flow across the site following topography and may possibly correspond with the lower areas to the south west of the area which are identified as being at higher risk of surface water flooding.
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Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates that approximately 65% of the site shows a risk of flooding with depths of between 0.3m-2m and flood velocity of 0.5-2m/s. The proximity of the closest reservoir to the site is 8.72 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to the site.
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Flood Source: Infrastructure Failure – Canals

Flood risk: canal	No canalised watercourses in area. No flood risk identified.
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Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	31.29	5.88	13.38
Surface water flooding depths	Max: 0.81m Average: 0.32m	Max: 1.03m Average: 0.49m	Max: 1.17m Average: 0.51m
Surface water hazards	Max: Significant Average: Low-Moderate	Max: Significant Average: Significant	Max: Significant Average: Significant
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	For events up to the 1% AEP event, over 37% of the site is at high or medium risk of surface water flooding from depths ranging from 0.32m to 1m. This represents a significant risk to all development. At the 0.1% AEP event approximately 14% of the site is shown to be impacted in localised areas. These areas extend under the higher probability events and are generally constrained to the surrounding highways and surfaced areas through the south west of the site. The subsequent maximum hazard is mainly significant under all events, however on average for the 3.33% AEP event is low - moderate. This hazard rating becomes more localised with the lower probability risk events, where there is on average a significant average hazard for the 1% and 0.1% events. As the surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure these extents are likely to change if the site layout is changed. Mapping indicates the potential surface water flows entering the site with topography dictating potential flow routes across the site generally in a south westerly direction, to the lower ground past A464/Burnley Road. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress.		
Surface water: mitigation options & site suitability	Surface water flooding appears to be significant in the south western area of the site and so may impact significantly on the redevelopment potential, however, localised redevelopment areas will need to consider surface water based on location. The redevelopment area is generally subject to a high surface water flood risk. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts		

0649 Former Adamroyd Mill, Victoria Road, Todmorden

across the lifetime of the development. Development must not reduce the area available for surface water storage as this would result in displacement of surface water towards adjacent development areas.

- Areas at risk of surface water flooding, certainly areas at high or medium risk, should be kept free from redevelopment.
- The FRA should also assess the potential for offsite surface water impacts on the proposed redevelopment. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes.
- The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes).
- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.
- Mapping indicates a risk to Victoria Road, and A646/Burnley Road, therefore off-site impacts on access and egress will need to be taken into account.
- The Council have decided to remove this site from allocation based on most up to date information available.

**Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield* - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.	3.33% AEP: 13.21l/s 1% AEP: 15.7l/s QBAR: 7.55l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s
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Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	5.25	311	100	210	11.1	Revised attenuation volume 260 m ³ (assuming outflow volume of 50 m ³)
1% AEP Rainfall+30%	7	437	120	300 (90m ³ of exceedance storage)	15.9	Revised attenuation volume 360 m ³ (assuming outflow volume of 60 m ³) (100m³ of exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water:	80% development represents a significant increase in development of this site.					

0649 Former Adamroyd Mill, Victoria Road, Todmorden

**flood risk
impacts from
development
site &
mitigation**

In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment.

It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above.

To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual redevelopment site areas at detailed design.

Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.

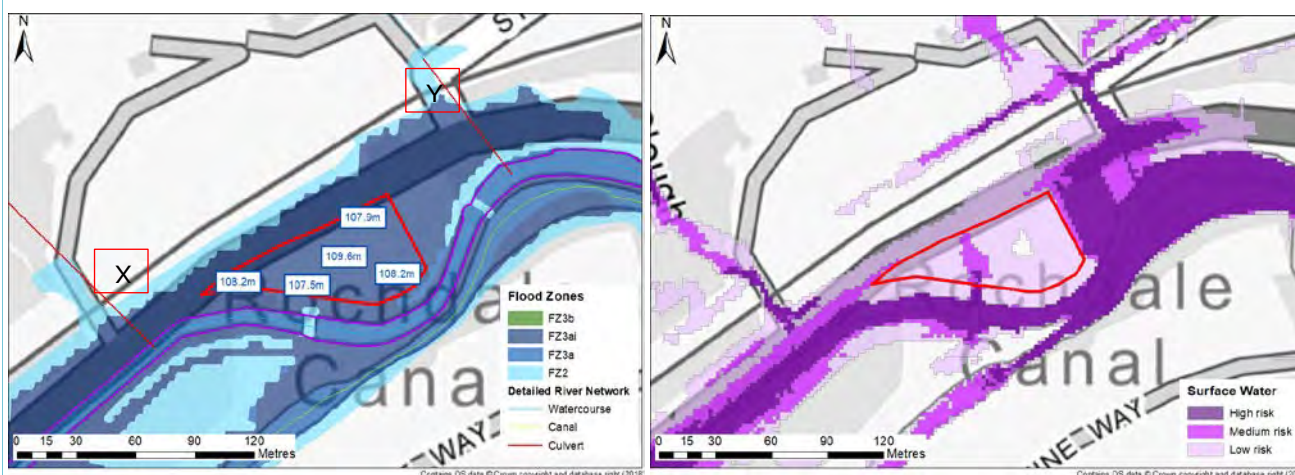
An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.

B.6 0915 Callis Mill, Halifax Road, Hebden Bridge

0915 Callis Mill, Halifax Road, Hebden Bridge

Site area	0.31 Ha
Existing use	Brownfield
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.25 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The southern boundary of the site is located adjacent to the River Calder, which runs parallel with the Rochdale Canal.
- Site levels vary with a slight dip in level in the middle of the site (107.5m AOD), and a raised area of land to the east (109.6m AOD).
- There are two culverts in close proximity to the site, one located south west (asset ID 0222/4) of the site which has a condition grade of 4 (good), and one located to the north east of the site and both outfall into the River Calder, as can be seen from the figure above (X and Y). The capacity and structural condition of one of the culverts has not been confirmed as part of this assessment and will need to be fully appraised as part of the FRA.
- Other flood risk assets located close to the site include a flood wall on the left bank of the River Calder (asset ID: 27933), condition grade 4 (Good) and on the right bank (asset ID: 52804), condition grade 3 (Fair). There is also a flood gate located to the south of the site on the River Calder (asset ID: 525569) with a condition of 3 (Fair).
- Approximately 60% of the site is within the Hebden CDA, drafted through the Level 1 SFRA. It is also within the Hebden Bridge FAS scheme. The site is half a mile away from the Capital Programme FRM scheme of Jumble Hole Clough.
- An 8m buffer is also required along the southern boundary adjacent to the River Calder where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse and associated defences for maintenance purposes.
- 100% of the site is located within the EA defined high risk Flood Zone 3, and therefore, the council

0915 Callis Mill, Halifax Road, Hebden Bridge

should review the suitability of this site for redevelopment owing to current flood risk, as this site is considered unsuitable for development.

- Drainage water flood issues have been reported owing to gully drainage in an area of Woodland View.
- The Council should locate all residential redevelopment outside of the identified fluvial flood risk areas, on this basis, the site is deemed unsuitable for development as the entire area is located within an identified fluvial flood risk area (Flood Zone 3), irrespective a detailed FRA will be required for planning.
- The average depth of flooding during the 1% AEP event is 0.3m. The depth of flooding limits options for residential development unless redevelopment is raised above design levels and emergency access can be achieved. Redevelopment of the site based on an 80% assumed developable area may result in significant volume of flood storage that will need to be mitigated. A more detailed FRA will be required.
- The Flood Zone 3 areas should be left as open space for storage of flood water, which therefore, coupled with significant flood depths, rules out any redevelopment potential for this site. Whilst More Vulnerable development may be considered based on first floor development or land raising, the impact of development will need to be considered further through the site specific FRA.
- Residential properties may potentially have difficulties in gaining flood insurance based on fluvial flood information provided.
- Under climate change conditions the site will be particularly susceptible to climate induced inundation owing to the finite capacity of the River Calder and the Rochdale Canal.
- Surface water flooding appears widespread across the site, although approximately 90% is within the low risk 0.1% AEP event. High risk and medium risk surface water flood outlines, although less than 10%, are localised and located through the centre of the western area of site. These outlines are within Flood Zone 3 extents and so should not impact significantly on the redevelopment potential. However, localised redevelopment areas will need to consider surface water based on location. Any redevelopment proposals within this site will need to take site runoff and offsite interactions into consideration.
- Future redevelopment will need to take safe access and egress into consideration (including emergency routes). There is extensive fluvial flood risk in this area, with all exit routes surrounding the site inundated. There are areas of low - high surface water risk to the A646/ Halifax Road. LiDAR and available mapping indicate that there are shallow depths from the site to the Halifax Road, on average approximately 0.25m and therefore first floor development could be considered as there would be an available access route.
- After consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, based on 100% Flood Zone 3 coverage, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	0.00	100	Not defined (as currently developed)
Flood Zone depth (m)	Max: 1.0 Mean: 0.3	Max: 1.0 Mean: 0.3	No depths
Flood Zone max hazard	Max: Significant Mean: Low-Moderate	Max: Significant Mean: Significant	No hazards
Climate change	Climate change impacts have been assessed by updating the existing model for the 1% AEP event, increasing the flow by 50% to represent the upper end climate change flows for the Humber basin. Based on the defended model the increase in depths on average are 0.014m and maximum 0.04. The increase in depths for the undefended model on average is 0.14m and maximum 0.18m. Any bridge blockage will also increase flood risk and the implications of this will need to be considered as part of a site specific FRA. The site is 100% within Flood Zone 3 and is at direct risk of flooding. Under climate change the flood risk will still present significant risk which the current day extents show.		
Historic flooding	The site is contained within the Environment Agency Historic Flood Map (HFM)		

0915 Callis Mill, Halifax Road, Hebden Bridge	
	outline and from available data there are no records of other historic flood events.
Defended	Environment Agency records indicate that the southern boundary of the site is protected from fluvial flooding from the River Calder by masonry flood wall assets. The condition of this site is Condition Grade 3 which is considered 'Fair' according to the EA's Condition Asset Manual. The Rochdale Canal runs parallel to the River Calder, on the opposite side of the site, which is protected by a masonry flood wall between the river and canal, and river and the site, to reduce the flood risk to the surrounding areas. The flood mapping shows inundation, however as there is a raised defence the risk will be mitigated. The flood wall may overtop during climate change scenarios. There are however, no areas surrounding the site which are reported to be an Area Benefiting from Defences, according to EA data. Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	100% of site is within River Calder at Callis Bridge and Charlestown Flood Warning Area
Mitigation options & site suitability	• There are significant depths of flooding, on average 0.3m, and therefore residential development is inappropriate for this site. The recommendation would be to restrict residential development to first floor level only. • Based on level of flood risk, CMBC should reconsider the suitability of this site for redevelopment at ground floor level owing to current flood risk and future implications of climate change, as the site is predominantly located within Flood Zone 3. First floor development may be considered. CMBC will have to provide strategic justification for inclusion of this site. • Redevelopment in areas covered by Flood Zone 3 may be difficult and land raising may result in a reduction in available flood storage. • Ideally, 'More Vulnerable' redevelopment should be directed to the areas outside of higher risk Flood Zones. However, as 100% of the site is within Flood Zone 3, the development potential of the site is limited. • Future flood levels may continue to impact access (including emergency access) across the site, with areas adjacent to Huddersfield Road becoming inundated, bridge blockage could increase the flood risk and further restrict this road which is the only potential access route. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • An 8m buffer is also required along the southern boundary adjacent to the River Calder where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse and associated defences for maintenance purposes. • Access (including emergency access) across the site will need to take account of future flood levels, as A646/Halifax Road, north of the site boundary is inundated and within Flood Zone 3. LiDAR and available mapping indicate that there are shallow depths, on average approximately 0.25m and therefore first floor development would have an available access route. • The Council have decided to remove allocation of this site, after consultation with the EA, LLFA and LPA (Section 2).
Flood Source: Groundwater	
Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 50\% < 75\%$. In comparison to fluvial flood risk, groundwater flood risk is a lesser, potentially more frequent flood risk which supports the

0915 Callis Mill, Halifax Road, Hebden Bridge

recommendation to remove allocation of this site.

Comparison with LiDAR data indicates a slight dip in level in the middle of the area in a southern direction, and a raised area of up to 1m in depth to the middle of the eastern half of the site, which would indicate that ponding if encountered may flow from the raised ground level (109.6m AOD) and pool in the lower areas (107.7m AOD) which would correspond with high - medium surface water flood risk in this area.

There is a masonry flood wall asset, owned and maintained by the EA, parallel to the southern boundary of the site. Ground water flooding may accumulate on the dry side of any raised flood defence, which if it occurs, could potentially increase the risk of groundwater pooling along the southern boundary of the site.

Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir The FRM indicates that 100% of the site is indicated to be at risk from Reservoir flooding. The reservoir has depths with a banding of >2m and flood velocity 0.5-2m/s. The proximity of the closest reservoir to the site is approximately 8.7 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to the site.

Flood Source: Infrastructure Failure – Canals

Flood risk: canal The Published EA canal mapping indicates that to the south of the site, there is a canalised watercourse, along the Rochdale Canal.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.94	8.38	87.54
Surface water flooding depths	Max: 0.16m Average: 0.15m	Max: 0.48m Average: 0.32m	Max: 1.5m Average: 0.73m
Surface water hazards	Max: Low Average: Low	Max: Moderate Average: Moderate	Max: Extreme Average: Significant
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	There is a localised surface water flood risk to this developed area for events up to the 1% AEP (Medium Risk) 3.33% AEP (High Risk) event with depths ranging from 0.15m - 0.48m. Based on surface water risk approximately 10% of the site cannot be developed. These areas extend under the 0.1% AEP event (Low Risk), with almost 90% of the surface water risk. Depths of flooding are on average 0.15m for the High Risk events, with localised areas of deeper flooding in the lower probability events (0.1% AEP). Mapping indicates the potential surface water flows entering the site with topography dictating potential flow routes across the site generally in an eastern direction. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. There is medium and high flood risk to surrounding roads, specifically A646/Halifax Road, and alternative access appears to be unavailable.		
Surface water: mitigation options & site suitability	Surface water flooding appears localised for the medium and high risk events, however it is widespread for the low risk event so could impact the redevelopment potential. However, localised development areas will need to consider surface water based on location. The site is subject to surface water flooding and site specific detailed surface water assessments and drainage strategies will be required as part of any FRAs. The FRAs will		

0915 Callis Mill, Halifax Road, Hebden Bridge

need to mitigate climate change impacts across the lifetime of the redevelopment.

- Areas at risk from surface water flooding, certainly areas at high or medium risk, should ideally be kept free from redevelopment or alternatively flows should be redirected using appropriate SuDS, although this potential is limited owing to the significant fluvial flood risk to the site.
- The FRAs should assess the potential for offsite surface water impacts on proposed redevelopments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes.
- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.
- Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. There is medium and high flood risk to surrounding roads, specifically A646/Halifax Road, and alternative access appears to be unavailable.
- Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.	3.33% AEP: 6.67l/s 1% AEP: 7.93l/s QBAR 3.81l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s
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Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30 %	8	226	70	155	17.0	Revised attenuation volume 190 m ³ (assuming outflow volume of 35 m ³)
1% AEP Rainfall+30 %	9.25	284	85	200 (45m ³ of exceedance storage)	22.2	Revised attenuation volume 243 m ³ (assuming outflow volume of 43 m ³) (53m³ of exceedance storage)

Climate change Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.

Surface water: flood risk impacts from development site & mitigation 80% development represents a significant increase in development of this site.
In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment.
It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above.
To illustrate the potential attenuation and storage for potential sites, the table above

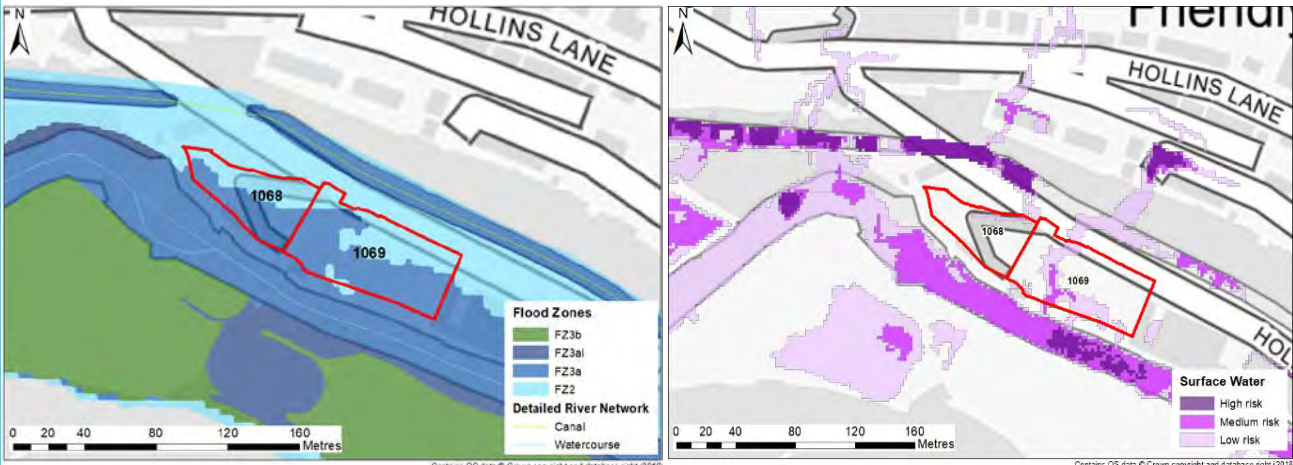
0915 Callis Mill, Halifax Road, Hebden Bridge

identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual redevelopment site areas at detailed design.

Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. The attenuation will be located in its entirety within Flood Zone 3.

An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.

B.7 1068 Land at, Hollins Mill Lane, Sowerby Lane

1068 Land at, Hollins Mill Lane, Sowerby Lane	
Site area	0.20 Ha
Existing use	Brownfield
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.16 Ha
Flood outlines (current day)  Contains OS data © Crown copyright and database right (2018) Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right. © Crown copyright, All rights reserved. 2018 Licence number 100023069	
Observations and Recommendations - The site is a brownfield site and is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG. - The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified. - The site is located within the River Calder to the south and the Rochdale Canal to the north, as can be seen from the figure above, and generally slopes from the north west to south east with ground levels dropping from around 90.7m AOD to 77.7m AOD. - An 8m buffer is also required along the southern boundary (adjacent to the River Calder) where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse and associated defences for maintenance purposes. - There is also a weir close to the site in the River Calder, the structural condition of the weir is unknown and will need to be fully appraised as part of the FRA. - Based on level of flood risk, CMBC should reconsider the suitability of this site for redevelopment owing to current flood risk. With average depths of 1.3m under the 1% AEP (Flood Zone 3) and maximum depths of 2.2m, and average depths of 2.5m and maximum depths of 4.5 under the 0.1% AEP event (Flood Zone 2) and future implications of climate change, as over 50% of the site is located within Flood Zone 3, CMBC will have to provide strategic justification for inclusion of this site. 100% of the site is within the Halifax CDA, drafted through the Level 1 SFRA. - Approximately 47% of the site is located in Flood Zone 2 and 53% is located within Flood Zone 3. The Council should locate all residential redevelopment outside of the identified fluvial flood risk areas, otherwise a more detailed FRA will be required, and this will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. Within Flood Zone 2, flood depths are extreme and therefore the possibility for first floor residential development cannot be built within 47% of the site. Within Flood Zone 3, residential properties could be developed for first floor use, however this can cause restriction to emergency egress.	

1068 Land at, Hollins Mill Lane, Sowerby Lane

- Residential properties on the southern border of the site could potentially have difficulties in gaining flood insurance based on fluvial flood information provided.
- Climate change outlines indicate that Flood Zone 3 extents will increase by approximately 10% to the north of the site. Therefore almost 65% of the site will be inundated by Flood Zone 3 under climate change conditions. A full assessment of climate change impacts will be required within site specific FRA. Hazard mapping has been provided to indicate depths and hazard rating. The average depth of flooding is 2.5m with extreme hazards for Flood Zone 2 and low for Flood Zone 3, with an average depth of 1.3m.
- Surface water flooding appears localised and so should not impact significantly on the redevelopment potential across the majority of the site, although a drainage water flood issue has been reported due to gully drainage in an area of Haugh End Lane. However localised redevelopment areas will need to consider surface water based on location as the depth to the southern extent of the site is likely to be significant.
- Future redevelopment will need to take safe access and egress into consideration (including emergency routes). There is extensive fluvial flood risk in this area, with all exit routes surrounding the site inundated under the 0.1% AEP event. Emergency egress may therefore restrict potential first floor residential development and therefore owing to flood depths and hazards the recommendation for this site is to remove allocation.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

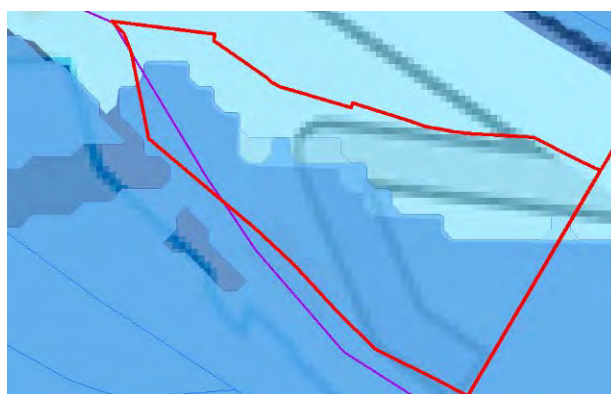
Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	46.62	53.36	Not defined (as currently developed)
Flood Zone depth (m)	Max: 4.5 Mean: 2.5	Max: 2.2 Mean: 1.3	N/A
Flood Zone hazard	Max: Extreme Mean: Extreme	Max: Low Mean: Low	N/A

Climate change

With almost 100% of this site currently located in Flood Zone 2 and 3, climate change is likely to have an impact on the level of risk to the site, most significantly in the centre.

Climate change impacts have been assessed by updating the existing model for the 1% AEP event, increasing the flow by 50% to represent the upper end climate change flows for the Humber basin. Based on the defended model the increase in depths on average are 0.3m and maximum 0.5m. The increase in depths for the undefended model on average is 0.35m and maximum 0.53m. Any bridge blockage will also increase flood risk and the implications of this will need to be considered as part of a site specific FRA.



Indicative Flood Extents for 1% AEP Defended and Undefended Climate Change Scenarios

1068 Land at, Hollins Mill Lane, Sowerby Lane

	Based on the 2015 Calder and Canals Sowerby model Contains OS data © Crown copyright and database right (2018) Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right The site is approximately 100% within Flood Zones 2 and 3. Available modelling indicates that under climate change the extents of Flood Zone 3a will increase slightly by approximately 10%.
Historic flooding	The site is contained within the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.
Defended	Environment Agency records indicate the site, is undefended from the River Calder, which flows adjacent to the southern border of the site, with high ground either side, which runs through the west of the site. There is however, high ground with 'some factory walls forming the channel side' across the southern boundary of the site. The section fronting the site is reported to be at Condition Grade 3, which is considered 'Fair' according to the EA's Condition Assessment Manual (CAM). There are however, no areas surrounding the site which are reported to be an Area Benefiting from Defences, according to EA data. Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	100% of the site is within River Calder and River Ryburn at Sowerby Bridge Flood Warning Area
Mitigation options & site suitability	• Ideally 'More Vulnerable' development should be directed to the areas outside of higher risk Flood Zones. The depths of flooding under the 1% AEP event are significant (1.3m) and the 0.1% AEP (2.5m). • Within Flood Zone 3, residential properties could be developed for first floor use, however this can cause restriction to emergency egress. There is extensive fluvial flood risk in this area and problems with access could also arise if any bridge blockage north west of the site on Hollins Mill Lane were to occur. • A new high-density development is likely to impede flood flows which could be a significant issue requiring compensatory storage. • Due to the level of risk and depth of flooding across this site (Flood Zone 2 and 3) a more detailed FRA will be required as part of the development strategy to reflect site specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and is within Flood Zone 3, the FRA will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. • More detailed assessment and provision for climate change should be made in the site specific FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • An 8m buffer is also required along the southern boundary (adjacent to the River Calder) where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse for maintenance purposes • Access (including emergency access) across the site will need to take account of future flood levels. All exit routes surrounding the site are inundated under the 0.1% AEP event.

1068 Land at, Hollins Mill Lane, Sowerby Lane

- Emergency egress may therefore restrict potential first floor residential development and therefore owing to access restrictions, flood depths and hazards the recommendation for this site is to remove allocation. The Council agree with this recommendation and have removed the site allocation.

Flood Source: Groundwater

Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 50\%$ $< 75\%$. LiDAR indicates a fall across the site from north east to south west, which indicates that ponding if encountered is likely to be minimal and localised as the water will tend to flow across the site following topography and into the River Calder.
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Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates approximately 90% of the site is indicated to be at risk from Reservoir flooding. The RFM shows that this area has depths with a banding of $> 2\text{m}$ and flood velocity of mainly $0.5\text{m}-2\text{m/s}$. The proximity of the closest reservoir to the site is approximately 6 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to this site.
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Flood Source: Infrastructure Failure – Canals

Flood risk: canal	The Published EA canal mapping indicates that to the north of the site, there is a canalised watercourse, the Rochdale Canal, although not raised so direct inundation is not possible by breach failure.
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Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.00	0.00	4.69
Surface water flooding depths	Not applicable	Not applicable	Max: 0.13m Average: 0.1m
Surface water hazards	Not applicable	Not applicable	Max: Low Average: Low

Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.
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Surface water: flood risk to development site	There is a minimal surface water flood risk to the north east of the site. Overall, less than 5% of the site is at some level of risk from surface water flooding, which is only for the 0.1% AEP (Low Risk) event. Maximum flood depths are low (0.13m) and average depths for this 0.1% AEP event. The subsequent maximum hazard is also low. The flood mapping indicates a slight potential for surface water flooding entering the site from adjacent areas, from the Rochdale Canal located north of the site, with a surface water flow route crossing Halifax Road entering the north east of the site. However, drainage routes from the site should be assessed as part of the FRA. Emergency access and egress will need to be taken into consideration as mapping indicates flood risk to the west of Hollins Mill Lane, with some areas of Low risk, and others localised areas show medium - high risk. The offsite impacts on access and egress appear manageable, with alternate routes available eastwards down Hollins Mill Lane.
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Surface water: mitigation options & site suitability	Surface water flood risk appears localised and so should not impact significantly on the redevelopment potential across the majority of the site. However, localised redevelopment areas will need to consider surface water based on location. A localised area of the site is subject to a low
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1068 Land at, Hollins Mill Lane, Sowerby Lane

flood hazard, under the 0.1% AEP event. As parts of the site are subject to a flood hazard a site specific detailed surface water assessments and drainage strategy will be required as part of any FRAs for redevelopment in this area. The FRA will need to mitigate climate change impacts across the lifetime of the redevelopment.

- Existing areas subject to surface water flooding should ideally be kept free from redevelopment or alternatively, flows should be redirected using appropriate SuDS.
- The FRA should assess the potential for offsite surface water impacts on the proposed redevelopments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes.
- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.
- The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the Designation Area (including emergency routes).
- Safe emergency access and egress routes due to surface water flood risk have been considered. Mapping indicates flood risk to the west of Hollins Mill Lane, with localised areas of low risk, and others localised areas to the east show medium - high risk. The offsite impacts on access and egress appear manageable, with alternate routes available eastwards down Hollins Mill Lane. However, fluvial flood risk is significant and the primary flood risk to this site, therefore the recommendation is to remove allocation based on fluvial flood risk.
- Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield* - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates	3.33% AEP: 0.96l/s 1% AEP: 1.15l/s QBAR 0.55l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s
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Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	2.5	9.8	88	25	66	Revised attenuation volume 69m ³ (assuming outflow volume of 44m ³)
1% AEP Rainfall+30%	3.25	123	30	95 (70m ³ of exceedance storage)	10.4	Revised attenuation volume 110m ³ (assuming outflow volume of 15 m ³) (46m ³ of exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					

1068 Land at, Hollins Mill Lane, Sowerby Lane

**Surface water:
flood risk
impacts from
development site
& mitigation**

80% development represents a significant increase in development of this site.

In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment.

It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above.

To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual redevelopment site areas at detailed design.

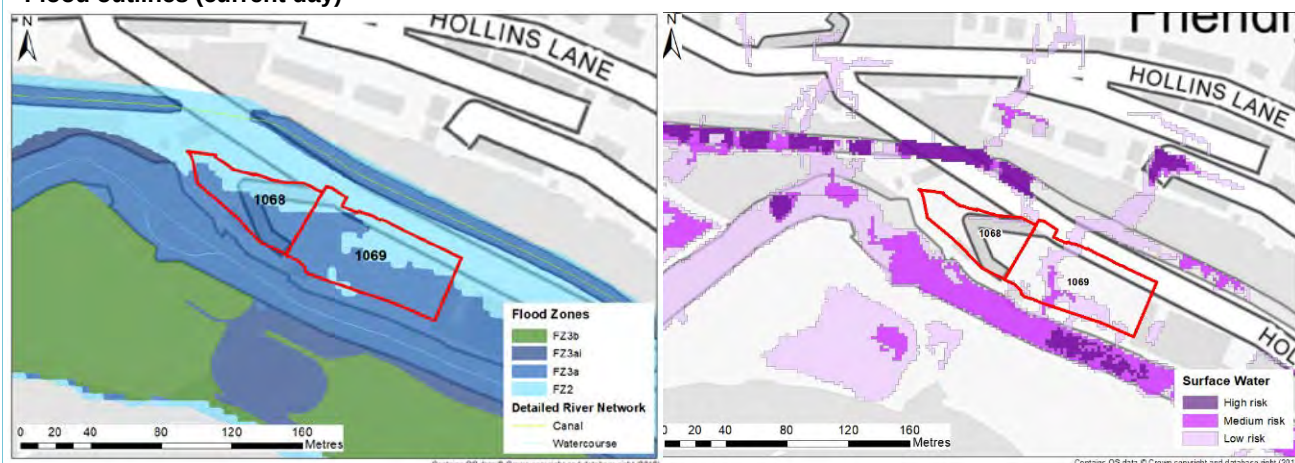
Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.

An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.

B.8 1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge

1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge	
Site area	0.38 Ha
Existing use	Brownfield
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.3 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a brownfield site and is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The site is located in between the River Calder to the south and the Rochdale Canal to the north, as can be seen from the figure above, and generally slopes from the north east to south west with ground levels dropping from around 87.5m AOD to 75 m AOD as the land slopes down to the River Calder. In the centre of the site, ground levels are approximately 85.8m AOD.
- There is also a weir close to the site in the River Calder, the structural condition of the weir is unknown and will need to be fully appraised as part of the FRA.
- 100% of the site is within the Halifax CDA, drafted through the Level 1 SFRA.
- An 8m buffer is also required along the southern boundary (adjacent to the River Calder) where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse and associated defences for maintenance purposes.
- By introducing More Vulnerable residential development into a high risk fluvial flood area (61.61% in Flood Zone 3) with moderate average depths of approximately 1.6m of flooding for the 1% AEP event, and extreme average depths of 2.9m under the 0.1% AEP event (38.38% in Flood Zone 2), increases the flood risk and vulnerability to the site.
- The Council should locate all residential redevelopment outside of the identified fluvial flood risk areas, otherwise a more detailed FRA will be required, and this will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. Within Flood Zone 3, residential properties could be developed for first floor use, however this can cause restriction to emergency egress. On this basis, CMBC should reconsider the suitability of this site for redevelopment owing to current flood risk. The recommendation for this site is to remove allocation.
- Residential properties on the southern border of the site could potentially have difficulties in gaining

1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge

flood insurance based on fluvial flood information provided which supports our recommendation for removal.

- Climate change outlines indicate that Flood Zone 3 extents will increase by approximately 15% to the north east of the site. Therefore almost 75% of the site will be inundated by Flood Zone 3 under climate change conditions. A full assessment of climate change impacts will be required within site specific FRAs.
- Surface water flooding appears localised to a surface water flow route through the western area of the site and the central southern area. However, these outlines are within Flood Zone 3 extents and so should not impact significantly on the redevelopment potential or additional mitigation, although a drainage water flood issue has been reported due to gully drainage in an area of Haugh End Lane. Localised redevelopment areas will need to consider surface water based on location.
- Any surface water attenuation strategies for the site will need to be designed so that it is not overwhelmed and effectively made redundant by natural surface water flooding.
- Redevelopment may also risk diversion of natural flow routes around the site placing other properties at risk. Redevelopment should not prevent the natural flow of surface water and any mitigation or SuDS facilities should be located outside of the surface water flow route. This may limit the available land for development at this site.
- Future redevelopment will need to take safe access and egress into consideration (including emergency routes). There is extensive fluvial flood risk in this area, with all exit routes surrounding the site inundated under the 0.1% AEP event. Although there are excess routes owing to surface water flood risk, fluvial flooding is the primary risk and safe access routes are unavailable under the 0.1% AEP event. Residential development will not be suitable for this site and therefore the allocation should be removed.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	38.38	61.61	Not defined (as currently developed)
Flood Zone depth	Max: 4.3 Mean: 2.9	Max: 2.2 Mean: 1.6	N/A
Flood Zone hazard	Max: Extreme Mean: Extreme	Max: Moderate Mean: Moderate	N/A

Climate change

Climate change impacts have been assessed by updating the existing model for the 1% AEP event, increasing the flow by 50% to represent the upper end climate change flows for the Humber basin. Based on the defended model the increase in depths on average are 0.4m and maximum 0.55m. The increase in depths for the undefended model on average is 0.35m and maximum 0.45m. Any bridge blockage will also increase flood risk and the implications of this will need to be considered as part of a site specific FRA.



Indicative Flood Extents for 1% AEP Defended and Undefended Climate Change Scenarios

Based on the 2015 Calder and Canals Sowerby model
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	Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right 100% of this Designation Area is currently located in Flood Zone 2 and 3. Available modelling indicates under climate change the extents of Flood Zone 3 will slightly increase by approximately 15%. These will extend to the north east of the site.
Historic flooding	The site is contained within the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.
Defended	Environment Agency records indicate the site, is undefended from the River Calder, which flows adjacent to the southern border of the site, with high ground either side. There is however, high ground with 'some factory walls forming the channel side' along the southern boundary of the site. The section fronting the site is reported to be at Condition Grade 3, which is considered 'Fair' according to the EA's Condition Assessment Manual (CAM). There are however, no areas surrounding the site which are reported to be an Area Benefiting from Defences, according to EA data. Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	100% of the site is within River Calder and River Ryburn at Sowerby Bridge Flood Warning Area
Mitigation options & site suitability	• Ideally 'More Vulnerable' development should be directed to the areas outside of higher risk Flood Zones. However, the level of flood risk makes this site at an unacceptable level of risk, with significant depths of flooding under the 1% AEP event (1.6m) and the 0.1% AEP (2.9m). • Within Flood Zone 3, residential properties could be developed for first floor use, however this can cause restriction to emergency egress. There is extensive fluvial flood risk in this area and problems with access could also arise if any bridge blockage north west of the site on Hollins Mill Lane were to occur. • A new high-density development is likely to impede flood flows which could be a significant issue requiring compensatory storage. • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 2 and 3) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3, the FRA will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • An 8m buffer is also required along the southern boundary (adjacent to the River Calder) where redevelopment is prohibited. This is an Environment Agency requirement to allow access to the watercourse for maintenance purposes • Access (including emergency access) across the site will need to take account of future flood levels. All exit routes surrounding the site are

1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge

inundated under the 0.1% AEP event.

- Emergency egress may therefore restrict potential first floor residential development and therefore owing to access restrictions, flood depths and hazards the recommendation for this site is to remove allocation. The Council agree with this recommendation and have removed the site from allocation.

Flood Source: Groundwater

Flood risk: ground water

100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 50\%$ $< 75\%$. Comparison with LiDAR data indicates a fall across the site from north east to south west, which indicates that ponding if encountered is likely to be minimal and localised as the water will tend to flow across the site following topography and into the River Calder. It is identified that if it occurs, ponding will potentially correspond with the lower areas to the south and the west identified as being at higher risk of fluvial and surface water flooding.

Flood Source: Infrastructure Failure – Reservoirs

Flood risk: Reservoir

The Reservoir Flood Map (RFM) indicates approximately 95% of the site is indicated to be at risk from Reservoir flooding. The RFM shows that this area has depths with a banding of $> 2\text{m}$ and flood velocity of $> 2\text{m/s}$. The proximity of the closest reservoir to the site is approximately 6.2 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to this site.

Flood Source: Infrastructure Failure – Canals

Flood risk: canal

The Published EA canal mapping indicates that to the north of the site, there is a canalised watercourse, the Rochdale Canal, although not raised so direct inundation is not possible by breach failure.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.00	4.12	20.80
Surface water flooding depths (m)	N/A	Max: 0.24m Average: 0.12m	Max: 0.62m Average: 0.15m
Surface water hazards	N/A	Max: Low Average: Low	Max: Significant Average: Low

Climate change

The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.

**Surface water: flood risk
to development site**

Surface water follows a natural flow route through the western area of the site and the central southern area of the site. Overall, approximately 25% of the site is at some level of risk from surface water flooding.

Average flood depths are 0.24m for the 1% AEP Medium Risk event, and 0.15m for the 0.1% AEP Low Risk event. The subsequent average hazard is Low for the 1% AEP event with localised areas indicating a Significant hazard.

Surface water flood extents appear to be influenced by the topography which indicates a fall in ground levels generally from north east to south west.

The flood mapping indicates potential for surface water flooding entering the site from adjacent areas, mostly from the Rochdale Canal located north of the site.

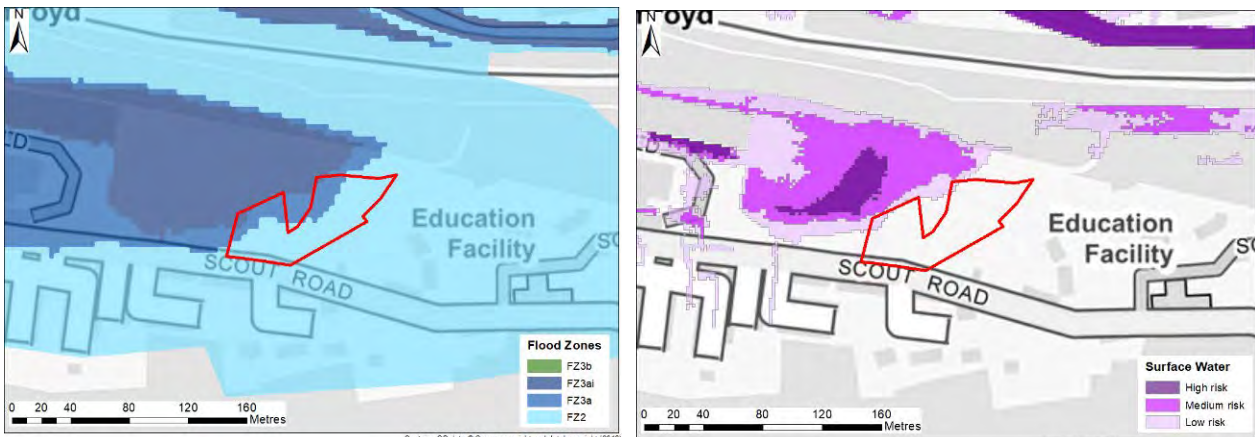
There is a surface water flow route through the western area of the site and the central southern area. Development may cause runoff to be diverted towards existing communities. Development should not prevent the natural flow of surface water and any mitigation or SuDS facilities should be located outside

1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge

of the surface water flow route. This may limit the available land for development at this site. However, these outlines are within Flood Zone 3 extents and so should not impact significantly on the redevelopment potential or additional mitigation. Localised redevelopment areas will need to consider surface water based on location. Emergency access and egress will need to be taken into consideration as mapping indicates flood risk to the west of Hollins Mill Lane, with some areas of Low risk, and others localised areas show medium - high risk. The offsite impacts on access and egress appear manageable, with alternate routes available eastwards down Hollins Mill Lane.						
Surface water: mitigation options & site suitability • Surface water flood risk appears localised to the main flow route and is likely to impact significantly on the redevelopment. However, localised redevelopment areas will need to consider surface water based on location. • The redevelopment is generally subject to a low risk of surface water flood hazards. A localised area of the site is subject to a medium flood hazard, under the 1% AEP event. A site specific detailed surface water assessments and drainage strategy will be required as part of any FRA for redevelopment in this area. The FRAs will need to mitigate climate change impacts across the lifetime of the development. • Areas at risk from surface water flooding, certainly areas at medium risk, should ideally be kept free from redevelopment or alternatively flows should be redirected using appropriate SuDS if practical. • The FRAs should assess the potential for offsite surface water impacts on proposed redevelopments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • Surface water flooding of the surrounding highways will need to be taken into account in consideration for emergency access and egress. Mapping indicates flood risk to the west of Hollins Mill Lane, with some areas of low risk, and other localised areas showing medium - high risk. The offsite impacts on access and egress appear manageable, with alternate routes available eastwards down Hollins Mill Lane. However, based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council have decided to remove the site from allocation.						
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.						
3.33% AEP: 1.83l/s 1% AEP: 2.17l/s QBAR: 1.05l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s						
Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	6	208	54	155	17.1	Revised attenuation volume 182m ³ (assuming outflow volume of 27m ³)

1069 Hollins Mill, Hollins Mill Lane, Sowerby Bridge						
1% AEP Rainfall+30%	7.75	285	70	215 (60m³ of exceedance storage)	23.8	Revised attenuation volume 250m ³ (assuming outflow volume of 35m ³) (68m³ of exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development site & mitigation	80% development represents a significant increase in development of this site. In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment. It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account CMBCs requirements described above. To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual redevelopment site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.					

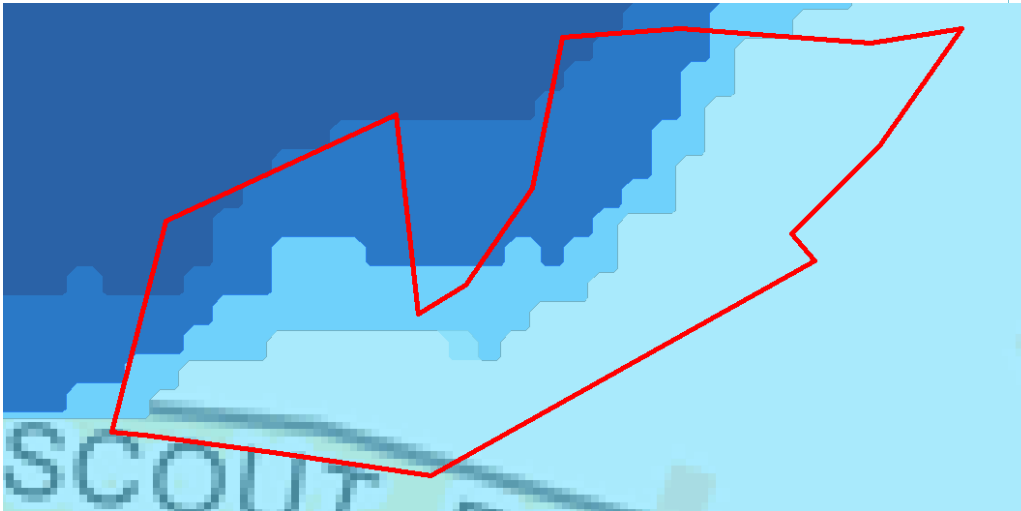
B.9 1556 Land at Rowan House, Scout Road, Mytholmroyd

1556 Land at Rowan House, Scout Road, Mytholmroyd	
Site area	0.37 Ha
Existing use	Greenfield with small brownfield area (<3%)
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.3 Ha
Flood outlines (current day)	
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Observations and Recommendations	
- The allocation site is identified as residential by CMBC and therefore classed as 'More Vulnerable', as per Table 2 of the FRCC-PPG. - The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development opportunities have been identified by the Council at this stage. - This site is within the Mytholmroyd FAS Scheme, and closer to the Capital Programme FRM schemes; Elphaborough Close Mytholmroyd and Scout Road/Stake Lane Mytholmroyd. - The site generally slopes from the south east to the north west with ground levels dropping from around 102 m AOD to 93 m AOD as the land slopes down to a football pitch on the north west of the site. - Approximately 70% of the site is located in Flood Zone 2, and 25% within Flood Zone 3 along the north western boundary of the site. - As a green field site, no residential development should be permitted with Flood Zone 3. Flood Zone 2 may be considered provided that flood risk can be fully managed for the lifetime of the development. Any development within the flood zone will need to include flood mitigation to compensate for any loss of flood plain or flood storage. - A detailed site specific FRA will be required which will have to show that the second part of the Exception Test has been satisfied in order for development to proceed, due to the fluvial flood risk at the site, as agreed by the EA. The Flood Zone 3 areas should be left open as open space for storage of flood water. - Detailed modelling indicates under climate change scenarios the extents of Flood Zone 3 will increase to approximately 50% of the site and will extend south eastwards and inundate the west of the site. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is limited, with the only exit route being Scout Road, which is however inundated under the 0.1% AEP event, and could impact on the development potential of the site. On this basis we recommend that the suitability of the site for development is reconsidered at this stage.	

1556 Land at Rowan House, Scout Road, Mytholmroyd

- Surface water flood risk appears minimal, with only 3% of overall risk for the 0.1% AEP (Low event), and so should not impact significantly on the development potential across the majority of the site. Although drainage water flood issues have been reported due to gully blockage in an area of Oxford Terrace and Hill View.
- After consultation with the EA, LLFA and LPA, the Council agree with JBA's recommendation and have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2)

Flood Source: Fluvial

Flood Zones (%)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	72.71	27.3	Not defined (as previously developed)
Flood Zone depth (m)	Max: 5.3 Mean: 2.2	Max: 3.24 Mean: 1.3	N/A
Flood Zone max hazard	Max: Extreme Mean: Extreme	Max: Extreme Mean: Significant	N/A
Climate change	Climate change impacts have been assessed by updating the existing model for the 1% AEP event, increasing the flow by 50% to represent the upper end climate change flows for the Humber basin. Based on the defended detailed model the increase in depths on average are 0.46m and maximum 1.2m. The increase in depths for the undefended model on average is 0.48m and maximum 1.26m.  Indicative Flood Extents for 1% AEP Climate Change Scenarios Based On 2015 Calder and Canals, Hebden model Contains OS data © Crown copyright and database right (2018) Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right. The site is currently 100% within Flood Zones 2 and 3. Available modelling indicates that under climate change scenarios the extents of Flood Zone 3 will increase to approximately 50% and will extend south eastwards and inundate the west of the site.		
Historic flooding	The site is contained within the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.		
Defended	The Environment Agency does not own or maintain any flood defence assets along the site and is therefore, not identified to be protected on the Environment Agency Flood Map for Planning. Environment Agency records indicate that to the north of the site, the River Calder is protected from fluvial flooding by a front line ridge of high ground. The section fronting the site is reported to be at Condition Grade 2, which is considered 'Good'		

1556 Land at Rowan House, Scout Road, Mytholmroyd

	according to the EA's Condition Assessment Manual (CAM). Flood risk to this site is dependent on the flood risk posed by the River Calder and future climate change.
Flood Warning Area	100% of the site is within River Calder and Cragg Brook and Mytholmroyd Flood Warning Area
Mitigation options & site suitability	• Due to the level of risk and significant (1% AEP event) / extreme (0.1% AEP event) depths of flooding across parts of this site (Flood Zone 2 and 3) residential development is considered unsuitable within Flood Zone 3. • Flood Zone 2 may be considered provided that flood risk can be fully managed for the lifetime of the development. However, ideally, 'More Vulnerable' development should be directed to the areas outside of higher risk flood zones and therefore CMBC should reconsider the suitability of this site for development owing to extreme flood depths and hazards across the site. • The site is at mostly extreme fluvial flood risk with depths under the 1% AEP event on average 1.3m (significant) and a maximum of 3.34m, and under the 0.1% event on average depths of 2.2m and maximum depths of 5.3m. These depths preclude More Vulnerable, residential development as there is increased flood risk and vulnerability to the site and there will be an implication on conveyance within the flood zones. • Any development at this site would need to include consideration of compensatory storage to prevent increase in flood risk elsewhere. Properties would also have difficulties in gaining flood insurance based on fluvial flood information provided. • A more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is 'More Vulnerable' and within Flood Zone 3, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • The small area of surface water risk that there is to the site, is within the fluvial flood extents and therefore should not require additional mitigation. • Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is unavailable surrounding the site, with the only exit route being Scout Road, which is inundated under the 0.1% AEP event which may impact on the development potential of the site. • Based on the most up to date information available, and after consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site.
Flood Source: Groundwater	
Flood risk: ground water	100% of the site indicated as having a susceptibility to groundwater emergence of <25%. In comparison with fluvial flood risk, groundwater is a lesser, potentially more frequent flood risk which supports the recommendation to reconsider the suitability of the site for development. LIDAR mapping indicates a fall in level across the area in a north-westerly direction, indicating that ponding, if encountered, is likely to be minimal as water will tend to flow across the site following topography.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: Reservoir	The Reservoir Flood Map (RFM) indicates approximately 95% of the site is indicated to be at risk from Reservoir flooding. The RFM shows that this area has depths with a banding of >2m and flood velocity of 0.5-2m/s. The proximity of the closest reservoir to the site is approximately 6.2 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to this site.

1556 Land at Rowan House, Scout Road, Mytholmroyd

Flood Source: Infrastructure Failure – Canals

Flood risk: canal No canalised watercourses in area. No flood risk identified.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)

Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.00	0.00	3.02
Surface water flooding depths	N/A	N/A	Max: 0.83m Average: 0.39m
Surface water hazards	N/A	N/A	Max: Significant Average: Moderate
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	Overall, there is minimal surface water flood risk to the site. There is only surface water flood risk the for 0.1% AEP (Low Risk) event. In the 0.1% AEP event flood depths are still relatively localised and on average 0.39m deep, with a moderate hazard rating on average. Mapping does not indicate significant surface water flows entering the site from the adjacent areas. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress.		
Surface water: mitigation options & site suitability	- Areas to the north west of the site are subject to very localised surface water flood risk with some small but significant areas of hazardous flooding (0.1% Low risk event). A site / development specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts across the lifetime of the development. - Areas at risk from surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using appropriate SuDS. - Whilst they appear to be minimal, the FRA should assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes. - The FRA will need to consider the impacts of surface water flood risk on access and egress routes, although potential routes appear available. - Surface water flooding of the surrounding highways will need to be taken into consideration for emergency access and egress. Mapping indicates minimal localised highway flooding below the 0.1% AEP event. In this event, there appears to be alternative access routes and therefore off-site impacts on access and egress appear manageable, however based on the significant fluvial risk to the site, we recommend CMBC to reconsider suitability of this site for development. The council agree with this recommendation and have removed the site allocation.		

Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)

Proposed development limiting runoff rate: Greenfield - IH124 Methodology (l/s)	3.33% AEP: 4.86l/s 1% AEP: 5.54l/s QBAR: 2.34l/s CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and
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1556 Land at Rowan House, Scout Road, Mytholmroyd

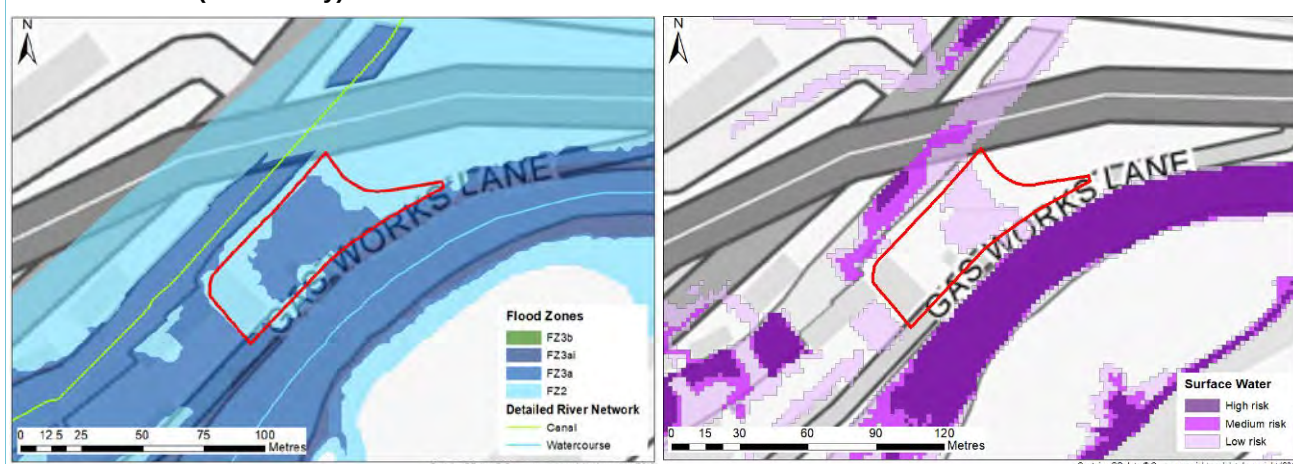
				including the 1 % AEP + 30% CC = 5l/s		
Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1 % AEP (m ³)
3.33% AEP Rainfall+30 %	7	215	60	15	16.9	Revised attenuation volume 45m ³ (assuming outflow volume of 30 m ³)
1% AEP Rainfall+30 %	9	300	80	220 (205 m ³ of exceedance storage)	24.1	Revised attenuation volume 260m ³ (assuming outflow volume of 40m ³) (215m ³ of exceedance storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development site & mitigation	To illustrate the potential attenuation and storage for site, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. This figure will need to be proportioned to actual development site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from a conventional piped surface water drainage system including a combination of oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage.					

B.10 1628 Riverside House, Gas Works Lane, Elland

1628 Riverside House, Gas Works Lane, Elland

Site area	0.26 Ha
Existing use	Brownfield
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	80% of total area (Agreed by CMBC) 0.21 Ha

Flood outlines (current day)



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Observations and Recommendations

- The site is a brownfield site that is identified as residential by CMBC and therefore classified as 'More Vulnerable', as per Table 2 of the FRCC-PPG
- The Council will provide the strategic justification for inclusion of this site within its development allocations for the Local Plan. No specific development proposals have currently been identified.
- The eastern boundary of the site is located along the River Calder watercourse, and the western boundary is located along the Calder and Hebble Navigation canal.
- The site generally slopes to the centre of the eastern border from the north east and south west site boundaries with ground levels dropping from around 64m AOD in the north, east and west corner and 62m AOD in the southern corner, to 60.4m AOD in the central eastern area of the site as the land slopes down to the River Calder.
- There is a sluice (asset ID: Ca-006-003) located on the Hebble Navigation, the structural condition of this asset is unknown and therefore will need to be assessed as part of an FRA.
- 100% of the site is within the Elland and Brighouse CDA, drafted through the Level 1 SFRA. The site is also half a mile away from the Capital Programme FRM scheme of Canker Dyke Century Road Elland.
- 49.62% of the developable site is located in Flood Zone 2, and 50.39% located within Flood Zone 3a, Therefore, 49.52% of the site is considered potentially suitable for redevelopment.
- The Council should locate all residential redevelopment outside of the identified fluvial flood risk areas, otherwise a more detailed FRA will be required, and this will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. The Flood Zone 3 areas should be left as open space for storage of flood water.
- An 8m buffer is also required along the eastern boundary (adjacent to the River Calder) and the western boundary (Calder and Hebble Navigation canal) where development is prohibited. This is an Environment Agency requirement to allow access to the watercourse for maintenance purposes. This may limit the developable area potential of the site.
- There is no detailed model for this site. Flood mapping in this instance is based on EA strategic

1628 Riverside House, Gas Works Lane, Elland

mapping and no climate change outlines are available (other than Flood Zone 2 approximation). A 1D model was provided for this area however this does not provide flood depths. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific FRAs. Under Climate Change conditions the site will be particularly susceptible to climate induced inundation, with Flood Zone 3 extents likely to increase the fluvial flood risk to the site. On this basis the suitability of this site for redevelopment should be reconsidered at this stage. It is recommended that detailed modelling will be required as part of any FRA to confirm flood extents and depths.

- The average estimated depth of flooding during the 1% AEP event is 0.3m. The depth of flooding limits residential development unless redevelopment is raised above design levels and emergency access can be achieved. However, access is restricted on Gas Works Lane and therefore development is unsuitable owing to current flood depths and access within Flood Zone 3. Residential properties may also potentially have difficulties in gaining flood insurance based on fluvial flood information provided.
- Surface water flooding appears mainly localised to the centre of the site, within Flood Zone 3 extents and so should not impact significantly on the redevelopment potential. However localised redevelopment areas will need to consider surface water based on location.
- Access to and from the site during a fluvial flood event appears highly problematic, as the majority of Gas Works Lane is within Flood Zone 3 extents under present day and climate change scenarios.
- The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates small areas of low surface water risk to Gas Works Lane, however medium - high risk on the bend of A629/Calderdale Way to the east of the site.
- Due to the potential fluvial and surface water flooding at the site, detailed modelling is required as part of an FRA to confirm flood extents and depths as 100% of the site exists within Flood Zone 2 and 3.
- Therefore, recommendation for this site is for CMBC to reconsider suitability of this site for development owing to estimated Flood Zone 3 depths, climate change Flood Zone 2 proxy outlines which inundate the site and potential bridge blockage which could increase the flood risk and access issues.
- After consultation with the EA, LLFA and LPA, the Council have decided to remove allocation of this site, which will therefore not be taken forward in the Local Plan, as stated in the site summary table (Section 2).

Flood Source: Fluvial

Flood Zones (%) (of developable area)	Flood Zone 2	Flood Zone 3	Flood Zone 3b
	49.62	50.39	No detailed model available. To be confirmed through an FRA
Flood Zone depth based on estimated lidar levels and published flood zones (m)	Unavailable based on strategic model	Max: 0.6 Average: 0.3	N/A
Flood Zone hazard	Unavailable based on strategic model	Unavailable based on strategic model	N/A
Climate change	There is no climate change model for this area. In the absence of any detailed modelling then Flood Zone 2 will be used as a proxy for the extent of Flood Zone 3 in 100 years' time to assess climate change impacts. Although this is a pragmatic approach to predicting climate change, the approach is consistent with other SFRA's and reflects professional modelling experience. It is often the case that Flood Zone 3 plus allowance for climate change can be similar to the Flood Zone 2 outline. With 100% of this site currently located in Flood Zone 2 and 3, climate change is likely to have a significant impact on the level of risk to the site.		
Historic flooding	The site is contained within the Environment Agency Historic Flood Map (HFM) outline and from available data there are no records of other historic flood events.		
Defended	Environment Agency records indicate that the site is protected by natural high		

1628 Riverside House, Gas Works Lane, Elland

	ground, including a walled channel in parts, adjacent to the River Calder. Further downstream, Canker Dyke enters the River Calder at a confluence and appears to enter a culvert beneath the access road to the north. There are no areas surrounding the site which are reported to be an Area Benefiting from Defences, although upstream of the B6114, there are masonry and concrete flood wall assets on the left bank and factory walls protecting the right bank of the Calder. The condition of these assets is between 2 - 4, which is considered as ranging between 'Good' and 'Poor' in accordance with the EA's Condition Assessment Manual⁴ (CAM). Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	100% of site is within River Calder at Elland - Saddleworth Road to Lowfields Business Park Flood Warning Area
Mitigation options & site suitability	• Ideally, 'More Vulnerable' redevelopment should be directed to the areas outside of higher risk Flood Zones. Due to the level of risk and estimated depths across this site (Flood Zone 3 and 2), CMBC should reconsider the suitability of this site for redevelopment. • A more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3, the FRA will have to show that the second part of the Exception Test has been satisfied in order for redevelopment to proceed. The 50% area within Flood Zone 3 should be left as open space. • The average estimated depth of flooding during the 1% AEP event is 0.3m. This depth of flooding limits residential development unless redevelopment is raised above design levels and emergency access can be achieved. However, access is restricted on Gas Works Lane and therefore development is unsuitable owing to current flood depths and access within the Flood Zone 3 extents and as discussed should be left open for flood storage. Residential properties may also potentially have difficulties in gaining flood insurance based on fluvial flood information provided. • Climate change and bridge blockage will result in increased flood risk, with Flood Zone 2 outlines providing a climate change proxy. • A new high-density development is likely to impede flood flows which could be a significant issue requiring compensatory storage. It is recommended that more detailed modelling is undertaken to confirm flood depths and hazards to the site. • Based on level of flood risk, CMBC should reconsider the suitability of this site for redevelopment owing to current flood risk and future implications of climate change, as over 50% of the site is located within Flood Zone 3. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • Future flood levels may continue to impact access (including emergency access) across the site, with areas adjacent to Huddersfield Road

⁴ Environment Agency. (2012). Visual Inspection Condition Grades. In: EA Condition Assessment Manual. Bristol: Environment Agency. p9.

1628 Riverside House, Gas Works Lane, Elland

becoming inundated, bridge blockage could increase the flood risk and further restrict this road the only potential access route, which supports the CMBC's decision to remove the site from allocation.

Flood Source: Groundwater
Flood risk: ground water

100% of the site indicated as having a susceptibility to groundwater emergence of $\geq 50\%$ $< 75\%$. Based on a review of LiDAR, the risk of ponding, if it occurs, is likely to be minimal and localised as water will tend to flow towards the River Calder.

However, there is an area of high ground protecting the River Calder, parallel to the eastern boundary of the site. Ground water flooding may accumulate on the dry side of any raised flood defence, which if it occurs, could potentially increase the risk of groundwater pooling along the eastern boundary of the site.

Flood Source: Infrastructure Failure – Reservoirs
Flood risk: Reservoir

The Reservoir Flood Map (RFM) indicates that 100% of the site is at risk from Reservoir flooding. The RFM shows that this area has depths with a banding of $> 2\text{m}$ and flood velocity of $> 0.5\text{-}2\text{m/s}$. The proximity of the closest reservoir to the site is approximately 6.2 miles away, which would therefore suggest a lower level of confidence in the reservoir flood risk to this site.

Flood Source: Infrastructure Failure – Canals
Flood risk: canal

The Published EA canal mapping indicates that to the west of the site, there is a canalised watercourse, the Calder and Hebble Navigation.

Flood Source: Surface Water (Risk of Flooding from Surface Water (RoFSW) map)
Surface Water Flood Risk to Proposed Development Site

Existing development: risk of flooding from surface water (%) (of developable area)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
	0.00	0.00	43.96
Surface water flooding depths (m)	N/A	N/A	Max: 0.83m Average: 0.39m
Surface water hazards	N/A	N/A	Max: Significant Average: Low

Climate change

The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.

**Surface water: flood risk
to development site**

There is no surface water flood risk below the 0.1% AEP (Low Risk) event, however approximately 44% of the site has surface water flood risk under this event. As the area is predominantly developed it will be reliant on a drainage system to manage surface water flooding. Flood depths are low and are on average 0.39m during the 0.1% AEP event. Hazard ratings in areas indicated to flood are generally Low with localised areas identified as presenting a Significant flood hazard in the 0.1% AEP event.

Mapping does not indicate significant surface water flows entering the site from the adjacent areas. Areas of surface water flood risk are localised and likely to relate to local topography.

Surface water flooding of the surrounding highways will need to be taken into consideration for emergency access and egress.

1628 Riverside House, Gas Works Lane, Elland

Surface water: mitigation options & site suitability

- Surface water flood risk appears localised and within Flood Zone 3 extents so should not impact significantly on the redevelopment potential across the majority of the site, were flooding to occur. However, localised redevelopment areas will need to consider surface water based on location.
- The redevelopment area is generally subject to low - moderate surface water flood hazards within the surface water flood map extents, with a localised area of significant hazard located north of the site under the 0.1% AEP event. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to any existing drainage routes and ponding areas. The FRA will need to mitigate climate change impacts across the lifetime of the development.
- Areas at risk from surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using appropriate SuDS. SuDS potential is limited due to significant fluvial flood risk.
- The FRA should also assess the potential for offsite surface water impacts on the proposed redevelopment. This will need to include consideration of potential inflows from adjacent sites.
- The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.
- Surface water flooding of the surrounding highways will need to be taken into consideration for emergency access and egress. Mapping indicates minimal localised highway flooding below the 0.1% AEP event. The high and medium risk events, although localised, are located on the bend of A629/Calderdale Way to the east of the site. However there appears to be alternative access routes to the east of Calderdale Way therefore off-site impacts on access and egress appear manageable. Fluvial flood risk is the most significant flood risk at this site and as a result the recommendation for removal of this site has been made, and has been confirmed by CMBC, based on information available.

**Indicative Surface Water Flood Risk From Proposed Development
(for Designation Area in its Entirety)**

Proposed development limiting runoff rate: Greenfield* - IH124 Methodology *In accordance with CMBC requirements we are basing the brownfield runoff rate on greenfield runoff rates.				3.33% AEP: 1.15l/s 1% AEP: 1.36l/s QBAR: 0.65l/s *CMBC specify greenfield rate of 2l/s/Ha or a minimum discharge of 5l/s Greenfield runoff rate for this site for all events up to and including the 1% AEP + 30% CC = 5l/s		
Design flood event (including climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	CMBC requirement for 50% reduction in discharge to river for events up to and including the 1% AEP (m ³)
3.33% AEP Rainfall+30%	3.5	125	30	95	10.3	Revised attenuation volume 110 m ³ (assuming outflow volume of 15 m ³)
1% AEP Rainfall+30%	4.75	174	45	130 (35m ³ exceedance storage)	14.6	Revised attenuation volume 152.5 m ³ (assuming outflow volume of 22.5m ³) (42.5m³ of exceedance)

1628 Riverside House, Gas Works Lane, Elland

						storage)
Climate change	Application of the central (30%) potential change anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events.					
Surface water: flood risk impacts from development site & mitigation	80% development represents a significant increase in development of this site. In accordance with the requirements specified by CMBC where brownfield sites are to be developed, the surface water runoff rates have been calculated using greenfield runoff rates as the hydraulics or connectivity of this site have not been confirmed as part of this assessment. It is recognised that this site includes areas of existing development and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the CMBCs requirements described above. To illustrate the potential attenuation and storage for potential sites, the table above identifies the required storage volumes for the proposed impermeable areas of the site if limiting greenfield equivalent runoff rates are applied. CMBC agreed that 80% of each site area would be most representative. These will need to be proportioned to actual development site areas at detailed design. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. These were calculated in accordance with CMBC requirements shown in Appendix A. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. The attenuation will be located in its entirety within flood zone 3. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted to regulate surface water discharge to the river then the sewer network, subject to detailed design ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. SuDS and attenuation requirements should be considered at the master planning stage. However, it is necessary to consider that SuDS potential may be limited as fluvial flooding at this site is a significant/primary risk.					

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