

Lancaster City Council Local Site Screening

Level 2 Strategic Flood Risk Assessment – Site Screening

Final Report

September 2018

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Revision history

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September 2018	Final Report	Henry Cumbers

Contract

This report describes work commissioned by Henry Cumbers, on behalf of Lancaster City Council, by an email dated 15 December 2017. Josh Rutherford and Howard Keeble of JBA Consulting carried out this work.

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Purpose

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1 Introduction

1.1 Local plan potential development site screening

To inform the Sequential Approach to the allocation of development through Lancaster City Council's upcoming Local Plan, JBA completed the Level 1 SFRA in 2017. Subsequently nine sites were chosen as potential Designation Areas / Development Sites where further, more detailed, site specific assessments were required to confirm the potential suitability of proposed development with respect to flood risk.

It is noted that no options for specific development or redevelopment within each Designation Area are available at this time.

This report provides a summary table for each site which incorporates the following:

- Screening Flood Risk Assessment (FRA);
- Outline drainage strategy;
- Level 2 site screening assessment.

Each assessment table that follows, describes the likely tidal, fluvial, groundwater, canal, reservoir and surface water (both offsite impacts and runoff generated by development) flood risk. In addition, flood risk mitigation options including requirements for further assessment are provided.

Based on available flood modelling data, each summary table includes an updated recommendation for the Council as to the likely suitability of development within each area, in terms of flood risk.

Summary of recommendations

Site Reference	Recommendations
1. 365 - Kingsway South	<ul style="list-style-type: none"> • Consider removal • No More Vulnerable development envisaged • 0.5 to 1.8m depth of flooding • Significant site access issues
2 498 - Masons Carpet Warehouse	<ul style="list-style-type: none"> • Consider Development • Less Vulnerable uses • Climate change depths to 0.8m • Current FZ3 shallow depths of flooding • Some access issues with current day flooding to 0.4m
3. 549 – Mellishaw South	<ul style="list-style-type: none"> • Consider removal • Green field • Less Vulnerable development • 0.5%AEP event depth of flooding to 0.7m • Climate change flood depth to 1m • Site split by Main River • Tidal dominated but fluvial risk too and development may exacerbate flood risk elsewhere

Site Reference	Recommendations
4. 550 – Mellishaw North	<ul style="list-style-type: none"> Consider developing Note significant variance between Flood Zone mapping, LiDAR and modelling According to the Flood Zone map the site is at significant risk however, LiDAR indicates a raised plateau with modelling indicating the site is within Flood Zone 1 Climate change results in flood depths of between 0 and 0.6m EA confirmation of variance in flood outline is required
5. LA04 – Caton Road	<ul style="list-style-type: none"> Consider removal 1% AEP event flood depth of 1m Fluvial dominated so a detailed FRA would be required to demonstrate flood risk management measures and that development would not increase risk elsewhere 0.1% AEP flood level of between 2 and 2.4m
6. LA18 – Glasson Industrial Estate	<ul style="list-style-type: none"> Consider development – provided access and emergency planning can be achieved FRA to consider overtopping and wave impacts Less Vulnerable Significant depth of flooding 0.2 to 1m
7. LPSA810 – Imperial Way	<ul style="list-style-type: none"> Consider development – prioritised in lower risk flood zones Avoid development in Flood Zone 3, flood depths recorded to be over 1.5m for 0.5% AEP tidal event Rest of site is in Flood Zone 1 (3ha), which should not preclude development in this location.
8. SA14 – Port of Heysham Expansion	<ul style="list-style-type: none"> Consider development the majority of site in Flood Zone 1. No need to attenuate at site. As this is a port site, free discharge may be permissible without increasing flood risk. Expansion area wholly within Flood Zone 1. FRA to consider overtopping and wave impacts Flood Zone 3 typical depth of flooding 0.3 to 0.6m during the 0.5% AEP event
9. SA19 – Port of Heysham	<ul style="list-style-type: none"> Consider development the majority of site in Flood Zone 1. No need to attenuate at site. As this is a port site, free discharge may be permissible without increasing flood risk. FRA to consider overtopping and wave impacts Flood Zone 3 typical depth of flooding 0.3 to 0.6m during the 0.5% AEP event

2 Site Appraisal Tables

2.1 365 – Kingsway South

Designation Area	Kingsway South
Site area (ha)	0.90
Existing use	Brownfield site. Industrialised.
Existing flood risk vulnerability classification	Less Vulnerable.
Proposed use	Mixed Use (Draft policy has suggested commercial, leisure, retail and possible residential including student accommodation.)
Proposed development flood risk vulnerability classification	Less Vulnerable and More Vulnerable development.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 0.77

Flood outlines (current day)

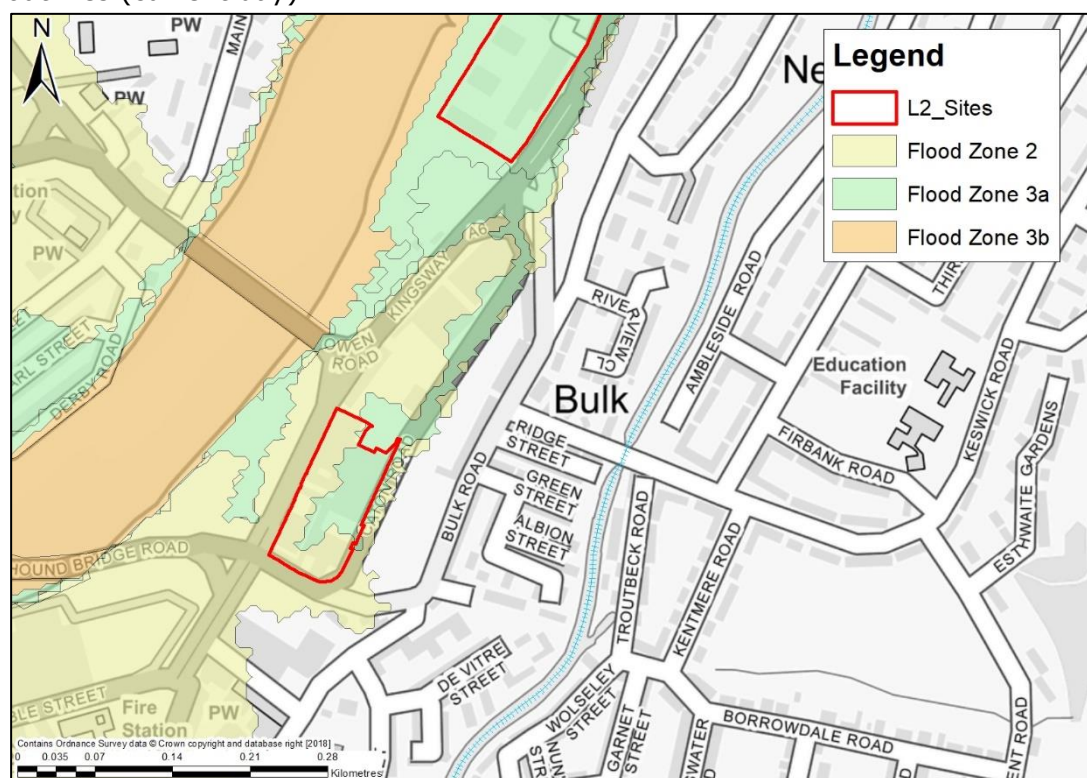


Figure 2.1.1 – Flood Zone Mapping

Designation Area

Kingsway South

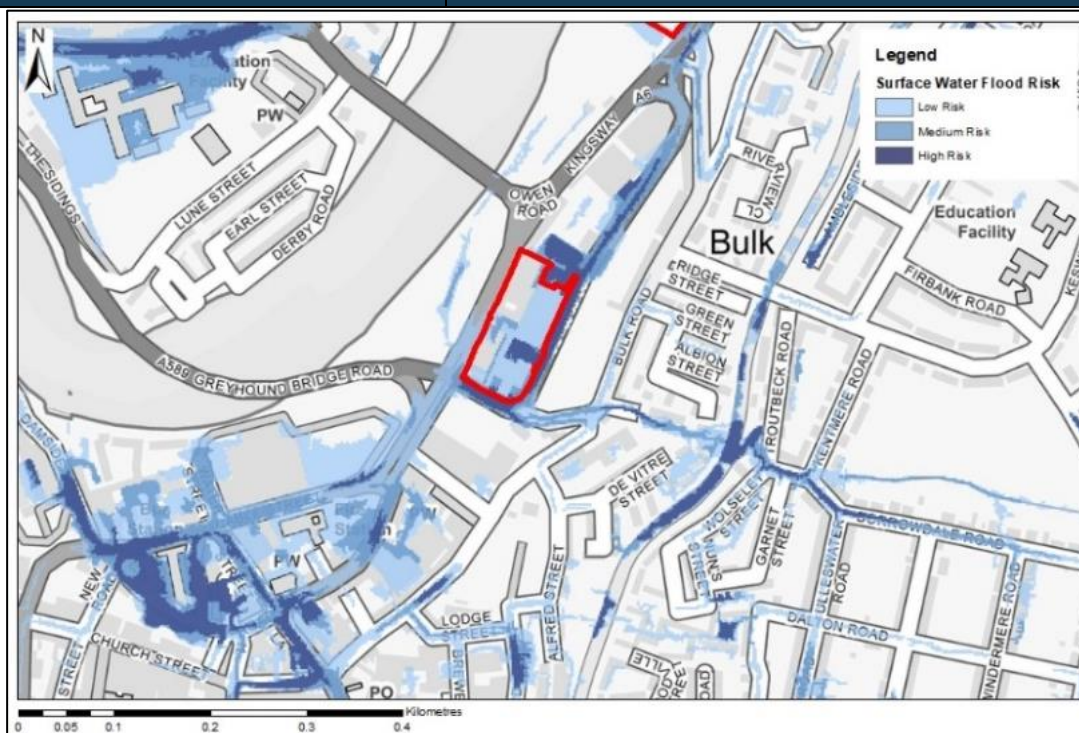


Figure 2.1.2 – Surface Water Flood Risk

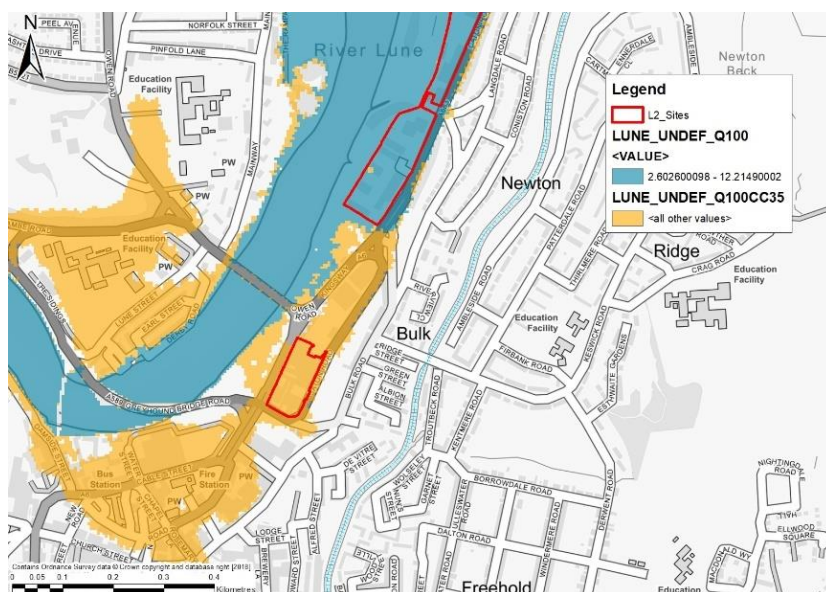
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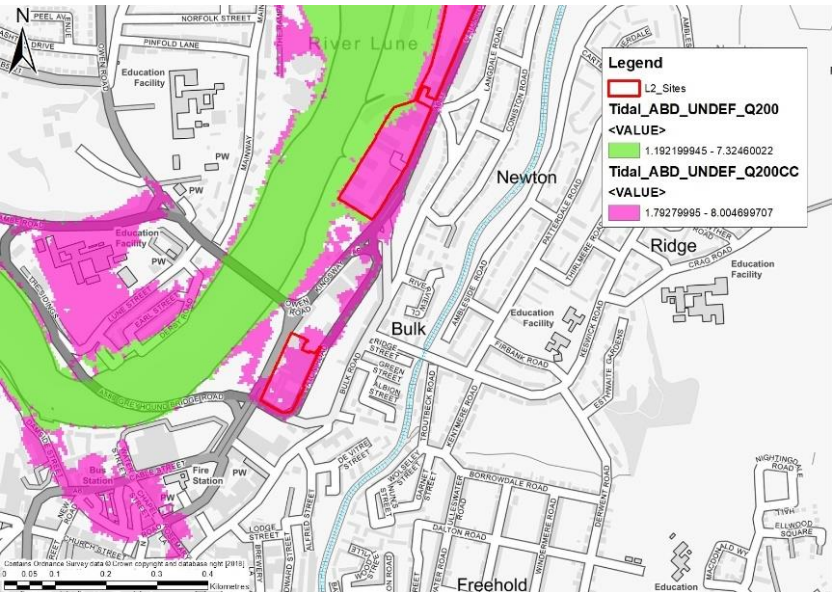
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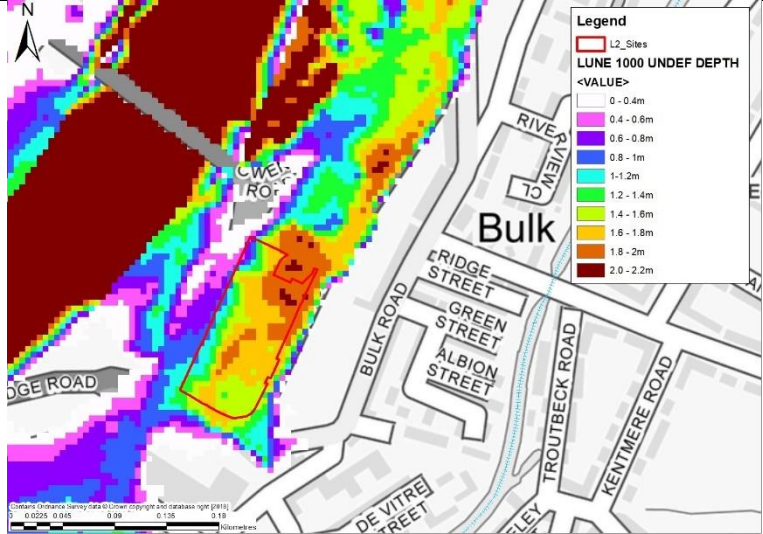
Observations and Recommendations

- The Council will provide the strategic justification for inclusion of this site. No specific development proposals have currently been identified.
- 42% of the site is located within Flood Zone 3a.
- The Council should consider reviewing the suitability of this site for redevelopment.
- Less vulnerable development will be protected to a 75 year defence standard. However, the depth of flooding during the design 1% AEP event and 1% CC AEP event is likely to be significant.
- Residential accommodation should not be considered at this location, owing to current flood risk and associated depths of flooding including future implications of climate change.
- More vulnerable development at this location would also introduce residential development into an area currently at flood risk. Residential development may potentially be considered at first floor level but only on the basis that emergency access/egress can be achieved. However, in this instance Caton Road is predicted to flood to significant depths.
- The modelled depths of flooding for 0.1% AEP (Flood Zone 2) is approximately 1.9m across the site.

Designation Area		Kingsway South	
Flood Source: Fluvial			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	58.35	41.65	0.00
Fluvial: Depth (m)	Max: 2.1 Mean: 1.6	Max: 1.8 Mean: 0.5	Defended site
Fluvial: Hazard	Mapping not available	Mapping not available	Defended site
Climate change guidance	<div><div>Fluvial</div><div>Climate change impacts have been assessed by updating the existing model, increasing the peak river flow by the North West regional allowance for each epoch and timeframe as identified in Table 1 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115. Representing an increase of 35% for climate change allowances (higher central).</div><div></div><div>Figure 2.1.3 - Lune Undefended 1% AEP event with climate change</div><div>Based on Lune Model 2011 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.</div><div>The fluvial climate change mapping indicates that the site is at risk of flooding during the 1% AEP CC scenario. Comparison with the published flood map indicates close correlation of Flood Zone 2 and the modelled climate change outline.</div></div>		

Designation Area	Kingsway South
	<p>Tidal</p> <p>The impacts of climate change on tidal levels has also been assessed based on increased sea level in accordance with the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115. Tidal inundation, coinciding with the 0.5% AEP event + CC scenario indicates less extensive flooding at the site. Fluvial risk is therefore considered the primary source of flooding in this instance.</p>  <p>Figure 2.1.4 – Tidal Undefended 0.5% AEP event with climate change increase mapping</p> <p>Based on Tidal ABD Study 2014 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.</p>
Historic flooding	The Designation Area is contained within the Environment Agency Historic flood outline.
Defended	<p>Available mapping and information indicates that the area is currently defended by flood defences. There is a flood wall running along the bank of the River Lune. The current condition of the asset is recorded as being Grade 4. An asset inspection is recommended to fully understand the risk in this area.</p> <p>Further, this asset has a relatively low design standard of 75 years. Tidal defence assets typically provide a standard of protection of 0.5% AEP level. The existing defence will over top during design and climate change scenarios.</p>
Flood Warning Area	100% of the site is within a Flood Warning Area. Flood Warning

Designation Area	Kingsway South
	Area described as "Low lying land including Lune Industrial Estate, Properties off and Including Lune Street and Lancaster Cricket Club."
Flood risk	<p>Kingsway South is a low-lying road located near the banks of the River Lune. It is within a defined EA Flood Warning Area and, therefore, any development should may use of the EA flood warning system to alert users of the site to a potential flood events. There is a risk of flooding from fluvial, surface water and canal breach failure flood events.</p> <p>Ground levels at the site are generally lower than surrounding topography. The LiDAR map, below, displays the topography within the area and indicates the potential risk of runoff from the surrounding areas.</p> <p>There are 3 sources of flood mapping: – the EA Flood Map, the 2014 Tidal ABD Study + CC and the 2011 Lune Model mapping. Published EA mapping takes precedent. The alternative flood maps provide wider information on site specific flood risks.</p>  <p>Figure 2.1.5 - 2m LiDAR map of the site</p>

Designation Area	Kingsway South
	 <p>Figure 2.1.6 - Lune Undefended Model 0.1% AEP event depths (m)</p> <p>Depth mapping for the 0.1% AEP event is representative of the 1 % AEP + CC flood mapping. Depths of flooding across the site typically range between 1.4-1.8m, with a max depth of flooding at 2.1m. The adjacent roads to the site are also within the modelled flood extents with varying depths between 0.8-1.4m which would prevent a safe access/egress from being achieved for the development.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • The Council should consider reviewing the suitability of this site for redevelopment. Less vulnerable development will be protected to an assumed 75 year standard. However, the depth of flooding during the design 1% AEP event and 1% CC AEP event is likely to be significant. • Residential accommodation should not be considered at this location, owing to current flood risk and associated depths of flooding including future impacts of climate change. • More vulnerable development at this location would introduce residential development into an area currently at flood risk. Residential development may potentially be considered at first floor level but only on the basis that emergency access/egress can be achieved. However, in this instance Caton Road is predicted to flood to significant depths. • The modelled depths of flooding for 0.1% AEP (Flood Zone 2) is approximately 1.9m across the site. • The Council should consider removing this site as a potential redevelopment area. • A site specific FRA will need to consider the flood limiting impacts of any existing defences on flood levels and also the existing developed area as any increase in development footprint may potentially result in increased risk elsewhere. • With depths of flooding for 0.1% AEP (2011 Lune Model) ranging between 0.8-1.4m along the adjoining roads to the site, safe access/egress is unlikely to be achievable. Without

Designation Area		Kingsway South	
	safe access/egress, the Council should remove the allocation from consideration.		
Flood Source: Groundwater			
Flood risk: groundwater	Whole site contained within area deemed to be between 25-50% risk of groundwater emergence occurring at the site. Interrogation of LiDAR indicates that the site is relatively low-lying which may worsen the extent of groundwater emergence during flood events.		
Flood Source: Infrastructure Failure – Reservoirs			
Flood risk: reservoir	Site is not within reservoir flood extents.		
Flood Source: Infrastructure Failure – Canals			
Flood risk: canal	There is a canal approximately 200m East of site, from inspection of the LiDAR the canal is located at a level 14m higher than the development site. The impact of a breach scenario from the canal should be considered as part of a FRA.		
Flood Source: Surface Water			
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)
	9.65	10.21	46.44
Surface water flooding depths	Max: 0.30-0.60m Mean: 0.15-0.30m	Max: 0.60-0.90m Mean: 0.30-0.60m	Max: >1.20m Mean: 0.30-0.60m
Surface water hazards	Max: Moderate Mean: Low	Max: Significant Mean: Moderate	Max: Significant Mean: 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	<p>Approximately 50% of the designation area is regarded as having a 'low' risk from surface water (0.1% AEP). Roughly 10% of the site is appraised to be at 'high' risk, presenting a 3.33% AEP of inundation from surface water flooding. Surface water is contained by existing site development. With surface water shown to pond around and against the existing buildings. The associated surface water mapping indicates that for a 'high' risk event the maximum depth of flooding is between 0.30-0.60m, however the mean depth for this return period is between 0.15-0.30m. The related hazard mapping signifies a 'moderate' hazard rating with the average hazard rating being defined as low for more frequent flood events. The adjacent Caton Road is inundated by surface water during 1% AEP with depths of flooding varying between 0.3-0.6m.</p> <p>LiDAR data indicates that there is a depression in the middle of the site, which may have an impact on overland flows and likelihood of surface water inundation. Any development on the site will need to take surface water flood risk into consideration in</p>		

Designation Area			Kingsway South			
			order to ensure flood risk are not increased.			
Surface water: mitigation options & site suitability			<ul style="list-style-type: none">Surface water flood risk is localised to the site entrance for the 3.3% AEP. Hazard mapping for the 3.3% AEP is typically 'low', with some areas of 'moderate' hazard.For higher return periods the surface water flood risk affects a greater proportion of the site extent. For example, the 0.1% AEP covers approximately 50% of the Designation Area.Caton Road is currently the primary access route to the site, however for 1% AEP, is inundated by surface water flooding of depths up to 0.6m. Kingsway (east of the site) is not at risk from surface water flooding and could be utilised for access/egress instead.Attenuation options for the site should utilise the existing low spots on site and seek to attenuate in these areas first.Depths of surface water inundation for the 1% AEP are largely between 0.30-0.60m, with a small area with maximum depth between 0.60-0.90m, within the site boundary.			
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 7l/s		
Design flood event (incl climate change)	Critical storm duration (Hrs)	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty assuming no infiltration Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20 %	7.5	531	132	399	22.5	0.03 ha 3.33%
3.33% AEP Rainfall+40 %	8.75	644	154	489	27.7	0.03 ha 3.33%
1% AEP Rainfall+20 %	8.75	733	154	579 (180m³ of exceedance storage)	32.7	0.04ha 4.44%
1% AEP Rainfall+40 %	9.75	874	172	702 (213m³ of exceedance storage)	39.7	0.05ha 5.56%
Climate change	Application of the central (20%) and upper band (40%) potential change anticipated for climate change in the table above shows the estimated					

Designation Area		Kingsway South
		attenuation volumes for the 3.33% and 1% AEP rainfall events.
Surface water: flood risk impacts from development site & mitigation		<p>Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p>

2.2 498 – Masons Carpet Warehouse, White Lund

Designation Area	Masons Carpet Warehouse, White Lund
Site area (ha)	0.20
Existing use	Brownfield site. Warehouse.
Existing flood risk vulnerability classification	Less Vulnerable.
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 0.17

Flood outlines (current day)

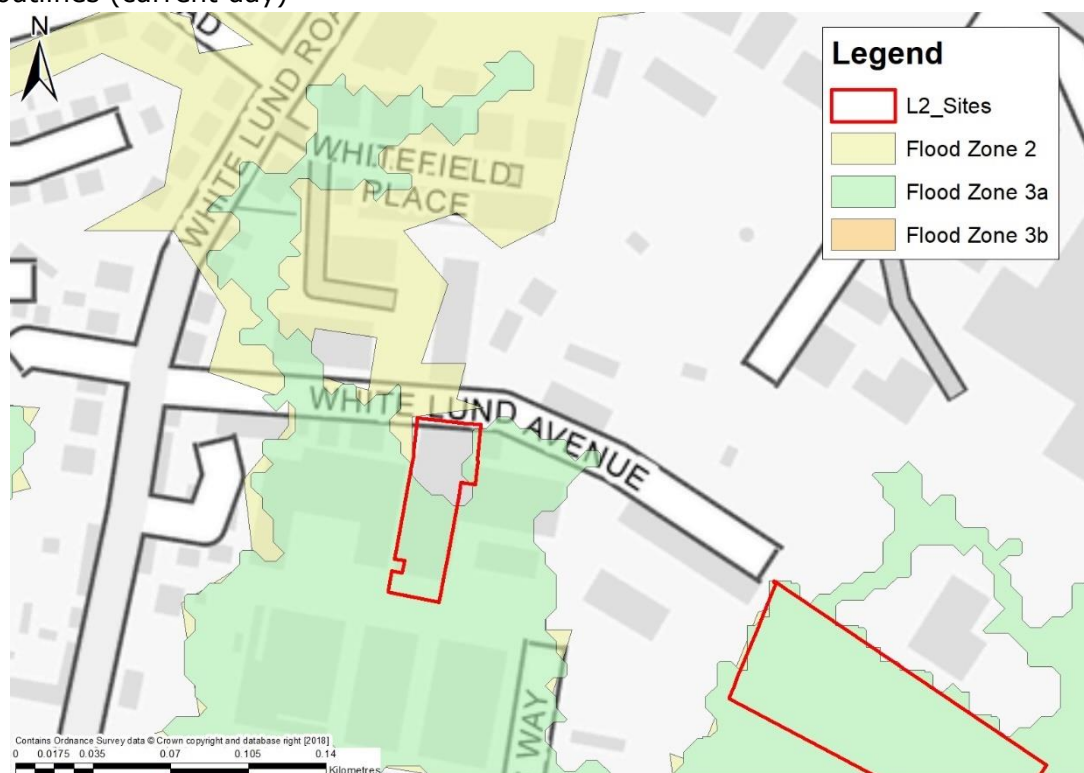


Figure 2.2.1 - Flood Zone Mapping

Designation Area

Masons Carpet Warehouse, White Lund

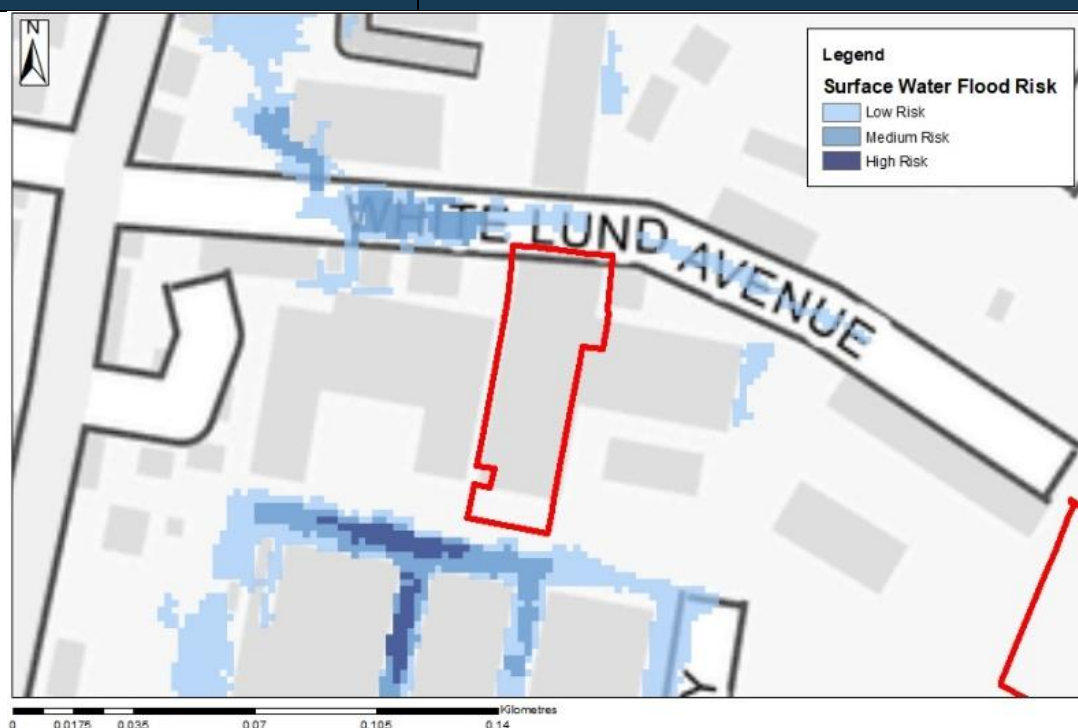


Figure 2.2.2 - Surface Water Flood Risk

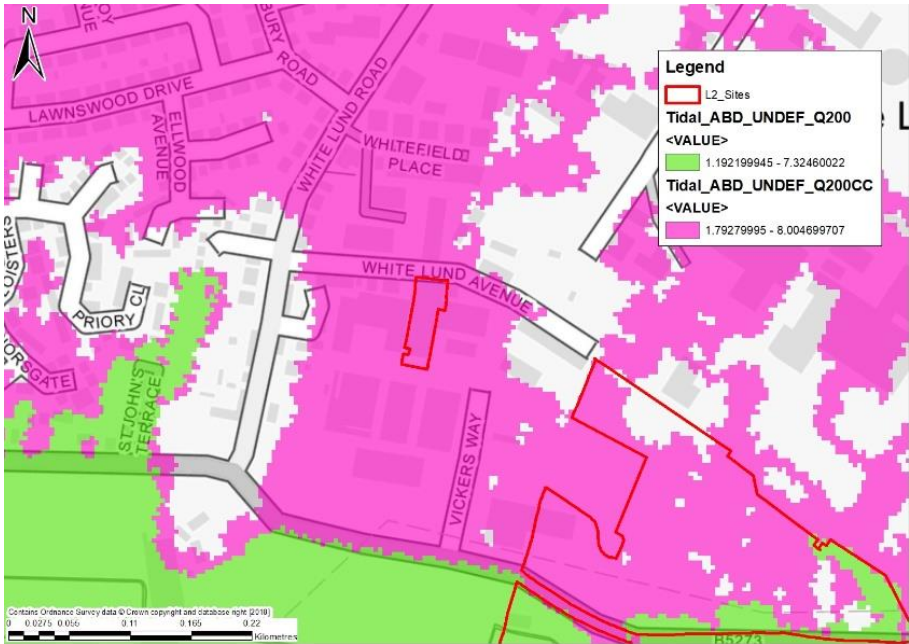
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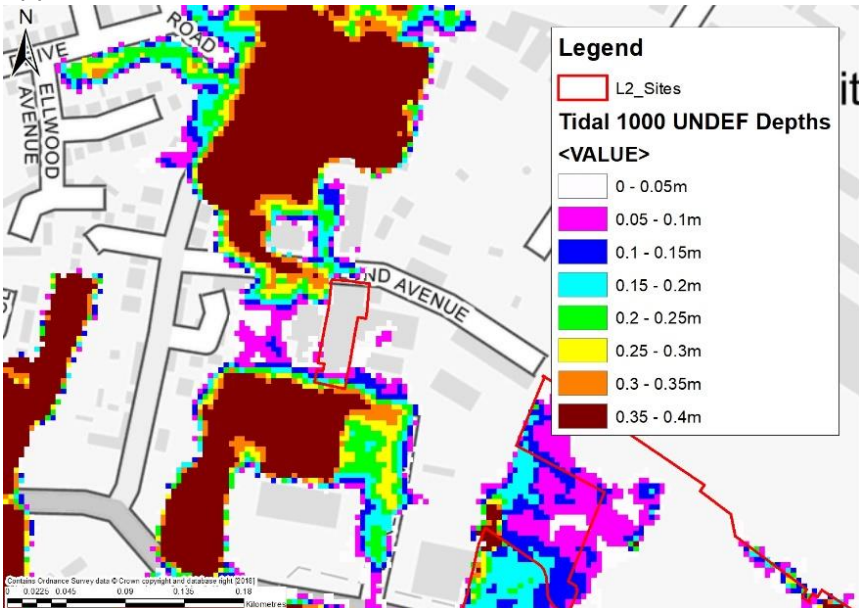
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Observations and Recommendations

- The Council will provide the strategic justification for inclusion of this site. No specific development proposals have currently been identified.
- Approximately 60% of the site is located within Flood Zone 3a, leaving approximately 40% of the total site area within Flood Zone 1 (0.08ha).
- The proposed development presents no change in existing flood risk vulnerability classification.
- Areas of Medium and Low risk of surface water inundation are defined along the main access road, White Lund Avenue. Surface water is not expected to present significant hinderance to safe access from the site during a flood event. Shallow depths of flooding along White Lund Avenue (<0.3m). SW flood risk should not preclude redevelopment of the site.
- No surface water flood risk has been identified within the site boundary.
- Based on the Tidal 2014 study, modelling indicates depths of flooding of up to 0.8m during a 0.5% + CC AEP event.
- Less Vulnerable development may be considered subject to a site specific FRA. Development will be at risk of flooding and mitigation and resilience measures will need to be considered. Based on available modelling, the current tidal 0.1% AEP flood event results in a depth of flooding less than 0.1m across the development site. Under climate change scenarios for the 0.5% + CC AEP event, the depth of flooding is predicted to increase to 0.8m.

Designation Area		Masons Carpet Warehouse, White Lund	
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.09	60.44	0.00
Tidal: Depth (m)	Max: 0.2m Mean: 0.1m	Max: <0.1m Mean: <0.1m	Not defined
Tidal: Hazard	Max: Low Mean: Low	Max: Low Mean: Low	Not defined
Climate change guidance (Tidal)	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p>  <p>Figure 2.2.3 - Tidal Un defended 0.5% AEP event with Climate change (Tidal ABD Study 2014)</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>The current 0.5% AEP outline does not affect the site. However, the climate change scenario indicates that the site would be inundated with a maximum depth of flooding at 0.8m with depths typically ranging between 0.5-0.6m across the site.</p>		
Historic flooding	The site is not contained within the Environment Agency Historic		

Designation Area	Masons Carpet Warehouse, White Lund
	flood outline.
Defended	The site area is defended to the south by an informal raised embankment.
Flood Warning Area	No part of the site is contained within the extent of the Flood Warning Area mapping.
Flood risk	<p>Based on available mapping the primary source of flood risk at the site is from tidal inundation. During a 0.1% AEP event, the maximum depths of flooding across the site are predicted to be less than 0.1m. Depths of flooding should not negatively impact redevelopment opportunities.</p>  <p>Figure 2.2.4 - Tidal Undefined 0.1% AEP Depths</p> <p>The southern perimeter of the site indicates a depth of flooding up to 0.2m for 0.1% AEP event.</p> <p>Access to the site is off White Lund Avenue and indicates flood depths up to 0.4m which may temporarily impede access during a flood event. Road levels will need to be considered as part of an FRA to confirm access and emergency planning arrangements.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Safe development level will need to take existing and future flood levels into account. • Consideration of Less Vulnerable development is permissible within Flood Zone 3a subject to an FRA demonstrating that development will be safe for the lifetime of the scheme. • Depending on the use of the proposed development, flood resilience measures may be considered. For example, raising socket levels, machinery and storage racking above anticipated flood depths to prevent damage. • The climate change mapping scenario indicates that safe access / egress will be difficult to achieve in practice. The whole site and neighbouring roads are within the climate change map extents and depths of flooding are expected to be typically 0.5-0.6m.

Designation Area		Masons Carpet Warehouse, White Lund	
Flood Source: Groundwater			
Flood risk: groundwater	Whole site contained within area deemed to be between 25-50% risk of groundwater emergence occurring at the site. Groundwater usually follows topography and as the site is situated on higher ground than the nearby river, water should be diverted by this profile.		
Flood Source: Infrastructure Failure – Reservoirs			
Flood risk: reservoir	Site is not within reservoir flood extents.		
Flood Source: Infrastructure Failure – Canals			
Flood risk: canal	There are no canals present near the site and therefore there is no flood risk from canals associated with this area.		
Flood Source: Surface Water			
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	0.00
Surface water flooding depths	Max: 0m Mean: 0m	Max: 0m Mean: 0m	Max: 0m Mean: 0m
Surface water hazards	Max: None Mean: None	Max: None Mean: None	Max: None Mean: None
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	The site does not fall within the available surface water flood risk extents and therefore, is not at risk from surface water flooding. However, as the site is within Flood Zones 2 and 3, a FRA will be required. The FRA should quantify the volume surface water runoff generated by development and provide volumes of attenuation required to ensure that runoff from the site does not increase surface water flood risk elsewhere. The impact of surface water on access to the site will need to be taken into consideration as part of the site specific FRA		
Surface water: mitigation options & site suitability	<ul style="list-style-type: none">As stated, the site does not fall within the surface water flood extents, however a FRA will typically be required to restrict runoff to greenfield rates. However, as the site is previously developed, discharge rates will have to be agreed with the LLFA, which may seek at least 50% betterment on the current discharge rate.		

Designation Area				Masons Carpet Warehouse, White Lund		
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 5l/s* *Discharge rate set to 5l/s in accordance with EA guidance.		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20 %	3.25	90	29	61	6.8	0.01 ha 5%
3.33% AEP Rainfall+40 %	3.75	110	34	77	8.5	0.01 ha 5%
1% AEP Rainfall+20 %	4	132	36	96 (35m³ of exceedance storage)	10.7	0.01ha 5%
1% AEP Rainfall+40 %	4.5	159	41	119 (42m³ of exceedance storage)	13.1	0.01ha 5%
Climate change	Application of the central (20%) and upper band (40%) 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	<p>Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p>					

2.3 549 – Mellishaw South

Designation Area	Mellishaw South
Site area (ha)	22.70
Existing use	Greenfield.
Existing flood risk vulnerability classification	N/A
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 19.30

Flood outlines (current day)

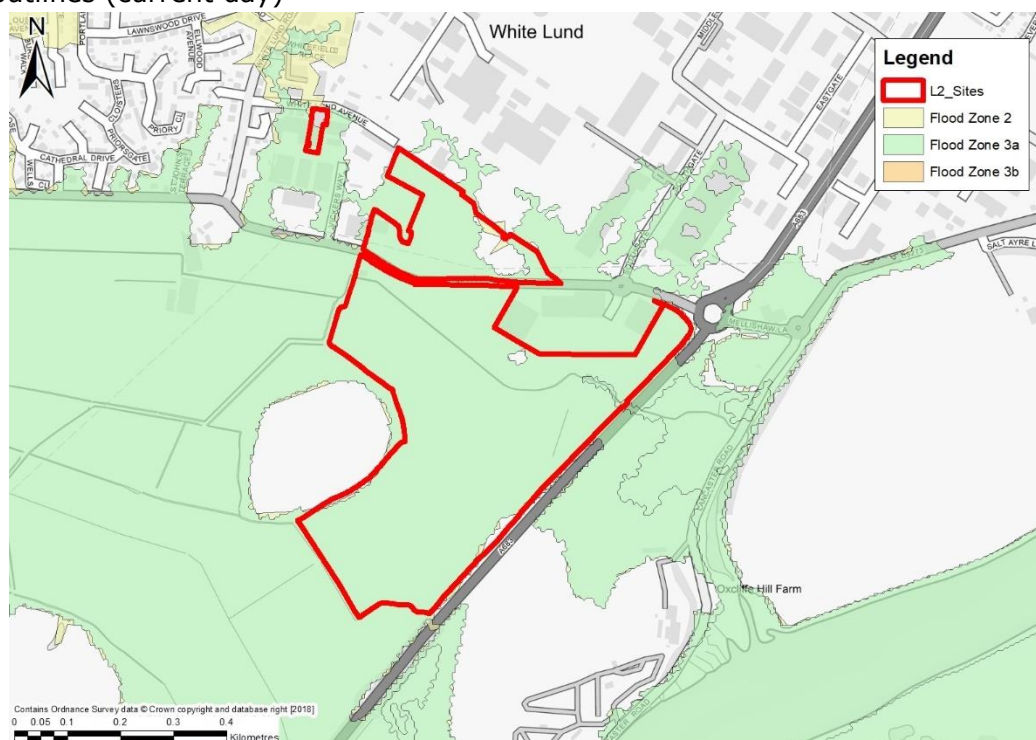


Figure 2.3.1 - Flood Zone Mapping

Designation Area

Mellishaw South

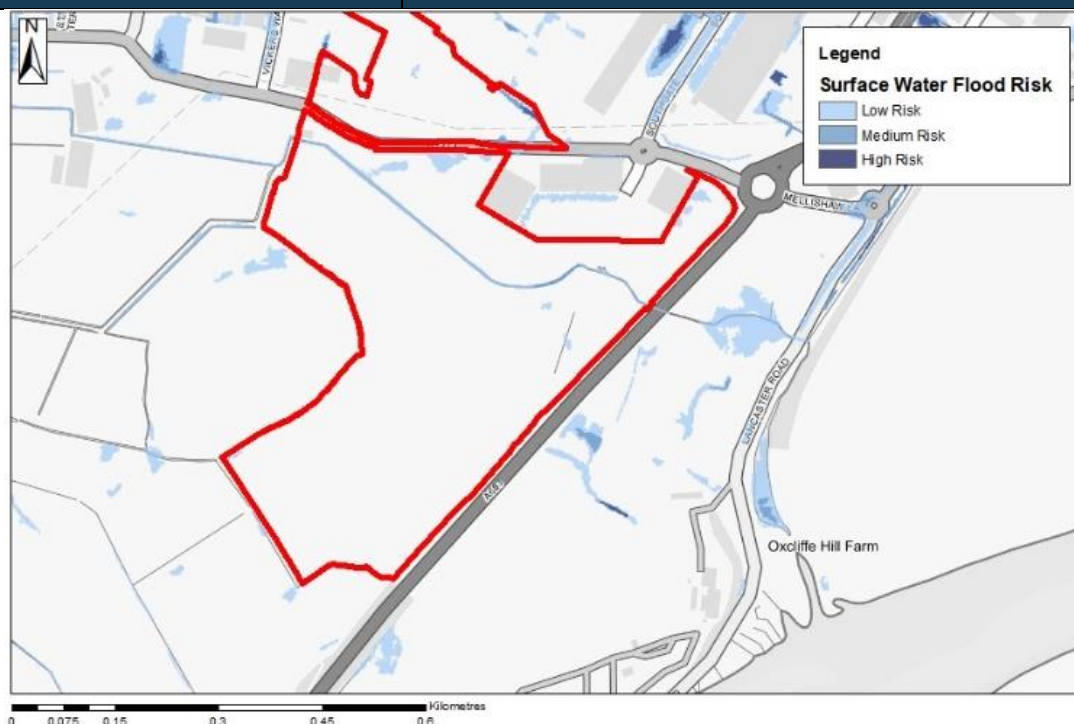


Figure 2.3.2 - Surface Water Flood Risk

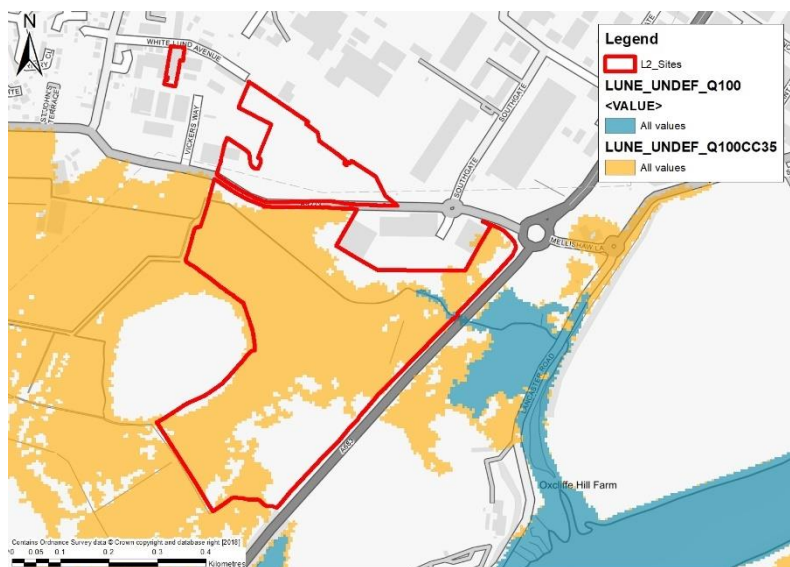
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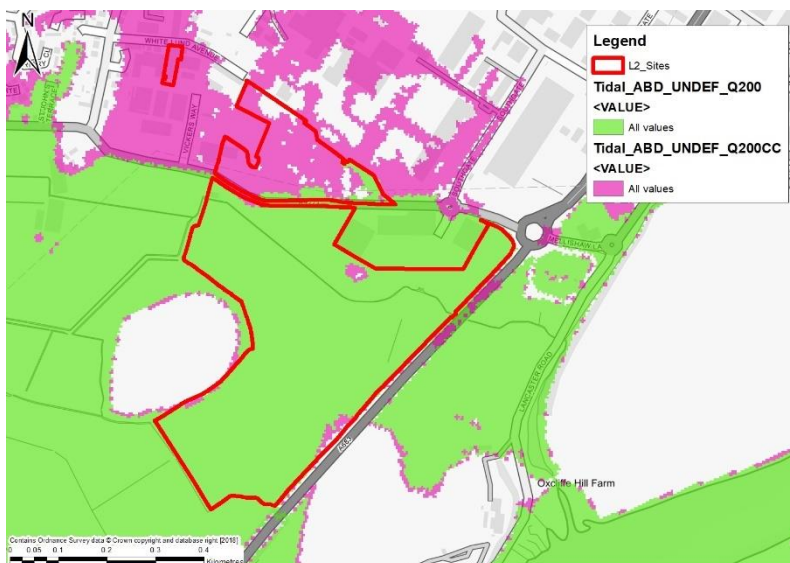
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Observations and Recommendations

- Approximately 98% of the site situated within Flood Zone 3a.
- A Main River bisects the site. Flows will need to be maintained as part of any development proposal.
- Tidal inundation is the primary source of flood risk at this site.
- The risk of surface water flooding is considered Low with some small localised areas of flooding and along the watercourse.
- Proposed development is employment which is defined as Less Vulnerable. Development may be considered acceptable within Flood Zone 3 subject to a site specific FRA that demonstrates flood risk can be effectively managed for the lifetime of the development.
- As the majority of the site is located within FZ3 it is not, therefore, feasible to directed development to areas of lower risk.
- 1m LiDAR mapping displays that the site is relatively flat with the majority of the site between 5.0m-5.5m AOD.
- An 8m buffer strip along the banks of the river for maintenance is assumed.
- The site is currently Greenfield and is at risk of flooding to significant depth. The site is at risk from both fluvial and tidal events. The Council should consider reviewing the suitability of this site for redevelopment owing to current flood risk and associated depths of flooding and future implications of climate change.
- Development is likely to result in a loss of flood storage. Development must not increase flood risk. The impact of development will need to be confirmed based on a specific development layout and appropriate FRA.

Designation Area		Mellishaw South	
Flood Source: Fluvial / Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.37	98.37	0.00
Fluvial: Depth (m)	Max: 1.2 Mean: 0.6	Max: 1.0 Mean: 0.4-0.5	Defended
Fluvial: Hazard	Mapping not available	Mapping not available	Defended
Climate change guidance (Fluvial)	Climate change impacts have been assessed by updating the existing model, increasing the peak river flow by the North West regional allowance for each epoch and timeframe as identified in Table 1 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115. Representing an increase of 35% for climate change allowances (higher central).		
			
<p>Figure 2.3.3 – Lune Undefended 1% AEP event with climate change</p> <p>Based on Lune Model 2011 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.</p>			
Tidal: Depth (m)	Max: 1.8 Mean: 0.9	Max: 1.5 Mean: 0.7	Defended
Tidal: Hazard	Max: Moderate	Max: Moderate	Defended

Designation Area		Mellishaw South	
	Mean: Low	Mean: Low	
Climate change guidance (Tidal)	<p>Climate change impacts have also been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p>  <p>Figure 2.3.4 - Tidal Undefended 0.5% AEP with CC</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>The site is within the 0.5% AEP tidal event. Climate change results in higher depths of flooding across the site. Flooding for this event also inundates the northern access road (Mellishaw Lane), access could be achieved via A683 to the east of the site in this case.</p>		
Historic flooding	The site is not contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.		
Defended	The site area includes an EA defined Main River which flows into the River Lune. It is defended on both sides with a standard of protection of 35 years.		
Flood Warning Area	As the site is undeveloped it is not located within a flood warning area.		
Flood risk	The majority of the site is within the defined Flood Zone 3 area. The site is at risk from both fluvial flooding during the 1% AEP event and tidal flooding during the 0.5% AEP event.		

Fluvial

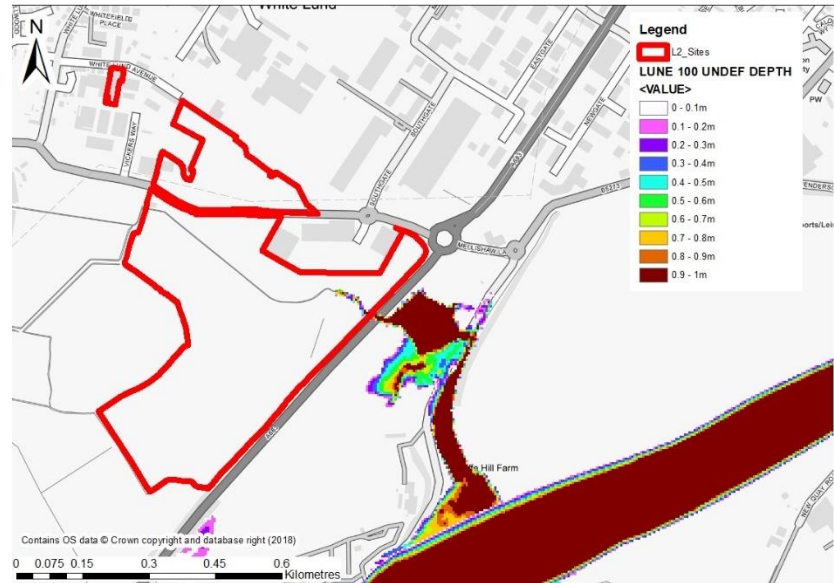


Figure 2.3.4 Lune Undefended 1% fluvial AEP event Depths

Based on Lune 2011 Model

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Relatively shallow depths (typically less than 0.4m) for 1% fluvial AEP, with some localised areas towards the north-east of higher depths of flooding. Flooding emanates from the Main River which bisects the site.

Designation Area

Mellishaw South

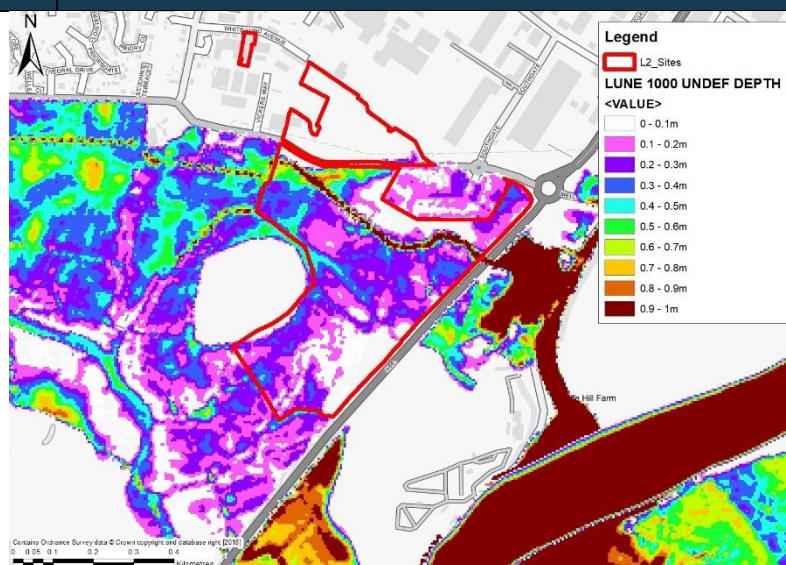


Figure 2.3.5 – Lune Undefended 0.1% fluvial AEP event Depths

Based on Lune 2011 Model

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Flooding associated with the 0.1% AEP affects a larger area of the site with higher typical depths. Average depths of flooding across the site are between 0.2-0.4m. Development is likely to result in a loss of flood storage, which would increase flood risk elsewhere. The impact of potential development will need to be confirmed based on a specific development layout and appropriate FRA as development must not increase flood risk elsewhere.

Tidal

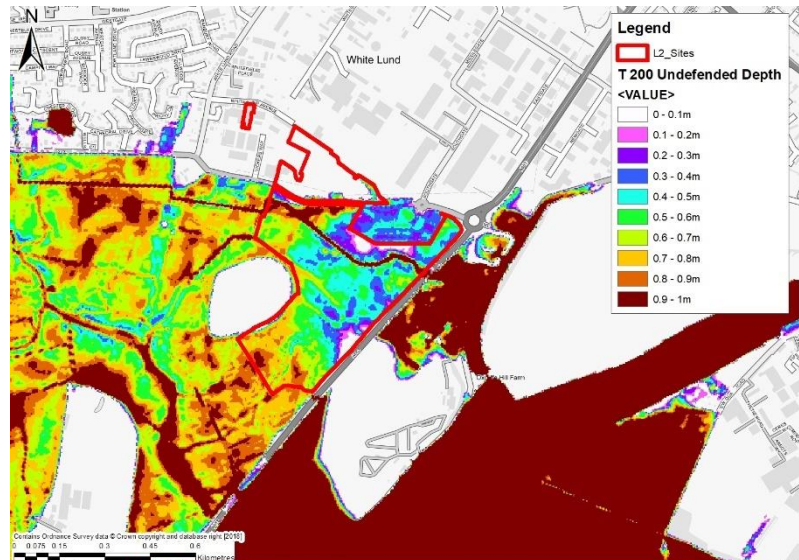


Figure 2.3.6 - Tidal Undefended 0.5% AEP Depths

Tidal inundation mapping indicates significantly higher depths of flooding associated with a tidal events relative to the fluvial model. Average depths of flooding for 0.5% AEP event are approximately 0.7m. These depths suggest that safe development will not be achievable in this area. The access road to the north (Mellishaw Lane) is also inundated in this event and access would need to be diverted to the A683, which is not located within the flood extents.

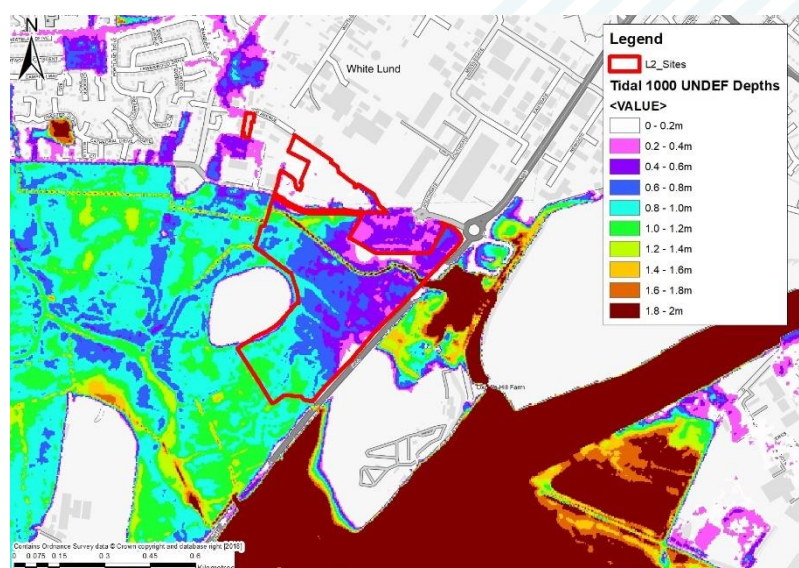


Figure 2.3.7 - Tidal Undefended 0.1% AEP Depths

Average depths of flooding across the site for 0.1%

Designation Area		Mellishaw South	
	undefended tidal event are between 0.6-1.0m. Due to these depths of flooding, the Council should consider removing this development site from the allocation.		
Mitigation options & site suitability	<ul style="list-style-type: none">The Council should consider reviewing the suitability of this site for redevelopment owing to current flood risk and associated depths of flooding and future implications of climate change.Development within areas covered by Flood Zone 3a may be difficult and land raising may result in a reduction in available flood storage. This may result in increased risk elsewhere.An 8m buffer would be required along the Main River where development 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. The road adjacent to the north of the site is also in Flood Zone 3 so will be inundated and prevent safe access/egress to the site.		
Flood Source: Groundwater			
Flood risk: groundwater	Site covers three different probabilities of groundwater emergence occurring. These range between 25% and 75% risk of groundwater emergence. Ground levels from LiDAR indicate the site is relatively low lying compared to the surrounding fields.		
Flood Source: Infrastructure Failure – Reservoirs			
Flood risk: reservoir	Site is not within reservoir flood extents.		
Flood Source: Infrastructure Failure – Canals			
Flood risk: canal	There are no canals present near the site and therefore there is no flood risk from canals associated with this area.		
Flood Source: Surface Water			
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	0.11	2.79
Surface water flooding depths	Max: 0m Mean: 0m	Max: 0.30-0.60m Mean: 0.15-0.30m	Max: 0.60-0.90m Mean: 0.15-0.30m
Surface water hazards	Max: None Mean: None	Max: Moderate Mean: Moderate	Max: Significant Mean: 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 flood risk is isolated to localised areas of the site only. Tidal flooding is the major flood risk at this location.		

Designation Area			Mellishaw South			
Surface water: mitigation options & site suitability			<ul style="list-style-type: none">Development should avoid the areas within the site at risk from the 1 in 1000 year event. As only 3% of the site area is at risk for this return period it should not largely affect the layout of the site.A FRA will be required to develop the site, this is to ensure that runoff generated by development does not increase flood risk elsewhere.			
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 69.9l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20 %	16	15163	2818	12345	69.9	0.82 ha 3.6%
3.33% AEP Rainfall+40 %	20	18450	3523	14928	84.5	1.00 ha 4.38%
1% AEP Rainfall+20 %	17	19957	2995	16962 (4617m³ of exceedance storage)	96.0	1.13 ha 4.98%
1% AEP Rainfall+40 %	20	23853	3523	20330 (5402m³ of exceedance storage)	115.1	1.36 ha 5.97%
Climate change	Application of the central (20%) and upper band (40%) 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	Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'. As part of this Level 2 Screening we have included calculations to provide an					

Designation Area	Mellishaw South
	<p>estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p>

2.4 550 – Mellishaw North

Designation Area	Mellishaw North
Site area (ha)	4.25
Existing use	Greenfield.
Existing flood risk vulnerability classification	N/A
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 3.62

Flood outlines (current day)

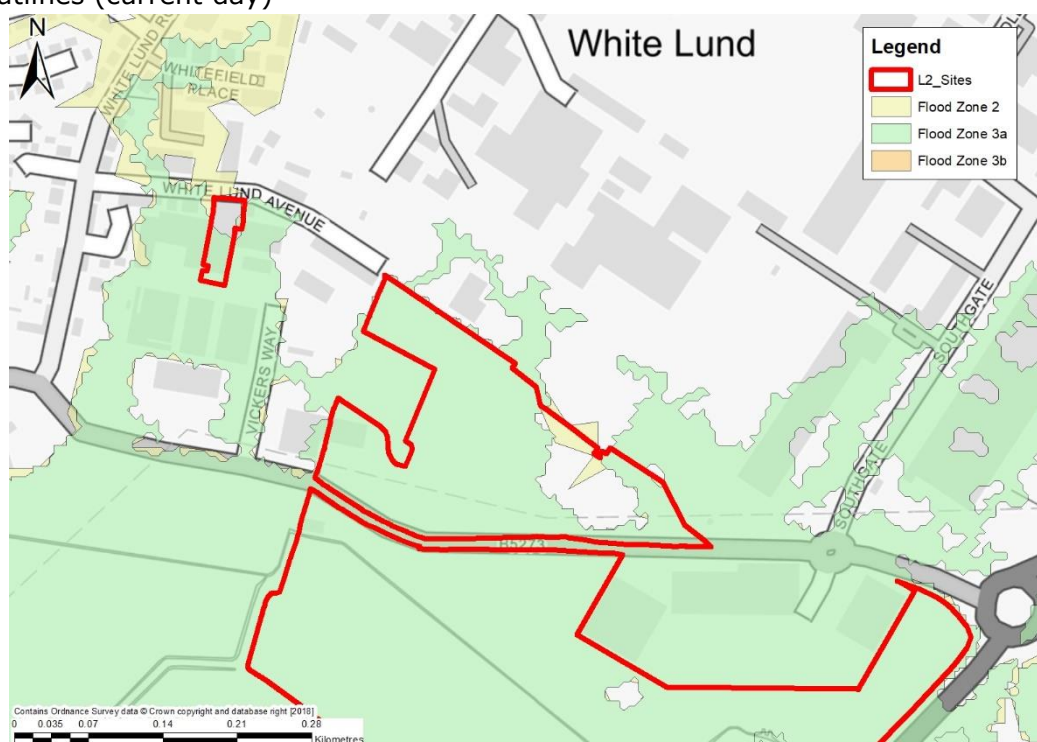


Figure 2.4.1 - Flood Zone Mapping

Designation Area

Mellishaw North

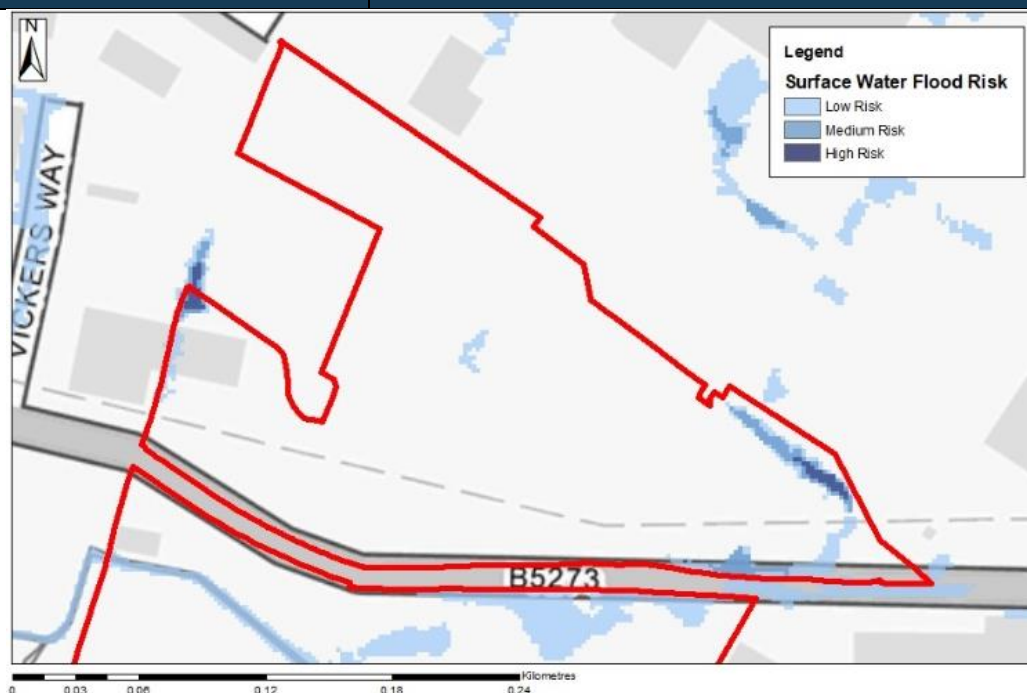


Figure 2.4.2 – Surface Water Flood Risk

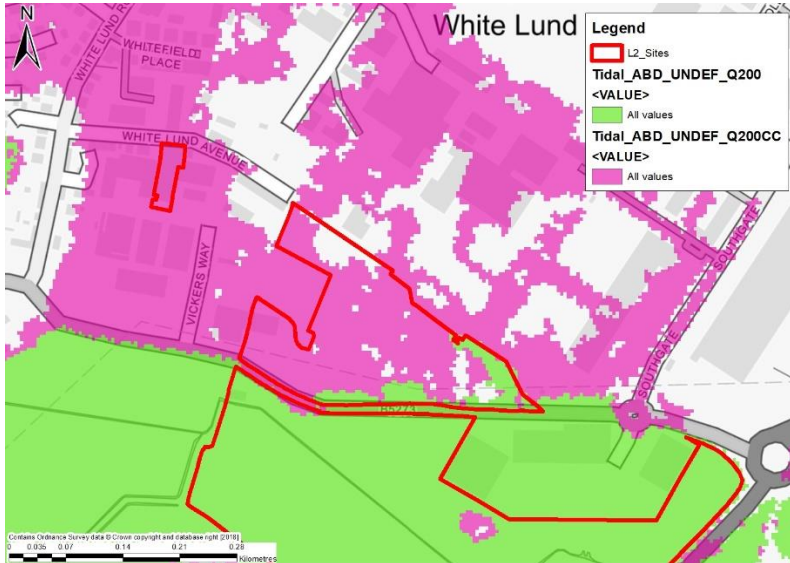
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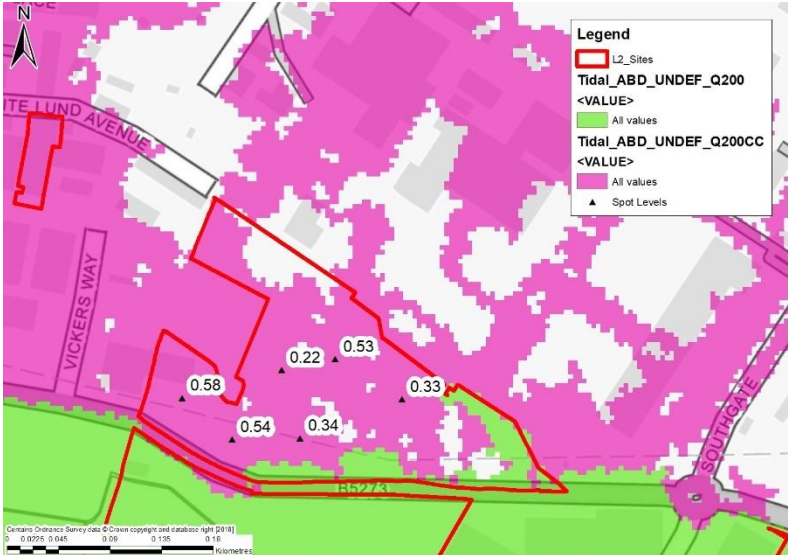
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Observations and Recommendations

- The proposals for this site are to redevelop the area for employment uses, this is defined as Less Vulnerable development. Approximately 85% of the site is within Flood Zone 3a which permits consideration of Less Vulnerable development subject to a site specific flood risk assessment that demonstrates flood risk can be managed for the life of the development.
- The site is currently Greenfield and is at risk of flooding (according to the EA Flood Zone Mapping) to significant depth. The site is at risk from both fluvial and tidal events. The Council should consider reviewing the suitability of this site for redevelopment owing to current flood risk and associated depths of flooding and future implications of climate change. However, LiDAR levels indicate that this site is elevated above the surrounding area.
- The EA will need to confirm acceptability of the site and confirm the reason for discrepancies between the published EA Flood Map and the models which have been used to appraise this site's flood risk. From the fluvial and tidal models, the site is predominantly situated in Flood Zone 1.
- Climate change allowances for the site indicate less extensive flooding when compared to the EA Flood Zone maps. Depths range between 0.2-0.6m across the site with a maximum localised depth of 1.3m. The access road B5273 is also inundated during the 0.5% + CC AEP event and may limit safe access and egress route from the site.
- There are no formal flood defences at this site.
- Some small localised pockets of surface water flood risk at the site, due to the site's topography. This may change as the site is developed and considerations should be made to the impact on surface water overland flows during the FRA.

Designation Area		Mellishaw North	
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	3.13	85.85	0.00
Tidal: Depth (m)	Max: 1.2 Mean: 0.8	Max: 0.9 Mean: 0.6	Undefined
Tidal: Hazard	Max: Low Mean: None	Max: Low Mean: None	Undefined
Climate change guidance (Tidal)	<div><div>Tidal</div><div>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</div><div></div><div>Figure 2.4.3 – Tidal Undefended 0.5% AEP event with climate change</div><div>Based on Tidal ABD Study 2014 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.</div><div>The site is at risk of tidal flooding during the 0.5% AEP Tidal Undefended event. Model outlines indicate that the site is not at risk of inundation under current flooding scenarios. However, the addition of climate change allowances results in flood extents affecting a much larger area of the site with predicted depths of between 0.2-0.6m</div></div>		

Designation Area	Mellishaw North
	<p>across the site in the undefended scenario, shown in Figure 2.4.4.</p>  <p>Figure 2.4.4 – Tidal Undefended 0.5% AEP event with climate change (Spot Level Depths)</p> <p>The EA Flood Map for Planning does not fully align with the available models for the area. EA Flood Map for Planning indicates that the approximately 85% of the site is situated within Flood Zone 3a. Flood Zone 3a outline represents a 1% AEP (fluvial) or 0.5% AEP (tidal) event. However, neither model's outlines for the design return periods indicate a similar outline to that indicated on the published Flood Zone map. Further modelling works may be required to verify the model extents as part of a detailed site specific FRA.</p>

Designation Area

Mellishaw North

Fluvial

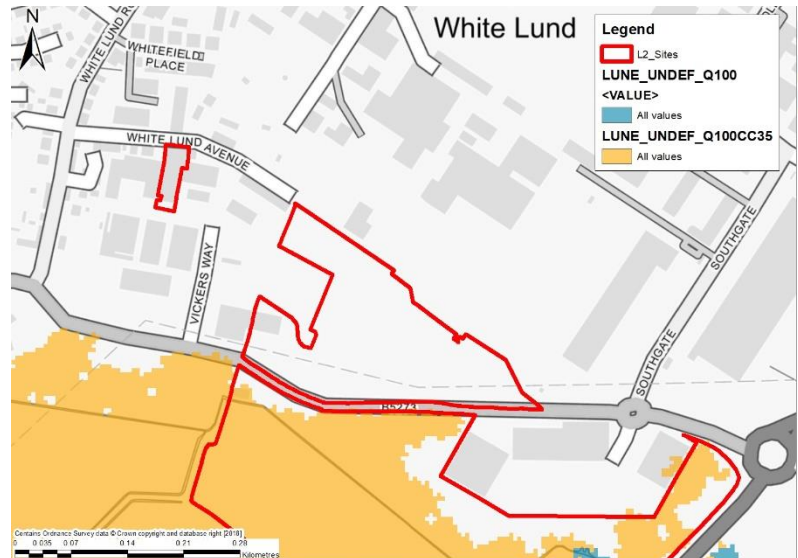


Figure 2.4.5 – Lune Undefended 1% AEP event with climate change

Based on Lune Model 2011

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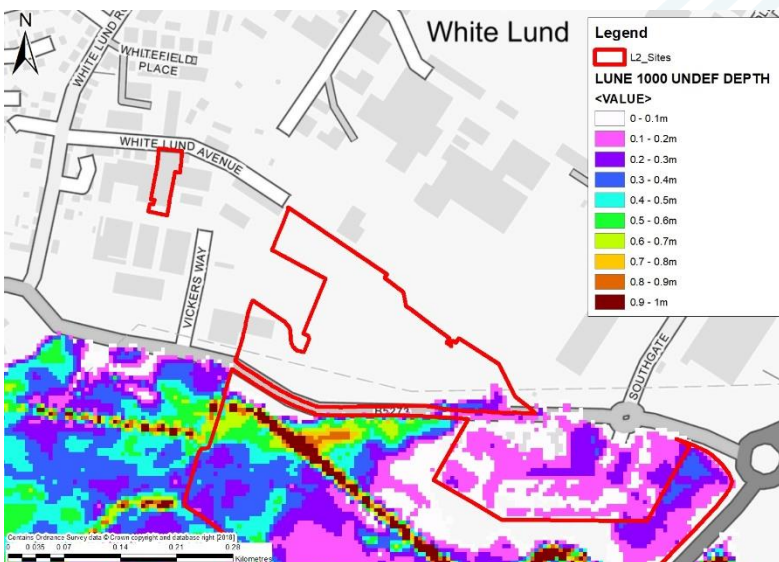
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Additional climate change allowances for fluvial inundation do not result in flooding of the site.



Figure 2.4.6 – 2m LiDAR of Site Area

Designation Area	Mellishaw North
	<p>Figure 2.4.6 is a map indicating topography of the site. Interrogation of the LiDAR map suggests that the discrepancy between the EA Flood Map and the modelled flood extents is due to an inaccuracy with the EA Flood Map. There is a high spot located towards the northern edge of the site, which is set approximately 4m above surrounding ground levels. The EA Flood Map does not indicate a correlating area within the site, however the modelled flood extents do. Therefore, in this instance, the modelled flood extents for the area should be used to appraise flood risk, as opposed to the EA Flood Map.</p>
Historic flooding	The site is not contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.
Defended	The nearby watercourse located in Mellishaw South is defended by virtue of the watercourse being lower than the surrounding land. According to the mapping, the asset is regarded as being 'high ground' and described as channel bed and bank.
Flood Warning Area	No part of the site is contained within the extent of the Flood Warning Area mapping.
Flood risk	<p><u>Fluvial</u></p>  <p>Figure 2.4.7 - Lune Undefended 0.1% AEP event Depths (m)</p> <p>For 0.1% AEP, there is a slight encroachment of flood emanating from the road to the south of the boundary. However, a large proportion of the site remains outside of the flood extents, so, the primary source of flood risk at this site is from tidal inundation.</p>

Designation Area

Mellishaw North

Tidal

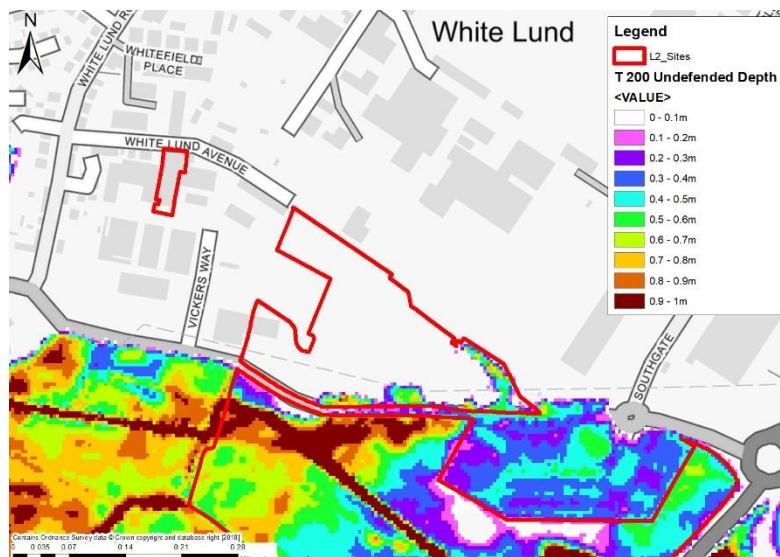


Figure 2.4.8 - Tidal Undefended 0.5% AEP Depths (m)

For the Tidal 2014 ABD study, the 0.5% AEP outline indicates that the site will be partially inundated from flooding from the south of the site. These depths of flooding range up to a maximum of 0.6m, however, as this is a small proportion of site area, it would be recommended to develop areas outside of the flood extents.

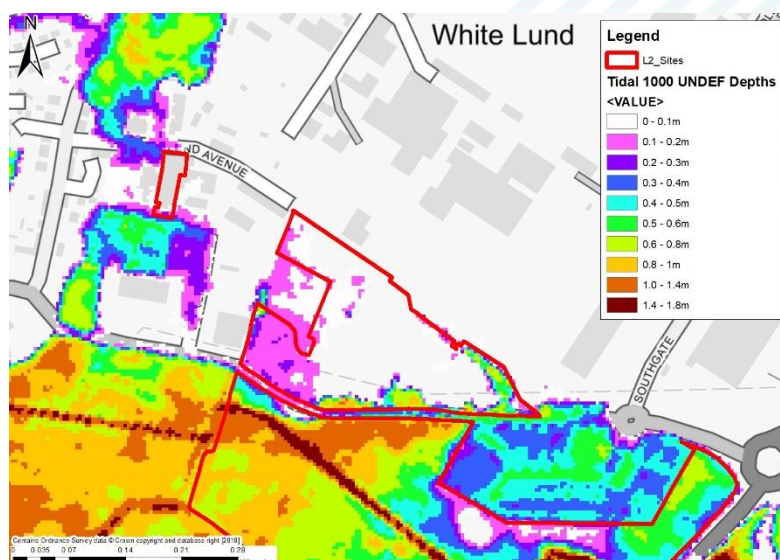


Figure 2.4.9 - Tidal Undefended 0.1% AEP Depths (m)

For the Tidal 0.1% AEP undefended case, the flood extents are similar to that of the 0.5% AEP. Higher depths of flooding are located in the southern and

Designation Area		Mellishaw North	
		eastern edges of the site boundary and these areas should be avoided for development. There are some areas in the west of the site which are inundated by floodwaters however, depths in this area are generally <0.2m which should not prevent less vulnerable development.	
Mitigation options & site suitability		<ul style="list-style-type: none">According to EA Flood Zone maps, only approximately 14% of the site is located within Flood Zones 1 or 2 presenting 0.6ha of developable site area not within Flood Zone 3. However, the fluvial and tidal models indicate that the Flood Zone maps may not be representative of the actual flood risk at the site. The EA will need to confirm acceptance of this site based on the provided model and topography analysis.Highly localised areas of surface water ponding.No other forms of flooding to be considered for the mitigation options.Access / egress will need to be considered at FRA level as the adjacent road, White Lund Avenue, is also within Flood Zone 3a.	
Flood Source: Groundwater			
Flood risk: groundwater		According to Areas Susceptible to Groundwater Flooding (AStGWF) mapping, the site is within an area regarded as having between 25-50% probability of groundwater emergence occurring.	
Flood Source: Infrastructure Failure – Reservoirs			
Flood risk: reservoir		Site is not within reservoir flood extents.	
Flood Source: Infrastructure Failure – Canals			
Flood risk: canal		There are no canals present near the site and therefore there is no flood risk from canals associated with this area.	
Flood Source: Surface Water			
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)
	0.43	1.25	2.21
Surface water flooding depths	Max: 0.30-0.60m Mean: 0.15-0.30m	Max: 0.60-0.90m Mean: 0.30-0.60m	Max: 0.60-0.90m Mean: 0.30-0.60m
Surface water hazards	Max: Significant Mean:	Max: Significant Mean: Moderate	Max: Significant Mean: Moderate

Designation Area		Mellishaw North				
		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		Generally, there is little flood risk posed to the site with a maximum of 2.2% of the site being within the surface water flood extents. There is a land drain on the western edge of the site which is causing some localised flood risk. There is additional flood risk noted on the eastern edge of the site which is caused by high/low spots on the site which causes surface runoff to pool up, thus creating flood risk. Due to the risk posed by site topography this must be considered during prior to development as cut/fill on site will affect the topography and therefore areas which are likely to cause pooling of runoff. Overall the hazard associated with surface water is regarded as 'moderate' with average depths of flooding noted to be between 0.30-0.60m.				
Surface water: mitigation options & site suitability		<ul style="list-style-type: none">The site will require a FRA being in FZ3 and should consider the potential impacts of the areas within the surface water flood map extents. The land drain and site topography will need to be considered as part of the assessment to ensure that flood risk is not worsened elsewhere.Topography of the site will have a major impact upon areas which may be subject to surface water flood risk and therefore development should aim to use this to divert water to a safe and manageable location.Maintenance of the land drain should also be considered further to ensure that the conveyance of the drain does not worsen flood risk at the site and can safely convey runoff away from the site.				
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 10.45 l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20%	22	3010	579	2431	92.0	0.16ha 3.81%
3.33% AEP Rainfall+40%	30	3732	790	2942	111.4	0.19ha 4.61%
1% AEP	22	3878	579	3298 (867m³ of	124.9	0.22ha

Designation Area			Mellishaw North			
Rainfall+20%				exceedance storage)		5.17%
1% AEP Rainfall+40%	24	4584	632	3952 (1010m ³ of exceedance storage)	149.6	0.26ha 6.20%
Climate change	Application of the central (20%) and upper band (40%) 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	<p>Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p>					

2.5 LA04 – Caton Road, Industrial Estate

Designation Area	Caton Road, Industrial Estate
Site area (ha)	34.49
Existing use	Brownfield. Industrial warehousing.
Existing flood risk vulnerability classification	Less Vulnerable.
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 29.32

Flood outlines (current day)

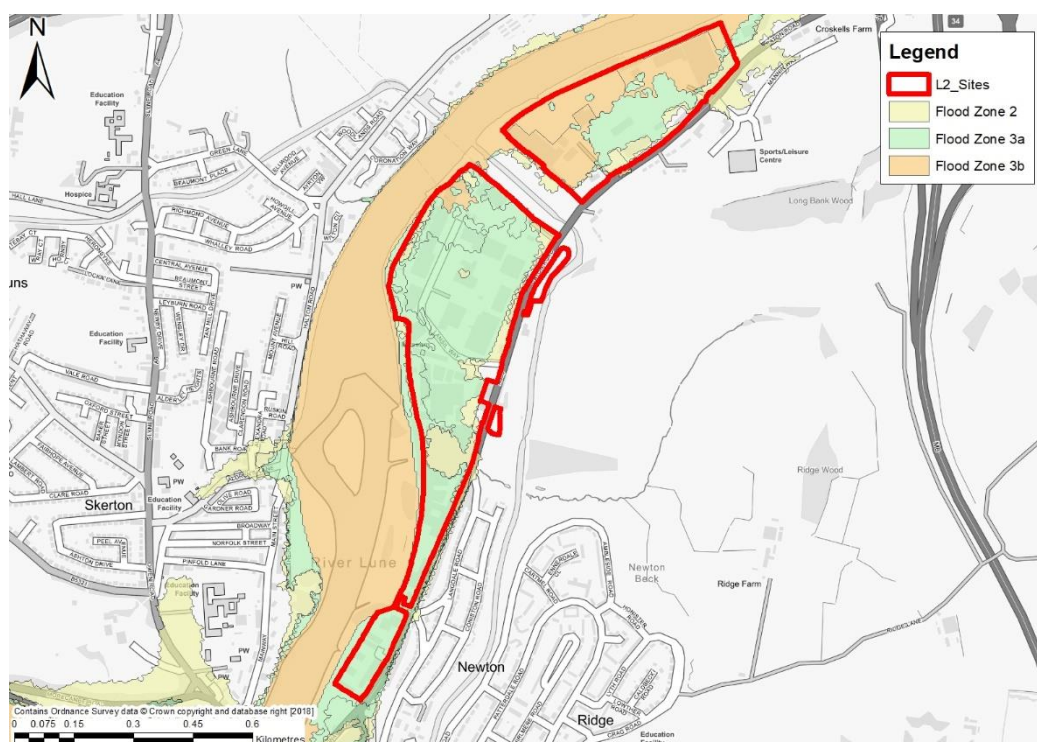


Figure 2.5.1 – Flood Zone Mapping

Designation Area

Caton Road, Industrial Estate

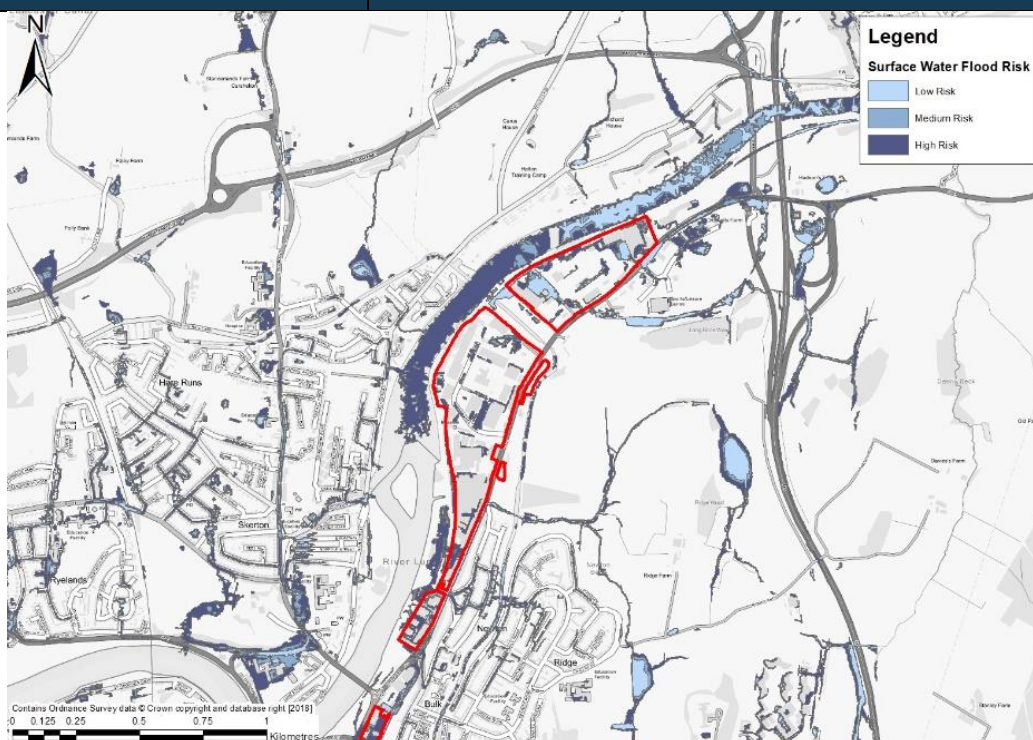


Figure 2.5.2 – Surface Water Flood Risk

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Observations and Recommendations

- Approximately 8%, is located within Flood Zone 3b. Less Vulnerable development will not be permitted within this area (or within the 8m buffer strip along the river corridor).
- A large majority of the site (76%) is within Flood Zone 3a and has previously been developed. This means the site's vulnerability classification will not change.
- Proposed development should be set at existing development levels to avoid reducing the volume of flood storage available. Flood risk should not be increased elsewhere.
- Site is defended to the west side from the River Lune from a raised embankment. However, the standard of protection for the asset is a 25 year event (4% AEP), flood risk from fluvial events is typically considered up to a 100 year event (1% AEP).
- **The Council should consider removing the site from its allocation** due to the modelled flood depths across the site, for 1% AEP these depths can reach up to 1.0m.
- Access should still be maintainable along Caton Road, as this is only within Flood Zone 2 in parts and the rest in Flood Zone 1.
- Site specific access issues will need to be considered as part of the FRA.
- Some localised surface water flood risk, largely in the northern catchment of the development. This varies from 'high' risk (greater than 3.3% AEP) to 'low' risk (between 0.1% - 1% AEP).

Designation Area		Caton Road, Industrial Estate	
Flood Source: Fluvial / Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	9.60	75.65	7.65
Fluvial: Depth (m)	Max: 2.8 Mean: 2.0-2.4	Max: 1.0 Mean: 0.5-0.6	Undefined
Fluvial: Hazard	Undefined	Undefined	Undefined
Climate change guidance (Fluvial)	Climate change impacts have been assessed by updating the existing model, increasing the peak river flow by the North West regional allowance for each epoch and timeframe as identified in Table 1 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115. Representing an increase of 35% for climate change allowances (higher central).		

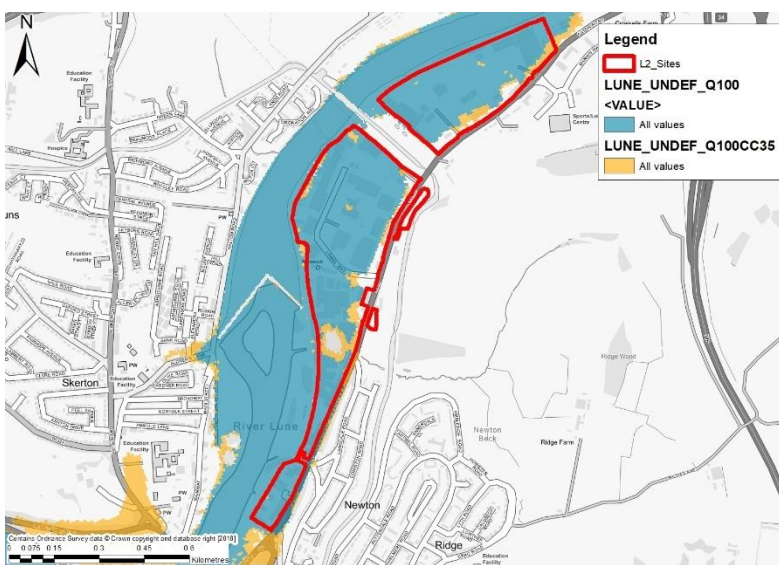
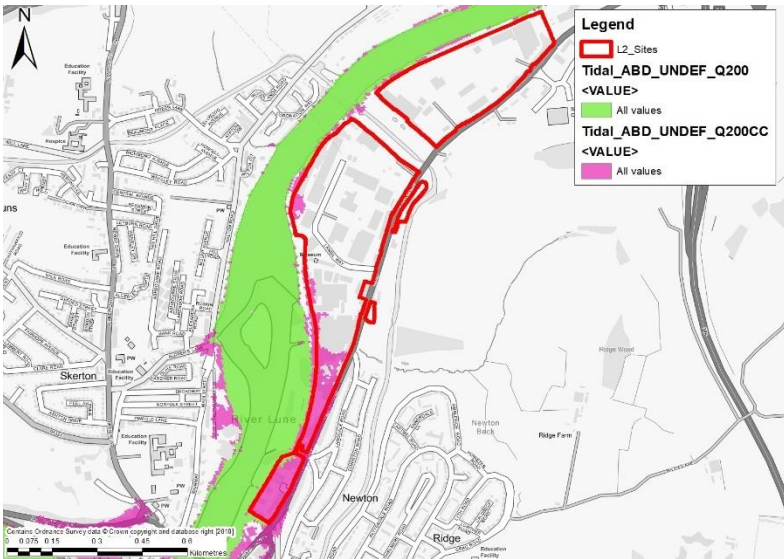
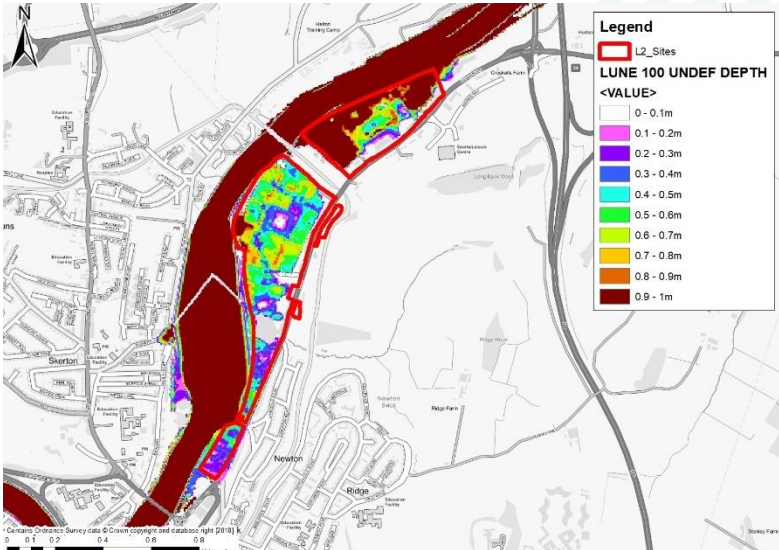


Figure 2.5.3 – Lune Undefended 1% AEP event with climate change

Based on Lune Model 2011
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The site is already largely affected by the Lune 1% AEP undefended scenario, shown in Figure 2.5.5. Whilst climate change allowances increase flood risk at the site, compared

Designation Area	Caton Road, Industrial Estate		
	to the existing model, there is only a slight increase in extents affecting the site.		
Tidal: Depth(m)	Max: 0.4 Mean: 0.1	Max: 0 Mean: 0	Undefined
Tidal: Hazard	Max: Low Mean: None	Max: None Mean: None	Undefined
Climate change guidance (Tidal)	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p>  <p>Figure 2.5.4 – Tidal Undefined 0.5% AEP event with climate change</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>For 0.5% AEP event with CC, the flood extents are increased at the development site and large areas towards the southern edge become inundated. However, due to the extents of the fluvial models, the primary source of flood risk at the site is that of fluvially influenced events.</p>		

Designation Area	Caton Road, Industrial Estate
Historic flooding	Approximately 90% of the site is within the Historic Flood map extents however no further flood records are available for this site.
Defended	The site is protected from the River Lune by an embankment only. It is described as "Channel Bed & Fragmented Raised Bank". It has a design standard of 25 years.
Flood Warning Area	Approximately 95% of the Designation Area is within the Flood Warning Area "Low lying land including properties off and including Damside Street, North Road, Parliament Street, Kingsway, The Ramparts and Aldren Lane, Lansil Industrial Estate and Riverside Industrial Estate". This is due to the proximity to the nearby River Lune.
Flood risk	<p><u>Fluvial</u></p> <p>Due to the site's proximity to the River Lune there is a risk of flooding from the river itself. There are flood defences between the Lune and the site, however, this is only a raised embankment with a standard of protection of 25 years. The condition of the embankment is graded as a 3, meaning it could benefit from minor repair works to ensure the longevity of the asset. Surveys should be undertaken in conjunction with a FRA to assess the expected lifetime of the asset and potentially whether any improvements will need to be made to the asset in future to further protect from flood risk.</p>  <p>Figure 2.5.5 – Lune Undefended 1% AEP Depths (m)</p> <p>Relatively high depths of flooding have been recorded from the Lune 2011 Model for the site at Caton Road. Depths in the northern section reach up to 1m which would not allow for safe development in this area.</p>

Designation Area

Caton Road, Industrial Estate

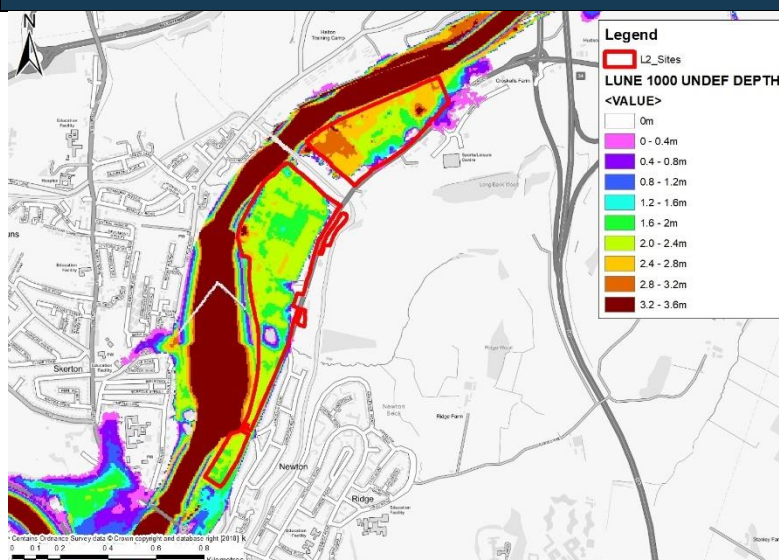


Figure 2.5.6 – Lune Undefended 0.1% AEP Depths (m)

Depths for 0.1% AEP event are significantly higher than the corresponding 1% AEP event levels. The average depth of flooding is approximately 2-2.4m.

Tidal

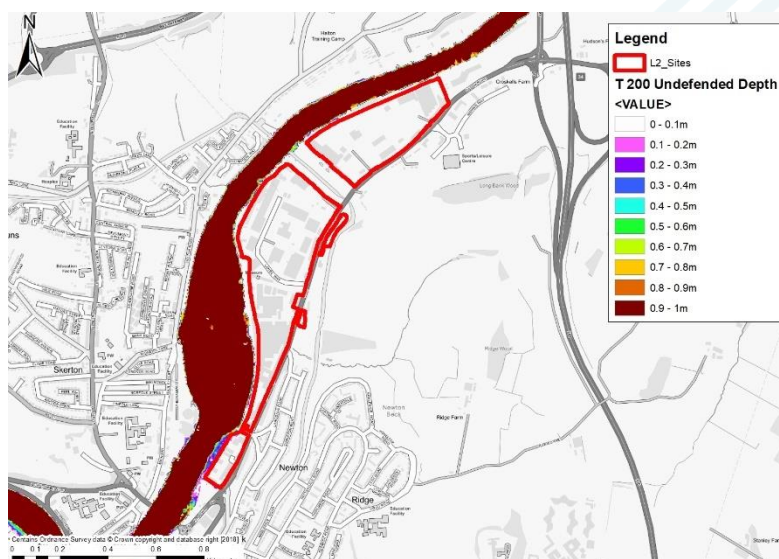
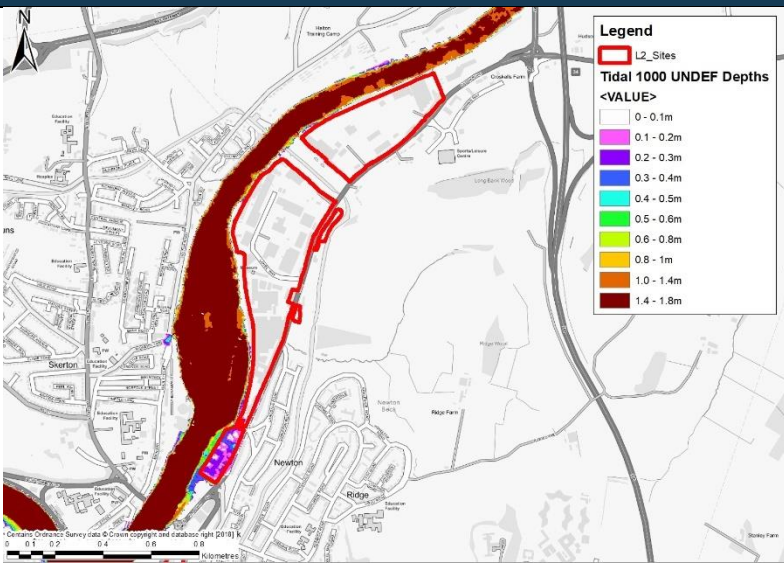


Figure 2.5.8 – Tidal Undefended 0.5% AEP Depths (m)

No part of the site is within the modelled flood extents for the tidal 0.5% AEP.

Designation Area		Caton Road, Industrial Estate
		 <p>Figure 2.5.9 - Tidal Undefended 0.1% AEP Depths (m)</p> <p>The southern edge of the site is within the modelled flood extents for the 0.1% AEP tidal event. Depths of flooding however are low in this area (<0.2m).</p>
Mitigation options & site suitability		<ul style="list-style-type: none"> Existing flood defences between the site and the River Lune should be surveyed alongside a site specific FRA to determine the expected design life of the asset and its likely standard of protection after climate change allowances. There are some areas of surface water ponding on the site. These would need to be managed as part of any development proposal. Safe access and egress should be achievable along Caton Road. Development should be set to existing ground levels due to the fact that any land raising within this area is likely to reduce the volume of flood storage available, thus increasing flood risk elsewhere. Depths of flooding recorded as being up to 1.0m for the 1% Lune undefended scenario which is too deep to allow for safe redevelopment of the site. The Council should consider removing this site from its allocation.
Flood Source: Groundwater		
Flood risk: groundwater		The majority of the site is regarded as having between 50-75% probability of groundwater emergence. Development should consider avoiding underground structures such as basements as these increase the susceptibility of groundwater emergence.
Flood Source: Infrastructure Failure – Reservoirs		
Flood risk: reservoir		Site is not within reservoir flood extents.
Flood Source: Infrastructure Failure – Canals		

Designation Area		Caton Road, Industrial Estate		
Flood risk: canal	The Lancaster Canal is raised and flows between the northern and southern extents of the site. The canal is approximately 15m higher in elevation than the surrounding areas and as such presents a significant risk of flooding to the site from the canal. A significant storm surge could overtop the canal in which may result in exceedance flows entering the site.			
Flood Source: Surface Water				
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)	
	3.88	2.94	11.88	
Surface water flooding depths	Max: 0.90-1.20m Mean: 0.15-0.30m	Max: 0.90-1.20m Mean: 0.30-0.60m	Max: >1.20m Mean: 0.30-0.60m	
Surface water hazards	Max: Significant Mean: Moderate	Max: Significant Mean: Moderate	Max: Significant Mean: Moderate	
Climate change	Application of the central (20%) and upper band (40%) 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 to development site	This site has a relatively high surface water flood risk with up to approximately 12% of the total land area being at risk from surface water flooding for the 'low risk' return period and approximately 4% of the site is within the 'high risk' return period. There are overland flow paths flowing along Caton Road being diverted towards the site which will affect the ability to achieve safe access / egress to the development during storm events.			
Surface water: mitigation options & site suitability	<ul style="list-style-type: none">Surface water flooding appears localised and so should 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. The development area is generally subject to a low surface water flood hazard. However, a site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to the ponded areas and potential outfalls into the Lune. Any requirement for new culverts will need to ensure surface water flood risk is managed. The FRA will need to mitigate climate change impacts across the lifetime of the development.			

Designation Area				Caton Road, Industrial Estate		
				<ul style="list-style-type: none">• Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS.• The FRA should also assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites.• The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes).		
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 330 l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty assuming no infiltration Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20%	8.5	20698	5049	15649	26.3	1.04 ha 3.02%
3.33% AEP Rainfall+40%	10	25120	5940	19180	32.2	1.28 ha 3.71%
1% AEP Rainfall+20%	9.75	28411	5792	22619 (6970m³ of exceedance storage)	38.0	1.51ha 4.38%
1% AEP Rainfall+40%	11	33942	6534	27408 (8228m³ of exceedance storage)	46.0	1.83ha 5.31%
Climate change	Application of the central (20%) and upper band (40%) 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	<p>Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p>					

Designation Area	Caton Road, Industrial Estate
	<p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p>

2.6 LA18 – Glasson Industrial Estate

Designation Area	Glasson Industrial Estate
Site area (ha)	5.41 (both red line boundaries shown in Fig 2.6.1)
Existing use	Brownfield. Industrial warehousing.
Existing flood risk vulnerability classification	Less Vulnerable.
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 4.60

Flood outlines (current day)

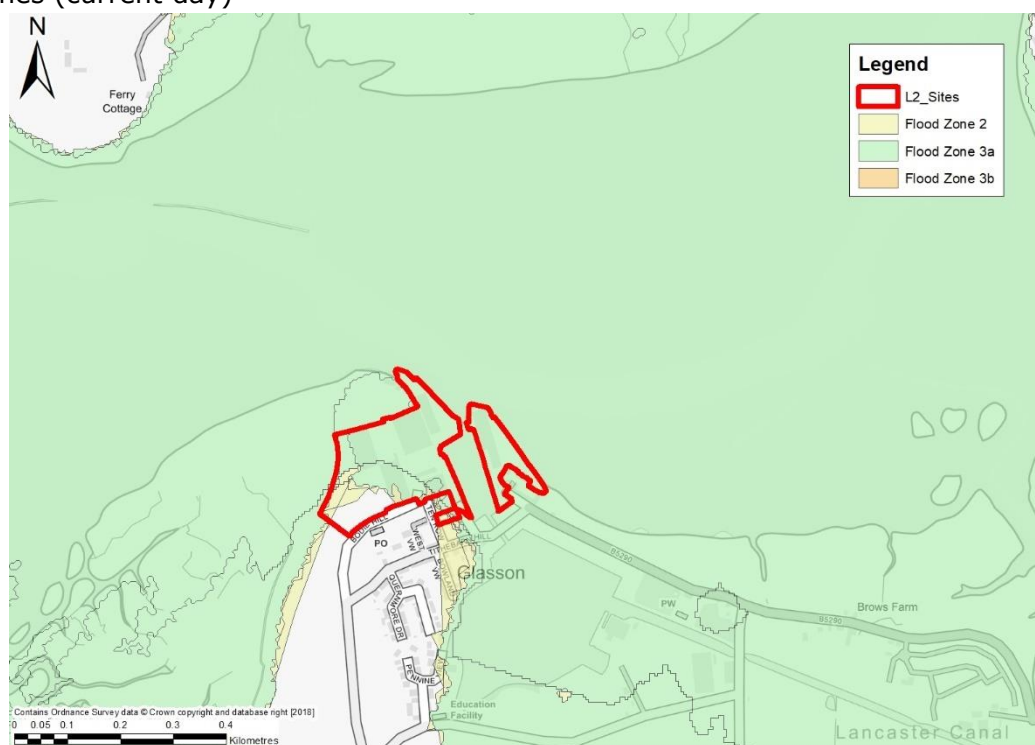


Figure 2.6.1 – Flood Zone Mapping

Designation Area

Glasson Industrial Estate

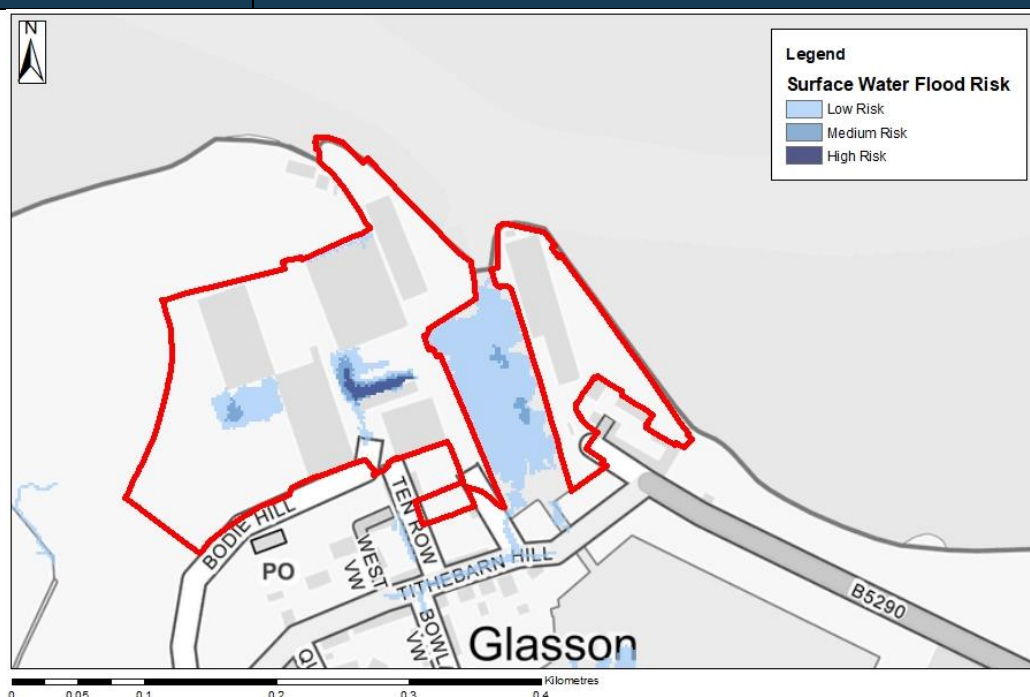


Figure 2.6.2 – Surface Water Flood Risk

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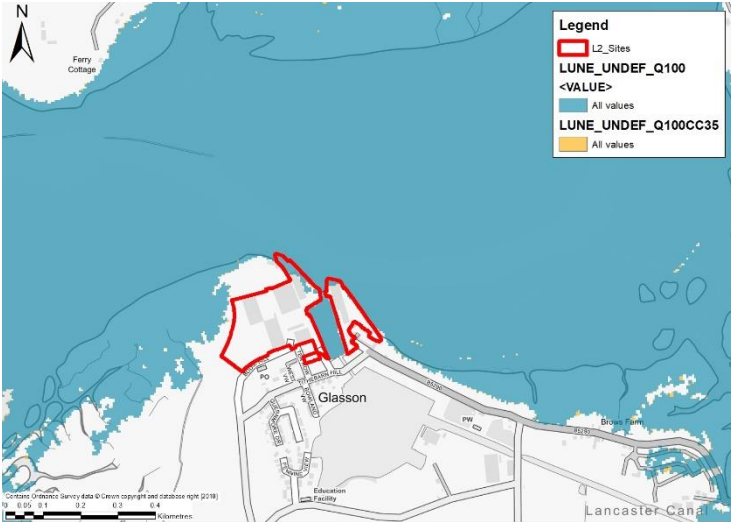
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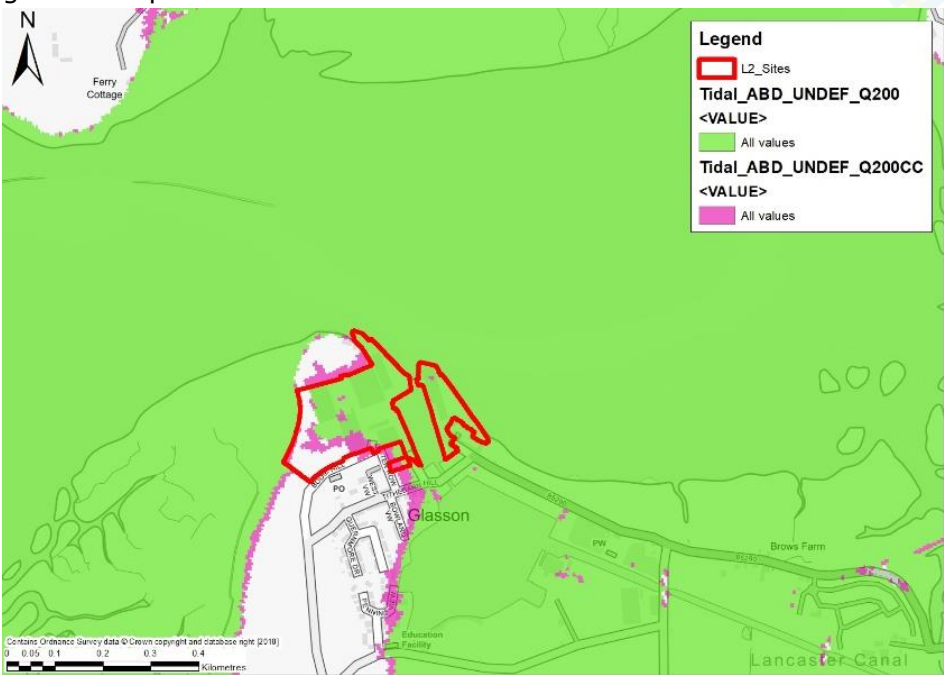
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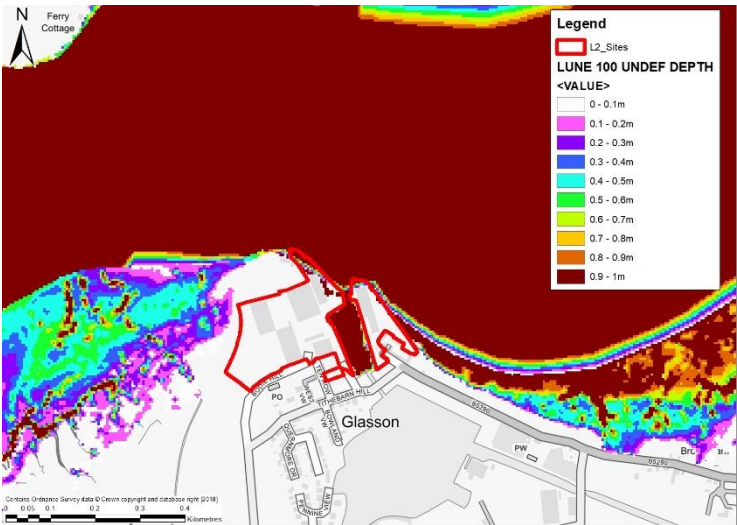
Observations and Recommendations

- Glasson Industrial Estate is situated on the Glasson Dock and is therefore, at risk from tidally influenced events. The majority (81%) of the site is in Flood Zone 3a which permits consideration of Less Vulnerable development uses.
- The site has previously been developed and industrial warehousing units currently exist at the site. The proposed development includes industrial and dock related uses so there is no proposed change in flood risk vulnerability.
- There is a dock gate along the northern edge of the site to regulate waters in the dock. In addition, there are adjacent flood defences that have a design standard of 200 years, typical of tidal flood defences.
- Flood map extents indicate that the site will be inundated from tidal flooding for a 0.5% AEP event. Flooding is predicted to increase when climate change allowances are considered.
- As flood risk is predominantly tidal, land raising in this area is unlikely to increase flood risk elsewhere. Development proposals will need to take flood risk and wave impact into account as part of the site specific FRA.
- Localised areas of surface water ponding will occur within the site boundary and an FRA should consider the locations of these 'ponds' to ensure that the development is not at risk from surface water flooding.
- Predicted depths of flooding are likely to be significant and associated access is likely to be difficult as the surrounding area becomes surrounded by tidal flooding.
- Site is within a 'Flood Warning Area' and any development in this area should make use of the EA's early flood warning system.

Flood Source: Tidal

Designation Area	Glasson Industrial Estate		
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	9.42	80.51	0.00
Climate change guidance (Fluvial)	<p><u>Fluvial</u></p> <p>Climate change impacts have been assessed by updating the existing model, increasing the peak river flow by the North West regional allowance for each epoch and timeframe as identified in Table 1 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115. Representing an increase of 35% for climate change allowances (higher central).</p>  <p>Figure 2.6.3 – Lune Undefended 1% AEP with CC</p> <p>Based on Lune Model 2011 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.</p> <p>Minor inundation from the Lune for 1% AEP, which is confined to the northern edge of the site. This is likely to be a modelling definition issues and the primary source of risk remains tidal inundation. Climate change from a fluvial event makes little difference to the 1% AEP event modelled flood outlines.</p>		
Tidal: Depth (m)	Max: 1.0 Mean: 0.6-0.8	Max: 0.7 Mean: 0.4-0.5	Undefined
Tidal: Hazard	Max: Modera te Mean: Low	Max: Moderate Mean: Low	Undefined

Designation Area	Glasson Industrial Estate
Climate change guidance (Tidal)	<p><u>Tidal</u></p> <p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p>  <p>Figure 2.6.4 – Tidal Un defended 0.5% AEP event with climate change</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>The primary source of flood risk at the site is due to tidally influenced events. Climate change impacts increases flood risk at the site.</p>
Historic flooding	Approximately 90% of the site is within the Historic Flooding mapping extent. The site is adjacent to the estuary which is the primary source of flooding. The site is now protected to some extent by raised defences which should act to mitigate the risk of future flood events.
Defended	The site is protected by numerous flood defences. The site is at risk from tidal flooding and therefore has higher design protection as a tidal defence. These defences include a steel sliding gate and a concrete flood wall.
Flood Warning Area	Approximately 90% of the Designation Area is defined as being in a Flood Warning Area. This is due to the nearby River Lune which presents a risk of flooding to the site. The Flood Warning Area is named as "Glasson, Thurnham Moss, Hillam Lane Farm, Wheatsheaf Cottages and Thurnham Bridge".

Designation Area	Glasson Industrial Estate
Flood risk	<p>The site is at risk from both fluvial and tidal flood events, according to the flood maps. The site is largely within Flood Zone 3a which only allows consideration of Less Vulnerable development. The site is currently already developed, however, details surrounding drainage and discharge locations are unknown. A site specific FRA will typically look to restrict discharge rates from a site to greenfield runoff rates, however, due to the site's proximity to the sea, direct discharge may be achievable. Outfalls into the sea will need to be considered in conjunction with tide levels to ensure that these do not become 'tide locked'.</p> <p><u>Fluvial</u></p>  <p>Figure 2.6.5 – Lune Undefended 1% AEP Depths (m)</p> <p>The site is slightly inundated on the northern edge of the perimeter from a 1% AEP event on the River Lune. This is confined to a very small area, with the majority of the site outside the modelled flood extents and these areas should be prioritised for development.</p>

Designation Area

Glasson Industrial Estate

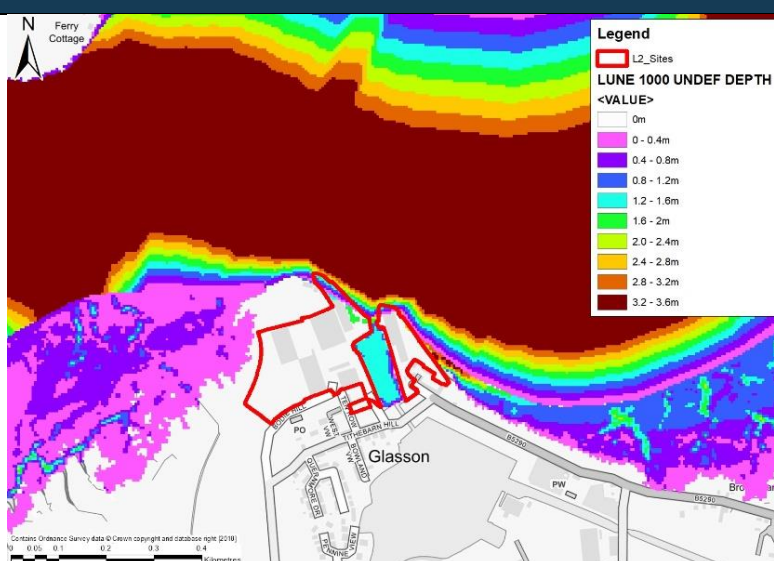


Figure 2.6.6 – Lune Undefended 0.1% AEP Depths (m)

Again, as with Figure 2.6.5, the site is largely unaffected by a fluvial event. The 0.1% AEP outline indicates flooding in a similar area to that of the 1%, which is confined to a localised section along the northern edge of the site.

Tidal

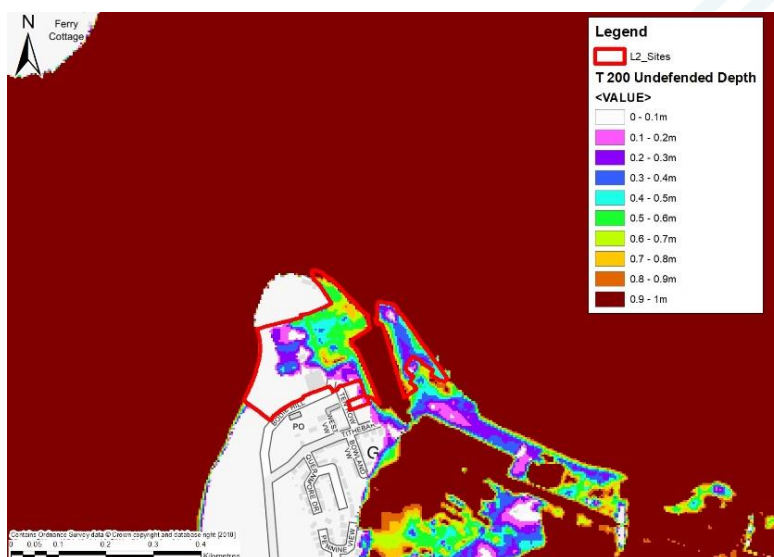
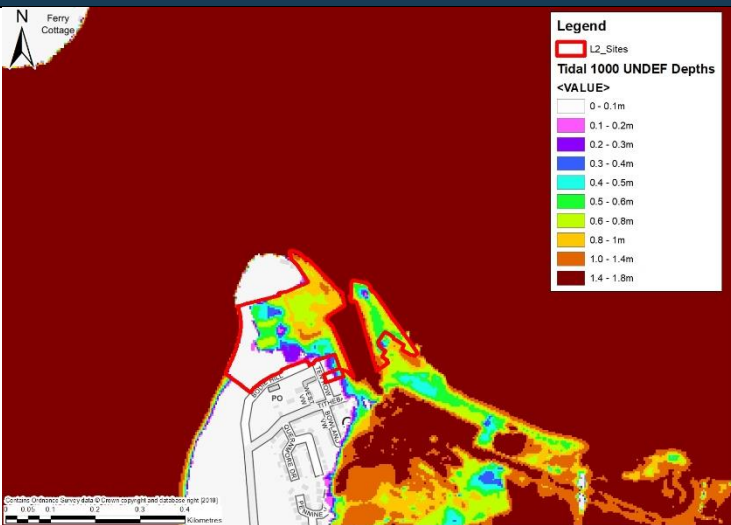


Figure 2.6.7 – Tidal Undefended 0.5% AEP Depths (m)

For the 0.5% AEP tidal undefended scenario, the site is inundated by flooding, affecting large areas of the site. These depths range between 0.2-0.7m, with higher depths of flooding located towards the eastern side of the site.

Designation Area	Glasson Industrial Estate
	 <p>Figure 2.6.8 – Tidal Undefended 0.1% AEP Depths (m)</p> <p>Greater depths of flooding across the site relative to the 0.5% AEP scenario. Depths increase to 1.0m on site. There is a slight variation between the modelled tidal flood extents and the published Flood Zone mapping</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> As this is a dock any proposed development will have to consider the impact of tidal flooding. Proposed development is for employment use. Approximately 10% site area in FZ1 which should be prioritised for development. Condition of assets should be confirmed for the purposes of the FRA to ensure that the defences will provide an acceptable level of protection for the lifetime of the development. 'Less vulnerable' developed may be permissible in FZ3 but must flood risk can be effectively managed throughout the lifetime of the development. Bodie Hill is a potential route to achieve safe access/egress from site during a flood event. It is in FZ1, however, forms a dry island and may not allow for a full evacuation from the area.
Flood Source: Groundwater	
Flood risk: groundwater	The site is at a fairly low risk of groundwater emergence occurring. The available mapping indicates that the site has <25% risk of groundwater emergence.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: reservoir	Site is not within reservoir flood extents.
Flood Source: Infrastructure Failure – Canals	
Flood risk: canal	The Glasson Branch of the Lancaster Canal is controlled by Glasson Dock Flood Gate. The asset regulates levels in the canal which is fed by the River Lune. This protects the surrounding area from canal overtopping and inundating the site.
Flood Source: Surface Water	

Designation Area		Glasson Industrial Estate				
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)	
		0.73	0.92		3.87	
Surface water flooding depths		Max: 0.15-0.30m Mean: 0.15-0.30m	Max: 0.15m-0.30m Mean: 0.15-0.30m		Max: 0.30-0.60m Mean: 0.15-0.30m	
Surface water hazards		Max: Moderate Mean: Low	Max: Moderate Mean: Moderate		Max: Significant Mean: Moderate	
Climate change		Application of the central (20%) and upper band (40%) 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 to development site		There are some localised pockets of surface water flood risk at the site but covers a small proportion of the total site area. For 0.1% AEP, only 4% of the site area is at risk from surface water runoff. There is a moderate hazard rating across the site for the 1% AEP where the extents of surface water flood risk have been mapped. Average depths of surface water flooding between 0.15-0.30m for all return periods.				
Surface water: mitigation options & site suitability		<ul style="list-style-type: none">Relatively low risk of surface water flooding at the site, the extents of which are confined to small localised areas on site. Surface water flood risk should not affect potential redevelopment of the area.Discharge of surface water in this location will typically not require to be limited to greenfield rates or betterment of existing rates due to the proximity of the sea which may be used for free discharge.As the site has been previously developed, SuDS may not be feasible in this location. Options for SuDS should be considered at an FRA level.Attenuation calculations have been provided below. However, as this is a port site, free discharge may be permissible. Tide levels will need to be confirmed at an FRA level to ensure that discharge will not become 'tide locked'.				
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
NOTE: This is a port facility and direct unattenuated discharge is assumed acceptable in this instance.						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 12.9 l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20%	20	3872	650	3222	98.8	0.21 ha 3.88%

Designation Area		Glasson Industrial Estate				
3.33% AEP Rainfall+40%	24	4662	780	3882	119.1	0.26 ha 4.81%
1% AEP Rainfall+20%	20	4943	650	4293 (1071m ³ of exceedance storage)	131.7	0.28ha 5.29%
1% AEP Rainfall+40%	24	5906	780	5126 (1244m ³ of exceedance storage)	157.2	0.34ha 6.32%
Climate change	Application of the central (20%) and upper band (40%) 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	<p>Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p> <p>NOTE: This is a port facility and direct unattenuated discharge is assumed acceptable in this instance.</p>					

2.7 LPSA810 – Land off Imperial Way

Designation Area	Land off Imperial Way
Site area (ha)	11.21
Existing use	Greenfield.
Existing flood risk vulnerability classification	N/A
Proposed use	Residential
Proposed development flood risk vulnerability classification	More Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 9.53

Flood outlines (current day)

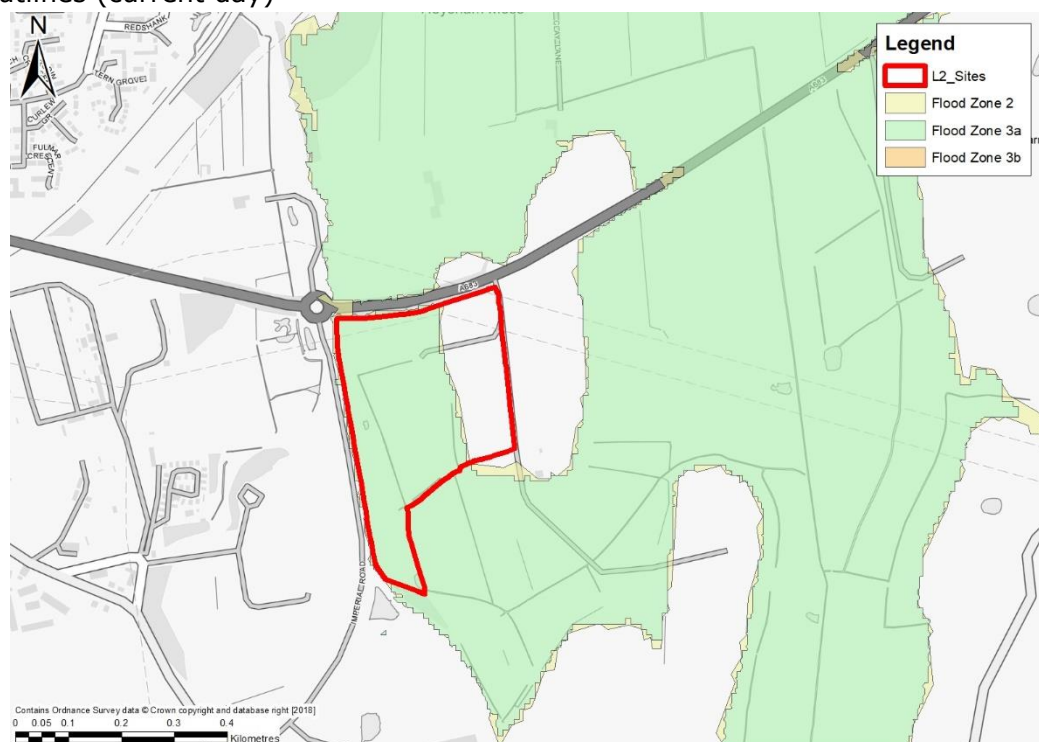


Figure 2.7.1 – Flood Zone Mapping

Designation Area

Land off Imperial Way

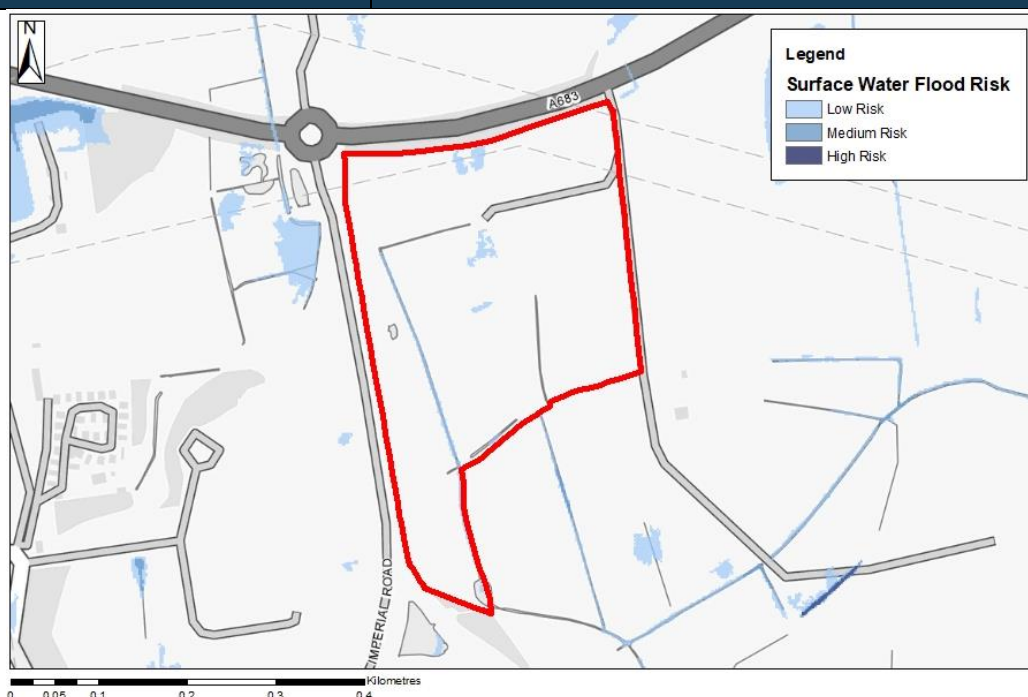


Figure 2.7.2 - Surface Water Flood Risk

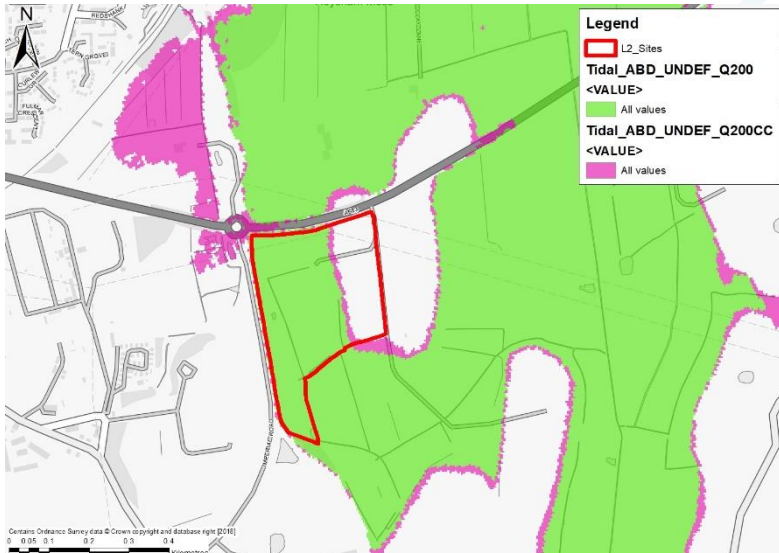
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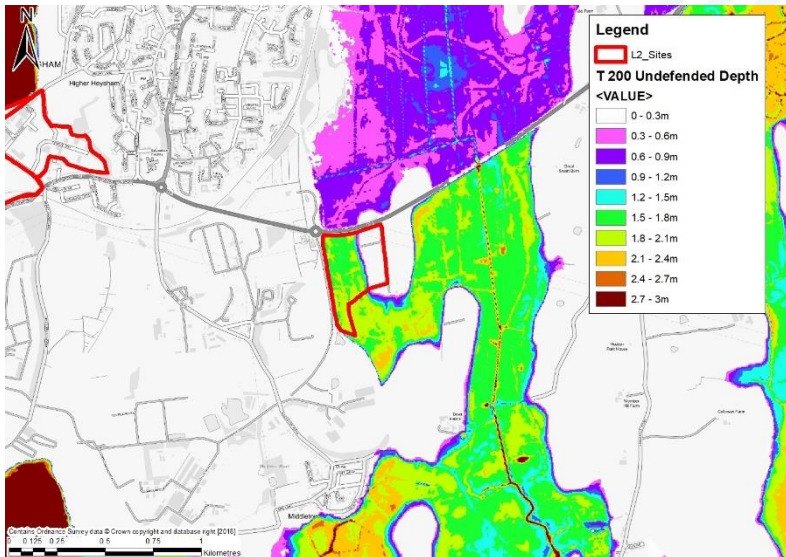
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Observations and Recommendations

- Majority of site (70%) located in Flood Zone 3a, and the proposed use is residential which should avoid development in higher risk areas. Leaving approximately 30% (3.4ha) of developable area in Flood Zone 1.
- Site is previously undeveloped and surface water discharge will typically be set to greenfield runoff rates.
- A land drain flowing through the site to the south, will need to be taken into consideration during the development planning phase to either redirect the drain or make use of it at the site.
- For the design 0.5% AEP, the site is inundated from a tidal event with depths ranging between 1.5-2.1m across the site.
- Approximately 3ha site area within FZ1 and this should be prioritised first as potential areas of development as this is the most acceptable zone for residential development.
- Any land raising within FZ3a may reduce available flood storage. This may increase flood risk elsewhere. Development should not result in increased flood risk, as this would be unacceptable from a planning perspective.
- Access roads to the site are located in FZ1. Safe access and egress should be achievable during flood events.

Designation Area		Land off Imperial Way	
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	1.41	70.80	0.00
Tidal: Depth (m)	Max: 3.0 Mean: 3.0	Max: 2.8 Mean: 1.2	Undefined
Tidal: Hazard	Max: Moderate Mean: Low	Max: Significant Mean: Moderate	Undefined
Climate change guidance (Tidal)	<p><u>Tidal</u></p> <p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p>  <p>Figure 2.7.3 - Tidal Undefended 0.5% AEP event with climate change</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>Climate change increases have been added to the existing 2014 Tidal ABD Study to predict the likely effects of climate</p>		

Designation Area	Land off Imperial Way
	change from a flood risk perspective. For this site, the climate change outline affects slightly more of the site than the existing 0.5% AEP outline, increasing flood risk at the site. However, it is a small increase in area which should not massively impact the site compared to the existing model.
Historic flooding	The Designation Area is not contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.
Defended	There is a flood defence measure approximately 500m east of the site. It is a channel embankment with a design standard of 35 years.
Flood Warning Area	No part of the site is contained within the extent of the Flood Warning Area mapping.
Flood risk	<p>Designation Area is 70% within FZ3a meaning that it is at risk from a 0.5% AEP or greater. Options for residential development within FZ3a are typically avoided due to the perceived level of risk. 'More vulnerable' development is subject to an exception test, at a FRA level, to justify the consequences against the risk of the development and try to avoid areas which are more likely to flood.</p> <p><u>Tidal</u></p>  <p>Figure 2.7.4 - Tidal Undefended 0.5% AEP Depths (m)</p> <p>For the design 0.5% AEP, the site is inundated from a tidal event with depths ranging between 1.5-2.1m across the site. There is an area of land located in Flood Zone 1 that is elevated above flood levels. This area could be considered for development. Safe access should not be impeded by flooding as the A683 is not within the modelled flood extents.</p>

Designation Area

Land off Imperial Way



Figure 2.7.5 - 2m LiDAR map of the site

The modelled flood extents correlate with the topography of the site with a higher elevated section of land situated on the east of the site. Approximately 3ha of site area is within this elevated land and this should be prioritised for safe development in terms of flood risk.

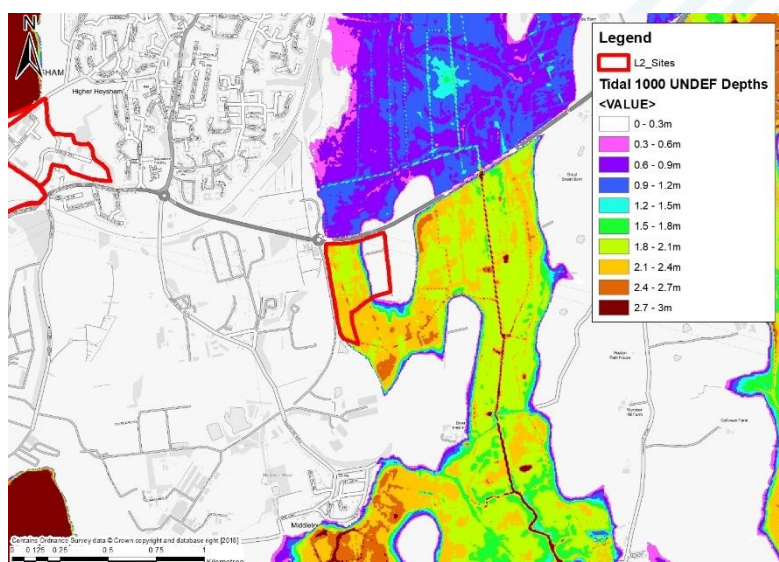


Figure 2.7.6 – Tidal Undefended 0.1% AEP Depths (m)

For 0.1% AEP event, max depths are recorded up to 2.1m which would not allow for development in this area. However, there is 3ha of site area not within any modelled flood extents and this area could be utilised for development. Access is still maintainable along A683 to the north of the site and is not within the flood extents.

Designation Area		Land off Imperial Way		
Mitigation options & site suitability	<ul style="list-style-type: none">The Council should prioritise development in areas not within modelled flood extents, leaving approximately 3ha of developable site area.Areas situated in Flood Zone 1 should be prioritised over higher risk areas (Flood Zone 3a).The depth of flooding within Flood Zone 3a exceeds 1.5m and development within these areas should be avoided.Access (including emergency access) should still be achievable along A683, to the northern edge of the site.			
Flood Source: Groundwater				
Flood risk: groundwater	According to the groundwater emergence maps, the Designation Site has between 25-50% risk of groundwater emergence at the site.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: reservoir	Site is not within reservoir flood extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	There are no canals present near the site and therefore there is no flood risk from canals associated with this area.			
Flood Source: Surface Water				
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	2.52	
Surface water flooding depths	Max: 0m Mean: 0m	Max: 0m Mean: 0m	Max: 0.30-0.60m Mean: 0.15-0.3m	
Surface water hazards	Max: Low Mean: Low	Max: Low Mean: Low	Max: Low Mean: Low	
Climate change	Application of the central (20%) and upper band (40%) 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 to development site	Risk of flooding from surface water at the site is relatively low. The associated hazard and depth mapping indicates that up to a 1% AEP, the maximum depth of flooding is 0m. Post-development discharge rates are typically required to be in keeping with those of the greenfield runoff rate to avoid increasing flood risk.			

Designation Area				Land off Imperial Way		
Surface water: mitigation options & site suitability				<ul style="list-style-type: none">Some localised pockets of surface water flood extents that only affect the Designation Area for a 0.1% AEP.Surface water runoff has a minimal impact upon the site and should not offer any issues in place of development of the site.As the site is currently greenfield, potential options for SuDS should be considered in the drainage strategy. Ground investigations will be required to confirm the viability of SuDS at the site.		
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 35 l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty assuming no infiltration Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20%	15	7328	1323	6005	67.9	0.40 ha 3.57%
3.33% AEP Rainfall+40%	18	8830	1588	7243	81.9	0.48 ha 4.31%
1% AEP Rainfall+20%	15	9598	1323	8275 (2270m³ of exceedance storage)	93.6	0.55ha 4.91%
1% AEP Rainfall+40%	18	11486	1588	9898 (2655m³ of exceedance storage)	111.9	0.66ha 5.89%
Climate change	Application of the central (20%) and upper band (40%) 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	Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'. As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was					

Designation Area	Land off Imperial Way
	<p>included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p>

2.8 SA14 – Port of Heysham Expansion

Designation Area	Port of Heysham Expansion
Site area (ha)	46.20
Existing use	Brownfield. Port warehouses.
Existing flood risk vulnerability classification	Less Vulnerable.
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 39.27

Flood outlines (current day)

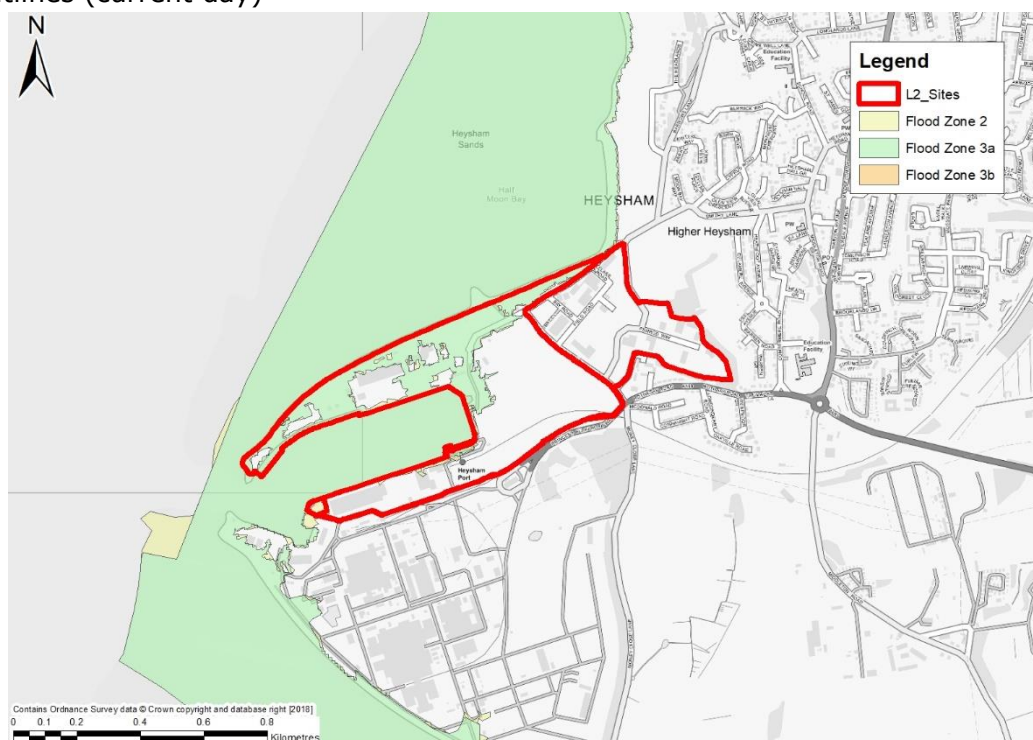


Figure 2.8.1 – Flood Zone Mapping

Designation Area

Port of Heysham Expansion

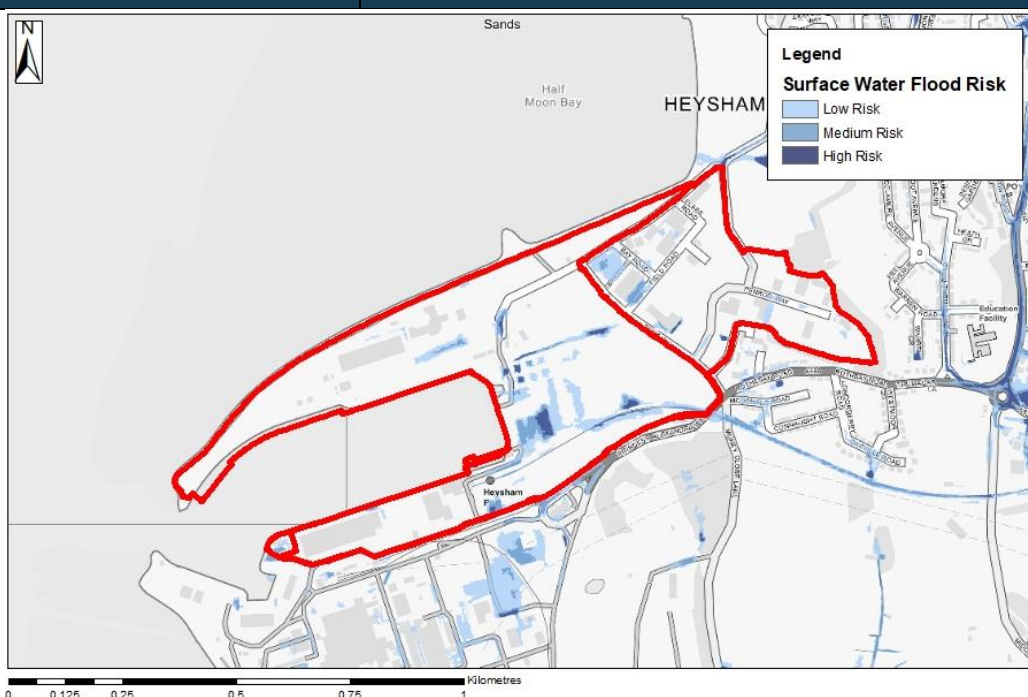


Figure 2.8.2 - Surface Water Flood Risk

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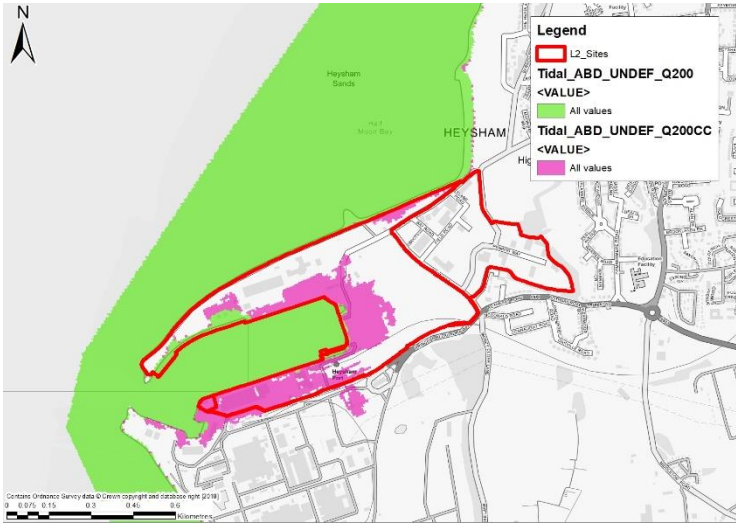
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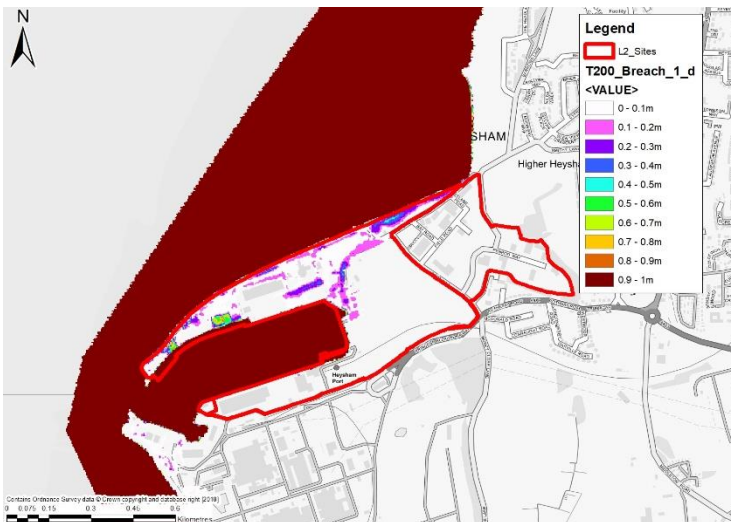
Observations and Recommendations

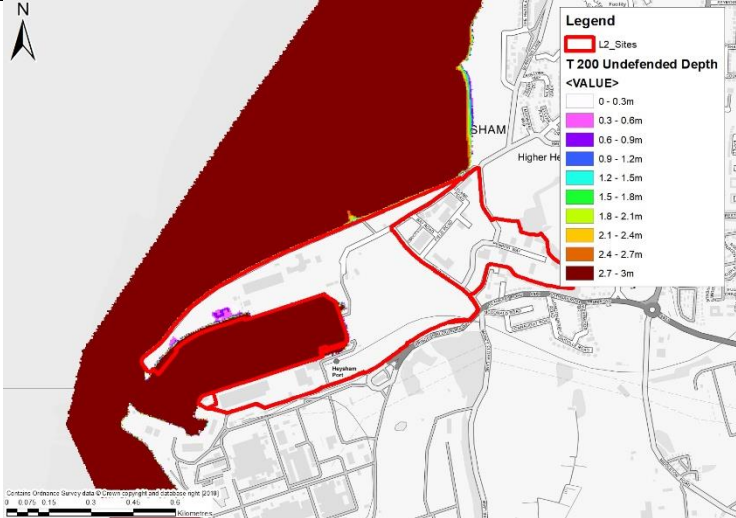
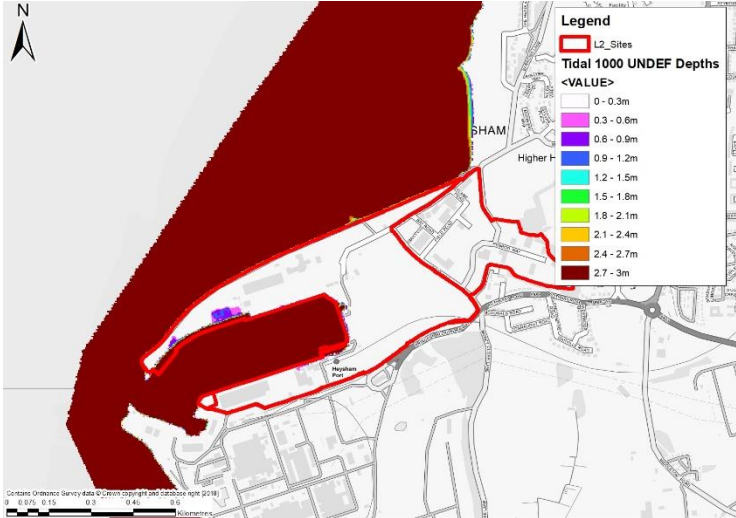
- Port of Heysham Expansion Site which currently has warehousing port related units on for industrial related purposes.
- Site would potentially be suitable for less vulnerable, essential infrastructure or water compatible development within the Flood Zone 3a according to the flood risk vulnerability classification.
- Approximately 77% of the site is located within Flood Zone 2 or Flood Zone 1, which would be more suitable for development than the higher risk areas (FZ3a).
- The site is within the Flood Warning Area of "Lancashire coastline at Heysham" and proposed development should make use of the EA's early flood warning system.
- There are some localised areas of surface water flood risk and consideration of these overland flows should be made as part of the site specific FRA.
- The site is considered suitable for redevelopment provided that a site specific FRA demonstrates that development will be safe for the lifetime of the scheme. The FRA will need to consider wave inundation.

Flood Source: Tidal

Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	2.16	22.72	0.00

Designation Area	Port of Heysham Expansion		
Tidal: Depth (m)	Max: 0.9 Mean: 0.6	Max: 0.6 Mean: 0.2	Undefined
Tidal: Hazard	Max: Significant Mean: None	Max: Moderate Mean: Low	Undefined
Climate change guidance (Tidal)	<p><u>Tidal</u></p> <p>Climate change impacts have been assessed by updating the existing model for peak sea level rise. This is in accordance with the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p>  <p>Figure 2.8.3 – Tidal Undefended 0.5% AEP with CC</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>Flooding to the site, for the undefended tidal 0.5% AEP with CC scenario, is to a maximum depth of 0.5m. Depths typically range between 0.2 and 0.5m for the climate change event. However, a large proportion of the site remains outside of the modelled flood extents and these areas should be prioritised for development.</p> <p>The site remains accessible as the surrounding roads are not within the flood extents.</p>		

Designation Area	Port of Heysham Expansion
Historic flooding	The site is not contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.
Defended	No known EA flood defences currently protect the site.
Flood Warning Area	Site is within the Flood Warning Area of "Lancashire coastline at Heysham" and should make use of the EA's early flood warning system.
Flood risk	<p>Flood risk at the site primarily results from tidal inundation due to the site's proximity to the sea. Approximately 23% of the total site area is within Flood Zone 3a which may be suitable for less vulnerable/water compatible uses.</p> <p><u>Tidal</u></p>  <p>Figure 2.8.4 – Tidal Breach (1) 0.5% AEP Depths (m)</p> <p>The associated breach model outlines supplied with the Tidal 2014 ABD Study indicates that the site experience localised flooding during the 0.5% AEP tidal event. Maximum depths of flooding on the site are approximately 0.6m in some highly localised areas. Average depths are typically less than 0.3m.</p>

Designation Area	Port of Heysham Expansion
	 <p>Figure 2.8.5 – Tidal Undefended 0.5% AEP Depths (m)</p> <p>Based on this modelling for the 0.5% AEP event undefended tidal event depths are less than 0.3m. Flood extents are highly localised.</p>  <p>Figure 2.8.6 – Tidal Undefended 0.1% AEP Depths (m)</p> <p>As with the 0.5% AEP, there is a small localised section of the site at risk of tidal flooding. Predicted depths of 0.9m within this area is predicted.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> As this is a port site, land raising, or elevated structures may be acceptable to reduce the risk of flooding from tidal inundation. Land raising in this area should not increase flood risk elsewhere as this is a tidal risk area. Majority of site within Flood Zone 1 and these areas should be prioritised for redevelopment. Surrounding road areas are all located within Flood Zone

Designation Area		Port of Heysham Expansion	
	1 so safe access/egress should be achievable during flood events.		
Flood Source: Groundwater			
Flood risk: groundwater	The site has a <25% risk of groundwater emergence occurring at the site. This is unlikely to be a significant constraint in this instance.		
Flood Source: Infrastructure Failure – Reservoirs			
Flood risk: reservoir	Site is not within reservoir flood extents.		
Flood Source: Infrastructure Failure – Canals			
Flood risk: canal	There are no canals present near the site and therefore there is no flood risk from canals associated with this area.		
Flood Source: Surface Water			
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)
	0.74	1.59	6.10
Surface water flooding depths	Max: 0.30-0.60m Mean: 0.15-0.30m	Max: 0.30-0.60m Mean: 0.15-0.30m	Max: 0.30-0.60m Mean: 0.15-0.30m
Surface water hazards	Max: Moderate Mean: Low	Max: Moderate Mean: Low	Max: Significant Mean: Low
Climate change	Application of the central (20%) and upper band (40%) 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 to development site	Up to 1% AEP, only 2% of the site is at risk from surface water flooding. Surface water flood risk is typically appraised up to 1% AEP so should not negatively impact the feasibility of redeveloping this area. Potentially the site may be able to discharge surface water runoff straight into the sea under free discharge, however, tidal levels should be confirmed to ensure that discharge does not become ‘tide locked’ and inundate the site.		

Designation Area		Port of Heysham Expansion				
Surface water: mitigation options & site suitability		<ul style="list-style-type: none">Options for SuDS may be limited due to the previous use of the site. These options should be considered further at an FRA level.Very little surface water flood risk at the site in small localised areas. Potential overland flows will need to be considered further in the FRA to ensure that they don't impact upon development.The surface water flood map extents indicate that safe access/egress should be achievable post development due to the expected low depths of flooding in these areas.				
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)						
NOTE: This is a port facility and direct unattenuated discharge is assumed acceptable in this instance.						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 76.8 l/s		
Design flood event (incl 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	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20%	36	35606	6967	28639	147.6	1.91 ha 4.13%
3.33% AEP Rainfall+40%	36	41540	6967	34573	178.1	2.30 ha 4.98%
1% AEP Rainfall+20%	36	44951	6967	37984 (9345m ³ of exceedance storage)	234.3	2.53ha 5.48%
1% AEP Rainfall+40%	36	52443	6967	45476 (10903m ³ of exceedance storage)	243.3	3.03ha 6.56%
Climate change	Application of the central (20%) and upper band (40%) 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	Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing					

Designation Area	Port of Heysham Expansion
	<p>runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p> <p><i>NOTE: This is a port facility and direct unattenuated discharge is assumed acceptable in this instance.</i></p>

2.9 SA19 – Port of Heysham

Designation Area	Port of Heysham
Site area (ha)	33.57
Existing use	Brownfield. Port warehouses.
Existing flood risk vulnerability classification	Less Vulnerable.
Proposed use	Employment
Proposed development flood risk vulnerability classification	Less Vulnerable.
Proposed development impermeable area (ha)	85% of total area (Assumed impermeable area) 28.53

Flood outlines (current day)

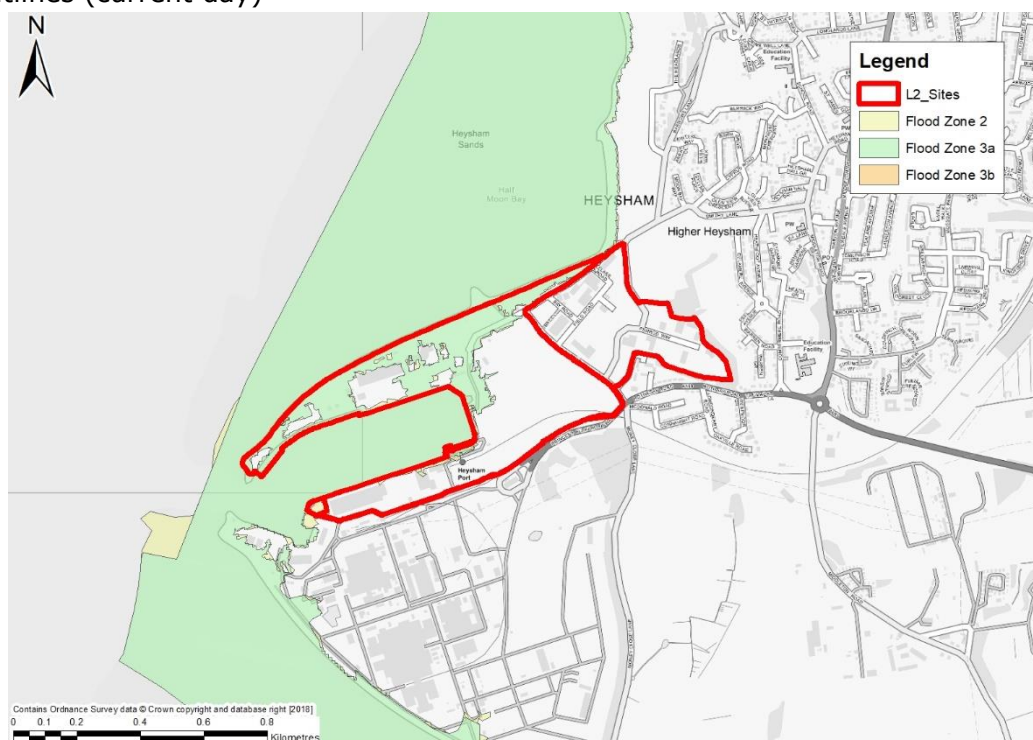


Figure 2.9.1 - Flood Zone Mapping

Designation Area

Port of Heysham

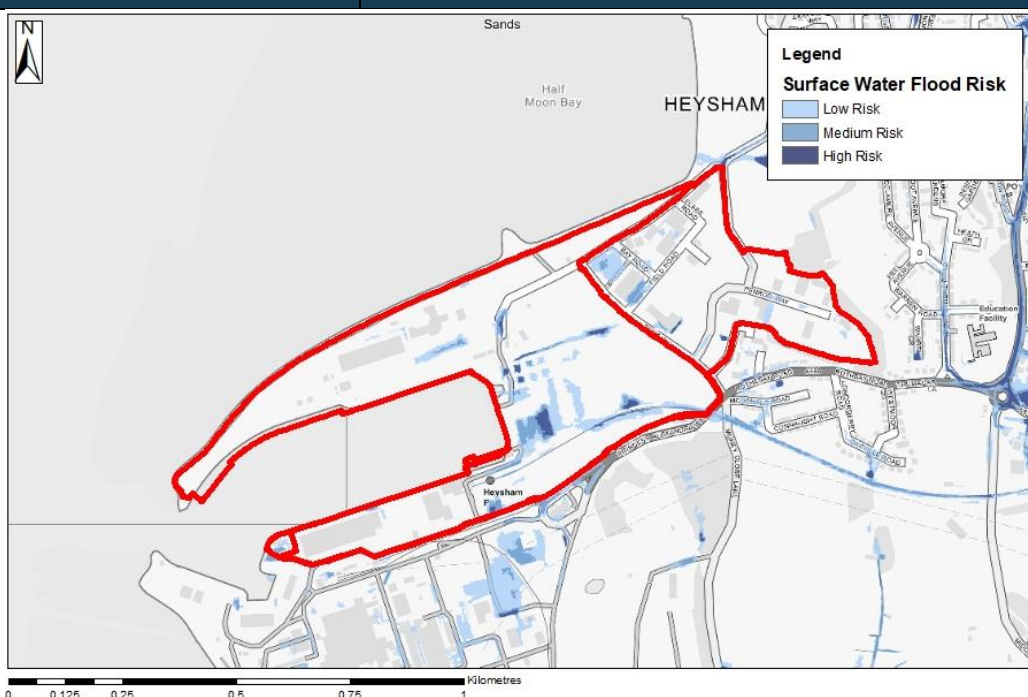


Figure 2.9.2 – Surface Water Flood Risk

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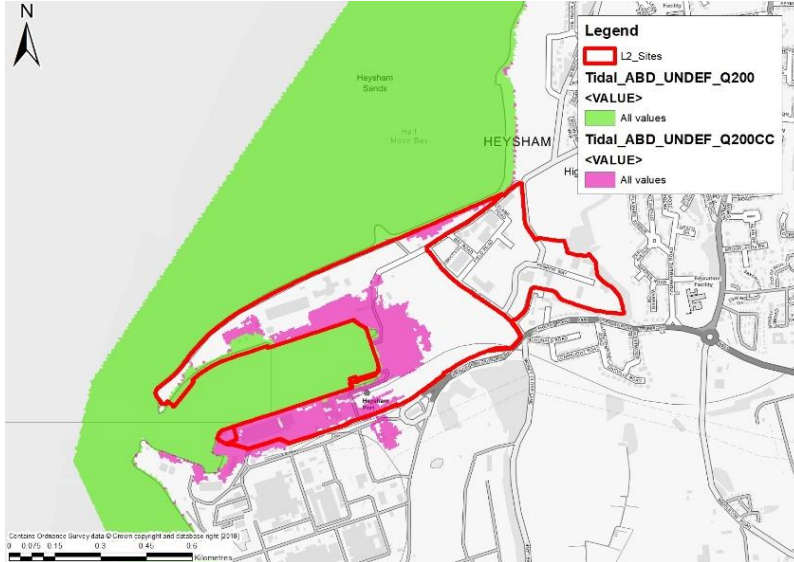
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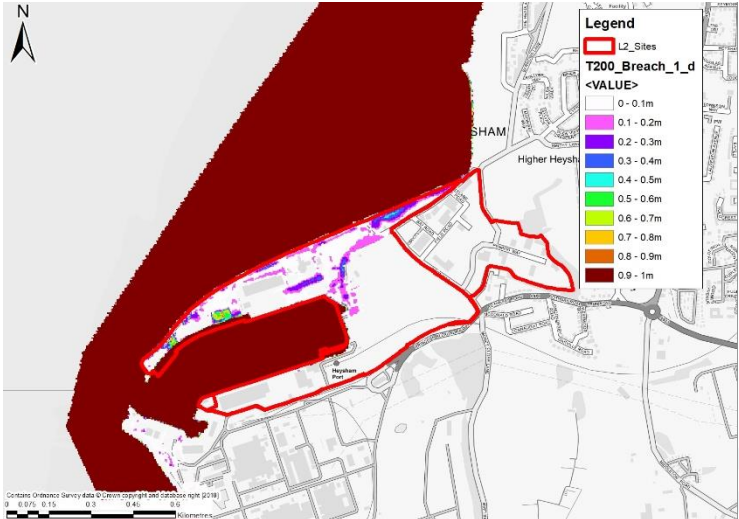
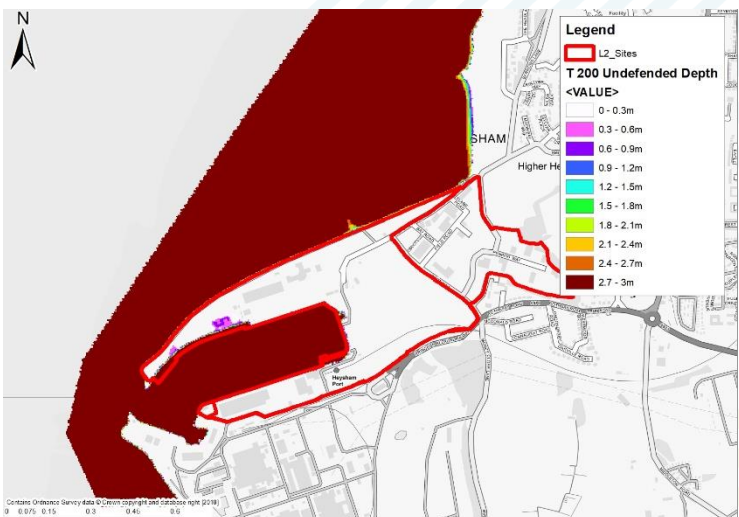
Observations and Recommendations

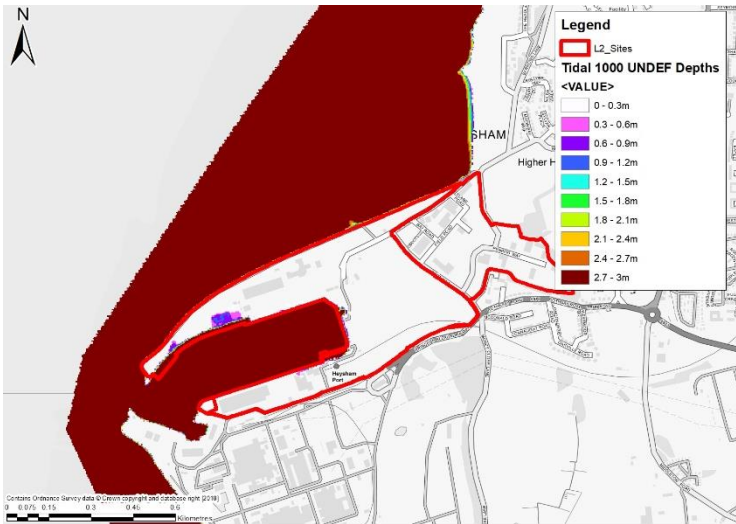
- Port of Heysham currently has port related infrastructure.
- Site would potentially be suitable for less vulnerable, essential infrastructure or water compatible development within the Flood Zone 3a according to the flood risk vulnerability classification.
- Approximately 69% of the site is located within Flood Zone 2 or Flood Zone 1, which would be more suitable for development than the higher risk areas (FZ3a).
- The site is within the Flood Warning Area of “Lancashire coastline at Heysham” and proposed development should make use of the EA’s early flood warning system.
- There are some localised areas of surface water flood risk and consideration of these overland flows should be made as part of the site specific FRA.
- The site is considered suitable for redevelopment provided that a site specific FRA demonstrates that development will be safe for the lifetime of the scheme. The FRA will need to consider wave inundation.

Flood Source: Tidal

Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	3.50	31.12	0.00
Tidal: Depth (m)	Max: 0.9 Mean: 0.6	Max: 0.6 Mean: 0.2	Undefined

Designation Area		Port of Heysham		
Tidal: Hazard	Max: Significant Mean: None	Max: Moderate Mean: Low	Undefined	
Climate change guidance (Tidal)	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North West regional allowance for each epoch and timeframe as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <div></div> <p>Figure 2.9.3 - Tidal Un defended 0.5% AEP with CC</p> <p>Based on Tidal ABD Study 2014 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.</p> <p>Flooding to the site, for the undefended tidal 0.5% AEP with CC scenario, is to a maximum depth of 0.5m. Depths typically range between 0.2 and 0.5m for the climate change event. However, a large proportion of the site remains outside of the modelled flood extents and these areas should be prioritised for development.</p> <p>The site remains accessible as the surrounding roads are not within the flood extents.</p>			
Historic flooding	The Designation Area is not contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.			
Defended	No known EA flood defences currently protect the site.			
Flood Warning Area	Site is within the Flood Warning Area of "Lancashire			

Designation Area	Port of Heysham
	coastline at Heysham" and should make use of the EA's early flood warning system.
Flood risk	<p>Flood risk at the site primarily results from tidal inundation due to the site's proximity to the sea. Approximately 31% of the total site area is within Flood Zone 3a which may be suitable for less vulnerable/water compatible uses.</p> <p><u>Tidal</u></p>  <p>Figure 2.8.4 – Tidal Breach (1) 0.5% AEP Depths (m)</p> <p>The associated breach model outlines supplied with the Tidal 2014 ABD Study indicates that the site experience localised flooding during the 0.5% AEP tidal event. Maximum depths of flooding on the site are approximately 0.6m in some highly localised areas. Average depths are typically less than 0.3m.</p>  <p>Figure 2.8.5 – Tidal Undefended 0.5% AEP Depths (m)</p>

Designation Area	Port of Heysham
	<p>Based on this modelling for the 0.5% AEP event undefended tidal event depths are less than 0.3m. Flood extents are highly localised.</p>  <p>Figure 2.8.6 – Tidal Undefended 0.1% AEP Depths (m)</p> <p>As with the 0.5% AEP, there is a small localised section of the site at risk of tidal flooding. Predicted depths of 0.9m within this area is predicted.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> As this is a port site, land raising may be acceptable to reduce the risk of flooding from tidal inundation. Land raising in this area should not worsen flood risk elsewhere as this is a port site and therefore, may be a viable option to further protect the area. No known formal EA flood defences currently exist to protect the site. Consideration of upgrading any existing assets to the required 0.5% AEP standard of protection or construction of those assets could be an option to protect the site from the current level of flood risk. Majority of site within FZ1 and these areas should be prioritised for development as opposed to the higher risk areas. Surrounding road areas are all within FZ1 so safe access/egress should be achievable during flood events.
Flood Source: Groundwater	
Flood risk: groundwater	The site has a <25% risk of groundwater emergence occurring at the site. This is unlikely to be a significant constraint in this instance.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: reservoir	Site is not within reservoir flood extents.
Flood Source: Infrastructure Failure – Canals	

Designation Area		Port of Heysham		
Flood risk: canal		There are no canals present near the site and therefore there is no flood risk from canals associated with this area.		
Flood Source: Surface Water				
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)	
	0.96	1.88	6.31	
Surface water flooding depths	Max: 0.30-0.60m Mean: 0.15-0.3m	Max: 0.30-0.60m Mean: 0.15-0.3m	Max: 0.30-0.60m Mean: 0.15-0.30m	
Surface water hazards	Max: Moderate Mean: Low	Max: Moderate Mean: Low	Max: Significant Mean: Low	
Climate change		Application of the central (20%) and upper band (40%) 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 to development site		Up to 1% AEP, only 2% of the site is at risk from surface water flooding. Surface water flood risk is typically appraised up to 1% AEP so should not negatively impact the feasibility of redeveloping this area. Potentially the site may be able to discharge surface water runoff straight into the sea under free discharge, however, tidal levels should be confirmed to ensure that discharge does not become 'tide locked' and inundate the site.		
Surface water: mitigation options & site suitability		<ul style="list-style-type: none">Options for SuDS may be limited due to the previous use of the site. These options should be considered further at an FRA level.Very little surface water flood risk at the site in small localised areas. Potential overland flows will need to be considered further in the FRA to ensure that they don't impact upon development.The surface water flood map extents indicate that safe access/egress should be achievable post development due to the expected low depths of flooding in these areas.		
Indicative Surface Water Flood Risk from Proposed Development (for Designation Area in its Entirety)				
NOTE: This is a port facility and direct unattenuated discharge is assumed acceptable in this				

Designation Area				Port of Heysham		
instance.						
Proposed development limiting runoff rate: Greenfield - FEH Statistical				QBar: 55.8 l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m³	Attenuation required m³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (ha) and % of site area
3.33% AEP Rainfall+20%	36	25912	5062	20850	147.9	1.39 ha 4.14%
3.33% AEP Rainfall+40%	36	30230	5062	25168	178.5	1.68 ha 5.00%
1% AEP Rainfall+20%	36	32713	5062	27650 (6800m³ of exceedance storage)	196.1	1.84ha 5.48%
1% AEP Rainfall+40%	36	38165	5062	33103 (7935m³ of exceedance storage)	234.8	2.20ha 6.55%
Climate change	Application of the central (20%) and upper band (40%) 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	<p>Lancaster City Council (LCC) produced the 2015 Planning Advisory Note (PAN) for 'Surface Water Drainage, Flood Risk Management and Watercourses' detailing the preferred approach of LCC for runoff management and development of new sites. LCC require that discharge to a watercourse or surface water sewer must be restricted to the estimated mean Greenfield runoff rate (QBAR) or restricted to a betterment of existing runoff rates for brownfield sites. LCC has stated a preference for storage areas to be open structures such as ponds/swales as opposed to underground tanks which will reduce the total land available to develop however this is in line with the approach set out by LCC of 'SuDS first'.</p> <p>As part of this Level 2 Screening we have included calculations to provide an estimated land take if a pond with an assumed depth of 1.5m was included as part of each development.</p> <p>Attenuation volumes are presented for the critical storm duration for the 1 in 30 year events with exceedance flows quantified up to the 1 in 100 year event. To prevent development worsening flood risk elsewhere, surface water runoff must be managed on site.</p> <p>NOTE: This is a port facility and direct unattenuated discharge is assumed acceptable in this instance.</p>					

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NOTE TO FILE

JBA Project Code	2017s6815
Contract	SFRA Lancaster Climate Change Mapping
Client	Lancaster City Council
Day, Date and Time	7 September 2018
Author	J Rutherford - Assistant Engineer
Reviewer	H Keeble - Technical Director
Subject	Climate change mapping

1 Introduction

Climate change mapping has been produced as part of the Level 2 SFRA Screening Assessment for Lancaster City Council. Four available models, provided under the SFRA commission, have been updated to reflect the potential impact of climate change upon the watercourses and coastal areas. Guidance has been taken from the Environment Agency (EA) "Flood risk assessments: climate change allowances" for the specific increases made to each model. The climate change mapping has been produced to indicate how flood extents are likely to increase in future, due to climate change impacts.

This mapping is intended to help define areas that are more sensitive to climate change impacts and can indicate how both existing communities as well as potential development opportunities may be affected by further flood risk.

Other than increasing design flows for climate change, no additional updates have been made to the available modelling. Flood mapping indicates the extent of flooding in the absence of defences.

This mapping forms an addendum to the City Council's Level 1 SFRA.

The following modelling has been used as the basis of the climate change mapping.

2 Model runs**2.1 Lune 2011**

The Lune 2011 model was increased by 35% to account for potential climate change increases. The map produced is the 1% AEP event and climate change increase. The provided mapping indicates the undefended scenario.

2.2 Wyre 2014

Wyre 2014 model was also increased by 35% which presents the 'higher central' allowance for the North West for the 'total potential change anticipated for the 2080s'. The mapping outlines the 1% AEP with 35% increase for climate change allowances. For the event, 3 separate storm durations of 5.5h, 11h and 17h were run due to the variable effects that different storm lengths have on the activation of flood gates and basin defences located in the catchments. In accordance with the process used in the original project report, the final produced outlines are the 3 separate storm duration extents merged into one.

2.3 Tidal Areas Benefitting from Defences (ABD) 2014

The Tidal ABD mapping was provided as part of the 2014 model. A 0.5% AEP for the year 2115 was also modelled based on the 95th percentile, in accordance with the 2011 climate change guidance. The sea-level increase for climate change ranged from 0.70m at Carnforth (north of study area) to 0.73m Crosby (south of study area).

2.4 Conder 2018

JBA Consulting produced the model for the Lune Tributaries, namely the River Conder in 2018. This has been run to include climate change increases in accordance with the EA guidance. The mapping provided indicates the 1% AEP defended case and 1% AEP

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defended for climate change, 35%. The associated model report indicates that the defended case does not largely affect flood risk in the area and only presents a slightly worse case when compared to the undefended outlines.

2.5 Wenning & Keer 2018

JBA are currently updating the models for the Lune and its tributaries for the Environment Agency. These models require EA internal review. Once these models have been updated, we will proceed to update this note in conjunction and provide the new climate change outlines for the associated models.

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1>

"North West - 'Higher central' 2080s 35% increase for CC"

3 Maps produced

3.1 Lune 2011

Lune 2011 - 1% AEP Undefended Event & 35% Climate Change. (2080s)

3.2 Wyre 2014

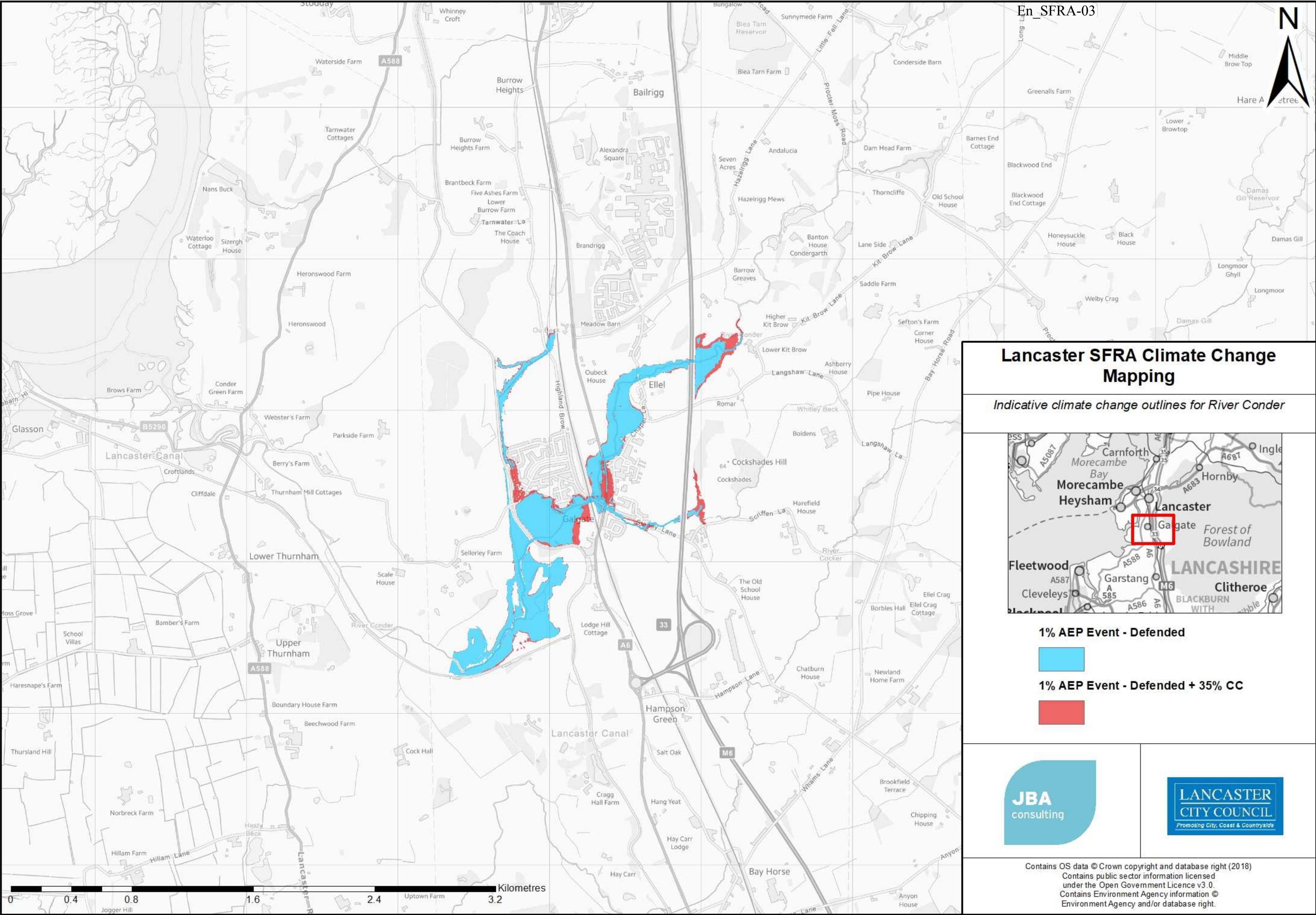
Wyre 2014 - 1% AEP Undefended Event & 35% Climate Change. (2080s)

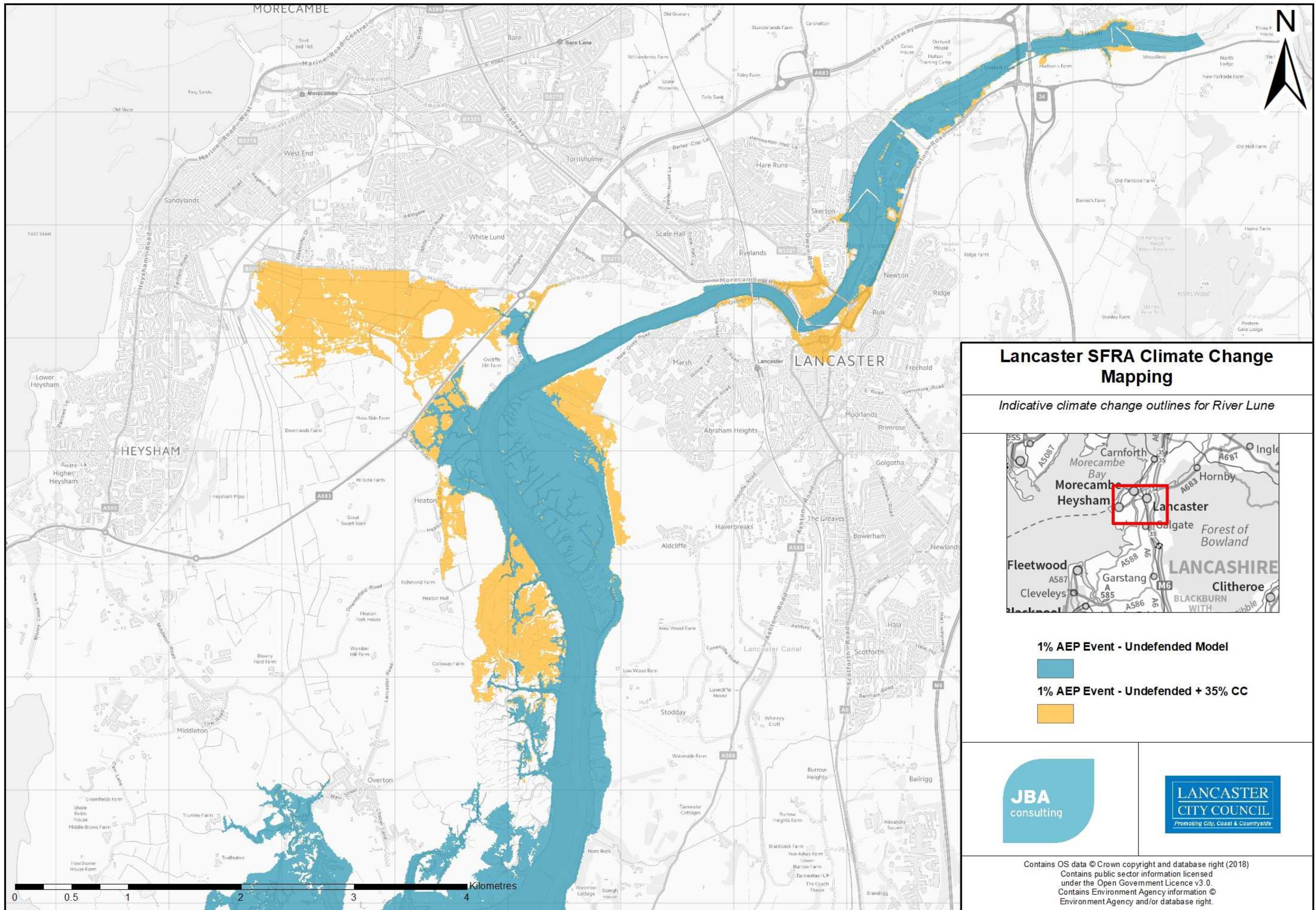
3.3 Tidal ABD 2014

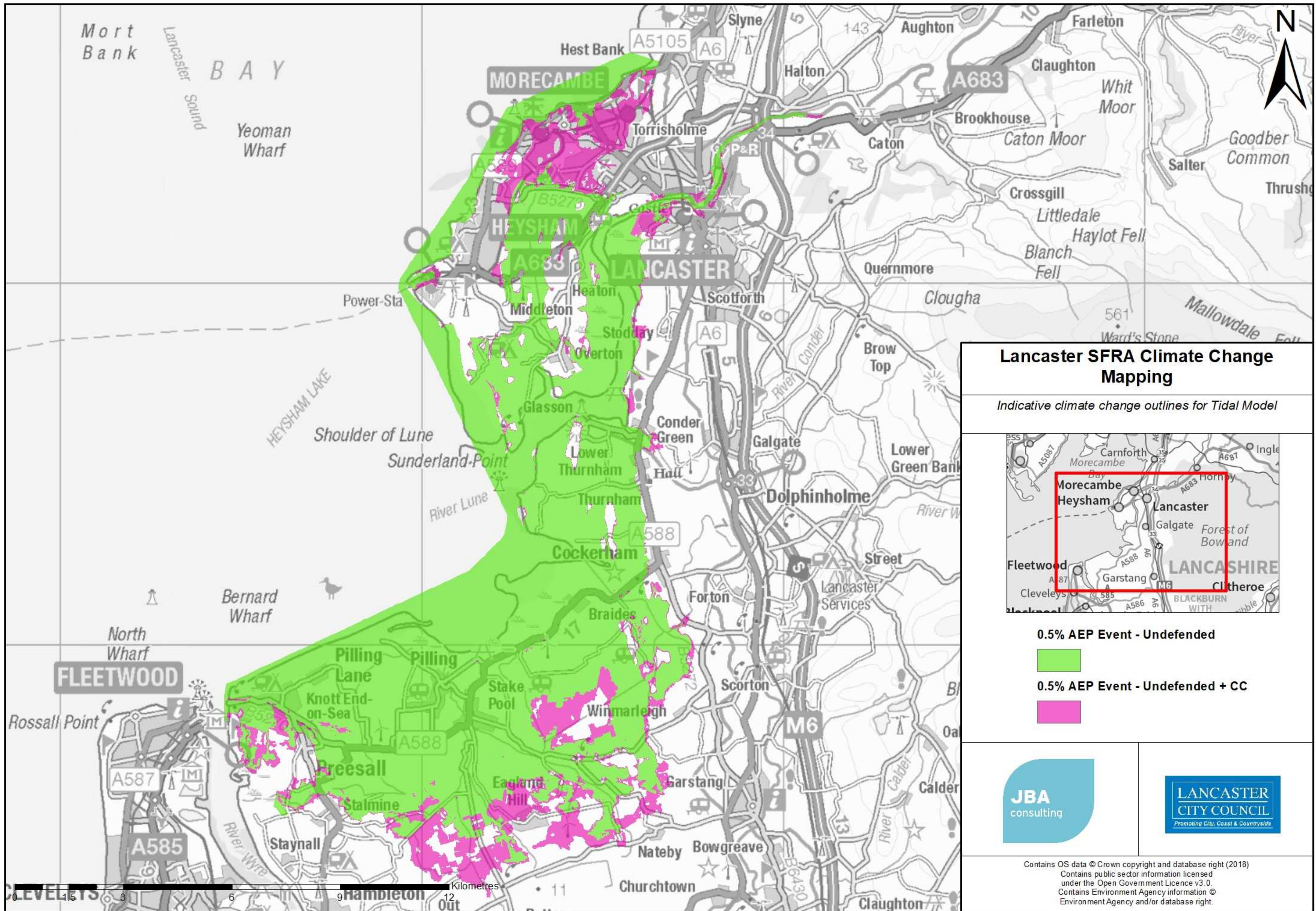
Tidal ABD 2014 - 0.5% AEP Undefended Event & Climate Change. (2080s)

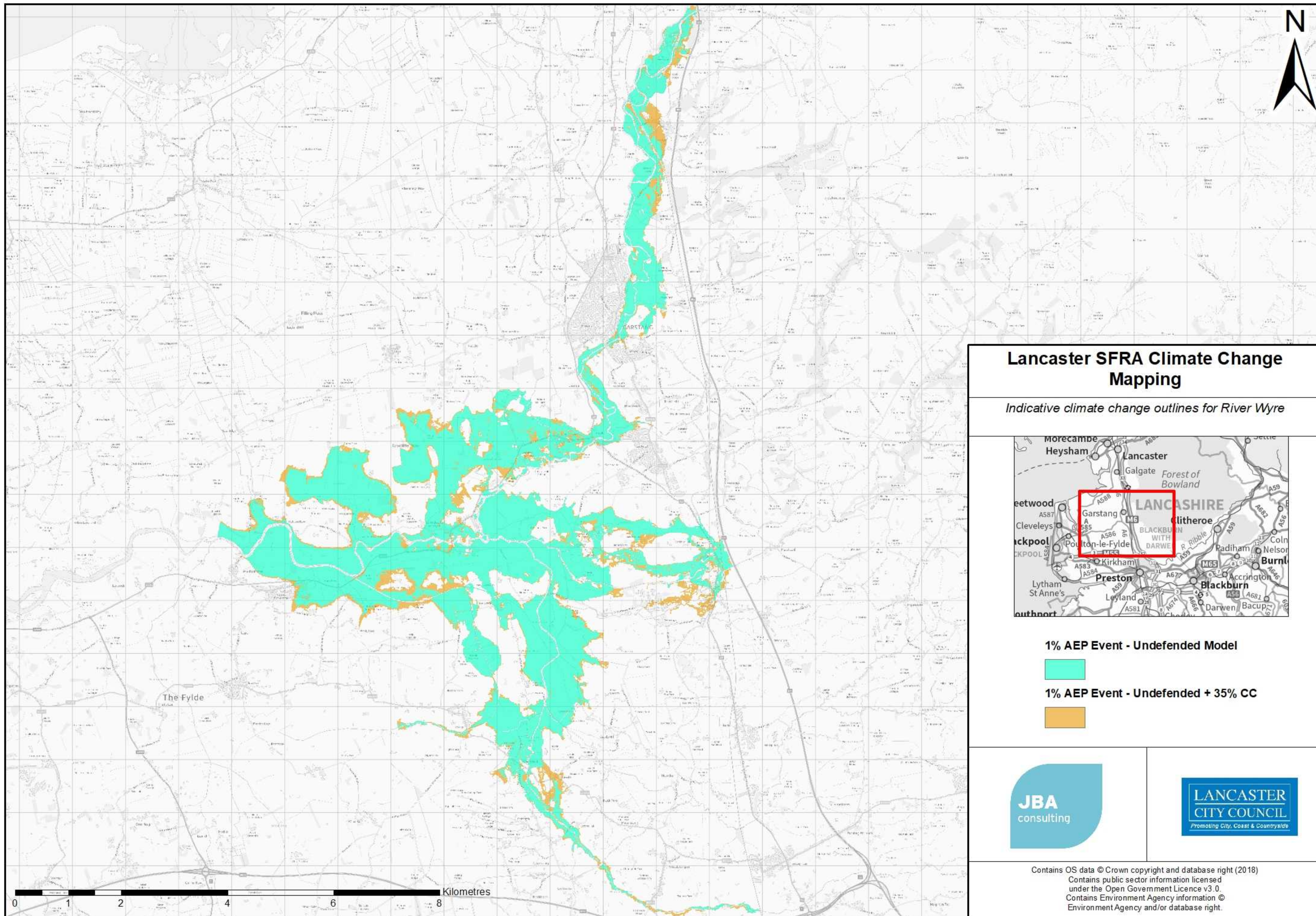
3.4 Conder 2018

Conder 2018 - 1% AEP Defended Event & 35% Climate Change. (2080s)









Lancaster SFRA Climate Change Mapping

Indicative climate change outlines for River Wyre



1% AEP Event - Undefended Model



1% AEP Event - Undefended + 35% CC



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