

Hartlepool Borough Council Local Plan Potential Sites Assessment

Level 2 Strategic Flood Risk
Assessment - Site Screening

August 2017

Final Submission

Hartlepool Borough
Council
Civic Centre
Hartlepool
County Durham
TS24 8AY



JBA Project Manager

Howard Keeble
 JBA Consulting
 Bank Quay House
 Sankey Street
 Warrington
 WA1 1NN

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Contract

This report describes work commissioned by Matthew Clifford, on behalf of Hartlepool Borough Council, by email dated 11 April 2017. David Barton & Alex Masters of JBA Consulting carried out this work.

Prepared by David Barton MEng CEng MICE
 Senior Chartered Engineer

..... Alex Masters MEng, Assistant Engineer

Reviewed by Howard Keeble MPhil BEng BSc CEng CEnv CSci
 CWEM MICE MCIWEM MCI
 Technical Director

Purpose

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

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1 Local Plan Potential Development Site Screening

1.1 Introduction

To inform the Sequential Approach to the allocation of development through Hartlepool Borough Council's upcoming Local Plan, a Level 1 SFRA was completed¹. This report identified several Designation Areas / Development Sites where further, more detailed site specific assessment, was required to confirm the potential suitability of proposed development site 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 FRA;
- Outline drainage strategy;
- Level 2 Site Screening Assessment.

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

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

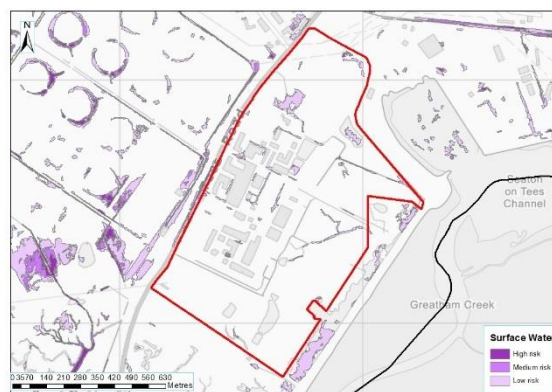
Hazard and depth mapping for each site are provided in the supporting documentation.

2 Site Appraisal Tables

2.1 EMP4b West of Seaton Channel

Designation Area		EMP4b West of Seaton Channel
Site area		77.07Ha
Existing use		Mix Greenfield / Brownfield including industrial chemical works establishment
Proposed use		Industrial (Note - no specific development opportunities have been specified for this site. Flood risk to any proposed industrial facility will need to be appraised in detail as part of any site-specific assessment. The FRA will need to include further consideration of detailed requirements for tidal and wave inundation modelling).
Proposed development flood risk vulnerability classification		Essential Infrastructure
Proposed development impermeable area		95% of total area (Specified by Hartlepool Borough Council) 73.22Ha

Flood outlines (current day)



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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 100% of the site is located within Flood Zone 3a
- The allocation is identified as Essential Infrastructure by HBC owing to its proximity to the existing industrial / chemical facility which imports / exports via Tees Ports facility. HBC identify that the optimum location to minimise environmental impacts for this use is one that is away from residential communities and is accessible to port facilities.
- In the absence of specific development proposals 'Essential Infrastructure' development is likely to be difficult to justify for all areas of this Designation Area. The existing developed area is already raised and remains at risk of flooding especially under climate change scenarios.
- Further land raising, or raised infrastructure may be considered as part of longer term essential infrastructure planning as this approach will not increase risk elsewhere. This will need to be considered further and confirmed as part of a site specific Flood Risk Assessment.
- Surface water flooding appears localised and 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.
- Published Flood mapping identifies approximately 30% of the Designation Area is indicated to be at risk from Reservoir flooding. Published mapping indicates flood depths within a banding of 0.3-2m

Designation Area		EMP4b West of Seaton Channel		
<p>and flood velocity <0.5m/s. Developers would need to consult on any related reservoir issues with the Local Planning Authority as part of the FRA.</p> <ul style="list-style-type: none"> The Council is aware that once Climate Change is taken account of the existing A178 Tees Road is at risk of inundation. Future redevelopment will need to take safe access and egress into consideration. There is extensive flood risk in this area and the adjacent flood embankment is known to have failed. Existing defences are not designed for extensive development, Climate Change, or Essential Infrastructure. 				
Flood Source: Tidal				
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b	
	0.05	99.63	0.00	
Flood Zone depth ² (m)	Max: >1.2 Mean: >1.2	Max: > 1.2 Mean: >1.2	Max: - Mean: -	
Flood Zone hazard	Max: Extreme Mean: Extreme	Max: Extreme Mean: Extreme	Max: - Mean: -	
Climate change	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North East 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>As the Designation Area is already 100% within both Flood Zone 2 and 3a in the current day there is no change in the flood extents across the Designation Area under climate change. As per the current day average flood depths will exceed 1.2m across the entire area. The corresponding Flood Zone hazard rating across the entire area will be Extreme (no change to current day).</p>			
Historic flooding	<p>The Designation Area is contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.</p>			
Defended	<p>Environment Agency records indicate the area is protected by a tidal defence embankment adjacent to Greatham Creek. The entire Designation Area is reported to be an Area Benefiting from Defences. The defence is reported to be at Condition Grade 3 with an upstream defence crest level of 5.56mOD and a downstream crest level of 4.68mOD. The defence embankment runs into high ground at the downstream end, to the rear of the Graythorpe Yard dock. Upstream of the Tees Road the defence is reported to be breached and in its place a retired line embankment with a construction date of 2014 is shown. Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.</p>			
Flood Warning Area	<p>100% of Designation Area within Tees Estuary at Greatham Creek Flood Warning Area</p>			
Flood risk	<p>Generally the low lying site is relatively level across the majority of the area with ground levels 1-1.5mOD. Ground levels tend to fall towards the south west corner where levels are around 0.75mOD. To the south and east of the site, ground levels are relatively level towards Greatham Creek and the flood defence embankment. A network of natural drains and ponds cross this undeveloped low lying area. A large raised area rises sharply across the north and west of the site to form a plateau (approx. level 3.5mOD) on which is located an existing industrial plant.</p> <p>The Designation Area is at greatest risk of flooding from the south where it adjoins Greatham Creek. Approximately 100% of the site is at risk of tidal flooding and located in Flood Zone 2 and 3a. For the lower area to the east and south average flood depths within Flood Zone 3a (0.5% AEP) are</p>			

Designation Area EMP4b West of Seaton Channel	
	<p>significantly in excess of 1.2m and the area has an Extreme Hazard Rating This is similar for Flood Zone 2 (0.1% AEP). For the raised area of existing development, average flood depths are 0.6-0.9m under the 0.5% AEP event, with depths increasing to 0.9-1.2m under the 0.1% AEP event. The hazard rating of this area is significant.</p> <p>The Environment Agency Flood Zone map indicates the extent of flooding in the absence of defences. Given the extents, source and depth of flooding shown these provide an indication of flood risk in the event of a defence failure. The site is located on the estuary front so flooding would be considered instantaneous and to full depth and any development proposals would need to consider the suitability of existing defences and any enhancements required to manage residual risk.</p>
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. The site is predominantly located within Flood Zone 3a where the typical depth of flooding (undefended scenario) is currently in excess of 1.2m with a significant hazard rating. • The site will be afforded an additional level of flood protection in the form of the raised defences. The Standard of Protection provided by the crest level of these defences has not been confirmed by this assessment. The site may, therefore, be reconsidered on this basis; subject to confirmation of residual risks and overtopping assessment as part of a detailed Flood Risk Assessment. The Environment Agency will need to be consulted as to site specific flood risks at that time. • Due to the level of risk across this site (Flood Zone 2, 3a) a more detailed FRA will be required to reflect the site specific development proposals and to demonstrate that flood risk can be effectively managed without increasing risk elsewhere. As the proposed use is Industrial and has been classified as a Essential Infrastructure designation the FRA would have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Development in areas covered by Flood Zone 3a may be difficult and land raising may result in a reduction in available flood storage, however in this instance, it is noted that this is a defended site within an area of tidal flood risk and land raising is unlikely to impact on tide levels. This will need to be considered further (including consideration of potential tidal/fluvial interactions) and confirmed as part of a site specific FRA. Without reference to the protection provided by the existing defences, land raising would need to be higher than the current industrial unit to reduce flood risk to an acceptable level. • Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • An 8m buffer is required along the southern boundary (adjacent to the Greatham Creek) 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. It is noted that the Tees Road is inundated to similar depths as the site within the undefended situation.
Flood Source: Ground Water	
Flood risk: ground water	<p>Majority of the Designation Area identified to be in No Risk Area. Northern and southern extents of Designation Area indicated as having a susceptibility to groundwater emergence of <25%. OS mapping indicates the presence of numerous interconnected ponds / ditches this may indicate shallow groundwater and the need for effective land drainage. Comparison</p>

Designation Area		EMP4b West of Seaton Channel		
	with LiDAR data indicates existing areas of development are raised above surrounding ground with a gradual fall towards Greatham Creek. Ground water flooding may accumulate on the dry side of any raised flood defence.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Published Flood mapping indicates approximately 30% of the southern part of the Designation Area is indicated to be at risk from Reservoir flooding. Published mapping indicates flood depths within a banding of 0.3-2m and flood velocity <0.5m/s. The interaction with the estuary would need to be evaluated further and developers would need to consult with the Local Planning Authority as part of FRA as the Designation Area is within the envelope of reservoir flooding on published flood maps.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
<i>Surface Water Flood Risk to Proposed Development Site</i>				
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)	
	0.02	0.07	2.67	
Surface water flooding depths	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.15-0.3m Average: 0.15-0.3m	
Surface water hazards	Max: Low Average: Low	Max: Low Average: Low	Max: Low Average: Low	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>There is minimal surface water flood risk to the area up to the 0.1% AEP (Low Risk) event. Overall approximately 3% of the site area is at some level of surface water flood risk, however the majority of the mapped surface water is localised and is indicated as being within, or adjacent to existing drains and ponds. Therefore, the percentage of actual surface water flooding is likely to be less. As the surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure these extents are likely to change if the site layout is changed. Average depths are shallow (0.15 to 0.3m) across all events with a low hazard rating. Large areas of the site are undeveloped and there appears to be a network of both managed and semi-naturalised drainage ditches across the area.</p> <p>Mapping does not identify overland surface water flow routes into and across the site from adjacent areas, but there appears to be adjoining ditches, primarily entering the site from the north-west A178 / Tees Road area. This potentially includes runoff from the highway and adjacent sites. OS Mapping indicates ponded waterbodies to the south, adjacent to Greatham Creek. These may collect surface water from the site. Whilst discharge of these is unconfirmed if they discharge to the estuary, this may impact the site and therefore this should be assessed as part of the FRA.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a low flood risk to the A178/Tees Road and therefore off site impacts on access and egress appear manageable.</p>			

Designation Area	EMP4b West of Seaton Channel
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 existing drainage ditches and ponded areas. Existing drainage ditches would need to be maintained or modified in such a way to not increase surface water flood risk. Any requirement for new culverts will need to ensure surface water flood risk is managed. The FRA will need to mitigate climate change impacts across the lifetime of the development. • 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 discharge to the adjacent ponds and Greatham Creek and if these discharge routes are proven, impacts on outfall capacity during high tidal flows will need to be assessed. • The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates a lower flood risk for the A178/Tees Road to the north of the site and therefore off site impacts on access and egress appear manageable.

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

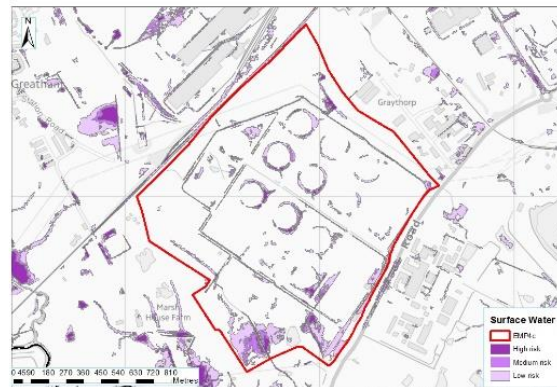
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP: 519.43l/s		
				1% AEP: 617.38l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (Ha) and % of site area
3.33% AEP Rainfall+20%	18	56471	16830	39641	42.3	2.64Ha 3.43%
3.33% AEP Rainfall+40%	24	71536	22439	49097	52.4	3.27Ha 4.25%
1% AEP Rainfall+20%	18	73381	20003	53378 (13737m ³ of exceedance storage)	47.9	3.56Ha 4.62% (0.92Ha 1.19%)
1% AEP Rainfall+40%	18	85611	20003	65608 (16511m ³ of exceedance storage)	58.9	4.37Ha 5.68% (1.10Ha 1.43%)
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	In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where					

Designation Area	EMP4b West of Seaton Channel
site & mitigation	<p>previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may not be required.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

2.2 EMP4c Philips Tank Farm

Designation Area		EMP4c Philips Tank Farm
Site area		150.43Ha
Existing use		Mix Greenfield / Brownfield including industrial tank farm establishment
Proposed use		Industrial (Note - no specific development opportunities have been specified for this site. Flood risk to any proposed industrial related facility will need to be appraised in detail as part of any site specific assessment. The FRA will need to include further consideration of detailed requirements for tidal and wave inundation modelling).
Proposed development flood risk vulnerability classification		Essential Infrastructure
Proposed development impermeable area		95% of total area (Specified by Hartlepool Borough Council) 142.91Ha

Flood outlines (current day)



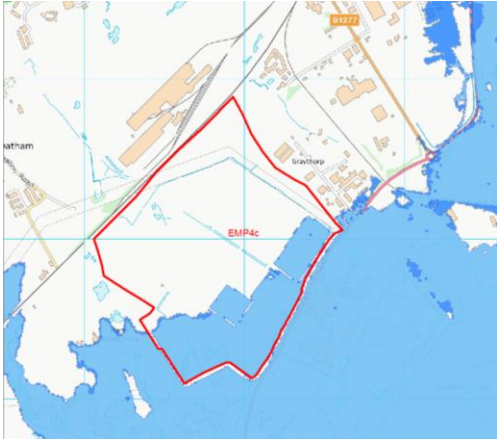
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Observations and Recommendations

- The allocation is identified as Essential Infrastructure by HBC owing to its proximity to the existing oil pipeline which runs from the coast. HBC identify that the optimum location to minimise environmental impacts for this use is one that is away from residential communities and linked to the oil pipeline.
- Approximately 80% of the site is currently located in Flood Zone 1 and is, therefore, suitable for redevelopment, although this reduces to 72% under climate change. The Council may consider allocating the Designation Area for development.
- The Council should consider rezoning Essential Infrastructure development outside of identified flood risk areas, otherwise a more detailed flood risk assessment will be required and this will have to show that the second part of the Exception Test has been satisfied in order for development to proceed.
- 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 Council is aware that once Climate Change is taken account of the existing A178 Tees Road is at risk of inundation. Future redevelopment will need to take safe access and egress into consideration. There is extensive flood risk in this area and the adjacent flood embankment is known to have failed. Existing defences are not designed for extensive development, Climate Change, or Essential Infrastructure.

Designation Area			
EMP4c Philips Tank Farm			
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	3.44	16.34	0.00 (defended)
Flood Zone depth ³ (m)	Max: >1.2 Mean: 0.9-1.2	Max: > 1.2 Mean: 0.9-1.2	Max: - Mean: -
Flood Zone hazard	Max: Extreme Mean: Significant	Max: Extreme Mean: Significant	Max: - Mean: -
Climate change	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North East 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>19% of the Designation Area is currently located within Flood Zones 2 and 3. Flood risk is mitigated to some extent by the EMP4b East of Seaton Channel defences.</p>  <p>Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios</p> <p>Based On 2015 Tidal Tees Model Update of Extreme Sea Level Still Water Level Contains OS data © Crown copyright and database right (2017) Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right.</p> <p>Modelling indicates under climate change the extents of both Flood Zone 2 and 3a will extend northwards by a similar amount to inundate approximately 30% of the Designation Area. Average flood depths will exceed 1.2m across this defined area. The hazard rating will be similar (significant / extreme) with the extents of each increased.</p>		
Historic flooding	The Designation Area is just outside of the Environment Agency Historic flood outline and from available data there are no records of other historic flood events.		
Defended	Environment Agency records indicate the area is protected by a tidal defence embankment adjacent to Greatham Creek. Areas within FZ3a are reported to be an Area Benefiting from Defences. The section fronting the adjacent site EMP4b is reported to be at Condition Grade 3 with the an upstream defence crest level of 5.56mOD and a downstream crest level of 4.68mOD. The defence embankment runs into high ground at the downstream end, to the rear of the Graythorpe Yard dock. Upstream of the Tees Road the defence is reported to be breached and in its place a retired line embankment with a construction date of 2014 is shown. Flood risk to		

Designation Area	
EMP4c Philips Tank Farm	
	<p>this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.</p>
Flood Warning Area	<p>No. Tees Estuary at Greatham Creek Flood Warning Area adjacent to south east boundary with <5% overlap at easternmost extent.</p>
Flood risk	<p>The Designation Area generally slopes from the north to south with ground levels varying from around 13.5m OD to 2.5M OD. The central and northern areas of the area is relatively level at around 8-10m, associated with the oil storage tanks. A high protective embankment bund surrounds the site.</p> <p>A network of natural drains and ponds cross this undeveloped low lying area to the south east of the site. The Tees Road runs adjacent to the eastern site boundary</p> <p>Whilst set back from Greatham Creek (landward of Designation Areas EM4b and EMP6) the Designation is at greatest risk of tidal flooding from the south. In the current day scenario approximately 20% of the southern area of the site is located within Flood Zone 2 and 3. Average flood depths within Flood Zone 3a (0.5% AEP) are significantly in excess of 1.2m and the area has an Significant Hazard Rating. These flood depths decrease in a northerly direction towards the edge of the flood zone (adjacent to the storage tank infrastructure). The Flood Zone 2 flood depths, hazard and extents are similar.</p> <p>The Environment Agency Flood Zone map indicates the extent of flooding in the absence of defences. Given the extents, source and depth of flooding shown these provide an indication of flood risk in the event of a defence failure. The site is located close to the estuary front so flooding would be considered instantaneous and to full depth and any development proposals would need to consider the suitability of existing defences and any enhancements required to manage residual risk.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • The Council may consider allocation reviewing the suitability of this site for redevelopment owing to current flood risk and associated depths of flooding and future implications of climate change. The site is located within Flood Zone 3a. • The site will be afforded an additional level of flood protection in the form of the raised defences. The Standard of Protection provided by the crest level of these defences has not been confirmed by this assessment. The site may, therefore, be reconsidered on this basis; subject to confirmation of residual risks and overtopping assessment as part of a detailed Flood Risk Assessment. The Environment Agency will need to be consulted as to site specific flood risks at that time. • Due to the level of risk across this site (Flood Zone 2, 3a) a more detailed FRA will be required to reflect the site specific development proposals and to demonstrate that flood risk can be effectively managed without increasing risk elsewhere. As the proposed use is Industrial and has been classified as a Essential Infrastructure designation the FRA would have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Development in areas covered by Flood Zone 3a may be difficult and land raising may result in a reduction in available flood storage however in this instance it is noted that this is a defended site within an area of tidal flooding and land raising is unlikely to impact on tidal levels. . This will need to be considered further (including consideration of potential tidal/fluviat interactions) and confirmed as part of a site specific FRA. Without reference to the protection provided by the existing defences, land raising would need to be set higher than the current industrial unit to reduce flood risk to an acceptable level. • Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated.

Designation Area		EMP4c Philips Tank Farm		
	<ul style="list-style-type: none"> An 8m buffer is required along the southern boundary (adjacent to the Greatham Creek) 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. It is noted that the Tees Road is inundated to similar depths as the site within the undefended situation. Significant area of the site appears suitable for redevelopment in terms of flood risk.. However, climate change will result in additional areas of the site being inundated. A detailed FRA for site specific proposal is required.. Development proposals should not include areas of the site at current or future risk of flooding. 			
Flood Source: Ground Water				
Flood risk: ground water	The majority of the Designation Area is identified to be in No Risk Area. The north-eastern extent of Designation Area is indicated as having a susceptibility to groundwater emergence of <25%. OS mapping indicates the presence of numerous interconnected ponds / ditches and this may indicate shallow groundwater and the need for effective land drainage. Comparison with LiDAR data indicates a fall in level across the area in a southerly direction, indicating that groundwater is likely to flow in this direction, corresponding with the existing drainage network.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within Reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
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)	
	1.39	1.89	7.61	
Surface water flooding depths	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.6-0.9m	
Surface water hazards	Max: Moderate Average: Low	Max: Moderate Average: Low	Max: Significant Average: Moderate	
Climate change	The current day 1 in 1000 year outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	There is relatively limited surface water flood risk to the majority of the area up to the 0.1% AEP (Low Risk) event. Overall approximately 11% of the site area is at some level of surface water flood risk, however the majority of the mapped surface water flooding is localised and is indicated as being either within or adjacent to existing drains. There are localised areas of deeper flooding (0.6-0.9m deep in the Low Risk Event) adjacent to drains towards the southern site boundary. These drains appear to discharge out of the site towards Tees Road and the adjacent site EMP4b. Whilst the higher depths appear to be within the ditches, it is noted that there are depths of flooding of between 0.3-0.6m adjacent to the ditches and in other localised areas across the site. Whilst the maximum hazards are significant in very localised areas, they are generally moderate or low across the site. With reference to the mapping the southern area appears to be a natural lower catchment and is likely to be less suitable for development. Large areas of the site are undeveloped and there appears to be a network			

Designation Area EMP4c Philips Tank Farm

of managed and semi-naturalised drains across the site. Surface water flood extents appear to be influenced by the presence of the existing buildings (tank farm) and the drainage infrastructure and these extents are likely to change if the site layout is changed.

Mapping does not identify overland surface water flow routes into the site from adjacent areas, however drainage routes from the site should be assessed as part of the FRA

Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a low flood risk to the A178/Tees Road and therefore off site impacts on access and egress appear manageable.

- Surface water: mitigation options & site suitability**
- 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 subject to low surface water flooding across the site with localised areas of low to moderate surface water flood hazard, which is most significant in the south west area adjacent to the ditches. This area is likely to be less suitable for development. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to the existing drainage routes and pond areas. Existing drainage ditches would need to be maintained or modified in such a way to not increase surface water flood risk. Any requirement for new culverts will need to ensure surface water flood risk is managed. The FRA will need to mitigate climate change impacts across the lifetime of the development.
 - 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 the ability to discharge from the site. If additional discharge is proposed the FRA will need to consider downstream outfall capacity during high tidal flows as this may result in the backing up of drainage ditches affecting the site.
 - The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates a lower flood risk for the Tees Road to the north of the site which provides a potentially suitable access.

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

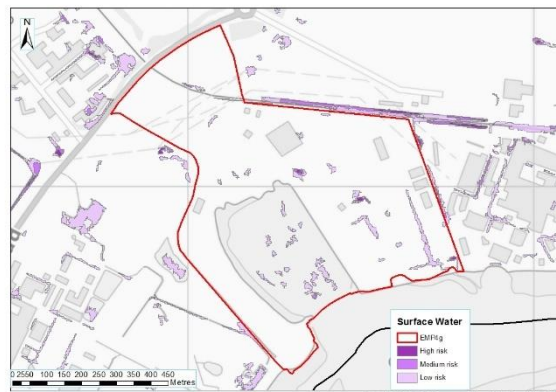
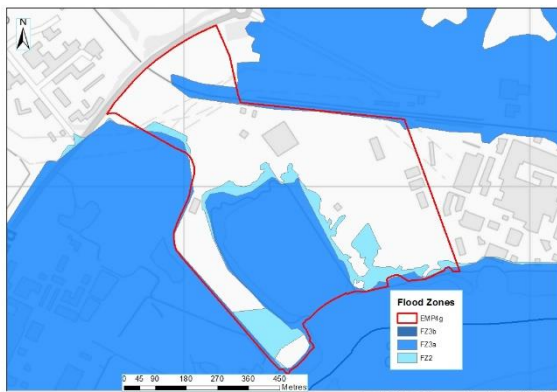
Proposed development limiting runoff rate:				3.33% AEP:	941.94l/s	
Greenfield - IH124 Methodology				1% AEP	1119.57l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (Ha) and % of site area
3.33% AEP Rainfall+20%	18	109080	30519	78561	46.2	5.24Ha 3.48%
3.33% AEP Rainfall+40%	24	138292	40692	97600	57.4	6.51Ha 4.33%
1% AEP Rainfall+20%	18	141756	36274	105482 (26921m ³ of	52.2	7.03Ha 4.67%

Designation Area EMP4c Philips Tank Farm						
				exceedance storage)		(1.79Ha 1.19%)
1% AEP Rainfall+40%	24	178296	48365	129931 (32331m ³ of exceedance storage)	64.3	8.66Ha 5.76% (2.16Ha 1.43%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.3 EMP4g Graythorpe Yard (Able Seaton Port)

Designation Area		EMP4g Graythorpe Yard (Able Seaton Port)
Site area	38.2Ha (Dock areas removed from measured area of Designation Area)	
Existing use	Mix Greenfield / Brownfield including industrial dockside establishment	
Proposed use	Industrial (Note - no specific development opportunities have been specified for this site. Flood risk to any proposed dock related facility will need to be appraised in detail as part of any site specific assessment. The FRA will need to include further consideration of detailed requirements for tidal and wave inundation modelling).	
Proposed development flood risk vulnerability classification	Essential Infrastructure	
Proposed development impermeable area	95% of total developable area (Specified by Hartlepool Borough Council) 36.29Ha	

Flood outlines (current day)



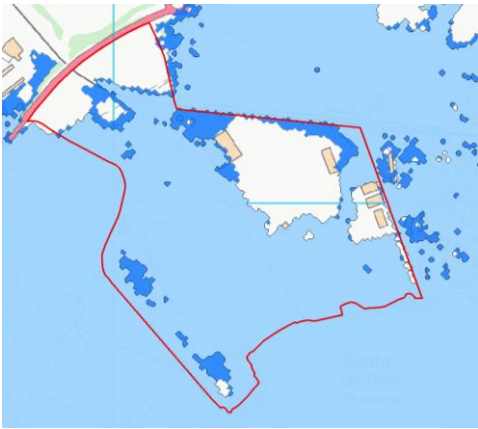
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Observations and Recommendations

- The allocation is identified as Essential Infrastructure by HBC as this site is where the environmental management related to ship and oil field infrastructure decommissioning takes place. HBC consider the designation area is operational for hazardous uses.
- Whilst approximately 80% of the developable site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- Under Climate Change conditions the docks will be particularly susceptible to climate induced inundation and 70% of the developable site will be at flood risk (30% in Flood Zone 1). The site is at risk under climate change but hazard mapping indicates how hazard varies with topography. Development should, therefore, be prioritised for lower risk areas.
- Further land raising, or raised infrastructure may be considered as part of longer term essential infrastructure planning as this approach will not increase risk elsewhere. This will need to be considered further and confirmed as part of a site specific Flood Risk Assessment.
- Surface water flooding appears localised and so should not impact significantly on the development potential across the majority of the site.
- The Council is aware that once Climate Change is taken account of the existing A178 Tees Road is at risk of inundation. Future redevelopment will need to take safe access and egress into consideration.

Designation Area EMP4g Graythorpe Yard (Able Seaton Port)			
Flood Source: Tidal			
Flood Zones (%) (of developable area)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	12.14	9.97	0.00 (defended)
Flood Zone depth ⁴ (m)	Max: >1.2 Mean: 0.15-0.3	Max: > 1.2 Mean: 0.15-0.3	Max: - Mean: -
Flood Zone hazard	Max: Significant Mean: Significant	Max: Significant Mean: Significant	Max: - Mean: -
Climate change	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North East 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>The Designation Area is currently partly within the Flood Zones and modelling indicates under climate change the extents of both Flood Zone 2 and 3a will extend northwards by a similar amount to inundate the majority of the Designation Area. Average flood depths will be 0.3-0.6m across the inundated areas, however there are more extensive areas with depths of 0.6-0.9m to the south in the 0.5% AEP plus climate change scenario. These depths increase in the 0.1% AEP plus climate change scenario and whilst the average depth remains at 0.3-0.6m there are larger areas of 0.9-1.2m deep flooding. The average hazard rating is significant / extreme with the extents of each increased.</p>  <p>Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios</p> <p>Based On 2015 Tidal Tees Model Update of Extreme Sea Level Still Water Level Contains OS data © Crown copyright and database right (2017) 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 south west corner of the area of the site is contained within the Environment Agency Historic flood outline. From available data there are no records of other historic flood events.		
Defended	Environment Agency records indicate a tidal defence embankment runs to the west adjacent to Greatham Creek and follows the western side of the dock, before running into high ground. High ground runs to the rear and eastern side of the dock and frontage. Downstream the defences fronting the Power Station potentially provide protection from outflanking. A small part of the area adjacent to the railway is reported to be an Area Benefiting from Defences. Flood risk to this site is dependent on the		

Designation Area	
	EMP4g Graythorpe Yard (Able Seaton Port)
	integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	100% of Designation Area within Tees Estuary at Greatham Creek Flood Warning Area
Flood risk	<p>Generally the low lying site is relatively level across the majority of the southern area in the vicinity of the dock hardstanding with ground levels between 4 and 5mOD. The Designation Area fronts Greatham Creek and contains a large flooded dock area. A rail line to the adjacent nuclear power station bisects the northern part of the area and runs adjacent to the northern boundary.</p> <p>The Designation Area is at greatest risk of flooding from the south where it adjoins Greatham Creek. Approximately 20% of the site is at risk of tidal flooding and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a (0.5% AEP) are 0.3-0.6m with localised areas of deeper flooding adjacent to the dock edge. This localised deeper flooding appears related to a sloping ramp to the dock and therefore both these depths and the % coverage may not be fully representative. Flood Zone 2 (0.1% AEP) covers similar depths and extents.</p> <p>It is also of note that there is potential for flooding to occur to the site from the adjacent sites EMP4b and EM5.</p> <p>The Environment Agency Flood Zone map indicates the extent of flooding in the absence of defences. Given the extents, source and depth of flooding shown these provide an indication of flood risk in the event of a defence failure. The site is located on the estuary front so flooding would be considered instantaneous and to full depth and any development proposals would need to consider the suitability of existing defences and any enhancements required to manage residual risk.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect site specific dock related infrastructure development proposals. This will be required in order to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is Essential Infrastructure, within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, and nature of the development proposals mitigation measures such as land raising and flood defences may need to be considered. Owing to the coastal location, it is unlikely that land raising will increase flood risk elsewhere. This will need to be considered further (including consideration of potential tidal/fluvial interactions) and confirmed as part of a site specific FRA to demonstrate any interactions with adjoining land and flow routes. • The site will be afforded an additional level of flood protection in the form of the raised defences. The Standard of Protection provided by the crest level of these defences has not been confirmed by this assessment. The site may, therefore, be reconsidered on this basis; subject to confirmation of residual risks and overtopping assessment as part of a detailed Flood Risk Assessment. The Environment Agency will need to be consulted as to site specific flood risks at that time. • Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated.

Designation Area		EMP4g Graythorpe Yard (Able Seaton Port)		
		<ul style="list-style-type: none"> The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels. This will need to be determined based on site specific proposals and operational requirements. 		
Flood Source: Ground Water				
Flood risk: ground water	Southern half of the Designation Area identified to be in No Risk Area. Majority of the northern half indicated as having a susceptibility to groundwater emergence of 25-50%. North east corner of Designation Area indicated as having a susceptibility to groundwater emergence of <25%. As it is part of the docks system the risk associated with ground water ponding is likely to be reduced and a localised issue. Ground water flooding may accumulate on the dry side of any raised flood defence.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within Reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
Surface Water Flood Risk to Proposed Development Site				
Existing development risk of flooding from surface water (%) (of developable area)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)	
	0.11	0.12	0.71	
Surface water flooding max depths	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.15-0.3m Average: 0.15-0.3m	
Surface water max hazards	Max: Low Average: Low	Max: Moderate Average: Low	Max: Moderate Average: Low	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>There is minimal surface water flooding below the 0.1% AEP (Low Risk) event and even in the higher event less than 1% of the site developable area is impacted. The majority of the mapped surface water is very localised and associated with dockside hardstanding and existing buildings. The areas of surface water ponding are potentially associated with the hardstanding profile or potentially issues with existing drainage. Surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure and these extents are likely to change if the site layout is changed. Depths are low, 0.15-0.3m on average. Hazard ratings in areas indicating flooding are low and locally moderate.</p> <p>Mapping does not identify overland surface water flow routes into and across the site from adjacent areas. Any discharge of surface water to the estuary may impact the site and should be assessed as part of the FRA.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a low flood risk to the A178/Tees Road and therefore off site impacts on access and egress appear manageable.</p>			

Designation Area		EMP4g Graythorpe Yard (Able Seaton Port)
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. Apart from localised areas the development area is not generally subject to a surface water flood risk. However, a site specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Areas 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 any existing or proposed discharges to the Greatham Creek and if these discharge routes are proven, impacts on outfall capacity during high tidal flows will need to be assessed. • The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates a lower flood risk for the A178/Tees Road to the north of the site and therefore off site impacts on access and egress appear manageable. 	

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

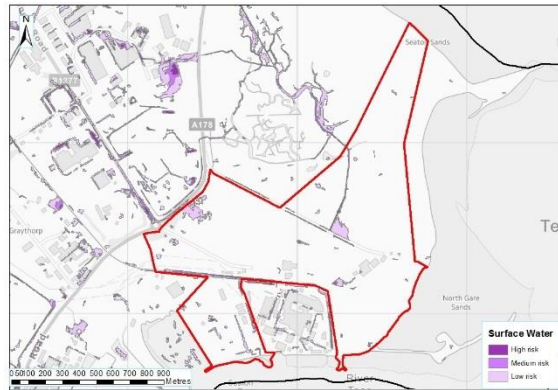
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	270.01/s	
				1% AEP:	320.92/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (Ha) and % of site area
3.33% AEP Rainfall+20%	18	27815	8748	19067	39.1	1.27Ha 2.66%
3.33% AEP Rainfall+40%	18	32450	8748	23702	48.6	1.58Ha 3.31%
1% AEP Rainfall+20%	18	36191	10398	25793 (6726m ³ of exceedance storage)	44.5	1.72Ha 3.60% (0.45Ha 0.94%)
1% AEP Rainfall+40%	18	42223	10398	31825 (8123m ³ of exceedance storage)	54.9	2.12Ha 4.44% (0.54Ha 1.13%)
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	In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may					

Designation Area	EMP4g Graythorpe Yard (Able Seaton Port)
	<p>not be required.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

2.4 EMP5 Nuclear Power Station Reserve

Designation Area		EMP5 Nuclear Power Station Reserve
Site area		140.54Ha
Existing use		Mix Greenfield / Brownfield including industrial and dockside establishment
Proposed use		Nuclear (Note - no specific development opportunities have been specified for this site. Flood risk to any proposed nuclear related facility will need to be appraised in detail as part of any site-specific assessment. The FRA will need to include further consideration of detailed requirements for tidal and wave inundation modelling).
Proposed development flood risk vulnerability classification		Essential infrastructure
Proposed development impermeable area		95% of total area (Specified by Hartlepool Borough Council) 133.51Ha

Flood outlines (current day)




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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.
- The site is included as Essential Infrastructure associated with existing and potential Nuclear facilities. A bespoke FRA will be required for any proposed development. This site is included as part of a national strategy for energy provision.
- Further land raising, or raised infrastructure may be considered as part of longer term essential infrastructure planning as this approach will not increase risk elsewhere. This will need to be considered further and confirmed as part of a site specific Flood Risk Assessment.
- Approximately 40% of the site is located in Flood Zone 1.
- Under Climate Change conditions the Designation Area will be particularly susceptible to climate induced inundation and 80% of the site will be at flood risk (20% in Flood Zone 1).
- 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.

Designation Area			
EMP5 Nuclear Power Station Reserve			
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	8.73	49.68	0.00
Flood Zone depth ⁵ (m)	Max: >1.2 Mean: 0.6-0.9	Max: > 1.2 Mean: 0.3-0.6	Max: - Mean: -
Flood Zone hazard	Max: Extreme Mean: Significant	Max: Extreme Mean: Significant	Max: - Mean: -
Climate change	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North East 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>Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios</p> <p>Based On 2015 Tidal Tees Model Update of Extreme Sea Level Still Water Level Contains OS data © Crown copyright and database right (2017) 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 Designation Area is currently approximately 60% within Flood Zones 2 and 3a. Available modelling indicates under climate change the extents of both Flood Zone 2 and 3a will increase to approximately 80%. These will extend to the east and there will also be an increase in the area inundated to the south adjacent to the Tees estuary.</p> <p>The revised climate change extents of the 1 in 200 and 1 in 1000 year outlines are relatively similar (with 1 in 1000 covering a slightly larger area). Average flood depths will increase to exceed 1.2m to the north of the site, and 0.6-0.9m through the central section in the 0.5%+CC AEP event. During the 0.1%+CC AEP event flood depths are on average in excess of 1.2m across the majority of the site. The hazard rating will be similar (Significant/Extreme).</p>		
Historic flooding	The Designation Area is just outside of the Environment Agency Historic flood outline and from available data there are no records of other historic flood events.		
Defended	Environment Agency records indicate the area is protected by natural high ground across the majority of the frontage. A floodwall fronts the power station site and this ties into high ground at each end. High ground is also indicated to follow the line of the watercourse which enters the site from the north. This watercourse appears to enter culvert beneath the access road to the north of the power station. Areas within FZ3a are reported to be an Area Benefiting from Defences. Flood risk to this site is dependent on the integrity and		

Designation Area EMP5 Nuclear Power Station Reserve	
	maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	Approximately 20% of Designation Area (existing developed area currently in south west area zone) within Tees Estuary at Greatham Creek Flood Warning Area
Flood risk	<p>The Designation Area consists of higher areas of ground to the south which reduces to a low-lying area to the north. The southern part of the area contains the Nuclear power station and part of the adjacent dock EMP4g and has a level of around 5mOD. To the north the large open undeveloped area is relatively level with an elevation of between 2 and 4mOD. There are localised areas of high ground of up to 5m within this area. To the north of the Designation Area ground levels rise to around 5-6mOD.</p> <p>The Designation Area fronts Greatham Creek and except for a defence wall fronting the adjacent power station is surrounded by natural sand dunes /high ground. A rail line and various access roads cross the Designation Area. An undefended fluvial watercourse crosses the Designation Area from north to south.</p> <p>The Designation Area is at greatest risk of flooding from the Tees / Greatham Creek. Approximately 60% of the central and northern part of the area is at risk of tidal flooding and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a (0.5% AEP) are 0.3-0.6m with localised areas of deeper flooding adjacent in the north east in excess of 1.2m adjacent to the fluvial watercourse and upstream of the access road. The hazard rating is Significant to locally Extreme. Flood Zone 2 covers an additional 10% of the Designation Area with more extensive areas of higher depth and hazard bandings.</p> <p>The Environment Agency Flood Zone map indicates the extent of flooding in the absence of defences. Given the extents, source and depth of flooding shown these provide an indication of flood risk in the event of a defence failure. The site is located on the estuary front so flooding would be considered instantaneous and to full depth and any development proposals would need to consider the suitability of existing defences and any enhancements required to manage residual risk.</p> <p>Whilst no details of development aspirations for this site have been provided, further development of a nuclear facility at this location will require substantive flood modelling and appraisal as part of any FRA.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect site specific nuclear related development proposals. This will be required in order to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is Essential Infrastructure, within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, and nature of the development proposals mitigation measures such as land raising and flood defences will need to be considered. Owing to the coastal location, it is unlikely that land raising will increase flood risk elsewhere. This will need to be considered further (including consideration of potential tidal/fluvial interactions) and confirmed as part of a site specific FRA to demonstrate any interactions with adjoining land and flow routes. • Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.

Designation Area		EMP5 Nuclear Power Station Reserve		
		<ul style="list-style-type: none"> Access (including emergency access) across the site will need to take account of future flood levels. This will need to be determined based on site specific proposals and operational requirements. 		
Flood Source: Ground Water				
Flood risk: ground water	<p>Eastern area indicated as having a susceptibility to groundwater emergence of <25%. Western area indicated as having a susceptibility of 25-50%. Extreme northern and southern areas indicated as no risk. OS mapping indicates the presence of numerous interconnected ditches and this may indicate shallow groundwater and the need for effective land drainage. Comparison with LiDAR data indicates that there are raised areas where existing development is located which is served by a drainage network. Groundwater is likely to flow in the direction, corresponding with the existing drainage network. Ground water flooding may accumulate on the dry side of any raised flood defence.</p>			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within Reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
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)	
	0.17	0.42	2.91	
Surface water flooding depths	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	
Surface water hazards	Max: Low Average: Low	Max: Moderate Average: Low	Max: Moderate Average: Moderate	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>There is minimal and only localised surface water flood risk to the majority of the site below the 0.1% (Low Risk) event. Overall approximately 4% of the site area is at some level of surface risk. The majority of the site appears to be undeveloped and there are two areas of surface water flood risk which appear to be associated with existing drainage ditches (one adjacent to the rail line). There is network of what appears to be managed drains within the low-lying area. The mapping indicates a northern area of surface water flooding which is potentially associated with the ditch beneath an access road (Depths in this area are 0.3-0.6m). There is a further area of localised surface water flooding indicated under the 0.1% AEP (Low Risk) event adjacent to the A178 / Tees Road, with depths 0.3-0.6m. Areas of surface water ponding on the dockside (which overlaps with Designation Area EMP4g) are likely to be associated with the profile of the hardstanding or potentially due to issues with existing drainage. The remaining areas of surface water flood risk are localised and likely to relate to local topography.</p> <p>Surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure and these extents are likely to change if the site layout is changed. The average localised hazard rating is low, rising to moderate in the 0.1% AEP event.</p> <p>Mapping does not indicate overland surface water flow routes into the site from adjacent areas, but it appears that there may potentially be incoming flows within ditches, primarily site from the north. Mapping does not indicate any</p>			

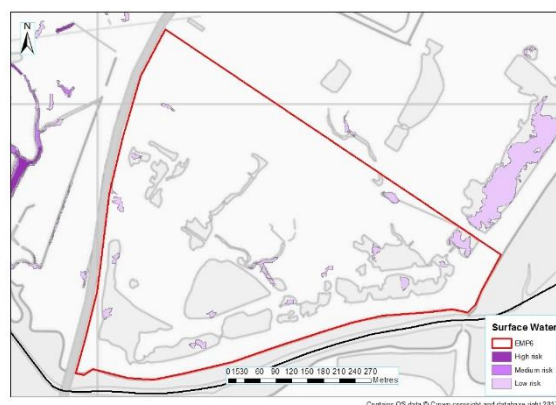
Designation Area		EMP5 Nuclear Power Station Reserve				
		<p>discharges from the site, but there may be outfalls to the Seaton on Tees Channel / River Tees. If proven, discharge of surface water to the estuary may impact the site and should be assessed as part of the FRA.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a low flood risk to the A178/Tees Road and therefore off-site impacts on access and egress appear manageable.</p>				
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 relatively low surface water flood hazard with localised areas of moderate of more significant depth and hazard, primarily associated with the existing drainage network. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to the existing drainage routes and ponded areas. Existing drainage ditches would need to be maintained or modified in such a way to not increase surface water flood risk. Any requirement for new culverts will need to ensure surface water flood risk is managed. The FRA will need to mitigate climate change impacts across the lifetime of the development. • 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). Surface water mapping indicates a lower flood risk for the Tees Road to the north of the site which provides a potentially suitable access. • If additional discharge to the Seaton on Tees Channel / River Tees is proposed the FRA will need to consider outfall capacity during high tidal flows. 				
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate:			3.33% AEP:	893.53l/s		
Greenfield - IH124 Methodology			1% AEP:	1062.03l/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%	18	91331	28950	62381	38.7	4.16Ha 2.96%
3.33% AEP Rainfall+40%	18	106553	28950	77603	48.1	5.17Ha 3.68%
1% AEP Rainfall+20%	18	118690	34410	84280 (21899m ³ of exceedance storage)	44.0	5.62Ha 4.00% (1.46Ha 1.04%)
1% AEP Rainfall+40%	18	138472	34410	104062 (26459m ³ of exceedance storage)	54.3	6.94Ha 4.94% (1.76Ha 1.26%)

Designation Area		EMP5 Nuclear Power Station Reserve
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may not be required.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>	

2.5 EMP6 Underground Storage

Designation Area		EMP6 Underground Storage
Site area		29.29Ha
Existing use		Green field mine workings
Proposed use		Potential Underground Storage Facility It is noted that the site is for underground storage and assessment of above ground structures is likely to be of limited benefit at this stage. No information on the underground facilities has been made available for this assessment.
Proposed development flood risk vulnerability classification		Essential Infrastructure
Proposed development impermeable area		50% of total area (Specified by Hartlepool Borough Council) 14.65Ha

Flood outlines (current day)



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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.
- 100% of the site is located within Flood Zone 3a.
- The allocation is identified as Essential Infrastructure by HBC owing to the historic mining within this area.
- All areas of the site remain at significant flood risk during current and climate change scenarios. The site is defended although the suitability of defences would need to be determined as part of a detailed Flood Risk Assessment.
- In the absence of specific development proposals Essential Infrastructure development is likely to be difficult to justify for all areas of this Designation Area.
- Further land raising, or raised infrastructure may be considered as part of longer term essential infrastructure planning as this approach will not increase risk elsewhere. This will need to be considered further and confirmed as part of a site specific Flood Risk Assessment.
- The Council is aware that once Climate Change is taken account of the existing A178 Tees Road is at risk of inundation. Future redevelopment will need to take safe access and egress into consideration. There is extensive flood risk in this area and the adjacent flood embankment is known to have failed. Existing defences are not designed for extensive development, Climate Change, or Essential Infrastructure.

Designation Area			
EMP6 Underground Storage			
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0	100	0.00 (defended)
Flood Zone depth ⁶ (m)	Max: >1.2 Mean: >1.2	Max: >1.2 Mean: >1.2	Max: - Mean: -
Flood Zone hazard	Max: Extreme Mean: Extreme	Max: Extreme Mean: Extreme	Max: - Mean: -
Climate change	<p>Climate change impacts have been assessed by updating the existing model, increasing the peak sea level by the North East 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>As the Designation Area is already 100% within both Flood Zone 2 and 3a in the current day there is no change in the flood extents across the Designation Area under climate change. As per the current day average flood depths will exceed 1.2m across the entire area. The corresponding Flood Zone hazard rating across the entire area will be Extreme (no change to current day).</p>		
Historic flooding	<p>The Designation Area is contained within the Environment Agency Historic flood outline. From available data, there are no records of other historic flood events. It is further noted that the site includes numerous ponds and ditches.</p>		
Defended	<p>Environment Agency records indicate the area is protected by a tidal defence embankment adjacent to Greatham Creek. The entire Designation Area is reported to be an Area Benefiting from Defences. The defence is reported to be at Condition Grade 3 with an upstream defence crest level of 5.56mOD and a downstream crest level of 4.68mOD. The defence embankment runs into high ground at the downstream end, to the rear of the Graythorpe Yard dock. Upstream of the Tees Road the defence is reported to be breached and in its place a retired line embankment with a construction date of 2014 is shown. Flood risk to this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site-specific FRA and proposals.</p> <p>The current condition of the flood defence, and its suitability for "Essential Infrastructure" development proposals will need to be determined as part of any change in proposed land use.</p> <p>It is noted that the site is for underground storage and assessment of above ground structures is likely to be of limited benefit at this stage. No information on the underground facilities has been made available for this assessment.</p>		
Flood Warning Area	100% of Designation Area within Tees Estuary at Greatham Creek Flood Warning Area		
Flood risk	<p>Generally, the low-lying site is relatively level across the majority of the area with ground levels at around 1mOD. Ground levels rise to the northeast boundary where levels to around 2.5mOD adjacent to Tees Road. Greatham creek lies to the south of the Designation Area separated from the site by a flood defence embankment. A network of drains and ponds cross this undeveloped low-lying area.</p> <p>The Designation Area is at greatest risk of flooding from the south where it adjoins Greatham Creek. Approximately 100% of the site is at risk of tidal flooding and located in Flood Zone 2 and 3a. Flood depths within Flood Zone 3a (0.5% AEP) are significantly in excess of 1.2m and the area has an Extreme Hazard Rating. This is similar for Flood Zone 2 (0.1% AEP).</p> <p>The Environment Agency Flood Zone map indicates the extent of flooding in the absence of defences. Given the extents, source and depth of flooding shown these provide an indication of flood risk in the event of a defence failure.</p>		

Designation Area		EMP6 Underground Storage
		The site is located on the estuary front so flooding would be considered instantaneous and to full depth and any development proposals would need to consider the suitability of existing defences and any enhancements required to manage residual risk.
Mitigation options & site suitability		<ul style="list-style-type: none"> It is assumed that any underground storage facility will require vehicular access with above ground warehousing and processing facilities. Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect site specific storage related development proposals. This will be required in order to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is Essential Infrastructure, within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. Given the depth of flooding, and nature of the development proposals mitigation measures such as land raising and flood defences will need to be considered. The suitability of any existing defences will need to be determined. Owing to the coastal location, it is unlikely that land raising will increase flood risk elsewhere. This will need to be considered further (including consideration of potential tidal/fluviat interactions) and confirmed as part of a site-specific FRA to demonstrate any interactions with adjoining land and flow routes. Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels. This will need to be determined based on site specific proposals and operational requirements.
Flood Source: Ground Water		
Flood risk: ground water		Majority of Designation Area indicated as having a susceptibility to groundwater emergence of <25%. OS mapping indicates the presence of numerous interconnected ponds / ditches and this may indicate shallow groundwater and the need for effective land drainage. It may also indicate the presence of subsidence associated with previous salt workings and the formation of flashes. There is the potential for surface water features to flow into underground mine workings and this risk should be assessed as part of the development strategy. Ground water flooding may accumulate on the dry side of any raised flood defence.
Flood Source: Infrastructure Failure – Reservoirs		
Flood risk: Reservoir		Published Flood mapping indicates approximately 95% of the Designation Area is indicated to be at risk from Reservoir flooding. Published mapping indicates flood depths within a banding of 0.3-2m and flood velocity <0.5m/s. The interaction with the estuary would need to be evaluated further and developers would need to consult with the Local Planning Authority as part of FRA as the Designation Area is within the envelope of reservoir flooding on published flood maps.
Flood Source: Infrastructure Failure – Canals		
Flood risk: canal		No canalised watercourses in area. No flood risk identified.

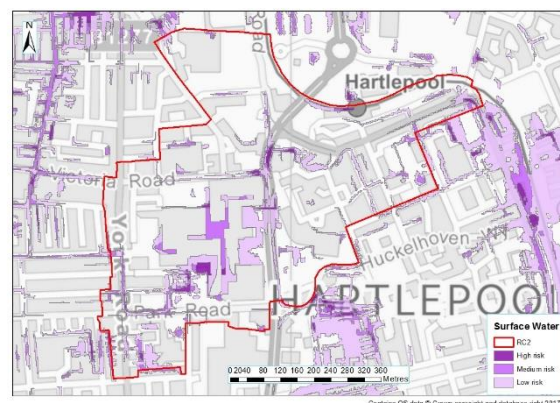
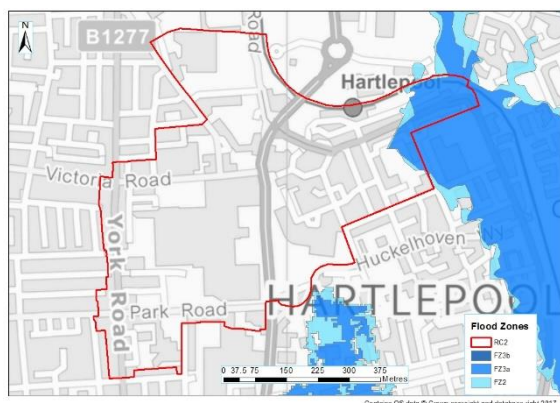
Designation Area EMP6 Underground Storage			
Flood Source: Surface Water			
<i>Surface Water Flood Risk to Proposed Development Site</i>			
Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
		0	0
Surface water flooding depths	Max: 0m Average: 0m	Max: 0m Average: 0m	Max: 0.15-0.3m Average: 0.15-0.3m
Surface water hazards	Max: - Average: -	Max: - Average: -	Max: Moderate Average: Low
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	<p>There is no surface water flood risk to the area up to the 0.1% AEP (Low Risk) event. At the 0.1% AEP event only 1.4% of the Development Area is shown to be impacted.</p> <p>The site is undeveloped and there are a number of ponds across the site. With reference to mapping the majority of the flood risk appears to be contained within pond areas and drainage ditches. These are likely to have a greater influence on potential development and modification of these under future development proposals would be likely to modify the surface water flood risk to the Development Area.</p> <p>Mapping does not identify overland surface water flow routes into and across the site from adjacent areas. Outfalls from the site to the estuary are unconfirmed and this should be assessed as part of the FRA.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a low flood risk to the A178/Tees Road and therefore off-site impacts on access and egress appear manageable.</p>		
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 risk however, the area is significantly ponded. A site specific detailed surface water assessment and drainage strategy will be required as part of any FRA, particularly in relation to the existing drainage ditches and ponded areas. Existing drainage ditches / ponds would need to be maintained or modified in such a way to not increase surface water flood risk. Any requirement for new culverts will need to ensure surface water flood risk is managed. There is the potential for surface water features to flow into underground mine workings and this risk should be assessed as part of the development strategy. The FRA will need to mitigate climate change impacts across the lifetime of the development. Surface water flooding appears localised and so should not impact significantly on the development potential. • 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 potential discharge to the adjacent Greatham Creek and if these discharge routes are proven, impacts on outfall capacity during high tidal flows will need to be assessed. • The FRA should consider the impacts of surface water flooding on access 		

Designation Area		EMP6 Underground Storage				
		and egress routes both within and outside the site (including emergency routes). Surface water mapping indicates a lower flood risk for the A178/Tees Road to the north of the site and therefore off-site impacts on access and egress appear manageable.				
Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	205.42l/s	
				1% AEP:	244.15l/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%	12	17033	4437	12596	34.0	0.84Ha 2.87%
3.33% AEP Rainfall+40%	18	22342	6656	15686	42.3	1.05Ha 3.57%
1% AEP Rainfall+20%	12	22359	5274	17085 (4489m ³ of exceedance storage)	38.8	1.14Ha 3.89% (0.30Ha 1.02%)
1% AEP Rainfall+40%	18	29002	7910	21092 (5406m ³ of exceedance storage)	47.9	1.41Ha 4.80% (0.36Ha 1.23%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may not be required.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.6 RC2 The Town Centre

Designation Area		RC2 The Town Centre
Site area		39.22Ha
Existing use		Brownfield / urbanised including commercial / retail / residential
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 33.34Ha

Flood outlines (current day)



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Observations and Recommendations

- The Town Centre Area represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Approximately 95% of the site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- The Council may consider allocating the Designation Area for development based on rezoning to avoid inappropriate development within areas at significant flood risk or hazard rating.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or:
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood risk extents are based on EA modelled wave overtopping. As flood water will flow by topography ground raising may impact on adjacent areas.
- Surface water flooding appears localised to existing urban areas. Any development proposals within this Designation Area will need to take site runoff and offsite interactions into consideration.

Designation Area RC2 The Town Centre			
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.61	4.77	0.00
Flood Zone depth ⁷ (m)	Max: 0.9-1.2 Mean: 0.3-0.6	Max: 0.9-1.2 Mean: 0.3-0.6	Max: - Mean: -
Flood Zone max hazard	Max: Significant Mean: Moderate	Max: Significant Mean: Moderate	Max: - Mean: -
Climate change	<p>5% of this Designation Area is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that the site is not at direct risk of flooding as a result of extreme sea level still water overtopping during either the 0.5% or 0.1% AEP events. A review of the flood modelling indicates that the flooding along this area of coastline, as defined by the EA flood map is as a consequence of wave overtopping rather than extreme sea levels on an undefended coastline.</p> <p>Based on comparison of the relative height of the undefended ground levels relative to the extreme sea levels, wave overtopping is likely to remain the primary flood mechanism under climate change scenarios. Current day wave overtopping extents for both the 0.5% AEP (Flood Zone 3) and 0.1% AEP (Flood Zone 2) scenarios show only a slight variation in flood extents. Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Wave overtopping for the 0.1% AEP event combined with still water climate change levels has, therefore, been used for climate change testing.</p> <p>Updated modelling to assess future wave overtopping extents may be required as part of a site specific FRA and the requirements would need to be agreed with the EA. For the purposes of the this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p> <p>Flood Zone 3a extents under climate change are likely to be similar to the current day Flood Zone 2. Flooding will be limited to the eastern part of the Designation Area. Mean flood depths will be on average 0.3-0.6m, with localised deeper areas (0.9-1.2m) to the east.</p> <p>The hazard rating will be Moderate across the majority of the climate change flood zones, rising to Significant in the eastern area.</p>		
Historic flooding	<p>From available data, there are 3no records of historic events from Hartlepool Fire Service in this Designation Area, although there is insufficient information to determine the flood source.</p> <p>A small area (<5%) to the south of the Designation Area is defined as being located within a Critical Drainage Area.</p>		
Defended	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p>		

Designation Area	RC2 The Town Centre
	<p>There are however defences along the coastal frontage which protect the site. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. This frontage is generally protected from coastal flooding by a front-line ridge of high ground / embankment of substantial width topped by a concrete flood wall.</p> <p>Based on a modelling review there is no extreme sea level still water overtopping flooding anticipated to the Designation Area for either the present day or climate change 0.5% AEP or 0.1% AEP events even if all flood defences were removed or breached. This is based on the level and extent of the existing high ground / embankment fronting the coastline and the relative levels across the Designation Area.</p>
Flood Warning Area	No
Flood risk	<p>Designation Area RC2 incorporated Designation Area RC17 in the east and the flood risk is generally as described under that Designation Area. Ground levels across the Designation Area generally rise towards the west and southwest, increasing from around 5m OD in the northeast to around 12m OD in the west.</p> <p>The area is currently developed with a mix of residential, retail and commercial development within the existing urban extent. The area includes the A689 Stockton Road which centrally bisects the Designation Area from north to south and the A178 which runs across the northern part of the Designation Area. Hartlepool Railway Station is situated on the northern edge of the Designation Area with the rail line adjacent to the northern boundary. A shopping centre complex covers the area to the east of the A689 Stockton Road. The Designation Area includes a college, Hartlepool Borough Council offices and a cinema complex.</p> <p>The Designation Area is at greatest risk of flooding from the coastal frontage which is approximately 370m to the east. A review of ground levels indicates that water emanating from wave overtopping will tend to flow northwards towards the Hartlepool Marina. Approximately 5% of the site (the eastern side) is at risk of tidal flooding (from wave overtopping) and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a increase from east to west, and are on average 0.3-0.6m with a maximum depth of 0.9 to 1.2m in a localised area adjacent to the north-eastern boundary. There is a Moderate to Significant hazard rating within the area of flood risk.</p> <p>Flood Zone 2 extents and depths are very similar with only a small increase in the area of each depth banding which results in a small increase in the flood zone to the west. The hazard rating remains as Moderate to Significant. The majority of the Designation Area to the west is within Flood Zone 1.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult. Given the existing layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. • Ideally 'More Vulnerable' Development should be directed to the areas outside of higher risk Flood Zones. Approximately 95% of the

Designation Area		RC2 The Town Centre		
	<p>area would be considered suitable for redevelopment.</p> <ul style="list-style-type: none"> Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and depending on development proposals further investigation may be required. The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	100% of Designation Area indicated as having a susceptibility to groundwater emergence of >75%. Comparison with LiDAR data indicates a fall in level across the area in an easterly direction, indicating that ponding if encountered is likely to be minimal as water will tend to flow across the site following topography. It is identified that the flow routes are towards the adjacent site RC7 and may result in ponding in that area.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
<i>Surface Water Flood Risk to Proposed Development Site</i>				
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)	
	0.86	2.83	10.86	
Surface water flooding depths	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.6 -0.9m Average: 0.15-0.3m	
Surface water hazards	Max: Moderate Average: Low	Max: Moderate Average: Low	Max: Significant Average: Low	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>Designation Area RC2 incorporated Designation Area RC17 in the east and the flood risk is generally as described under that Designation Area. There is a localised surface water flood risk to this developed area at the 3.33% AEP (High Risk) event. These areas extend under the higher probability events and are generally constrained to highways and surfaced areas, through the Designation Area. Depths of flooding are on average 0.15-0.3m with localised areas of deeper flooding in the lower probability events.</p> <p>Mapping indicates the potential surface water flows entering the site with topography dictating potential flow routes across the site generally in an eastern direction.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Whilst there is flood risk to surrounding roads, alternative access appears to be</p>			

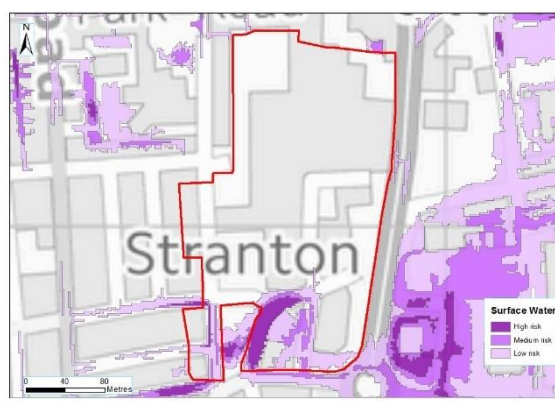
Designation Area		RC2 The Town Centre				
	available.					
Surface water: mitigation options & site suitability	<ul style="list-style-type: none"> Surface water flooding appears localised and so should not impact significantly on the development potential across the majority of the site. However, localised development areas will need to consider surface water based on location. The designation area is subject to surface water flooding and site specific detailed surface water assessments and drainage strategies will be required as part of any FRAs. The FRAs will need to mitigate climate change impacts across the lifetime of the development. Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS. The FRAs should assess the potential for offsite surface water impacts on proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available. 					
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	109.14/s	
				1% AEP:	129.72/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%	48	34635	9430	25205	127.9	1.68Ha 4.28%
3.33% AEP Rainfall+40%	48	40407	9430	30977	157.2	2.07Ha 5.27%
1% AEP Rainfall+20%	48	43948	11208	32740 (7535m ³ of exceedance storage)	139.8	2.18Ha 5.57% (0.50Ha 1.28%)
1% AEP Rainfall+40%	48	51273	11208	40065 (9088m ³ of exceedance storage)	197.5	2.67Ha 6.81% (0.61Ha 1.54%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the</p>					

Designation Area	RC2 The Town Centre
	<p>proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

2.7 RC5 The Brewery and Stranton

Designation Area		RC5 The Brewery and Stranton
Site area		5.68Ha
Existing use		Brownfield / urbanised including commercial / retail / residential
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 4.83Ha

Flood outlines (current day)



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Observations and Recommendations

- The Town Centre Area (Brewery and Stranton site) represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Approximately 80% of the site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- The Council may consider allocating the Designation Area for development based on rezoning to avoid inappropriate development within areas at significant flood risk or hazard rating.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of fluvial flooding or:
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood mapping in this instance is based on EA strategic mapping and no Climate Change outlines are available (other than Flood Zone 2 approximation). These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments. Land raising within extents of flooding would result in an increased risk of flooding to adjacent property. Hazard mapping has been provided to indicate depths and hazard rating.
- 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 as the depth to the southern extent of the site is likely to be significant.

Designation Area RC5 The Brewery and Stranton			
Flood Source: Fluvial			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.28	20.36	0.00
Flood Zone depth ⁸ (m)	Max: 0.9-1.2 Mean: 0.3-0.6	Max: 0.9-1.2 Mean: 0.3-0.6	Max: - Mean: -
Flood Zone hazard	No data available	No data available	No data available
Climate change	<p>21% of this Designation Area is currently located in Flood Zone 2 and 3. Given the proximity to the watercourse, fluvial climate change impacts should be assessed within a site specific FRA by increasing peak flows by the total potential change anticipated for the '2080s' (2070 to 2115) corresponding with the highest risk Flood Zone and the proposed development Vulnerability Classification.</p> <p>Flood extents at this location are based on EA strategic modelling techniques rather than detailed modelling. For the current screening in the absence of a detailed hydraulic model the current day Flood Zone 2 outline has been used to provide a representation of the future extents of Flood Zone 3a under Climate Change (noting that under the fluvial case, Flood Zone 3a is based on the 1% AEP flood event). This indicates a very marginal increase in impacted area and a small increase in flood depths (<100mm) based on the available modelling. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p>		
Historic flooding	From available data, there are no records of historic flood events in this Designation Area.		
Defended	<p>Environment Agency records indicate that the Burn Valley Beck open channel maintained watercourse which enters culvert upstream of the Designation Area (Penrhyn Street / York Road) is undefended with high ground either side. From Penrhyn Street to the coast the watercourse is culverted as public sewer. The culvert is reported to have a considerable (>2m) radius. Northumberland Water have built a pumping station close to the coast to prevent surface water flooding when the outfall from this watercourse is tide locked. The modelling undertaken to derive the flood zones excludes the effects of this pumping station. The capacity and structural condition of the culvert has not been confirmed as part of this assessment.</p>		
Flood Warning Area	No		
Flood risk	<p>Ground levels across the site generally fall from the north to south, reducing from around 12m OD to 7.0m OD. The southern part of the site extends out into a valley bottom (associated with the upstream watercourse) where it begins to widen.</p> <p>The area is currently urbanised with a mix of residential, retail and commercial properties within a dense network of streets and highways. The A689 follows the eastern boundary and Stockton Road follows the southern boundary.</p> <p>The Designation Area is at greatest risk of flooding from fluvial flooding from the watercourse which enters a culvert west of the area at Penrhyn Street / York Road. It is not at risk from Tidal Flooding. Approximately 21% of the southern part of the area is at risk of fluvial flooding and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a increase towards the valley bottom (potentially the historic line of the watercourse) with localised maximum depths of 0.9 to 1.2m around the</p>		

Designation Area	
RC5 The Brewery and Stranton	
	<p>Elwick Road / Stranton Area. This corresponds with most significant surface water flooding. Average depths are 0.3-0.6m, although there are extensive areas with depths up to 0.9m. Flood Zone 2 extents and depths are similar with only a small increase in the area of each depth banding and increased depth of up to 50mm. The majority of the Designation Area to the north is within Flood Zones 1.</p> <p>Modelling to define the fluvial Flood Zone maps is based on a similar method as was used for the Generalised National Fluvial Flood Zones Modelling. The modelling report identifies that channel capacity was assumed to be QMED (1 in 2 year flood) and that the culvert capacities or the effects of the downstream pumping have not been modelled as part of the previous study. The report identifies that based on these assumptions that the flood outlines are likely to be conservative.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect site specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • The capacity and structural condition of the culvert has not been confirmed as part of this assessment and will need to be assessed as part of the Flood Risk Assessment. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing urban layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. 'More Vulnerable' Development should be directed to the areas outside of higher risk Flood Zones. Approximately 80% of the site would be considered suitable for development. • More detailed assessment and provision for climate change should be made in the site specific FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available.
Flood Source: Ground Water	
Flood risk: ground water	The southern half of the Designation Area indicated as having a susceptibility to groundwater emergence of 25-50%. The northern half of the Designation Area is indicated as having a susceptibility to groundwater emergence of >75%. LiDAR indicates a fall across the site from north to south, which indicates that ponding if encountered is likely to be minimal and potentially correspond with the lower areas to the south identified as being at higher risk of surface water flooding.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.
Flood Source: Infrastructure Failure – Canals	
Flood risk: canal	No canalised watercourses in area. No flood risk identified.

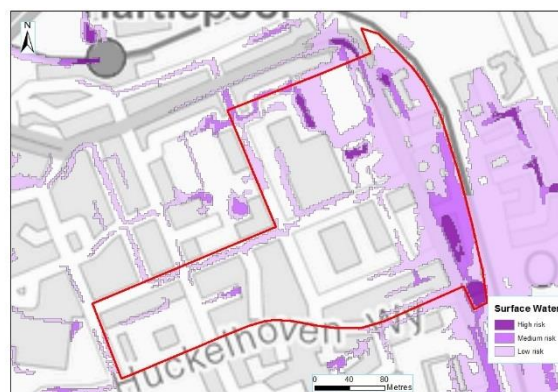
Designation Area RC5 The Brewery and Stranton			
Flood Source: Surface Water			
<i>Surface Water Flood Risk to Proposed Development Site</i>			
Existing development risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)
		2.39	1.99
Surface water flooding depths	Max: 0.6-0.9m Average: 0.3-0.6m	Max: 0.6-0.9m Average: 0.3-0.6m	Max: 0.9-1.2m Average: 0.3-0.6m
Surface water hazards	Max: Significant Average: Moderate	Max: Significant Average: Moderate	Max: Significant Average: Moderate
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	<p>There is a surface water flood risk to the southern part of the Designation Area. Overall, 11% of the Designation Area is at some level of risk from surface water flooding. Maximum flood depths are locally significant (greater than 0.6m). Average water depths are in the region of 0.3-0.6m. The subsequent maximum hazard is locally Moderate with localised areas of Significant hazard.</p> <p>Surface water flood extents appear to be influenced by the presence of the existing road layout and buildings and drainage capacity is restricted to a single area of the site between Elwick and Burn Road. This area appears to be a low spot between areas of higher ground to the north and south.</p> <p>The flood mapping indicates limited potential for surface water flooding entering the site from adjacent areas.</p> <p>Surface water flooding is not indicated to impact the highways surrounding the Designation Area (with the exception the Elwick - Burns Road area). Whilst this will need to be taken into account in consideration of emergency access and egress as mapping indicates a limited flood risk the offsite impacts on access and egress appear manageable.</p>		
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. A localised area of the Designation Area is subject to a Significant flood hazard. As parts of the Designation Area are subject to a flood hazard a site specific detailed surface water assessments and drainage strategy will be required as part of any FRAs for development in these area. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Existing areas subject to surface water flooding should ideally be kept free from development or alternatively, flows should be redirected using SuDS. • The FRA should assess the potential for offsite surface water impacts on the proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. • The FRA should consider the impacts of surface water flooding on access and egress routes both within and outside the Designation Area (including emergency routes). 		

Designation Area RC5 The Brewery and Stranton						
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	16.13l/s	
				1% AEP:	19.18l/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%	48	4910	1394	3516	120.8	0.23Ha 4.13%
3.33% AEP Rainfall+40%	48	5729	1394	4335	148.9	0.29Ha 5.09%
1% AEP Rainfall+20%	48	6223	1657	4566 (1050m ³ of exceedance storage)	131.9	0.30Ha 5.36% (0.07Ha 1.23%)
1% AEP Rainfall+40%	48	7260	1657	5603 (1268m ³ of exceedance storage)	161.8	0.37Ha 6.58% (0.08Ha 1.49%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.8 RC7 Lynn Street

Designation Area RC7 Lynn Street	
Site area	8.31Ha
Existing use	Brownfield / urbanised including commercial / residential
Proposed use	Mixed Residential / Commercial
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	85% of total area (Specified by Hartlepool Borough Council) 7.06Ha

Flood outlines (current day)



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Observations and Recommendations

- The Lynn Street Area represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Approximately 32% of the site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- The Council may consider allocating the Designation Area for development base on rezoning to avoid inappropriate development within areas at significant flood risk.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood risk extents are based on EA modelled wave overtopping. As flood water will flow by topography ground raising may impact on adjacent areas.
- 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.

Designation Area RC7 Lynn Street			
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	4.60	63.05	0.00
Flood Zone depth ⁹	Max: >1.2m Mean: 0.6-0.9	Max: >1.2m Mean: 0.6-0.9	Max: - Mean: -
Flood Zone 3 hazard	Max: Extreme Mean: Significant	Max: Significant Mean: Significant	Max: - Mean: -
Climate change	<p>68% of this site is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that the site is not at direct risk of flooding as a result of extreme sea level still water overtopping during either the 0.5% or 0.1% AEP events. A review of the flood modelling indicates that the flooding along this area of coastline, as defined by the EA flood map is as a consequence of wave overtopping rather than extreme sea levels on an undefended coastline.</p> <p>Based on comparison of the relative height of the undefended ground levels relative to the extreme sea levels, overtopping is likely to remain the primary flood mechanism under climate change scenarios. Current day wave overtopping extents for both the 0.5% AEP (Flood Zone 3) and 0.1% AEP (Flood Zone 2) scenarios show a slight variation in flood extents. Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Wave overtopping for the 0.1% AEP event combined with still water climate change levels has, therefore, been used for climate change testing.</p> <p>Updated modelling to assess future wave overtopping extents may be required as part of a site-specific FRA and the requirements would need to be agreed with the EA. For the purposes of the this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p> <p>Flood Zone 3a extents under climate change are likely to be similar to the current day Flood Zone 2. Flooding will be limited to the eastern half of the Designation Area. Mean flood depths will be on average 0.6-0.9m, with localised deeper areas (>1.2m) to the east.</p> <p>The hazard rating will be Significant across the majority of the climate change flood zone, rising to Extreme in the eastern area.</p>		
Historic flooding	From available data, there are no records of historic flood events in this Designation Area.		
Defended	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage which protect the site. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. This frontage is generally</p>		

Designation Area	RC7 Lynn Street
	<p>protected from coastal flooding by a front-line ridge of high ground / embankment of substantial width topped by a concrete flood wall.</p> <p>Based on a modelling review there is no extreme sea level still water overtopping flooding anticipated to the Designation Area for either the present day or climate change 0.5% AEP or 0.1% AEP events even if all flood defences were removed or breached. This is based on the level and extent of the existing high ground / embankment fronting the coastline and the relative levels across the Designation Area.</p>
Flood Warning Area	No
Flood risk	<p>Ground levels across the Designation Area generally rise towards the west and southwest, increasing from around 5m OD in the northeast to around 7m OD in the southwest. There is a sharp reduction in ground level of around 1m (4m OD) towards the east of the site (within the narrow strip of land to the east of the A178 / Mainsforth Terrace). It appears that there is recent residential development in this area and therefore current ground levels are unconfirmed.</p> <p>The area is currently developed with a mix of residential and commercial development within a dense network of streets and highways including the A178. A rail line lies adjacent to the eastern boundary.</p> <p>The Designation Area is at greatest risk of flooding from the coastal frontage which is approximately 250m to the east. A review of ground levels indicates that wave overtopping flows will tend to flow northwards towards the Hartlepool Marina. Approximately 68% of the Designation Area (the eastern side) is at risk of tidal flooding (from wave overtopping) and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a increase from east to west, and are on average 0.6-0.9m with maximum depths in excess of 1.2m in a localised area adjacent to the north-eastern boundary. There is a Significant hazard rating within the area of flood risk.</p> <p>Flood Zone 2 extents and depths are similar with only a small increase in the area of each depth banding. The average hazard rating remains as Significant, but there is a localised area of Extreme flood risk associated with the deeper area of flooding to the east of the A178 / Mainsforth Road. The western portion of the Designation Area is within Flood Zone 1.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. • 'More Vulnerable' Development should be directed to the areas outside of higher risk Flood Zones (i.e. FZ 1 and 2). Approximately 36% of the area would be considered suitable for redevelopment. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and

Designation Area		RC7 Lynn Street		
		<p>depending on development proposals further investigation may be required.</p> <ul style="list-style-type: none"> The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 		
Flood Source: Ground Water				
Flood risk: ground water	<p>100% of Designation Area indicated as having a susceptibility to groundwater emergence of >75%. Comparison with LiDAR data indicates a fall in level across the area in an easterly direction, indicating that ponding if encountered is likely to be minimal over much of the site as water will tend to flow across the site following topography. It is identified that if it occurs, ponding will potentially correspond with the lower areas to the east identified as being at higher risk of tidal and surface water flooding.</p>			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
<i>Surface Water Flood Risk to Proposed Development Site</i>				
Existing development: risk of flooding from surface water (%)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)	
	1.96	5.51	25.74	
Surface water flooding depths (m)	Max: 0.6-0.9m Average: 0.15-0.3m	Max: 0.9-1.2m Average: 0.3-0.6m	Max: 0.9-1.2m Average: 0.3-0.6m	
Surface water hazards	Max: Significant Average: Moderate	Max: Significant Average: Moderate	Max: Significant Average: Moderate	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>There is a significant surface water flood risk to the eastern part of the Designation Area Overall, 33% of the Designation Area is at some level of risk from surface water flooding. Maximum flood depths are locally significant (greater than 0.9-1.2m). Average water depths are in the region of 0.3-0.6m. The subsequent average hazard is Moderate with localised areas indicating a Significant hazard.</p> <p>Surface water flood extents appear to be influenced by the presence of the existing road layout and buildings. However, there is a significant area of surface water flood risk to the A178 / Mainsford Terrace area adjacent to the rail line. This corresponds with the topography which indicates a fall in ground levels generally from west to east.</p> <p>The flood mapping indicates limited potential for surface water flooding entering the Designation Area from adjacent areas.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a number of alternative routes and therefore off-site impacts on access and egress appear manageable.</p>			

Designation Area		RC7 Lynn Street				
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. Parts of the Designation Area are subject to a Significant flood hazard and a site specific detailed surface water assessments and drainage strategies will be required as part of any FRAs for development in these area. The FRAs will need to mitigate climate change impacts across the lifetime of the development. Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS. The FRAs should assess the potential for offsite surface water impacts on proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. Any FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available. 					
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	23.08l/s	
				1% AEP:	27.43l/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%	48	7334	1994	5340	128.2	0.36Ha 4.28%
3.33% AEP Rainfall+40%	48	8556	1994	6562	157.5	0.44Ha 5.27%
1% AEP Rainfall+20%	48	9306	2370	6936 (1596m ³ of exceedance storage)	140.1	0.46Ha 5.57% (0.11Ha 1.28%)
1% AEP Rainfall+40%	48	10857	2370	8487 (1925m ³ of exceedance storage)	171.4	0.57Ha 6.81% (0.13Ha 1.54%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the</p>					

Designation Area	RC7 Lynn Street
	<p>proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

2.9 RC11 York Road South

Designation Area		RC11 York Road South
Site area		3.28Ha
Existing use		Brownfield / urbanised including commercial / retail / residential
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 2.79Ha

Flood outlines (current day)



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Observations and Recommendations

- The York Road South Area represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Approximately 85% of the site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- The Council may consider allocating the Designation Area for development base on rezoning to avoid inappropriate development within areas at significant flood risk.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of fluvial flooding or:
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood mapping in this instance is based on EA strategic mapping and no Climate Change outlines are available (other than Flood Zone 2 approximation). These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.
- 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.

Designation Area RC11 York Road South			
Flood Source: Fluvial			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.63	15.69	0.00
Flood Zone depth ¹⁰ (m)	Max: 0.6-0.9 Mean: 0.3-0.6	Max: 0.6-0.9 Mean: 0.3-0.6	Max: - Mean: -
Flood Zone hazard	No data available	No data available	No data available
Climate change	<p>16% of this Designation Area is currently located in Flood Zone 2 and 3a. Given the proximity to the watercourse, fluvial climate change impacts should be assessed within a site-specific FRA by increasing peak flows by the total potential change anticipated for the '2080s' (2070 to 2115) corresponding with the highest risk Flood Zone and the proposed development Vulnerability Classification.</p> <p>Flood extents at this location are based on EA strategic modelling techniques rather than detailed modelling. For the current screening in the absence of a detailed the full hydraulic model the current day Flood Zone 2 outline has been used to provide a representation of the future extents of Flood Zone 3a under Climate Change (noting that under the fluvial case, Flood Zone 3a is based on the 1% AEP flood event). This indicates a very marginal increase in impacted area and a small increase in flood depths (<100mm) based on the available provided modelling. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p>		
Historic flooding	From available data, there are no records of historic flood events in this Designation Area.		
Defended	<p>Environment Agency records indicate that the Burn Valley Beck open channel is a maintained watercourse which enters a culvert upstream of the south west corner of the Designation Area (Penrhyn Street / York Road) is undefended with high ground either side. From Penrhyn Street to the coast the watercourse is culverted as public sewer. The culvert is reported to have a considerable (>2m) radius. Northumberland Water have built a pumping station close to the coast to prevent surface water flooding when the outfall from this watercourse is tide locked. The modelling undertaken to derive the flood zones excludes the effects of this pumping station. The capacity and structural condition of the culvert has not been confirmed as part of this assessment.</p>		
Flood Warning Area	No		
Flood risk	<p>Ground levels across the site generally decline from the northwest to southeast, reducing from around 12m OD to 7.3m OD. The southern part of the site extends out into a valley bottom (associated with the upstream watercourse) where it begins to widen.</p> <p>The area is currently urbanised with a mix of residential, retail and commercial properties within a dense network of streets and highways including the more significant York and Warwick Roads.</p> <p>The Designation Area is at greatest risk of flooding from fluvial flooding from the watercourse which enters a culvert immediately southwest of the site at Penrhyn Street / York Road. It is not at risk from Tidal Flooding. Approximately 16% of the southern part of the area is at risk of fluvial flooding and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a increase towards the valley bottom (potentially the historic line of the watercourse) with a very localised maximum depth of 0.6 to 0.9m and average depths of 0.3-0.6m. Flood Zone 2 extents and depths</p>		

10 Environment Agency Hartlepool FRM Study (Fluvial and Tidal) 2008

Designation Area RC11 York Road South	
	<p>are very similar with only a small increase in the area of each depth banding. The majority of the Designation Area to the north is within Flood Zone 1, with an additional small strip of land to the south of the site where it rises on the opposite valley side.</p> <p>Modelling to define the fluvial Flood Zone maps is based on a similar method as was used for the Generalised National Fluvial Flood Zones Modelling. The modelling report identifies that channel capacity was assumed to be QMED (1 in 2 year flood) and that the culvert capacities or the effects of the downstream pumping have not been modelled as part of the previous study. The report identifies that based on these assumptions that the flood outlines are likely to be conservative.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect site specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • The capacity and structural condition of the culvert has not been confirmed as part of this assessment and will need to be assessed as part of the Flood Risk Assessment. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing urban layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. Ideally 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. Approximately 84% of the site would be considered suitable for development. • More detailed assessment and provision for climate change should be made in the site specific FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. • The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available.
Flood Source: Ground Water	
Flood risk: ground water	The majority of the Designation Area indicated as having a susceptibility to groundwater emergence of 25-50%. The northern area is indicated as having a susceptibility to groundwater emergence of >75%. LiDAR indicates a fall across the site from north to south, which indicates that ponding if encountered is likely to be minimal and if encountered is likely to be minimal as water will tend to flow across the site following topography.
Flood Source: Infrastructure Failure – Reservoirs	
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.
Flood Source: Infrastructure Failure – Canals	
Flood risk: canal	No canalised watercourses in area. No flood risk identified.

Designation Area RC11 York Road South			
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	0.34
Surface water flooding depths (m)	Max: - Average: 0 -0.15m	Max: 0-0.15m Average: 0 -0.15m	Max: 0.3-0.6m Average: 0.15-0.3m
Surface water hazards ¹¹	Max: - Average: -	Max: Low Average: Low	Max: Significant Average: Low
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	<p>There is little or no surface water flood risk to the majority of the Designation Area across all events.</p> <p>However, in the Low Risk (0.1% AEP) event the southern area is shown to experience surface water flooding with localised depths on average 0.15-0.3m reaching a maximum of 0.3-0.6m. The hazard is generally low, with some very localised areas indicating a Significant hazard. Overall, 6% of the Designation Area is at some level of risk from surface water flooding.</p> <p>Surface water flood extents appear to be influenced by the presence of the existing road layout and buildings, with the main flooding being seen in the southern area of the B1277 York Road and adjoining side streets. The topography shows that ground levels generally fall from north to south, towards the unnamed watercourse which enters culvert to the south of the Designation Area</p> <p>The flood mapping indicates some but relatively limited potential for surface water flooding entering the Designation Area from adjacent areas, with no significant flow routes seen to cross the area.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a number of alternative routes and therefore off-site impacts on access and egress appear manageable.</p>		
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. As parts of the Designation Area are subject to a significant flood hazard a site specific detailed surface water assessments and drainage strategy will be required as part of any FRAs for development in these area. The FRAs will need to mitigate climate change impacts across the lifetime of the development. • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS. • The FRAs should assess the potential for offsite surface water impacts on proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. • Any FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available. 		

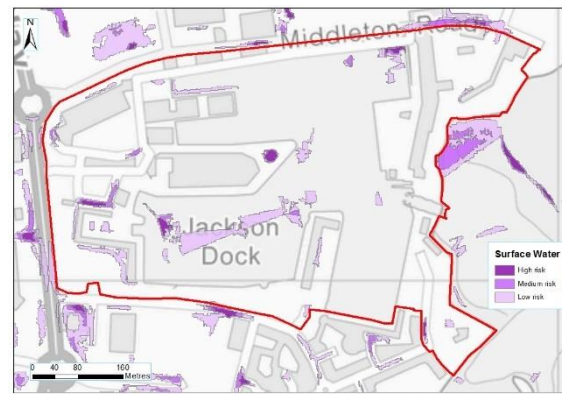
11 Environment Agency: *What is the updated Flood Map for Surface Water*. November 2013

Designation Area		RC11 York Road South				
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield QBAR - IH124 Methodology				3.33% AEP:	9.32l/s	
				1% AEP:	11.07l/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%	48	2836	805	2031	120.7	0.14Ha 4.12%
3.33% AEP Rainfall+40%	48	3309	805	2504	148.8	0.17Ha 5.08%
1% AEP Rainfall+20%	48	3595	956	2639 (608m ³ of exceedance storage)	132.0	0.18Ha 5.36% (0.04Ha 1.23%)
1% AEP Rainfall+40%	48	4194	956	3238 (734m ³ of exceedance storage)	162.0	0.22Ha 6.57% (0.05Ha 1.49%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.10 RC12 The Marina

Designation Area		RC12 The Marina
Site area	19.55Ha (Dock areas removed from measured area of Designation Area)	
Existing use	Brownfield / urbanised including commercial / retail / residential	
Proposed use	Mixed Residential /Commercial	
Proposed development flood risk vulnerability classification	More Vulnerable	
Proposed development impermeable area	85% of total developable area (Specified by Hartlepool Borough Council) 16.61Ha	

Flood outlines (current day)



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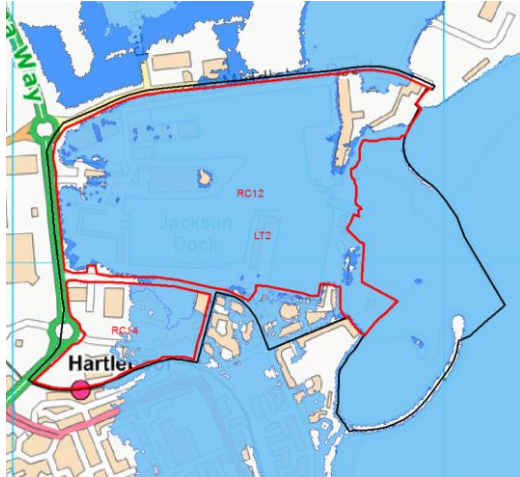
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Observations and Recommendations

- The Marina represents a significant urban extent and is considered by the Council to be a key regeneration area. No specific development opportunities have been identified by the Council at this stage.
- Approximately 80% of the developable site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- Under Climate Change conditions the docks will be particularly susceptible to climate induced inundation and upwards of 85% of the developable site will be at flood risk. Under this scenario 15% of the developable site will remain within Flood Zone 1.
- The associated depth and hazard rating vary with topography.
- More Vulnerable development may be considered provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where development may be considered.
- Flood risk extents are based on EA tidal modelling. Ground raising will not result in increased tidal risk to adjacent areas.
- 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.

Designation Area RC12 The Marina			
Flood Source: Tidal			
Flood Zones (%) (of developable area)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	6.07	13.10	0.00
Flood Zone depth ¹² (m)	Max: 0.3-0.6 Mean: 0.0-0.15	Max: 0.3-0.6 Mean: 0.0-0.15	Max: - Mean: -
Flood Zone 3 hazard	Max: Significant Mean: Low	Max: Moderate Mean: Low	Max: - Mean: -
Climate change	<p>19% of the developable Designation Area is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that dependent upon location the Designation Area is at risk of flooding as a consequence of either direct extreme sea level still water overtopping, wave overtopping or a combination of both. The eastern area fronting the coast at the Old Harbour, each side of Jackson Dock and the frontage towards the northern harbour pier is predominantly at risk from wave overtopping in the current day, although it appears that there may also be a risk of extreme sea level overtopping in the climate change scenario. In the current day, there is a narrow strip of coastal flooding in both the 0.5% (FZ3a) and 0.1% (FZ2) AEP events. In contrast, the inland area surrounding Jackson Dock and The Marina is predominately at risk from extreme sea level overtopping. This area is not shown to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) events.</p> <p>There is an area to the south of Jackson Dock which in the current day 0.5 % (FZ3a) AEP event primarily appears to be risk from overland flow from wave overtopping of the old town frontage to the south. Dependent upon a detailed review of ground levels there may also be a risk to this area from extreme sea level overtopping in the 0.1% (FZ2) AEP emanating from Jackson Dock to the north. Under climate change this area is at risk of flooding from both sources.</p> <p>Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Updated modelling to assess future wave overtopping extents may be required as part of a site-specific FRA and the requirements would need to be agreed with the EA.</p> <p>2008 Model</p> <p>Wave overtopping outlines for the current day 0.1% AEP events combined with still water climate change levels has, therefore, been used for climate change testing (see relevant mapping in Appendices).</p> <p>For areas impacted by wave overtopping, for the purposes of this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. This indicates that climate change flooding from this source is likely to be limited and similar to the current day, limited to a narrow strip along the coastal frontage with depths up to 0.6m and a Low to locally Significant flood hazard. In addition, localised section of this frontage may become inundated due to being overtopped by extreme still water overtopping. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p>		

Designation Area	RC12 The Marina
	<p>2012 Model</p> <p>Wave overtopping outlines for the current day 0.5% AEP events combined with still water climate change levels has, therefore, been used for climate change testing (see relevant mapping in Appendices).</p>  <p>Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios</p> <p>Based On 2008 Hartlepool Model Update of Extreme Sea Level Still Water Level Contains OS data © Crown copyright and database right (2017) 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 areas adjacent to the Jackson Dock / Marina are undefended and subject to flooding from extreme still water overtopping under climate change. Preliminary modelling indicates that almost 85% of the Designation Area becomes at risk of flooding under the 0.5% AEP climate change event. There is a localised area to the west around Harbour Walk / Marine Way and a north-eastern area of residential / commercial properties between Middleton Road and Commercial Street which are not shown to flood. Flood depths are on average 0.3-0.6m and up to 1.2m in areas adjacent to the dockside. Flood extents are similar under the climate change 0.1% AEP event, with deeper flooding covering more extensive areas. The extreme still water overtopping flood extents also appear to extend south from the Jackson Dock into the adjacent Designation Area RC14, which enlarges the area flooded as a consequence of overland flow emanating from the southern Old Town defence wave overtopping.</p>
<p>Historic flooding</p>	<p>From available data, there are no records of historic flood events in this Designation Area.</p>
<p>Defended</p>	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage which protect the Designation Area. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. The eastern coastal frontage is generally protected from coastal overtopping by defence walls at the Old Harbour, either side of the Jackson Dock and to the northern harbour arm. The outer harbour piers are also assessed to provide some (albeit slight) benefit and therefore the Flood Zone mapping is based on the undefended situation with both the defence walls and outer harbour piers removed.</p> <p>Based on a modelling review if the front-line defences are breached or removed, there will be a narrow strip of flood risk potentially associated with both extreme</p>

Designation Area	RC12 The Marina
	<p>sea level overtopping and wave overtopping, primarily along the coastal frontage. The time for this flood risk to occur is subject to a more detailed assessment of potential flow routes and the tidal curve, but based on the proximity the area inundated would be likely to be instantaneous. A preliminary review of LiDAR ground levels at the defence line indicate that in the event of a breach, water levels could be up 0.6-0.9m locally in the vicinity of the breach in the climate change 0.1% AEP event (significantly less in the current day scenario). Flood depths are likely be lower inland, potentially due to the storage influence of the dock.</p>
Flood Warning Area	<p>Approximately <5% of Designation Area (eastern edge of site) within North Sea at West of Hartlepool Flood Warning Area</p>
Flood risk	<p>Designation Area RC12 is incorporated within Designation Area LT2 and the flood risks are generally also as described under that Designation Area.</p> <p>Ground levels across the Designation Area are relatively level within the Jackson Dock / Marina area with an average ground level of 4.5m OD. The north-east area in the vicinity of Middleton Road / Commercial Street is slightly higher at around 5.5m OD. Immediately west of the Designation Area, the A179 Marina Way is slightly elevated at around 7.0m OD.</p> <p>The area is currently developed with a mix of residential, retail and commercial development and open dockside within a network of streets and highways.</p> <p>In the current day, the Designation Area is at greatest risk of flooding from the coastal frontage. As explained above, dependent upon location the flooding is either as a consequence of wave overtopping or extreme sea level still water overtopping. The current day flood risk under the 0.5% (FZ3a) and 0.1% (FZ2) are generally limited to a narrow strip along the coastal frontage and this is likely to be primarily related to wave overtopping. In addition, it appears that the whilst this assessment has removed the area of dock from the percentage coverage calculations, the Designation Area may still incorporate areas of foreshore and revetment which may account for the higher area flood risk percentages. This would require furthermore detailed assessment as part of any subsequent FRA to confirm the land boundary. In the 0.1% (FZ2) outline, there are localised areas of flooding extending inland from the coastal frontage, with depths of 0-0.15m. There is also localised flooding of up to 0.6m on the small promontory adjacent to the Old Harbour. In addition, under this Flood Zone there is shallow flooding (0-0.15m) to the south of Jackson Dock which are considered to be associated with overland flows emanating from wave overtopping of the defences fronting the Old Town to the south.</p> <p>The majority of the Designation area is within Flood Zone 1.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of future flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may result in a reduction in flood storage. However, in this instance, it is noted that this is an area of tidal flood risk and land raising is unlikely to impact on tide levels. • 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include

Designation Area		RC12 The Marina		
	<p>specific climate change scenarios and depending on development proposals further investigation may be required.</p> <ul style="list-style-type: none"> The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	100% of Designation Area indicated as having a susceptibility to groundwater emergence of >75%. Based on a review of LiDAR, the risk of ponding, if it occurs, is likely to be minimal and localised as water will tend to flow towards the dock.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
Surface Water Flood Risk to Proposed Development Site				
Existing development: risk of flooding from surface water (%) (of developable area)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)	
	0.37	0.38	2.08	
Surface water flooding depths (m)	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	
Surface water hazards	Max: Moderate Average: Low	Max: Moderate Average: Low	Max: Moderate Average: Low	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>Designation Area RC12 is incorporated within Designation Area LT2 and the flood risks are generally as described under that Designation Area.</p> <p>There is limited surface water flooding below the 0.1% AEP (Low Risk) event and even in this higher event, less than 3% of the developable Designation Area is impacted. The majority of the localised surface water flooding appears associated with areas of dockside hardstanding, existing building layout, carparks and roadways. The majority of the area is developed and therefore reliant on a drainage system. As the site is generally flat overland surface water flows appear minimal. Depths are low, 0.15-0.3m on average. Hazard ratings in areas indicating flooding are low with very localised areas identified as presenting a moderate flood hazard.</p> <p>Mapping does not indicate significant surface water flows entering the site from the adjacent areas.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates minimal localised highway flooding below the 0.1% AEP event. In this higher event, although there are localised depths of 0.3-0.6m there appears to be alternative access routes and therefore off-site impacts on access and egress appear manageable.</p>			
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. Areas of the Designation Area are subject to localised surface water flooding and a site / development specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The 			

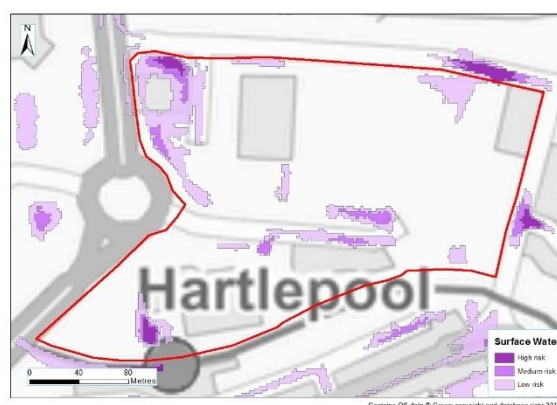
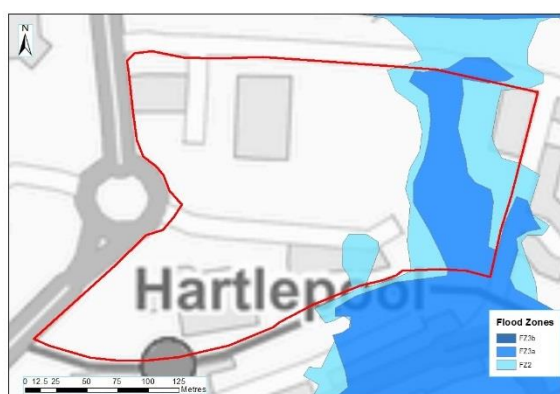
Designation Area		RC12 The Marina				
		<p>FRA will need to mitigate climate change impacts across the lifetime of the development. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may not be required.</p> <ul style="list-style-type: none"> • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS. • Whilst they appear to be minimal, the FRA should assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes. • The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential routes appear available. • If discharge to the nearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events. 				
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP	54.4l/s	
				1% AEP:	64.66l/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%	48	17265	4700	12565	128.0	0.84Ha 2.47%
3.33% AEP Rainfall+40%	48	20143	4700	15443	157.3	1.03Ha 3.04%
1% AEP Rainfall+20%	48	21908	5587	16321 (3756m ³ of exceedance storage)	139.8	1.09Ha 3.21% (0.25Ha 0.74%)
1% AEP Rainfall+40%	48	25559	5587	19972 (4529m ³ of exceedance storage)	171.1	1.33Ha 3.93% (0.30Ha 0.89%)
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	<p>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may not be required.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit</p>					

Designation Area	RC12 The Marina
	<p>off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

2.11 RC14 Trincomalee Wharf

Designation Area		RC14 Trincomalee Wharf
Site area		6.38Ha
Existing use		Brownfield / urbanised including commercial / retail / leisure
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 5.42Ha

Flood outlines (current day)



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Observations and Recommendations

- Trincomalee Wharf represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Approximately 80% of the site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment, this reduced to 74% under climate change. The council may consider allocating the Designation Area for development
- The Council may consider allocating the Designation Area for development base on rezoning to avoid inappropriate development within areas at significant flood risk.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood risk extents are based on EA modelled wave overtopping. As flood water will flow by topography ground raising may impact on adjacent areas.
- 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.

Designation Area		RC14 Trincomalee Wharf		
Flood Source: Tidal				
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b	
	9.96	10.49	0.00	
Flood Zone depth ¹³ (m)	Max: 0.3-0.6m Mean: 0.15-0.3m	Max: 0.15-0.3m Mean: 0.0-0.15	Max: - Mean: -	
Flood Zone max hazard	Max: Significant Mean: Low	Max: Moderate Mean: Low	Max: - Mean: -	
Climate change	<p>20% of this Designation Area is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that in the current day the site is not at direct risk of flooding as a result of extreme sea level still water overtopping during 0.5% (FZ3a) event. A review of the flood modelling indicates that the flooding along this area of coastline, as defined by the EA flood map is as a consequence of wave overtopping rather than extreme sea levels on an undefended coastline. Dependent upon a detailed review of ground levels there may also be a risk to this area from extreme sea level overtopping in the 0.1% (FZ2) AEP emanating from Jackson Dock to the north. Under climate change this area is at risk of flooding from both sources and the area within Flood Zone 1 reduces to 74% within the 2012 model update.</p> <p>Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Updated modelling to assess future wave overtopping extents may be required as part of a site specific FRA and the requirements would need to be agreed with the EA. For the purposes of this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. Wave overtopping outlines for the current day 0.1% AEP events combined with still water climate change levels has, therefore, been used for climate change testing. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p> <p>Flood Zone 3a and 2 under climate change cover similar extents. Flooding will extend westwards and cover approximately 25% of the Designation Area. Mean flood depths under the 0.5% (FZ3a) climate change scenario will be 0.3-0.6m with localised maximum depths of 0.6-0.9m depths. The extents of each depth banding will increase under the 0.1% (FZ2) climate change scenario.</p>			
Historic flooding	From available data, there are no records of historic flood events in this Designation Area.			
Defended	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage which protect the Designation Area. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies,</p>			

Designation Area	RC14 Trincomalee Wharf
	<p>namely Hartlepool Borough Council and PD Ports.</p> <p>For flooding from Jackson Dock to the north the eastern coastal frontage is generally protected from coastal overtopping by defence walls at the Old Harbour, either side of the Jackson Dock and between the Dock and the northern harbour arm. The outer harbour piers are also assessed to provide some (albeit slight) benefit and therefore the Flood Zone mapping is based on the undefended situation with both the coastal defence walls and outer harbour piers removed.</p> <p>To the south east of the Designation Area the coastal frontage is generally protected from coastal flooding by a front-line ridge of high ground / embankment of substantial width topped by a concrete flood wall. Based on a modelling review there is no extreme sea level still water overtopping flooding anticipated to the Designation Area for the present day or climate change 0.5% AEP or 0.1% AEP events directly from the south-east coast even if all flood defences were removed or breached. This is based on the level and extent of the existing high ground / embankment fronting the coastline and the relative levels across the Designation Area.</p> <p>For flooding from Jackson Dock, there is a risk of flooding from extreme still water levels both potentially in the 0.1% current day situation and in the 0.5% and 0.1% climate change events. The time for this flood risk to occur is subject to a more detailed assessment of potential flow routes and the tidal curve, but based on the proximity the area inundated would be likely to be instantaneous. A preliminary review of LiDAR ground levels at the defence line indicate that in the event of a breach, water levels could be up 0.6-0.9m locally in the vicinity of the breach in the climate change 0.1% AEP event (significantly less in the current day scenario). Flood depths are likely to be lower inland, potentially due to the storage influence of the dock.</p>
Flood Warning Area	No
Flood risk	<p>Designation Area RC14 is incorporated within Designation Area LT2 and the flood risks are generally also as described under that Designation Area.</p> <p>The Designation Area generally declines in ground level from around 8.0m in the southwest to around 5.3m in the northeast. There is a slight valley from south to north and this corresponds with potential flow routes for flooding from the south.</p> <p>The area is currently developed with a mix of retail / leisure facilities. There is a large area of undeveloped open space to the centre of the Designation Area. Hartlepool Railway Station is situated on the southern edge of the Designation Area with the rail line adjacent to the southern boundary. Immediately west of the Designation Area, the A179 Marina Way is slightly elevated at between 6m and 13m OD.</p> <p>The Designation Area is at greatest risk of flooding from the coastal frontage which is approximately 350m to the east. A review of ground levels indicates that water emanating from wave overtopping will tend to flow northwards towards the Hartlepool Marina. Approximately 20% of the site (the eastern side) is at risk of tidal flooding (from wave overtopping) and located in Flood Zone 2 and 3a. Flood Zone 3a is restricted to a narrow strip to the east of the site, with shallow flooding of 0-0.15m and a Low hazard rating. Under FZ2, the flood extents and depths increase. Whilst this is primarily considered due to an increase in overtopping flows from the south, there may also be localised overtopping as a result of high still water levels within Jackson Dock. However, this requires confirmation through a more detailed assessment of ground levels. The average depth of flooding increases to 0-0.15m, however the hazard rating remains Low.</p> <p>The majority of the Designation Area to the west is within Flood Zone 1.</p>

Designation Area		RC14 Trincomalee Wharf		
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. • 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. Approximately 74% of the area would be considered suitable for redevelopment. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and depending on development proposals further investigation may be required. • The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	100% of Designation Area indicated as having a susceptibility to groundwater emergence of >75%. Based on a review of LiDAR, the risk of ponding, if it occurs, is likely to be minimal and localised as water will tend to flow towards the dock.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
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)	
	0.54	1.57	8.58	
Surface water flooding depths	Max: 0.15-0.3m Average: 0.15 -0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.3-0.6m	
Surface water hazards	Max: Low Average: Low	Max: Moderate Average: Low	Max: Significant Average: Moderate	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			

Designation Area RC14 Trincomalee Wharf

Surface water: flood risk to development site

Designation Area RC14 is incorporated within Designation Area LT2 and the flood risks are generally as described under that Designation Area.

There is limited surface water flooding below the 0.1% AEP (Medium Risk) event. In the 0.1% AEP event flood depths are still relatively localised and on average 0.15m-0.6m deep, with a Low Hazard Rating. In the 0.1% AEP (Low Risk) event flood extents are more extensive, and make up around 10% of the site area. Average depths are between 0.3-0.6m, with a Moderate hazard. Depths are greatest in the western part of the Designation Area whilst on average are Moderate the hazard increases locally to Significant under the 0.1% AEP event. There is a localised area of similar flood depths to the south of the Development area at the cinema car park.

The majority of the localised surface water flooding appears associated with areas of hardstanding, existing buildings layout carparks and roadways. As the area is predominantly developed it will be reliant on a drainage system to manage surface water flooding.

Mapping does not indicate significant surface water flows entering the site from the adjacent areas. The Designation Area has a relatively level ground profile and overland surface water flow routes appear to be limited. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates minimal localised highway flooding below the 0.1% AEP event. In this higher event, although there are localised depths of 0.3-0.6m there appears to be alternative access routes and therefore off-site impacts on access and egress appear manageable.

- Surface water: mitigation options & site suitability**
- Areas of the Designation Area are subject to localised surface water flooding with some more extensive areas of deeper more hazardous flooding in the more extreme events. A site / development specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts across the lifetime of the development.
 - Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS.
 - Whilst they appear to be minimal, the FRA should assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes.
 - The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential routes appear available.
 - If discharge to the nearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events.

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

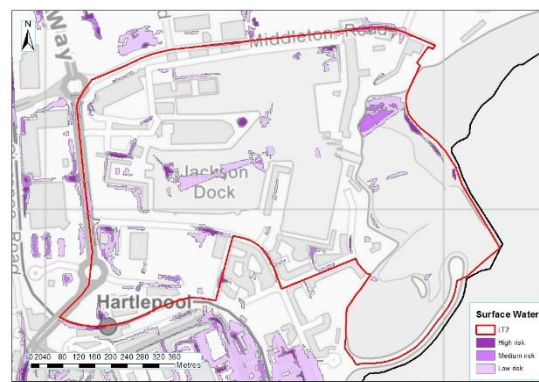
Proposed development limiting runoff rate: Greenfield - IH124 Methodology (l/s)				3.33% AEP:	17.72l/s	
				1% AEP:	21.06l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (Ha) and % of site area
3.33% AEP Rainfall+20%	48	5630	1531	4099	128.2	0.27Ha 4.28%
3.33% AEP	48	6569	1531	5038	157.5	0.34Ha

Designation Area		RC14 Trincomalee Wharf				
Rainfall+40%						5.26%
1% AEP Rainfall+20%	48	7145	1820	5325 (1226m ³ of exceedance storage)	140.1	0.34Ha 5.56% (0.08Ha 1.28%)
1% AEP Rainfall+40%	48	8335	1820	6515 (1477m ³ of exceedance storage)	171.4	0.43Ha 6.81% (0.10Ha 1.54%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.12 LT2 The Marina

Designation Area		LT2 The Marina
Site area		30.99Ha (Dock Areas removed from measured area of Designation Area)
Existing use		Brownfield / urbanised including commercial / retail / leisure / residential
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 26.34Ha

Flood outlines (current day)



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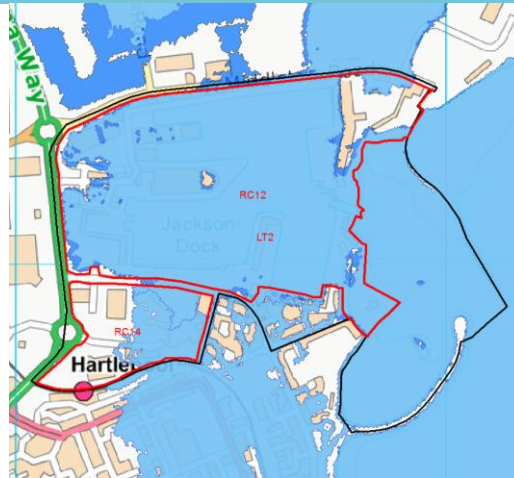
Observations and Recommendations

- The Marina represents a significant urban extent and is considered by the Council to be a key regeneration area. No specific development opportunities have been identified by the Council at this stage.
- Approximately 82% of the developable site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- Under Climate Change conditions the docks will be particularly susceptible to climate induced inundation and upwards of 63% of the developable site will be at flood risk (37% in Flood Zone 1).
- The associated depth and hazard rating vary with topography.
- More Vulnerable development may be considered provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where development may be considered.
- Flood risk extents are based on EA tidal modelling. Ground raising will not result in increased tidal risk to adjacent areas.
- A site specific FRAs will be required to confirm safe development levels (taking into account climate change and wave action) and that an emergency evacuation plan demonstrates safe egress
- 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.

Designation Area			
LT2 The Marina			
Flood Source: Tidal			
Flood Zones (%) (of developable area)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	6.93	11.33	0.00
Flood Zone depth ¹⁴ (m)	Max: 0.3-0.6 Mean: 0.0-0.15	Max: 0.3-0.6 Mean: 0.0-0.15	Max: - Mean: -
Flood Zone hazard	Max: Significant Mean: Low	Max: Moderate Mean: Low	Max: - Mean: -
Climate change	<p>19% of the developable Designation Area is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that dependent upon location the Designation Area is at risk of flooding as a consequence of either direct extreme sea level still water overtopping, wave overtopping or a combination of both. The eastern area fronting the coast at the Old Harbour, each side of Jackson Dock and the frontage towards the northern harbour pier is predominantly at risk from wave overtopping in the current day, although it appears that there may also be a risk of extreme sea level overtopping in the climate change scenario. In the current day, there is a narrow strip of coastal flooding in both the 0.5% (FZ3a) and 0.1% (FZ2) AEP events. In contrast, the inland area surrounding Jackson Dock and The Marina is predominately at risk from extreme sea level overtopping. This area is not shown to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) events. The area to the south of Jackson Dock (RC14) in the current day 0.5 % (FZ3a) AEP event primarily appears to be risk from overland flow from wave overtopping of the old town frontage to the south. Dependent upon a detailed review of ground levels there may also be a risk to this area from extreme sea level overtopping in the 0.1% (FZ2) AEP emanating from Jackson Dock to the north. Under climate change this area is at risk of flooding from both sources.</p> <p>Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Updated modelling to assess future wave overtopping extents may be required as part of a site specific FRA and the requirements would need to be agreed with the EA. For the purposes of this SFRA wave overtopping outlines for the current day 0.1% AEP events combined with still water climate change levels has, therefore, been used for climate change testing. For areas impacted by wave overtopping, for the purpose of this SFRA, in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. This indicates that climate change flooding from this source is likely to be limited and similar to the current day, limited to a narrow strip along the coastal frontage with depths up to 0.6m and a Low to locally Significant flood hazard. In addition, localised section of this frontage may become inundated due to being overtopped by extreme still water overtopping. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p>		

Designation Area

LT2 The Marina



Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios

Based On 2008 Hartlepool Model Update of Extreme Sea Level Still Water Level
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The areas adjacent to the Jackson Dock / Marina are undefended and subject to flooding from extreme still water overtopping under climate change. Preliminary modelling indicates that almost the entire northern part of the Designation Area (the RC12 area) becomes at risk of flooding under the 0.5% AEP climate change event. There is a localised area to the west around Harbour Walk / Marine Way and a north-eastern area of residential / commercial properties between Middleton Road and Commercial Street which are not shown to flood. In addition, the area to the south west (RC14) is shown not to flood. Flood depths are on average 0.3-0.6m and up to 1.2m in areas adjacent to the dockside. Flood extents are similar under the climate change 0.1% AEP event, with deeper flooding covering more extensive areas. The extreme still water overtopping flood extents extends south from the Jackson Dock into the area of Designation Area RC14, which also enlarges the area flooded as a consequence of overland flow emanating from the southern Old Town defence wave overtopping.

Historic flooding

From available data, there are no records of historic flood events in this Designation Area.

Defended

The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.

There are however defences along the coastal frontage which protect the Designation Area. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. The eastern coastal frontage is generally protected from coastal overtopping by defence walls at the Old Harbour, either side of the Jackson Dock and to the northern harbour arm. The outer harbour piers are also assessed to provide some (albeit slight) benefit and therefore the Flood Zone mapping is based on the undefended situation with both the defence walls and outer harbour piers removed.

Based on a modelling review if the front-line defences are breached or removed, there will be a narrow strip of flood risk potentially associated with both extreme sea level overtopping and wave overtopping, primarily along the coastal frontage. The time for this flood risk to occur is subject

Designation Area	LT2 The Marina
	<p>to a more detailed assessment of potential flow routes and the tidal curve, but based on the proximity the area inundated would be likely to be instantaneous. A preliminary review of LiDAR ground levels at the defence line indicate that in the event of a breach, water levels could be up 0.6-0.9m locally in the vicinity of the breach in the climate change 0.1% AEP event (significantly less in the current day scenario). Flood depths are likely be lower inland, potentially due to the storage influence of the dock.</p> <p>To the south east of the Designation Area the coastal frontage is generally protected from coastal flooding by a front line ridge of high ground / embankment of substantial width topped by a concrete flood wall. Based on a modelling review there is no extreme sea level still water overtopping flooding anticipated to the Designation Area for the present day or climate change 0.5% AEP or 0.1% AEP events directly from the south-east coast even if all flood defences were removed or breached. This is based on the level and extent of the existing high ground / embankment fronting the coastline and the relative levels across the Designation Area.</p>
<p>Flood Warning Area</p>	<p>Approximately <5% of Designation Area (eastern edge of site) within North Sea at West of Hartlepool Flood Warning Area</p>
<p>Flood risk</p>	<p>Designation Area LT2 incorporated Designation Area RC12 and RC14 and the flood risks are generally as described under those Designation Areas.</p> <p>Ground levels across the Designation Area are relatively level within the northern Jackson Dock / Marina area with an average ground level of 4.5m OD. The north-east area in the vicinity of Middleton Road / Commercial Street is slightly higher at around 5.5m OD.</p> <p>To the south of Jackson Dock the Designation Area generally rises in ground level from around 4.0m to around 8.0m in the southwest. There is a slight valley running south to north and this corresponds with potential flow routes for flooding from the south.</p> <p>The area is currently developed with a mix of residential, retail and commercial development and open dockside within a network of streets and highways. To the south there is mix of retail / leisure facilities. There is a large area of undeveloped open south of Jackson Dock. Hartlepool Railway Station is situated on the southern edge of the Designation Area with the rail line adjacent to the southern boundary. Immediately west of the Designation Area, the A179 Marina Way is slightly elevated at between 6 and 13m OD.</p> <p>In the current day, the Designation Area is at greatest risk of flooding from the coastal frontage. As explained above, dependent upon location the flooding is either as a consequence of wave overtopping or extreme sea level still water overtopping. The current day flood risk under the 0.5% (FZ3a) and 0.1% (FZ2) are generally limited to two areas; a narrow strip along the coastal frontage (likely to be primarily related to wave overtopping) and the area south of Jackson Dock where flooding is most likely from wave overtopping from the coastal defences to the south east.</p> <p>It appears that the whilst this assessment has removed the area of dock from the percentage coverage calculations, the Designation Area may still incorporate areas of foreshore and revetment which may account for the higher area flood risk percentages. This would require furthermore detailed assessment as part of any subsequent FRA to confirm the land boundary. In the 0.1% (FZ2) outline, there are localised areas of flooding extending inland from the coastal frontage, with depths of 0-0.15m. There is also localised flooding of up to 0.6m on the small promontory adjacent to the Old Harbour. In addition, under this Flood Zone there is shallow flooding (0-0.15m) to the south of Jackson Dock which is considered to be associated with overland flows emanating from wave overtopping of the defences fronting the Old Town to the south.</p>

Designation Area		LT2 The Marina		
	The majority of the Designation area is within Flood Zone 1.			
Mitigation options & site suitability	<ul style="list-style-type: none"> Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. However, in this instance, it is noted that this is within an area of tidal flood and land raising is unlikely to impact on tide levels. 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. Approximately 80% of the area would be considered suitable for redevelopment in the current day, however this reduces to 37% under climate change (Flood Zone 1 climate change). Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and depending on development proposals further investigation may be required. The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	100% of Designation Area indicated as having a susceptibility to groundwater emergence of >75%. Based on a review of LiDAR, the risk of ponding, if it occurs, is likely to be minimal and localised as water will tend to flow towards the dock.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
Surface Water Flood Risk to Proposed Development Site				
Existing development: risk of flooding from surface water (%) (of developable area)	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)	
	0.53	0.90	4.22	
Surface water flooding depths (m)	Max: 0.15-0.3m Average: 0.15 -0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	
Surface water hazards	Max: Moderate	Max: Moderate	Max: Significant	

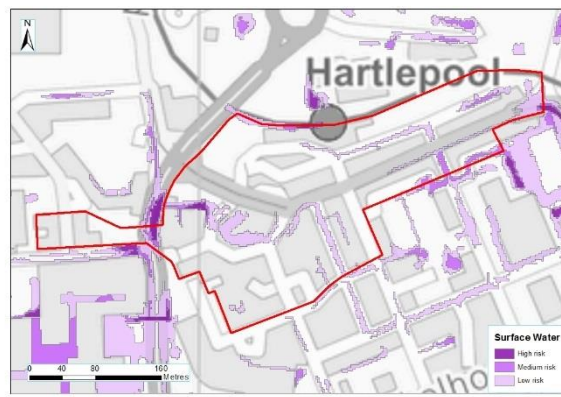
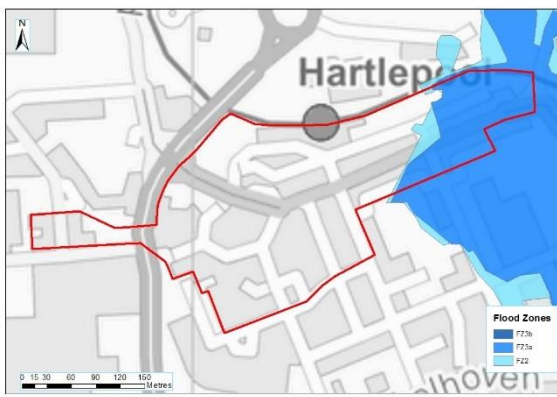
Designation Area		LT2 The Marina		
		Average: Low	Average: Low	Average: Low
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>Designation Area LT2 incorporated Designation Area RC12 and RC14 and the flood risks are generally as described under those Designation Areas.</p> <p>There is relatively little surface water flooding below the 0.1% AEP (Low Risk) event and even in the higher event, less than 6% of the developable Designation Area is impacted. The majority of the localised surface water flooding appears associated with areas of dockside hardstanding, existing building layout car parks and roadways. As the area is predominantly developed it will be reliant on a drainage system to manage surface water flooding. Flood depths are low and are on average 0.15-0.3m during the 1% AEP and 0.1% AEP events. Hazard ratings in areas indicated to flood are generally Low with localised areas identified as presenting a Significant flood hazard in the 0.1% AEP event. South of Maritime Road (RC14) there are more extensive areas of localised flood risk, with maximum depths of flooding of 0.3-0.6m in the area of the Maritime Road / Lanyard area during the 0.1% AEP year event.</p> <p>Mapping does not indicate significant surface water flows entering the site from the adjacent areas. The Designation Area has a relatively level ground profile and overland surface water flow routes appear to be limited. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates minimal localised highway flooding below the 0.1% AEP event. In this higher event, although there are localised depths of 0.3-0.6m there appears to be alternative access routes and therefore off-site impacts on access and egress appear manageable.</p>			
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. Areas of the Designation Area are subject to localised surface water flooding and a site / development specific detailed surface water drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS. • Whilst they appear to be minimal, the FRA should assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes. • The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential routes appear available. • If discharge to the nearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events. 			

Designation Area		LT2 The Marina				
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	86.08l/s	
				1% AEP:	102.31l/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%	48	27363	7437	19926	128.2	1.33Ha 2.22%
3.33% AEP Rainfall+40%	48	31923	7437	24486	157.6	1.63Ha 2.72%
1% AEP Rainfall+20%	48	34721	8840	25881 (5955m ³ of exceedance storage)	140.1	1.73Ha 2.88% (0.40Ha 0.66%)
1% AEP Rainfall+40%	48	40507	8840	31667 (7181m ³ of exceedance storage)	171.5	2.11Ha 3.52% (0.48Ha 0.80%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. There may be an opportunity for development to discharge direct to sea and attenuation in that instance may not be required.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.13 RC17 Late Night Uses Areas

Designation Area	RC17 Late Night Uses Areas
Site area	7.52Ha
Existing use	Brownfield / urbanised including commercial / retail / residential
Proposed use	Retail / Commercial / Residential
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	85% of total area (Specified by Hartlepool Borough Council) 6.39Ha

Flood outlines (current day)



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Observations and Recommendations

- The Late Night Uses Area represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Whilst approximately 83% of the site is located in Flood Zone 1 and is, therefore, suitable for redevelopment. This reduces slightly under climate change. The Council may consider allocating the Designation Area for development.
- The Council may consider allocating the Designation Area for development based on rezoning to avoid inappropriate development within areas at significant flood risk or hazard rating.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or:
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood risk extents are based on EA modelled wave overtopping. As flood water will flow by topography ground raising may impact on adjacent areas.
- Surface water flooding appears localised to existing urban areas. Any development proposals within this Designation Area will need to take site runoff and offsite interactions into consideration.

Designation Area		RC17 Late Night Uses Areas		
Flood Source: Tidal				
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b	
	1.71	15.52	0.00	
Flood Zone depth ¹⁵ (m)	Max: 0.6-0.9 Mean: 0.3-0.6	Max: 0.6-0.9 Mean: 0.3-0.6	Max: - Mean: -	
Flood Zone hazard	Max: Significant Mean: Moderate	Max: Significant Mean: Moderate	Max: - Mean: -	
Climate change	<p>17.2% of this site is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that the site is not at direct risk of flooding as a result of extreme sea level still water overtopping during either the 0.5% or 0.1% AEP events. A review of the flood modelling indicates that the flooding along this area of coastline, as defined by the EA flood map is as a consequence of wave overtopping rather than extreme sea levels on an undefended coastline.</p> <p>Based on comparison of the relative height of the undefended ground levels relative to the extreme sea levels, overtopping is likely to remain the primary flood mechanism under climate change scenarios. Current day wave overtopping extents for both the 0.5% AEP (Flood Zone 3) and 0.1% AEP (Flood Zone 2) scenarios show a slight variation in flood extents. Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Wave overtopping for the 0.1% AEP event combined with still water climate change level has, therefore, been used for climate change testing.</p> <p>Updated modelling to assess future wave overtopping extents may be required as part of a site-specific FRA and the requirements would need to be agreed with the EA. For the purposes of this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p> <p>Flood Zone 3a extents under climate change are likely to be similar to the current day Flood Zone 2. Flooding will be limited to the eastern part of the Designation Area. Mean flood depths will be on average 0.3-0.6m, with localised deeper areas (0.6-0.9m) to the east.</p> <p>The hazard rating will be Moderate across the majority of the climate change flood zone, rising to Significant in the eastern area.</p>			
Historic flooding	From available data, there are no records of historic flood events in this Designation Area.			
Defended	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage which protect the site. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. This frontage is generally</p>			

Designation Area	RC17 Late Night Uses Areas
	<p>protected from coastal flooding by a front-line ridge of high ground / embankment of substantial width topped by a concrete flood wall.</p> <p>Based on a modelling review there is no extreme sea level still water overtopping flooding anticipated to the Designation Area for either the present day or climate change 0.5% AEP or 0.1% AEP events even if all flood defences were removed or breached. This is based on the level and extent of the existing high ground / embankment fronting the coastline and the relative levels across the Designation Area.</p>
Flood Warning Area	No
Flood risk	<p>Designation Area RC17 is incorporated within Designation Area RC2 and the flood risks are generally also as described under that Designation Area.</p> <p>Ground levels across the Designation Area generally rise towards the west and southwest, increasing from around 5m OD in the northeast to around 10m OD in the southwest.</p> <p>Designation Area RC17 is also contained within the extents of the larger RC2 Designation Area.</p> <p>The area is currently developed with a mix of residential, retail and commercial development within a dense network of streets and highways including the A178. Hartlepool Railway Station is situated on the northern edge of the Designation Area with the rail line adjacent to the northern boundary. The Designation Area includes a college, Hartlepool Borough Council offices and a cinema complex.</p> <p>The Designation Area is at greatest risk of flooding from the coastal frontage which is approximately 370m to the east. A review of ground levels indicates that wave overtopping flows will tend to flow northwards towards the Hartlepool Marina. Approximately 17% of the Designation Area (the eastern side) is at risk of tidal flooding (from wave overtopping) and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a increase from east to west, and are on average 0.3-0.6m with a maximum depth of 0.6 to 0.9m in a localised area adjacent to the north-eastern boundary. There is a Moderate to Significant hazard rating within the area of flood risk.</p> <p>Flood Zone 2 extents and depths are very similar with only a small increase in the area of each depth banding. The hazard rating remains as Moderate to Significant. The majority of the Designation Area to the west is within Flood Zone 1.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may result in a reduction in flood storage. • 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. Approximately 80% of the area would be considered suitable for redevelopment. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk.

Designation Area		RC17 Late Night Uses Areas		
	<ul style="list-style-type: none"> • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and depending on development proposals further investigation may be required. • The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	100% of Designation Area indicated as having a susceptibility to groundwater emergence of >75%. Comparison with LiDAR data indicates a fall in level across the area in an easterly direction, indicating that ponding if encountered is likely to be minimal as water will tend to flow across the site following topography. It is identified that the flow routes are towards the adjacent site RC7 and may result in ponding in that area.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface Water				
<i>Surface Water Flood Risk to Proposed Development Site</i>				
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)	
	0.53	1.38	8.96	
Surface water flooding depths (m)	Max: 0.15-0.3m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	
Surface water hazards ¹⁶	Max: Moderate Average: Low	Max: Moderate Average: Low	Max: Significant Average: Low	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	<p>Designation Area RC17 is incorporated within Designation Area RC2 and the flood risks are generally also as described under that Designation Area.</p> <p>There is little or no surface water flood risk to the Designation Area in the High and Medium Risk Events, with only limited flooding appearing to be related to overland flow from the adjacent A179 / Marina Way in the west of the site. There are additional pockets of flood risk in these events, which is limited to highways. Flooding is more extensive in the 0.1% AEP event. The overland flow from the A179 covers a larger area, with maximum depths of 0.3-0.6m. The associated maximum hazard in this area is Significant. Elsewhere, in the 0.1% AEP event the flooding generally follows the lines of roadways and is within carparks. There is more significant flood risk to the east of the site, with ground levels falling from west to east.</p> <p>The flood mapping indicates the potential for surface water to enter and collect in the site from adjacent areas, with a significant flow routes seen</p>			

16 Environment Agency: *What is the updated Flood Map for Surface Water*. November 2013

Designation Area		RC17 Late Night Uses Areas				
	to cross the area in an easterly direction from the A179. Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress, however mapping indicates a number of alternative routes and therefore off-site impacts on access and egress appear manageable.					
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 designation area is subject to surface water flooding and site / development specific detailed surface water assessments and drainage strategies will be required as part of any FRAs. The FRAs will need to mitigate climate change impacts across the lifetime of the development. • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS. • The FRAs should assess the potential for offsite surface water impacts on proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. • The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available. 					
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	20.93l/s	
				1% AEP:	24.87l/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%	48	6649	1808	4841	128.1	0.32Ha 4.29%
3.33% AEP Rainfall+40%	48	7757	1808	5949	157.4	0.40Ha 5.27%
1% AEP Rainfall+20%	48	8436	2149	6287 (1446m ³ of exceedance storage)	140.1	0.42Ha 5.57% (0.10Ha 1.28%)
1% AEP Rainfall+40%	48	9842	2149	7693 (1744m ³ of exceedance storage)	171.4	0.51Ha 6.82% (0.12Ha 1.55%)
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	In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate. It is recognised that this Designation Area site includes areas of brownfield and					

Designation Area	RC17 Late Night Uses Areas
	<p>specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

2.14 RC16 Northgate / Union Street Local Centre

Designation Area		Northgate / Union Street Local Centre
Site area		0.35Ha
Existing use		Brownfield / urbanised including commercial / retail / residential
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 0.30Ha

Flood outlines (current day)



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Observations and Recommendations

- The Northgate / Union Street Local Centres Area is an existing urban extent. No specific redevelopment opportunities have been identified by the Council at this stage.
- 96% of the area is located within Flood Zone 3. 100% of the site remain at significant flood risk during current and climate change scenarios. Taking climate change into account the site, in terms of flood risk, is unlikely to be developable.
- If considered feasible, development would entail significant tidal flood mitigation measures such as ground raising and / or defence enhancement.
- Taking the above into account, for Flood Zones 2 and 3, the Council have confirmed that:
 - there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or:
 - More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress.

Flood Source: Tidal

Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	1.33	97.66	0.00
Flood Zone depth¹⁷ (m)	Max: 0.3-0.6 Mean: 0.15-0.3	Max: 0.3-0.6 Mean: 0.15-0.3	Max: - Mean: -
Flood Zone hazard	Max: Moderate Mean: Low	Max: Moderate Mean: Low	Max: - Mean: -
Climate change	99% of this Designation Area is currently located with Flood Zone 2 and 3a.		

17 Environment Agency Hartlepool Flood Mapping & FWI Study 2012

Designation Area	Northgate / Union Street Local Centre
	<p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that the Designation Area is at risk of flooding as a consequence of either direct extreme sea level still water overtopping or wave overtopping. In the current day flooding from the west (Hartlepool Dock) appears to be driven primarily by extreme sea level still water overtopping. The Designation Area is also impacted by wave overtopping from the eastern frontage (in the 0.1% AEP Flood Zone 2) which results in overland flow across the headland.</p> <p>Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Updated modelling to assess future wave overtopping extents may be required as part of a site-specific FRA and the requirements would need to be agreed with the EA.</p> <p>Wave overtopping outlines for the current day events combined with still water climate change levels has, therefore, been used for climate change testing. For areas impacted by wave overtopping, for the purposes of this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths. The 2012 model this indicates that climate change flooding from both sources is likely to cover the entirety of the Designation area with depths of 0.9-1.2m in the 0.5%+climate change scenario. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments.</p>
Historic flooding	<p>From available data, there is no record of historic event from Hartlepool Fire Service in this Designation Area, although there is insufficient information to determine the flood source.</p>
Defended	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage however these do not appear to provide protection to the Designation Area due to the height and width of the headland. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. The outer harbour piers provide some (albeit slight) benefit and therefore the Flood Zone mapping is based on the undefended situation with both the defence walls and outer harbour piers removed.</p> <p>Based on a modelling review if the defences are breached or removed, there will not be an additional risk of flooding to the Designation Area.</p>
Flood Warning Area	<p>100% of Designation Area in North Sea Coast at Victoria Harbour Flood Warning Area</p>
Flood risk	<p>Designation Area RC16 is incorporated within Designation Area LT1 and the flood risks are generally as described under that Designation Area.</p> <p>The Designation Area is relatively level over the majority of the area with ground levels at around 3.8-4.0m OD. LiDAR indicated a marginal increase (approx. 200mm) in ground levels to the west towards Hartlepool Dock. To the east ground levels rise significantly across the headland, reaching approximately 13m OD before reducing to around 7mOD towards the coastal frontage.</p>

Designation Area Northgate / Union Street Local Centre	
	<p>The area is currently urbanised with a mix of residential, retail and commercial properties within a dense network of streets and highways.</p> <p>The Designation Area is at greatest risk of tidal flooding from the harbour frontage which is approximately 100m to the west. A review of ground levels indicates that the area is at risk from direct extreme sea level still water overtopping from the harbour</p> <p>There is also a risk of tidal flooding as a consequence of wave overtopping of the coastal frontage on the eastern side of the headland. This results in overland flow across the headland and flooding to the northern part of the Designation Area.</p> <p>Approximately 100% of the Designation Area is at risk of tidal flooding and located in Flood Zone 2 and 3a. Average flood depths within Flood Zone 3a increase from east to west, and are on average 0.0-0.15m with maximum depths of 0.3-0.6m in a localised area adjacent to the north and western boundary. There is a Low to Moderate hazard rating within the area of flood risk.</p> <p>Flood Zone 2 extents and depths are very similar with only a small increase in the area of each depth banding. The average hazard rating remains as Low to Moderate. In this more extreme event, the modelling identifies a connectivity in flooding from the wave overtopping of the eastern frontage.</p>
Mitigation options & site suitability	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. • Given the extent / depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may result in a reduction in flood storage. • 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. The entire Designation Area is seen to be within the Flood Zone and therefore likely to be unsuitable for development. • Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. • More detailed assessment and provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and depending on development proposals further investigation may be required. • The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. • Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west.
Flood Source: Ground Water	
Flood risk: ground water	100% of Designation Area indicated as having a susceptibility to groundwater emergence of <25%. Based on a review of LiDAR, the risk of ponding, if it occurs, is likely to be minimal and localised as water will

Designation Area		Northgate / Union Street Local Centre	
	tend to flow towards the dock.		
Flood Source: Infrastructure Failure – Reservoirs			
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.		
Flood Source: Infrastructure Failure – Canals			
Flood risk: canal	No canalised watercourses in area. No flood risk identified.		
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)
	0.77	9.85	13.75
Surface water flooding depths (m)	Max: 0.15-0.3m Average: 0.15 -0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.6-0.9m Average: 0.3-0.6m
Surface water hazards	Max: Moderate Average: Low	Max: Moderate Average: Low	Max: Significant Average: Moderate
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.		
Surface water: flood risk to development site	<p>Designation Area RC14 is incorporated within Designation Area LT2 and the flood risks are generally as described under that Designation Area.</p> <p>The Designation Area is a block of buildings with only one area (Abbey Street) not covered by existing buildings. These buildings and the Designations Area will be impacted by surface water flooding from the adjoining streets (Northgate and Sunnyside) and therefore flood extents over these areas, whilst not included in the coverage areas above are described below. The surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure these extents are likely to change if the site layout is changed.</p> <p>Flood depths in the 3.33% AEP event covers a very localised area of the site. However, there is additional flooding to the adjoining highways (depths 0.3-0.6m with a Moderate Hazard). The depths and extents increase for the higher events with depths of 0.6-0.9m and a Moderate / Significant hazard in the 0.1% AEP event. The flood extents along Sunnyside are potentially contained by the presence of an adjacent wall.</p> <p>Mapping indicates potential surface water flows entering the site from the adjacent areas. Topography dictates potential flow routes from higher ground to the east.</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates flood depths of 0.6-0.9m to surrounding highways during the Low probability events.</p>		
Surface water: mitigation options & site suitability	<ul style="list-style-type: none"> • The surface water flood risk depths and extents may limit the development potential based on extents and depths. Parts of the Designation Area and the adjoining roads are subject to a significant flood hazard and a site specific detailed surface water assessment and drainage strategies will be required as part of any FRA for development in these areas. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS. • The FRAs should assess the potential for offsite surface water impacts on proposed developments. This will need to include 		

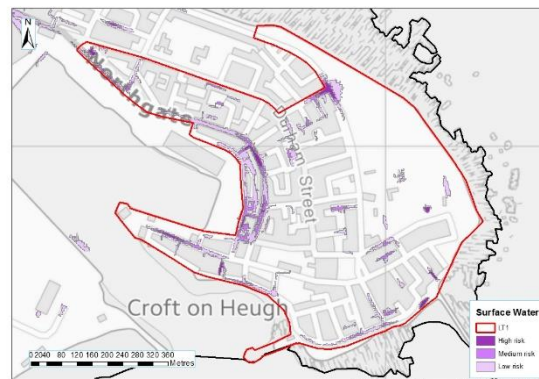
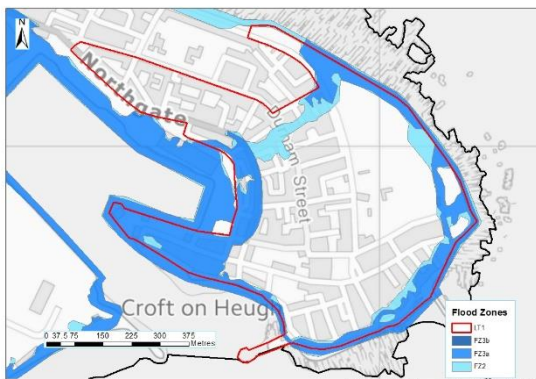
Designation Area Northgate / Union Street Local Centre						
<p>consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes.</p> <ul style="list-style-type: none"> Any FRA will need to consider the impacts of surface water flooding on access and egress routes. 						
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	0.99l/s	
				1% AEP:	1.17l/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%	48	303	86	217	121.5	0.01Ha 4.11%
3.33% AEP Rainfall+40%	48	353	86	267	149.7	0.02Ha 5.06%
1% AEP Rainfall+20%	48	384	101	283 (66m ³ of exceedance storage)	133.7	0.02Ha 5.36% (0.00Ha 1.25%)
1% AEP Rainfall+40%	48	447	101	346 (79m ³ of exceedance storage)	164.0	0.02Ha 6.56% (0.01Ha 1.50%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table</p>					

Designation Area	Northgate / Union Street Local Centre
	presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.

2.15 LT1 The Headland

Designation Area	LT1 The Headland
Site area	43.73Ha
Existing use	Brownfield / urbanised including commercial / retail / residential
Proposed use	Mixed Residential / Commercial
Proposed development flood risk vulnerability classification	More Vulnerable
Proposed development impermeable area	85% of total area (Specified by Hartlepool Borough Council) 37.17Ha

Flood outlines (current day)



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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 73% of the site is located in Flood Zone 1 and is, therefore, considered suitable for redevelopment.
- The Council should consider rezoning More Vulnerable development outside of identified flood risk areas, otherwise a more detailed flood risk assessment will be required and this will have to show that the second part of the Exception Test has been satisfied in order for development to proceed.
- The Council may consider allocating the Designation Area for development.
- The Council may consider allocating the Designation Area for development based on rezoning to avoid inappropriate development within areas at significant flood risk or hazard rating.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or:
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood risk extents are based on EA modelled wave overtopping. As flood water will flow by topography ground raising may impact on adjacent areas.
- Surface water flooding appears localised to existing urban areas. Any development proposals within this Designation Area will need to take site runoff and offsite interactions into consideration.

Designation Area		LT1 The Headland		
Flood Source: Tidal				
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b	
	6.13	20.31	0.00	
Flood Zone depth ¹⁸ (m)	Max: 0.9-1.2m Average: 0.15-0.3m	Max: 0.9-1.2m Average: 0.15-0.3m	Max: - Average: -	
Flood Zone hazard	Max: Significant Average: Moderate	Max: Significant Average: Moderate	Max: - Average: -	
Climate change	<p>26.44% of this Designation Area is currently located with Flood Zone 2 and 3a.</p> <p>Climate change impacts have been assessed by reviewing the peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The EA flood map indicates that the Designation Area is at risk of flooding as a consequence of either direct extreme sea level still water overtopping or wave overtopping. In the current day flooding from the west (Hartlepool Dock) appears to be driven primarily by extreme sea level still water overtopping. The Designation Area is also impacted by wave overtopping from the southern and eastern frontage (in the 0.1% AEP Flood Zone 2) which results in a localised strip of flooding to the perimeter of the Designation Area and a strip of overland flow across the headland.</p> <p>Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Updated modelling to assess future wave overtopping extents may be required as part of a site-specific FRA and the requirements would need to be agreed with the EA. Wave overtopping outlines for the current day 0.1% AEP events combined with still water climate change levels has, therefore, been used for climate change testing. For areas impacted by wave overtopping, for the purposes of this SFRA in the absence of modelling the existing Flood Zone 2 wave overtopping outline has been used to provide a representation of the likely change in future flood extents and depths for Flood Zone 3a. These proxy climate change outlines may not be suitable to support development proposals, depending on site specific development aspirations and a full assessment of climate change impacts will be required within site specific Flood Risk Assessments. For these areas, the flood zone extents are likely to be similar to the current day and primarily limited to a narrow strip adjacent to the eastern and southern perimeter. With the exception of a deeper area around the Heugh Battery, flood depths will be on average 0.15-0.3m with a Moderate Hazard rating. The Hazard rating is likely to be higher adjacent to the front line (along South Crescent). Overland flow from the defences overtopping the eastern side of the headland will increase flood risk to the north of the Designation Area.</p> <p>For the western areas (primarily impacted by extreme sea level still water overtopping) flood extents for the 0.5% AEP (FZ3) under the climate change scenario will extend slightly but will be constrained by the existing topography. From the 2012 model average depths in the western area will be 0.6-0.9m with localised areas where flood depths exceed 1.2m.</p>			
Historic flooding	<p>From available data, there are 5no records of historic events from Hartlepool Fire Service in this Designation Area, although there is insufficient information to determine the flood source.</p>			

Designation Area	LT1 The Headland
<p>Defended</p>	<p>The Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along northern Hartlepool coastal frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage however these do not appear to provide protection to the Designation Area due to the height and width of the headland. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. The outer harbour piers provide some (albeit slight) benefit and therefore the Flood Zone mapping is based on the undefended situation with both the defence walls and outer harbour piers removed.</p> <p>Based on a modelling review if the defences are breached or removed, there will not be an additional risk of flooding to the Designation Area from extreme sea level still water overtopping.</p>
<p>Flood Warning Area</p>	<p>Part. Western extents of Designation Area within North Sea Coast at Victoria Harbour, Hartlepool, Flood Warning Area. Eastern extents within North Sea Coast at the Headland, Hartlepool, Flood Warning Area</p>
<p>Flood risk</p>	<p>Designation Area LT1 incorporates Designation Area RC16 - Local Centre 13 and the flood risks are generally as described under that Designation Area.</p> <p>The Designation Area is a headland with ground levels ranging from around 4m OD along the western dock side to around 13mOD in the centre. Ground levels along the southern and eastern coastal frontages are variable, generally around 6mOD to the south and rising to around 11m to the east.</p> <p>The area is currently urbanised with a mix of residential, retail and commercial properties within a dense network of streets and highways.</p> <p>The Designation Area is at greatest risk of tidal flooding from both the western harbour frontage (primarily extreme sea level still water overtopping) and the southern and eastern frontages (primarily wave overtopping).</p> <p>The current day flood risk under the 0.5% (FZ3a) and 0.1% (FZ2) are generally limited to two areas; the western area adjacent to Hartlepool Dock where flooding is most likely from extreme sea level still water overtopping and a narrow strip along the southern and eastern coastal frontage where flooding is primarily related to wave overtopping. In the current day scenario, approximately 73% of the site is at risk of flooding and within Flood Zone 2 and 3a.</p> <p>In the western area under the 0.5% AEP (FZ3a) flood depths are 0-0.15m on average, with larger areas where depths are up to 1.25m. The hazards rating in this area is on average Moderate, but rises to Significant in places. For the 0.1% AEP, the flood extents are broadly similar, although the extents of each depth and hazard banding is increased. In this more extreme event, the modelling identifies a connectivity in flood extents from east to west from the wave overtopping of the coastal frontage.</p> <p>For the eastern and southern areas, under the 0.5% AEP (FZ3a) flood depths are 0-0.15m on average, with areas where depths are up to 0.9m. There is a localised deeper area to the east around the Heugh Battery where flood depths are more significant. The hazards rating is on average Moderate, but rises to Significant in places. For the 0.1% AEP, the flood extents are broadly similar, although the extents of each depth and hazard banding is increased.</p>

Designation Area		LT1 The Headland		
Mitigation options & site suitability	<ul style="list-style-type: none"> Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed. Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may result in a reduction in flood storage. 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. Approximately 73% of the area would be considered suitable for redevelopment. Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and depending on development proposals further investigation may be required. The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	The western portion of Designation Area indicates a susceptibility to groundwater emergence of <25%. The Eastern portion of Designation Area indicates no risk. Based on a review of LiDAR, the risk of ponding, if it occurs, is likely to be minimal and localised as water will tend to flow towards the dock.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
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)	
	0.69	1.51	5.31	
Surface water flooding depths (m)	Max: 0.3-0.6m Average: 0.15 -0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.6-0.9m Average: 0.3-0.6m	
Surface water hazards	Max: Moderate Average: Low	Max: Significant Average: Moderate	Max: Significant Average: Moderate	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			

Designation Area		LT1 The Headland
Surface water: flood risk to development site	<p>Designation Area LT1 incorporates Designation Area RC16 - Local Centre 13 and the flood risks are generally as described under that Designation Area.</p> <p>The area consists of developed areas of existing buildings, with undeveloped greenfield areas to the east.</p> <p>There is limited and localised flooding under the 3.33% AEP event, which is generally limited to roadways. These areas and depths increase under the 1% AEP and 0.1% AEP events, with the most extensive and deepest/most hazardous flooding across the western areas of Northgate and Sunnyside Road. In addition, there is localised flooding to the North East around the junction of Moor Parade and Broad Field Street. There is also a larger area of flooding indicated along the Southgate and Back Throston Street Area, with further localised flooding to streets across the development area.</p> <p>The surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure these extents are likely to change if the site layout is changed. As the area is predominantly developed it will be reliant on a drainage system to manage surface water flooding.</p>	
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. Areas of the Designation Area are subject to localised surface water flooding with some more extensive areas of deeper more hazardous flooding in the more extreme events. A site / development specific detailed surface water assessment and drainage strategy will be required as part of any FRA. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS. • Whilst they appear to be minimal, the FRA should assess the potential for offsite surface water impacts on the proposed development. This will need to include consideration of inflows from adjacent sites and propose methods to manage existing offsite impacts and flow routes. • The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential routes appear available. • If discharge to the nearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events. 	

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

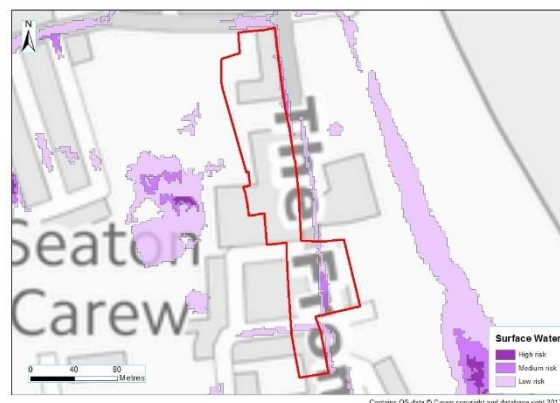
Proposed development limiting runoff rate:				3.33% AEP:	123.29/s	
Greenfield - IH124 Methodology				1% AEP:	146.54/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m ³	Outflow volume m ³	Attenuation required m ³	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (Ha) and % of site area
30yr Rainfall+20%	48	37497	10652	26845	120.6	1.79Ha 4.09%
30yr Rainfall+40%	48	43747	10652	33095	148.7	2.21Ha 5.05%

Designation Area	LT1 The Headland					
100yr Rainfall+20%	48	47519	12661	34858 (8013m ³ of exceedance storage)	131.8	2.32Ha 5.31% (0.53Ha 1.22%)
100yr Rainfall+40%	48	55439	12661	42778 (9683m ³ of exceedance storage)	161.7	2.85Ha 6.52% (0.65Ha 1.48%)
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>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>					

2.16 RC16 Seaton Front Local Centre

Designation Area		RC16 Seaton Front Local Centre
Site area		1.44Ha
Existing use		Brownfield / urbanised including commercial / retail / residential
Proposed use		Mixed Residential / Commercial
Proposed development flood risk vulnerability classification		More Vulnerable
Proposed development impermeable area		85% of total area (Specified by Hartlepool Borough Council) 1.22Ha

Flood outlines (current day)




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Observations and Recommendations

- The Seaton Front Local Centres Area represents a significant urban extent. No specific development opportunities has been identified by the Council at this stage.
- Whilst approximately 87% of the site is located in Flood Zone 1 and is, therefore, suitable for redevelopment.
- The Council may consider allocating the Designation Area for development.
- The Council may consider allocating the Designation Area for development based on rezoning to avoid inappropriate development within areas at significant flood risk or hazard rating.
- For Flood Zones 2 and 3, the Council have confirmed that:
 - a) there is a presumption that no More Vulnerable development will be permitted within the defined extent of tidal flooding or:
 - b) More Vulnerable development may only be considered as 1st floor development provided that a site specific FRA demonstrates apartments will be safe for the lifetime of the development and that an emergency evacuation plan demonstrates safe egress. Hazard mapping identifies areas of low and moderate hazard where 1st floor development may potentially be considered.
- Flood risk extents are based on EA modelled wave overtopping. As flood water will flow by topography ground raising may impact on adjacent areas.
- Surface water flooding appears localised to existing urban areas. Any development proposals within this Designation Area will need to take site runoff and offsite interactions into consideration.

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Flood Source: Fluvial			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.00	12.49	0.00
Flood Zone depth ¹⁹ (m)	Provided model does not indicate flooding to Area	Provided model does not indicate flooding to Area	-
Flood Zone hazard	Provided model does not indicate flooding to Area	Provided model does not indicate flooding to Area	-
Climate change	<p>13% of this Designation Area is currently located with Flood Zone 2 and 3a. Climate change impacts have been assessed by reviewing peak sea level, increasing it by the North East regional allowance for each epoch as identified in Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowances guidance up to 2115.</p> <p>The provided modelling indicates that in the climate change scenario, there is no flooding in the 0.5% AEP event, however there appears to be flooding to the southern part of the Designation area in the 0.1% AEP event. Flood depths are on average 0 to 0.15m, increasing to 0.3-0.6m in very localised areas. Approximately 20% of the site becomes inundated. Flood hazards are Low increasing to Moderate locally.</p>  <p>Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios</p> <p>Based On 2011 Tidal Tees Model Update of Extreme Sea Level Still Water Level Contains OS data © Crown copyright and database right (2017) Contains public sector information licensed under the Open Government Licence v3.0. Contains Environment Agency information © Environment Agency and/or database right.</p> <p>Based on comparison of the relative height of the undefended ground levels relative to the extreme sea levels, wave overtopping is likely to remain the primary flood mechanism under climate change scenarios. Whilst still water levels have been modelled for climate change inundation, EA wave overtopping scenarios cannot be updated based on current available modelling. Updated modelling to assess future wave overtopping extents may be required as part of a site-specific FRA and the requirements would need to be agreed with the EA.</p>		
Historic flooding	<p>From available data, there is no record of historic events from Hartlepool Fire Service in this Designation Area, although there is insufficient information to determine the flood source.</p>		

Designation Area	RC16 Seaton Front Local Centre
<p>Defended</p>	<p>Provided records indicate that the Environment Agency does not own or maintain any flood defence or coastal erosion protection assets along this frontage and the Designation Area is, therefore, not identified to be protected on the Environment Agency Flood Map for Planning.</p> <p>There are however defences along the coastal frontage which protect the site, and whilst not identified in the current EA datasets, they were included in a previous 2016 dataset. The reason for this variation should be investigated. This network of flood defences and coastal erosion protection structures are owned and maintained by a range of bodies, namely Hartlepool Borough Council and PD Ports. This frontage appears to be protected from coastal flooding by a front line low concrete wall.</p> <p>A review of the provided model and LiDAR ground levels indicates that there would be no extreme sea level still water overtopping flooding to the Designation Area for the current day 0.5% AEP and 0.1% AEP events even if all flood defences were removed or breached. In the climate change scenario, whilst there is no flooding in the 0.5% AEP event, there does appear to be flooding in the 0.1% AEP event. Initial comparison of still water climate change water levels to undefended ground levels indicates that for the majority of the frontage the ground is sufficiently high to defend against still water flooding. However, modelling indicates flooding impacts from a southern slipway at Church Road. The slipway is undefended and the high ground / road behind appears to form the defence line. In conclusion, based on a review of available information it is considered that a breach or removal of the front-line defences would not result in extreme sea level still water overtopping flooding.</p> <p>However, flood risk to the site is also likely to result from wave overtopping and will therefore be dependent on the integrity and maintained condition of defences. The residual risk associated with defence failure will need to be fully appraised as part of any site-specific FRA and proposals. It is also noted that the flood model and the published flood zones do not correspond and this should be investigated further.</p>
<p>Flood Warning Area</p>	<p>No</p>
<p>Flood risk</p>	<p>Ground levels across the Designation Area are relatively level over the majority of the area reducing from around 6m OD in the north to 5m OD in the south. The Designation Area is set back approximately 50-100m from the coastal frontage with a relatively flat profile between the area and the seafront.</p> <p>The narrow Designation Area is currently developed with a mix of residential and retail / seafront facilities. The A178 generally runs in northerly direction adjacent to the eastern boundary, bisecting the site to the south east where the Development Area extends locally towards the seafront. An open grassed recreational area sits between the seafront and the A178.</p> <p>According to the EA Flood Zone maps the Designation Area is currently at greatest risk of flooding from the coastal frontage with the risk limited to the south-east part of the site to the east of the A178. It is noted that whilst the EA Flood Zone mapping indicates that this area is within Flood Zone 2 and 3a, the provided model does not indicate current day flood risk to this area and this would need to be investigated further as part of any site-specific FRA. The majority of the Designation Area to the west of the A178 is within Flood Zone 1.</p>
<p>Mitigation options & site suitability</p>	<ul style="list-style-type: none"> • Due to the level of risk and depth of flooding across parts of this Development Area (Flood Zone 3a and 2) a more detailed FRA will be required as part of the development strategy to reflect the site-specific development proposals and to demonstrate that flood risk can be effectively managed over the lifetime of the development without increasing risk elsewhere. As the proposed use is More Vulnerable

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	<p>and within Flood Zone 3a, the FRA will have to show that the second part of the Exception Test has been satisfied in order for development to proceed.</p> <ul style="list-style-type: none"> Given the depth of flooding, More Vulnerable development in areas covered by Flood Zone 2 and 3a may be difficult and given the existing layout, mitigation measures such as land raising may be difficult and may result in a reduction in flood storage. However, in this instance, it is noted that this is a defended site within an area of tidal flood risk and land raising is unlikely to impact on tide levels. This will need to be considered further and confirmed as part of a site specific FRA to demonstrate any interactions with adjoining land and flow routes. 'More Vulnerable' Development should be directed to the areas outside of higher risk flood zones. Approximately 80% of the area would be considered suitable for redevelopment. Provision will need to be made to confirm any drainage paths which enable flow across the area and maintain these so that they do not increase flood risk. Provision for climate change should be made in the FRA ensuring the site will remain safe in the future, assuming current risk can be mitigated. The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding. Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available to the west. 			
Flood Source: Ground Water				
Flood risk: ground water	100% of Designation Area is indicated as having a susceptibility to groundwater emergence of <25%.			
Flood Source: Infrastructure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastructure Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
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	1.20	3.27	
Surface water flooding depths (m)	Max: - Average: -	Max: 0.3-0.6m Average: 0.15-0.3m	Max: 0.3-0.6m Average: 0.15-0.3m	
Surface water hazards	Max: - Average: -	Max: Moderate Average: Low	Max: Significant Average: Low	
Climate change	The current day 0.1% AEP outline provides an indication of the likely increase in depth and extent of the more frequent events as a consequence of climate change impacts.			
Surface water: flood risk to development site	The Designation Area consists of rows of buildings along the seafront on adjoining The Front road. These buildings and the Designations Area will be impacted by surface water flooding from the adjoining roads and therefore flood extents over these areas, whilst not generally included in the coverage areas above are described below. The surface water flood extents appear to be influenced by the presence of the existing buildings and drainage infrastructure these extents are likely to change if the site			

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	<p>layout is changed.</p> <p>There is no flooding indicated in in the 3.33% AEP event with localised flooding to The Front in the 1% AEP event. The flood extents and depths / hazard increase in the 1% AEP event although generally appear to be limited to The Front roadway. Whilst average depths are between 0.15-0.3m, maximum depths are locally higher at 0.3-0.6m. Hazards are on average Low, but rise locally to Significant in the 0.1% AEP event.</p> <p>Mapping indicates limited surface water flows entering the site from the adjacent areas. The ground profile of the area is relatively level</p> <p>Surface water flooding of the surrounding highways will need to be taken into account in consideration of emergency access and egress. Mapping indicates flood depths of 0.3-0.6m to surrounding highways during the Low probability events, however alternative routes appear available and therefore off-site impacts on access and egress appear manageable.</p>					
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. Parts of the Designation Area and the adjoining roads are subject to a significant flood hazard and a site specific detailed surface water assessment and drainage strategies will be required as part of any FRA for development in these areas. The FRA will need to mitigate climate change impacts across the lifetime of the development. • Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS. • The FRAs should assess the potential for offsite surface water impacts on proposed developments. This will need to include consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes. • Any FRA will need to consider the impacts of surface water flooding on access and egress routes. 					
Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology				3.33% AEP:	10.4l/s	
				1% AEP:	12.36l/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%	12	817	225	592	31.5	0.04Ha 2.74%
3.33% AEP Rainfall+40%	18	1072	337	735	39.2	0.05Ha 3.40%
1% AEP Rainfall+20%	12	1074	267	807 (215m ³ of exceedance storage)	36.2	0.05Ha 3.73% (0.01Ha 0.99%)
1% AEP Rainfall+40%	18	1393	400	993 (258m ³ of exceedance storage)	44.5	0.07Ha 4.59% (0.01Ha 1.19%)
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.					

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<p>Surface water: flood risk impacts from development site & mitigation</p>	<p>In accordance with the requirements specified by Hartlepool Borough Council where greenfield sites are to be developed, the surface water run-off rates should not exceed, and where possible, should reduce the existing run off rates. Where previously developed (brownfield) sites are to be developed, surface water run-off rates should seek to achieve greenfield equivalent run off rates or be reduced by a minimum of 50% of the existing site run-off rate.</p> <p>It is recognised that this Designation Area site includes areas of brownfield and specific proposals for redevelopment will need to be provided as part of any FRA. This will need to take into account the Hartlepool Borough Councils requirements described above. To illustrate the potential attenuation and storage for Designation Areas the table above identifies the required storage volumes for the proposed impermeable areas of the Designation Area if limiting greenfield equivalent run off rates are applied. These will need to be proportioned to actual development site areas within the Designation Area to provide an indication of attenuation / storage requirements.</p> <p>Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate change. To limit off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events.</p> <p>An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted ranging from oversized pipes or underground storage tanks to SuDS techniques and attenuation basins. As a guide to the likely land take associated with this the table presents the area of a 1.5m deep surface storage pond and the percentage of the total site area. SuDS and attenuation requirements should be considered at the master planning stage.</p>

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Registered Office

South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

t: +44(0)1756 799919
e: info@jbaconsulting.com

Jeremy Benn Associates Ltd
Registered in England
3246693



Visit our website
www.jbaconsulting.com