

## 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



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## **Revision History**

Revision Ref / Date Issued	Amendments	Issued to
V1.0 / May 2017	-	Matthew Clifford
V1.1 / July	HBC following comments	Matthew Clifford
V1.2 / July	HBC following comments	Matthew Clifford
V1.3 / August	Updated following EA comments	Cameron Sked (EA) Matthew Clifford
V1.4 / August	Updated RC16 Northgate / Union Street Obs. /Rec. following EA Comments	Cameron Sked (EA) Matthew Clifford
V1.5 / August	EMP6 Vulnerability Classification in response to EA Letter Date: 16/08/17	Cameron Sked (EA) Matthew Clifford

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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.

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## 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 completed<sup>1</sup>. 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.

<sup>1</sup> Hartlepool Borough Council Local Plan Level 1Strategic Flood Risk Assessment. JBA Consulting. 2017

# 2 Site Appraisal Tables

## 2.1 EMP4b West of Seaton Channel

Designation Area EMP4b Wes	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 is 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

Flood Source: Tidal

#### EMP4b West of Seaton Channel

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.

• 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 Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.05	99.63	0.00
Flood Zone depth <sup>2</sup> (m)	Max: >1.2	Max: > 1.2	Max: -
	Mean: >1.2	Mean: >1.2	Mean: -
Flood Zone hazard	Max: Extreme Mean: Extreme	Max: Extreme Mean: Extreme	Max: - Mean: -
Climate change	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. 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).		
Historic flooding	The Designation Area 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 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.		
Flood Warning Area	100% of Designation Are Warning Area	ea within <b>Tees Estuary at</b>	Greatham Creek Flood
Flood risk	Generally the low lying s with ground levels 1-1.5 west corner where level the site, ground levels and flood defence embankm this undeveloped low lying the north and west of the which is located an exist The Designation Area is adjoins Greatham Creek flooding and located in F and south average flood	ite is relatively level across mOD. Ground levels tend s are around 0.75mOD. re relatively level towards of the area. A large raised a te site to form a plateau (a ting industrial plant. at greatest risk of flooding c. Approximately 100% of flood Zone 2 and 3a. For to d depths within Flood Zo	s the majority of the area to fall towards the south To the south and east of Greatham Creek and the drains and ponds cross rea rises sharply across pprox. level 3.5mOD) on g from the south where it the site is at risk of tidal he lower area to the east one 3a (0.5% AEP) are

#### 2 Tidal Tees Integrated Flood Risk Modelling Study 2011

Designation Area	EMP4b West of Seaton Channel
	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. 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.
Mitigation options & site suitability	<ul> <li>enhancements required to manage residual risk.</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>Development in areas covered by Flood Zone 3a may be difficult and land raising may result in a reduction in available flood strage, 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.</li></ul>
	<ul> <li>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.</li> <li>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</li> </ul>
	<ul> <li>and associated defences for maintenance purposes.</li> <li>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.</li> </ul>
Flood Source: Ground Wa	iter
Flood risk: ground water	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

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: Infrastructo	ure 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: Infrastructu	ure Failure – Canals			
Flood risk: canal	No canalised watercours	ses in area. No flood risk	identified.	
Flood Source: Surface Wa	iter			
Surface Water Flood Risk	to Proposed Developme	ent 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)	
	0.02	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	increase in depth and extent of the more frequent events as a consequence of climate change impacts. 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. 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. 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			

Designation Area	EMP4b West of Seaton Channel
Surface water: mitigation options & site suitability	<ul> <li>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.</li> </ul>
	<ul> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDs.</li> </ul>
	• 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: 1% AEP:	519.43l/s 617.38l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	47.9	3.56Ha 4.62% (0.92Ha 1.19%)
1% AEP Rainfall+40%	18	85611	20003	65608 (16511m <sup>3</sup> 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 pra a for n lt s T d d C p e e d d a A A A C c r a for n n lt s s T d d C P P e e d d a a for n n lt s s T d d c c for n n s s t s s s t s s s s s s s s t s	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 or development to discharge direct to sea and attenuation in that instance may not be required. 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 provide an indication of attenuation / storage requirements. 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. 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 oresents the area of a 1.5m deep surface storage pond and the percentage of the otal site area. SuDS and attenuation requirements should be considered at the master planning stage.

### 2.2 EMP4c Philips Tank Farm

Designation Area EMP4c Phi	ilips 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 is 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.

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Designation Area	EMP4c Philips Tank Far	m	
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	3.44	16.34	0.00 (defended)
Flood Zone depth <sup>3</sup> (m)	Max: >1.2	Max: > 1.2	Max: -
	Mean: 0.9-1.2	Mean: 0.9-1.2	Mean: -
Flood Zone hazard	Max: Extreme	Max: Extreme	Max: -
	Mean: Significant	Mean: Significant	Mean: -
Climate change	Climate change impact model, increasing the p for each epoch and time Risk Assessments: Clim 19% of the Designation 3. Flood risk is mitiga Channel defences.	ts have been assessed b beak sea level by the North eframe as identified in Table hate Change Allowances gu Area is currently located w ted to some extent by the	y updating the existing East regional allowance a 3 of the GOV.UK Flood iidance up to 2115. rithin Flood Zones 2 and EMP4b East of Seaton
	Indicative Flood Extension Scenarios Based On 2015 Tidal Tees M Contains OS data © Crown of Contains public sector inform Contains Environment Agend Modelling indicates und and 3a will extend north 30% of the Designation this defined area. The h the extents of each incr	nts for 0.5% AEP & 0.1% Model Update of Extreme Sea Leve copyright and database right (2017 nation licensed under the Open Go cy information © Environment Ager ler climate change the exter wards by a similar amount to Area. Average flood depths azard rating will be similar (s eased.	AEP Climate Change el Still Water Level ) vernment Licence v3.0. ncy and/or database right. Ints of both Flood Zone 2 o inundate approximately s will exceed 1.2m across significant / extreme) with
Historic flooding	The Designation Area flood outline and from a flood events.	is just outside of the Envir available data there are no	onment Agency Historic records of other historic
Defended	Environment Agency r defence embankment a reported to be an Area adjacent site EMP4b is upstream defence cress 4.68mOD. The defe downstream end, to the Tees Road the defence line embankment with a	ecords indicate the area adjacent to Greatham Creek Benefiting from Defences. Is reported to be at Condition t level of 5.56mOD and a de nce embankment runs in rear of the Graythorpe Yard is reported to be breached a construction date of 2014	is protected by a tidal . Areas within FZ3a are The section fronting the on Grade 3 with the an ownstream crest level of to high ground at the d dock. Upstream of the and in its place a retired is shown. Flood risk to

<sup>3</sup> Tidal Tees Integrated Flood Modelling Study 2011



Designation Area	EMP4c Philips Tank Farm
	this site is dependent on the integrity and maintained condition of defences and residual risk associated with defence failure will need to be fully appraised as part of any site specific FRA and proposals.
Flood Warning Area	No. <b>Tees Estuary at Greatham Creek</b> Flood Warning Area adjacent to south east boundary with <5% overlap at easternmost extent.
Flood risk	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.
	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
	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.
	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.
Mitigation options & site suitability	• 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.
	<ul> <li>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.</li> </ul>
	<ul> <li>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/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 set higher than the current industrial unit to reduce flood risk to an acceptable level.</li> <li>Provision for climate change should be made in the FRA ensuring the site will remain acfe in the future.</li> </ul>



Designation Area	EMP4c Philips Tank Far	m	
	<ul> <li>An 8m butter 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.</li> <li>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.</li> <li>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.</li> </ul>		
Flood Source: Ground W	ater		
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 in likely to flow in this direction corresponding with the existing drainage network.		
Flood Source: Infrastruct	ure Failure – Reservoir	S	
Flood risk: Reservoir	Designation Area not w	vithin Reservoir flood mappi	ing extents.
Flood Source: Infrastruct	ure Failure – Canals		
Flood risk: canal	No canalised watercou	rses in area. No flood risk	identified.
Surface Water Flood Piel	ater k to Proposod Dovolopr	nont Sito	
Existing development:	High Risk	Medium Risk	Low Risk
risk of flooding from surface water (%)	(3.33% AEP outline)	(1% AEP outline)	(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	<ul> <li>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 flood nazard, 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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDs.</li> <li>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.</li> <li>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 insk for the Tees Road to the north of the site which provides a potentially suitable access.</li> </ul>
Surface Water Flood Rist (for Designation Area in	k From Proposed Development its Entiretv)

Proposed developm Greenfield - IH124 M	unoff rate:	3.33% AEP: 1% AEP	941.94l/s 1119.57l/s			
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 (26921m³ of	52.2	7.03Ha 4.67%

Designation Area	EM	P4c Philips	Tank Farm			
				exceedance storage)		(1.79Ha 1.19%)
1% AEP Rainfall+40%	24	178296	48365	129931 (32331m <sup>3</sup> of exceedance storage)	64.3	8.66Ha 5.76% (2.16Ha 1.43%)
Climate change	Application for climate the 3.33% a	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	the 3.33% and 1% AEP rainfall events. In accordance with the requirements specified by Hartlepool Borough Coun- where greenfield sites are to be developed, the surface water run-off rates shou not exceed, and where possible, should reduce the existing run off rates. Whe previously developed (brownfield) sites are to be developed, surface water run-of- rates should seek to achieve greenfield equivalent run off rates or be reduced by minimum of 50% of the existing site run-off rate. It is recognised that this Designation Area site includes areas of brownfield ar specific proposals for redevelopment will need to be provided as part of any FR. This will need to take into account the Hartlepool Borough Councils requirement described above. To illustrate the potential attenuation and storage for Designatio Areas the table above identifies the required storage volumes for the propose impermeable areas of the Designation Area if limiting greenfield equivalent run of rates are applied. These will need to be proportioned to actual development si areas within the Designation Area to provide an indication of attenuation / storag requirements. Attenuation volumes are presented for the critical storm duration for the 3.33% AE (standard drainage design) and 1% AEP (exceedance) events for climate chang To limit off site surface water flood impacts attenuation storage will be require both for the design drainage and exceedance events. An FRA and appropriate drainage / attenuation strategy will be required. There a a variety of appropriate techniques which could be adopted ranging from oversize pipes or underground storage tanks to SuDS techniques and attenuation basin As a guide to the likely land take associated with this the table presents the area a 1.5m deep surface storage pond and the percentage of the total site area. Suf-				Borough Council off rates should off rates. Where ace water run-off be reduced by a f brownfield and part of any FRA. cils requirements e for Designation or the proposed equivalent run off development site nuation / storage or the 3.33% AEP climate change. will be required, uired. There are g from oversized enuation basins. sents the area of site area. SuDS planning stage.	

## 2.3 EMP4g Graythorpe Yard (Able Seaton Port)

Designation Area EMP4g G	raythorpe 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 is 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.

JBA

Designation Area	EMP4g Graythorpe Yard	(Able Seaton Port)	
Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
(of developable area)	12.14	9.97	0.00 (defended)
Flood Zone depth <sup>4</sup> (m)	Max: >1.2	Max: > 1.2	Max: -
	Mean: 0.15-0.3	Mean: 0.15-0.3	Mean: -
Flood Zone hazard	Max: Significant	Max: Significant	Max: -
	Mean: Significant	Mean: Significant	Mean: -
Climate change	Climate change impacts model, increasing the per for each epoch and tim Flood Risk Assessment 2115. The Designation Area modelling indicates under 2 and 3a will extend n majority of the Designat across the inundated are depths of 0.6-0.9m to t scenario. These depths scenario and whilst the larger areas of 0.9-1.2r significant / extreme with <b>Indicative Flood Exten Scenarios</b> Based On 2015 Tidal Tees M Contains OS data © Crown of Contains public sector inform Contains Environment Agence	s have been assessed eak sea level by the North heframe as identified in ts: Climate Change Allo is currently partly within er climate change the ex- orthwards by a similar ion Area. Average flood eas, however there are m he south in the 0.5% A increase in the 0.1% A e average depth remain in deep flooding. The a in the extents of each inc of the area of the site	by updating the existing h East regional allowance Table 3 of the GOV.UK bwances guidance up to In the Flood Zones and itents of both Flood Zone amount to inundate the d depths will be 0.3-0.6m hore extensive areas with EP plus climate change AEP plus climate change average hazard rating is reased. <b>K</b> AEP Climate Change Level Still Water Level 017) Government Licence v3.0. Agency and/or database right.
Historic flooding	The south west corner Environment Agency His no records of other histo	of the area of the site storic flood outline. From pric flood events.	is contained within the available data there are
Defended	Environment Agency re- to the west adjacent to the dock, before running and eastern side of the fronting the Power Statio A small part of the area Benefiting from Defence	cords indicate a tidal de Greatham Creek and fol g into high ground. High dock and frontage. Do on potentially provide pro adjacent to the railway i es. Flood risk to this s	fence embankment runs lows the western side of a ground runs to the rear ownstream the defences otection from outflanking. s reported to be an Area site is dependent on the

4 Tidal Tees Integrated Flood Modelling Study 2011

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 <b>Tees Estuary at Greatham Creek</b> Flood Warning Area
Flood risk	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. 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. It is also of note that there is potential for flooding to occur to the site from the adjacent sites EMP4b and EM5. 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
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> </ul>



Designation Area	EMP4g Graythorpe Yard	(Able Seaton Port)			
	<ul> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>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.</li> </ul>				
Flood Source: Ground Wa	ter				
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 reduced and a localised issue. Ground water flooding may accumulate on the dry side of any raised flood defence.				
Flood Source: Infrastructu	ure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not wit	hin Reservoir flood map	ping extents.		
Flood Source: Infrastructu	ure Failure – Canals		· · · · ·		
Flood risk: canal	No canalised watercours	es in area. No flood risk	c identified.		
Flood Source: Surface Wa	ater				
Surface Water Flood Risk	to Proposed Developme	ent Site			
Existing development risk of flooding from surface water (%)	High RiskMedium RiskLow(3.33% AEP outline)(1% AEP outline)(0.1% AP)		Low Risk (0.1% AEP outline)		
(of developable area)	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 Max: Moderate Max: Moderate		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	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. 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. 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.				

Designation Area		EMP4g Graythorpe Yard (Able Seaton Port)					
Surface water: mitigation options & site suitability		<ul> <li>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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the surface water of a surface water for a surface water for a surface water for a surface water flooding should be redirected across the surface water of a surface water flooding should be redirected across the surface water of a surface water flooding should be redirected across the surf</li></ul>					
		•	The FRA s impacts or	should also and the propos	assess the pote sed developmer	ntial for offsite nt. This will ne	surface water eed to include
		<ul> <li>consideration of inflows from adjacent sites.</li> <li>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.</li> <li>The FRA should consider the impacts of surface water flooding or 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 of site impacts on access and egress and egress and corest appear mapping.</li> </ul>			scharges to the roven, impacts e assessed. ter flooding on site (including s a lower flood ad therefore off e.		
Surface Water Flo (for Designation A	od Risk rea in it	Fron s En	n Propose tirety)	d Developm	ent		
Proposed developm Greenfield - IH124 I	nent limit Methodo	ing r logy	unoff rate:		3.33% AEP: 1% AEP:	270.01l/s 320.92l/s	
Design flood event (incl climate change)	Critica storm duratic Hrs	l on	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	44.5	1.72Ha 3.60% (0.45Ha 0.94%)
1% AEP Rainfall+40%	18		42223	10398	31825 (8123m <sup>3</sup> of exceedance storage)	54.9	2.12Ha 4.44% (0.54Ha 1.13%)
Climate change	Applica anticipa volume	ation ated es for	of the ce for climate the 3.33%	entral (20%) change in the and 1% AEF	and upper ba table above sho rainfall events.	nd (40%) potows the estimation	ential change ted attenuation
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)
	not be required. 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.
	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. 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 table site area.
	master planning stage.

## 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 is 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.

JBA

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 depth⁵ (m)	Max: >1.2	Max: > 1.2	Max: -				
	Mean: 0.6-0.9	Mean: 0.3-0.6	Mean: -				
Flood Zone hazard	Max: Extreme	Max: Extreme	Max: -				
	Mean: Significant	Mean: Significant	Mean: -				
Climate change	Climate change impacts increasing the peak sea epoch and timeframe a Assessments: Climate C	a have been assessed by fa level by the North East is as identified in Table 3 of Change Allowances guidated as identified in Table 3 of Change Allowances guidated and the second structure of the se	<ul> <li>updating the existing model, regional allowance for each of the GOV.UK Flood Risk nce up to 2115.</li> <li><b>1% AEP Climate Change</b></li> <li>vel Still Water Level</li> <li>Government Licence v3.0. Jency and/or database right.</li> <li>60% within Flood Zones 2 mate change the extents of oximately 80%. These will ase in the area inundated to 0 and 1 in 1000 year outlines ghtly larger area). Average orth of the site, and 0.6-0.9m event. During the 0.1%+CC of 1.2m across the majority</li> </ul>				
Historic flooding	of the site. The hazard The Designation Area is outline and from availa events.	of the site. The hazard rating will be similar (Significant/Extreme). 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					
Defended	Environment Agency re ground across the major site and this ties into hig to follow the line of the v watercourse appears to the power station. Area from Defences. Flood	ecords indicate the area i rity of the frontage. A flood gh ground at each end. H vatercourse which enters enter culvert beneath the as within FZ3a are reported risk to this site is depen	s protected by natural high wall fronts the power station igh ground is also indicated the site from the north. This access road to the north of ed to be an Area Benefiting indent on the integrity and				

<sup>5</sup> Tidal Tees Integrated Flood Modelling Study 2011



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 <b>Tees Estuary at Greatham Creek</b> Flood Warning Area
Flood risk	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. 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
	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. The Environment Agency Flood Zone map indicates the extent 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. 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.
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>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.</li> </ul>
	between surface water and tidal flooding.

Designation Area	EMP5 Nuclear Power Sta	tion Reserve		
	• 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 Wa	ater			
Flood risk: ground water	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 in 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.			
Flood Source: Infrastruct	ure Failure – Reservoirs			
Flood risk: Reservoir	Designation Area not wit	hin Reservoir flood mapp	ing extents.	
Flood Source: Infrastruct	ure Failure – Canals			
Flood risk: canal	No canalised watercours	ses in area. No flood risk	identified.	
Flood Source: Surface Wa	ater			
Surface Water Flood Risk	to Proposed Developme	ent Site		
Existing development: risk of flooding from	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)	
Surface water (70)	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: LowMax: ModerateMax: ModerateAverage: LowAverage: LowAverage: Moderate			
Climate change	The current day 0.1% AE in depth and extent of th change impacts.	EP outline provides an ind e more frequent events a	ication of the likely increase s a consequence of climate	
Surface water: flood risk to development site	change impacts. 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. 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.			

Designation Area	EM	EMP5 Nuclear Power Station Reserve				
	disc Cha may Sur acc indi on a	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. 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: mitig options & site suita	jation bility • •	<ul> <li>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, 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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDs.</li> <li>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.</li> <li>The FRA should consider the impacts of surface water flood insk for the Tees Road to the north of the site which provides a potentially suitable access.</li> <li>If additional discharge to the Seaton on Tees Channel / River Tees is proposed the FRA will need to consider outfall capacity during bigh tidal</li> </ul>				
Indicative Surface	Water Flood	d Risk From	n Proposed	Development		
(Ior Designation A	rea in its En	urety)		0.000/ 1.55	000 501/	
Proposed developm Greenfield - IH124 I	nent limiting r Methodology	unott rate:		3.33% AEP: 1% AEP:	893.53l/s 1062.03l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	Time to empty (assuming no infiltration) Hrs	Total storage required: Area (Ha) and % of site area
3.33% AEP	18	91331	28950	62381	38.7	4.16Ha

106553

118690

138472

28950

34410

34410

77603

84280

(21899m<sup>3</sup> of

exceedance

(26459m<sup>3</sup> of

exceedance

storage)

104062

storage)

48.1

44.0

54.3

18

18

18

Rainfall+20%

Rainfall+40%

Rainfall+20%

Rainfall+40%

3.33% AEP

1% AEP

1% AEP

2.96%

5.17Ha

3.68%

5.62Ha

4.00%

(1.46Ha

1.04%)

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	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. 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. 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. 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.

### 2.5 EMP6 Underground Storage

Designation Area EMP6 Undergr	ound 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.

JBA

Designation Area	EMP6 Underground Stora	ige					
Flood Source: Tidal							
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b				
	0	100	0.00 (defended)				
Flood Zone depth <sup>6</sup> (m)	Max: >1.2	Max: >1.2	Max: -				
	Mean: >1.2	Mean: >1.2	Mean: -				
Flood Zone hazard	Max: Extreme	Max: Extreme	Max: -				
	Mean: Extreme	Mean: Extreme	Mean: -				
Chimate change	Climate change impacts increasing the peak sea epoch and timeframe as Assessments: Climate Ch As the Designation Area the current day there is no Area under climate chang exceed 1.2m across the rating across the entire as	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. 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)					
Historic flooding	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.						
Defended	Environment Agency reco embankment adjacent to reported to be an Area B be at Condition Grade 3 w a downstream crest leve high ground at the downs Upstream of the Tees Ro place a retired line emba Flood risk to this site is de defences and residual ris appraised as part of any s The current condition of the Infrastructure" development any change in proposed I It is noted that the site is ground structures is likely on the underground facility	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. 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. 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.					
Flood Warning Area	100% of Designation Are Warning Area	ea within <b>Tees Estuary</b>	at Greatham Creek Flood				
Flood risk	Generally, the low-lying s with ground levels at ar boundary where levels to creek lies to the south of flood defence embankm undeveloped low-lying an	site is relatively level act ound 1mOD. Ground around 2.5mOD adjace f the Designation Area s nent. A network of dr ea.	ross the majority of the area levels rise to the northeast nt to Tees Road. Greatham separated from the site by a ains and ponds cross this				

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).

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.

6 Tidal Tees Integrated Flood Modelling Study 2011



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> <li>It is assumed that any underground storage facility will require vehicular access with above ground warehousing and processing facilities.</li> <li>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.</li> <li>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/fluvial interactions) and confirmed as part of a site-specific FRA to demonstrate any interactions with adjoining land and flow routes.</li> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>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.</li> </ul>
Flood Source: Ground Wa	iter
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: Infrastructu	ure 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: Infrastructu	ure Failure – Canals
Flood risk: canal	No canalised watercourses in area. No flood risk identified.

### Designation Area

## EMP6 Underground Storage

### Flood Source: Surface Water

Surface Water Flood Risk to Proposed Development Site							
Existing development: risk of flooding from	High Risk (3.33% AEP outline)	Medium Risk (1% AEP outline)	Low Risk (0.1% AEP outline)				
Surface water (%)	0	0	1.40				
Surface water flooding	Max: 0m	Max: 0m	Max: 0.15-0.3m				
depths	Average: 0m	Average: 0m	Average: 0.15-0.3m				
Surface water hazards	Max: -	Max: -	Max: Moderate				
	Average: -	Average: -	Average: Low				
Climate change	The current day 0.1% AE in depth and extent of the change impacts.	P outline provides an inc e more frequent events a	dication of the likely increase as a consequence of climate				
Surface water: flood risk to development site	There is no surface water event. At the 0.1% AEP to be impacted.	flood risk to the area up event only 1.4% of the	to the 0.1% AEP (Low Risk) Development Area is shown				
	The site is undeveloped a With reference to mapp contained within pond are greater influence on pote future development propor risk to the Development	and there are a number of bing the majority of the eas and drainage ditches ential development and bsals would be likely to m Area.	of ponds across the site. e flood risk appears to be s. These are likely to have a modification of these under hodify the surface water flood				
	<ul> <li>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.</li> <li>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.</li> </ul>						
Surface water: mitigation options & site suitability	<ul> <li>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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDs.</li> </ul>						
	<ul> <li>The FRA should also on the proposed dev inflows from adjacent</li> </ul>	assess the potential for elopment. This will need sites.	offsite surface water impacts d to include consideration of				
	The FRA should con Creek and if these dis during high tidal flows	sider potential discharg charge routes are prove s will need to be assesse	e to the adjacent Greatham n, impacts on outfall capacity ed.				
	The FRA should cons	sider the impacts of surfa	ace water flooding on access				

**Designation Area** 

Surface water:

impacts from

& mitigation

flood risk

**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: 1% AEP:	205.42l/s 244.15l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	38.8	1.14Ha 3.89% (0.30Ha 1.02%)
1% AEP Rainfall+40%	18	29002	7910	21092 (5406m <sup>3</sup> 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.

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 development site 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.

> 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.

> 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.

> 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.



## 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 <sup>7</sup> (m)	Max: 0.9-1.2	Max: 0.9-1.2	Max: -			
	Mean: 0.3-0.6	Mean: 0.3-0.6	Mean: -			
Flood Zone max hazard	Max: Significant	Max: Significant	Max: -			
Climata abanga	Mean: Moderate	Mean: Moderate	Mean: -			
Chimate change	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.					
	Change Allowances guidance up to 2115. 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.					
	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.					
	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. 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.					
Historic flooding	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. A small area (<5%) to the south of the Designation Area is defined as being located within a Critical Drainage Area					
Defended	The Environment Agence coastal erosion protect frontage and the Desig protected on the Environ	y does not own or main tion assets along north gnation Area is, therefo nment Agency Flood Ma	tain any flood defence or hern Hartlepool coastal ore, not identified to be p for Planning.			

### 7 Environment Agency Hartlepool Flood Mapping & FWI Study 2012
Designation Area	RC2 The Town Centre
	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. 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.
Flood Warning Area	No
Flood risk	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. 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. 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. 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
Mitigation options & site suitability	<ul> <li>Is within Flood Zone 1.</li> <li>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.</li> <li>Given the depth of flooding. More Vulnerable development in areas</li> </ul>
	<ul> <li>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.</li> <li>Ideally 'More Vulnerable' Development should be directed to the areas outside of higher risk Flood Zones. Approximately 95% of the</li> </ul>



Designation Area	RC2 The Town Centre		
	area would be consi	dered suitable for redeve	elopment.
	<ul> <li>Provision will need t enable flow across t increase flood risk.</li> </ul>	o be made to confirm an the area and maintain th	ny drainage paths which nese so that they do not
	<ul> <li>More detailed assess be made in the FRA assuming current ris modelling does not depending on devel required.</li> <li>The FRA should also</li> </ul>	ssment and provision for a ensuring the site will re- sk can be mitigated. Co include specific climate lopment proposals furth	r climate change should emain safe in the future, urrent wave overtopping e change scenarios and er investigation may be
	between surface wa	ter and tidal flooding.	
	<ul> <li>Access (including en account of future floo is available to the we</li> </ul>	nergency access) across od levels, however it app est.	the site will need to take ears that suitable access
Flood Source: Ground Wa	ater		
Flood risk: ground water	100% of Designation groundwater emergence a fall in level across th ponding if encountered across the site following are towards the adjacent	Area indicated as have of >75%. Comparison we area in an easterly of is likely to be minimal a topography. It is identi t site RC7 and may resul	ving a susceptibility to vith LiDAR data indicates direction, indicating that s water will tend to flow fied that the flow routes t in ponding in that area.
Flood Source: Infrastructu	ure Failure – Reservoirs		
Flood risk: Reservoir	Designation Area not wit	thin published reservoir f	lood mapping extents.
Flood Source: Infrastructu	ure Failure – Canals		
Flood risk: canal	No canalised watercours	ses in area. No flood risl	k identified.
Flood Source: Surface Wa	ater		
Surface Water Flood Risk	to Proposed Developme	ent Site	
Existing development:	High Risk	Medium Risk	Low Risk
surface water (%)	(3.33% AEP outline)	(1% AEP outline)	(0.1% AEP outline)
	0.86	2.83	10.86
Surface water flooding depths	Max: 0.15-0.3m	Max: 0.3-0.6m	Max: 0.6 -0.9m
Curfoos water bararda	Average: 0.15-0.5m	Average: 0.15-0.5m	Average: 0.15-0.5m
Surface water flazarus	Average: Low	Average: Low	Average: Low
Climate change	The current day 0.1% / increase in depth and consequence of climate	AEP outline provides ar I extent of the more change impacts.	n indication of the likely frequent events as a
Surface water: flood risk to development site	Designation Area RC2 i and the flood risk is gene	ncorporated Designatior erally as described unde	n Area RC17 in the east r that Designation Area.
	There is a localised surfa 3.33% AEP (High Risk) of probability events and an surfaced areas, through average 0.15-0.3m with probability events. Mapping indicates the po- topography dictating pot- eastern direction.	ace water flood risk to th event. These areas exter re generally constrained the Designation Area. Designation Area. Designation Area flo localised areas of deeper otential surface water flo ential flow routes across of the surrounding bigbwa	is developed area at the end under the higher to highways and Depths of flooding are on er flooding in the lower ws entering the site with the site generally in an
	into account in consider there is flood risk to surr	ation of emergency acc ounding roads, alternativ	ess and egress. Whilst ve access appears to be



Designation Area		RC	2 The Town	Centre			
		ava	ilable.				
Surface water: mitig options & site suita	ation bility	<ul> <li>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 conside 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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS.</li> <li>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.</li> <li>The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available.</li> </ul>		uld not impact majority of the ed to consider ea is subject to surface water as part of any mpacts across y be kept free directed using surface water ed to include ose methods to water flooding ernative routes			
Indicative Surface	Water F	-lood	Risk From	n Proposed	Development		
(for Designation A	rea in it	s En	tirety)				
Proposed developm	ent limit	ing ru Iogy	unoff rate:		3.33% AEP: 1% AFP <sup>.</sup>	109.14l/s 129.72l/s	
Design flood	Critica	l	Inflow	Outflow	Attenuation	Time to	Total
event (incl climate change)	storm duratic Hrs	on	volume m <sup>3</sup>	volume m <sup>3</sup>	required m <sup>3</sup>	empty (assuming no infiltration) Hrs	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 <sup>3</sup> of exceedance storage)	139.8	2.18Ha 5.57% (0.50Ha 1.28%)
1% AEP Rainfall+40%	48		51273	11208	40065 (9088m <sup>3</sup> 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	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 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						



Designation Area	RC2 The Town Centre
	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.
	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.
	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.

# 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.

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Designation Area	RC5 The Brewery and St	ranton	
Flood Source: Fluvial			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	0.28	20.36	0.00
Flood Zone depth <sup>8</sup> (m)	Max: 0.9-1.2	Max: 0.9-1.2	Max: -
	Mean: 0.3-0.6	Mean: 0.3-0.6	Mean: -
Flood Zone hazard	No data available	No data available	No data available
	Given the proximity to the should be assessed with by the total potential che corresponding with the development Vulnerabilities. Flood extents at this I techniques rather than determine the absence of a detailed outline has been used to Flood Zone 3a under Clitics. Flood Zone 3a is based very marginal increase depths (<100mm) based change outlines may no depending on site specific of climate change impact Assessments.	the watercourse, fluvia and a site specific FRA ange anticipated for the highest risk Flood ty Classification. ocation are based or detailed modelling. For de hydraulic model the provide a representat mate Change (noting the on the 1% AEP flood in impacted area and on the available mode t be suitable to support is development aspirat the suil be required with	I climate change impacts by increasing peak flows be '2080s' (2070 to 2115) Zone and the proposed in EA strategic modelling or the current screening in current day Flood Zone 2 ion of the future extents of hat under the fluvial case, l event). This indicates a a small increase in flood lling. These proxy climate t development proposals, ions and a full assessment in site specific Flood Risk
Historic flooding	From available data, the Designation Area.	ere are no records of h	istoric flood events in this
Defended	Environment Agency re channel maintained wat Designation Area (Penri ground either side. Fror culverted as public sewe (>2m) radius. Northumb to the coast to prevent s watercourse is tide locke zones excludes the effe structural condition of th assessment.	cords indicate that the tercourse which enters byn Street / York Road n Penrhyn Street to the er. The culvert is report erland Water have bui surface water flooding ed. The modelling und ects of this pumping s is culvert has not beer	e Burn Valley Beck open s culvert upstream of the l) is undefended with high e coast the watercourse is ted to have a considerable It a pumping station close when the outfall from this ertaken to derive the flood tation. The capacity and n confirmed as part of this
Flood Warning Area	No		
Flood risk	Ground levels across t reducing from around 12 extends out into a v watercourse) where it be The area is currently urb commercial properties w The A689 follows the ea	he site generally fall 2m OD to 7.0m OD. The alley bottom (associ- egins to widen. anised with a mix of re- rithin a dense network stern boundary and Ste	from the north to south, he southern part of the site ated with the upstream esidential, retail and of streets and highways. bockton Road follows the

southern boundary. 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

### 8 Environment Agency Hartlepool FRM Study (Fluvial and Tidal) 2008

Designation Area	RC5 The Brewery and Stranton
	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. 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.
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.</li> <li>Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available.</li> </ul>
Flood Source: Ground Wa	ter
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: Infrastructu	ire Failure – Reservoirs
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.
Flood Source: Infrastructu	ire Failure – Canals
FIOOD FISK: CANAI	NO CANAIISED WATERCOURSES IN AREA. NO TIOOD RISK IDENTIFIED.

# Designation Area

# RC5 The Brewery and Stranton

# Flood Source: Surface Water

Surface Water Flood Risk	to Proposed Developme	ent 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)		
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% A increase in depth and consequence of climate	AEP outline provides I extent of the more change impacts.	an indication of the likely e frequent events as a		
Surface water: flood risk to development site	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. 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.				
	The flood mapping indicates limited potential for surface water flooding entering the site from adjacent areas.				
	surrounding the Designa Road area). Whilst this v of emergency access and the offsite impacts on ac	ation Area (with the ex- will need to be taken int d egress as mapping ir cess and egress appe	o account in consideration ndicates a limited flood risk ar manageable.		
Surface water: mitigation options & site suitability	• Surface water floodi significantly on the o site. However, local surface water based Area is subject to Designation Area are surface water assess part of any FRAs for to mitigate climate development.	ing appears localised development potential lised development are on location. A localise a Significant flood has subject to a flood has sments and drainage s development in these change impacts ac	and so should not impact across the majority of the eas will need to consider ed area of the Designation azard. As parts of the card a site specific detailed strategy will be required as a area. The FRA will need ross the lifetime of the		
	<ul> <li>Existing areas subject to surface water flooding should ideally be kept free from development or alternatively, flows should be redirected using SuDS.</li> </ul>				
	The FRA should ass on the proposed consideration of inflo manage existing offs	ess the potential for off developments. This ows from adjacent area site impacts and flow ro	site surface water impacts will need to include s and propose methods to putes.		
	The FRA should con access and egress Area (including ements)	nsider the impacts of routes both within and rgency routes).	surface water flooding on d outside the Designation		

### **Designation Area**

### **RC5 The Brewery and Stranton**

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

1.0 0.0.9.						
Proposed development limiting runoff rate: Greenfield - IH124 Methodology			3.33% AEP: 1% AEP:	16.13l/s 19.18l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m³	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	131.9	0.30Ha 5.36% (0.07Ha 1.23%)
1% AEP Rainfall+40%	48	7260	1657	5603 (1268m <sup>3</sup> 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	In accordar where gree	nce with th nfield sites	e requirement are to be dev	nts specified by reloped, the surfa	Hartlepool Bo	orough Council off rates should

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 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.

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.

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.



# 2.8 RC7 Lynn Street

Designation Area RC7 Lynr	n 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 <sup>9</sup>	Max: >1.2m	Max: >1.2m	Max: -
	Mean: 0.6-0.9	Mean: 0.6-0.9	Mean: -
Flood Zone 3 hazard	Max: Extreme	Max: Significant	Max: -
	Mean: Significant	Mean: Significant	Mean: -
Climate change	68% of this site is curren Climate change impacts level, increasing it by the as identified in Table 3 of Change Allowances guid The EA flood map indica a result of extreme seale or 0.1% AEP events. A flooding along this area of a consequence of wave of undefended coastline. Based on comparison of levels relative to the ext the primary flood mecha day wave overtopping ev 0.1% AEP (Flood Zone extents. Whilst still water inundation, EA wave ove current available modellin combined with still water for climate change testion Updated modelling to a required as part of a site to be agreed with the B absence of modelling the has been used to provid flood extents and depths be suitable to support de development aspirations will be required within sit Flood Zone 3a extents un current day Flood Zone the Designation Area. If with localised deeper are The hazard rating will b change flood zone, rising	atty located with Flood Zo have been assessed by e North East regional al of the GOV.UK Flood Ris dance up to 2115. These that the site is not at evel still water overtopping review of the flood mode of coastline, as defined be overtopping rather than evel of the relative height of reme sea levels, overto anism under climate cha dents for both the 0.5% e 2) scenarios show a er levels have been mode ertopping scenarios canr ing. Wave overtopping climate change levels h g. ssess future wave over e-specific FRA and the re EA. For the purposes of e existing Flood Zone 2 w le a representation of th s. These proxy climate of evelopment proposals, de and a full assessment of the specific Flood Risk As nder climate change are 2. Flooding will be limit vean flood depths will be as (>1.2m) to the east. the Significant across the g to Extreme in the east.	one 2 and 3a. reviewing the peak sea lowance for each epoch k Assessments: Climate direct risk of flooding as ng during either the 0.5% delling indicates that the by the EA flood map is as extreme sea levels on an the undefended ground pping is likely to remain nge scenarios. Current AEP (Flood Zone 3) and slight variation in flood lelled for climate change not be updated based on for the 0.1% AEP event as, therefore, been used topping extents may be equirements would need of the this SFRA in the wave overtopping outline e likely change in future change outlines may not epending on site specific f climate change impacts sessments. likely to be similar to the ed to the eastern half of the on average 0.6-0.9m, e majority of the climate etarn area.
nistoric liooaing	Designation Area.	ere are no records of his	tone hood events in this
Defended	The Environment Agence coastal erosion protection frontage and the Designa protected on the Environ There are however defer the site. This network of structures are owned and Hartlepool Borough Court	y does not own or mainta n assets along northern ation Area is, therefore, ment Agency Flood Map nces along the coastal fr flood defences and coa d maintained by a range ncil and PD Ports. This	ain any flood defence or Hartlepool coastal not identified to be o for Planning. ontage which protect stal erosion protection of bodies, namely frontage is generally

# 9 Environment Agency Hartlepool Flood Mapping & FWI Study 2012

Designation Area	RC7 Lynn Street
	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 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.
Flood Warning Area	No
Flood risk	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. 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. 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 orth-eastern boundary. There is a Significant hazard rating within the area of flood risk.
	The western portion of the Designation Area is within Flood Zone 1.
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>'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.</li> <li>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.</li> <li>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 overtooping</li> </ul>
	assuming current risk can be mitigated. Current wave overtopping modelling does not include specific climate change scenarios and



Designation Area	RC7 Lynn Street				
Flood Source: Ground Wa	<ul> <li>depending on development proposals further investigation may be required.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>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.</li> </ul>				
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 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.				
Flood Source: Infrastructu	ure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not wit	hin published reservoir f	flood mapping extents.		
Flood Source: Infrastructu	ıre Failure – Canals				
Flood risk: canal	No canalised watercourses in area. No flood risk identified.				
Flood Source: Surface Wa	iter				
Surface Water Flood Risk	to Proposed Developme	ent 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)		
Surface water flooding	1.90 Max: 0.6.0.0m	5.51 Mov: 0.0.1.2m	25.74 Mov: 0.0.1.2m		
depths (m)	Average: 0.15-0.3m	Average: 0.3-0.6m	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% A increase in depth and consequence of climate of	AEP outline provides ar extent of the more change impacts.	n indication of the likely frequent events as a		
Surface water: flood risk to development site	There is a significant su Designation Area Overa of risk from surface wat significant (greater than region of 0.3-0.6m. The localised areas indicating Surface water flood exte the existing road layout a of surface water flood ris to the rail line. This corr fall in ground levels gene The flood mapping indic entering the Designation Surface water flooding of into account in considera mapping indicates a nur impacts on access and e	rface water flood risk to all, 33% of the Designati er flooding. Maximum 0.9-1.2m). Average of subsequent average h g a Significant hazard. ents appear to be influer nd buildings. However, k to the A178 / Mainsfor responds with the topogenally from west to east. ates limited potential for Area from adjacent area f the surrounding highwa ation of emergency acce mber of alternative route gress appear manageal	the eastern part of the on Area is at some level flood depths are locally water depths are in the hazard is Moderate with need by the presence of there is a significant area and Terrace area adjacent graphy which indicates a or surface water flooding as. ays will need to be taken less and egress, however es and therefore off-site ble.		



Designation Area		RC7 Lynn Stre	et			
Surface water: mitig options & site suita	gation bility	<ul> <li>Surface water flooding appears localised and so should not imposignificantly on the development potential across the majority of site. However, localised development areas will need to consultate surface water based on location. Parts of the Designation Area subject to a Significant flood hazard and a site specific deta surface water assessments and drainage strategies will be required as part of any FRAs for development in these area. The FRAs need to mitigate climate change impacts across the lifetime of development.</li> <li>Areas subject to surface water flooding should ideally be kept from development or alternatively flows should be redirected u SuDS.</li> </ul>			buld not impact majority of the ed to consider nation Area are becific detailed will be required The FRAs will lifetime of the ly be kept free edirected using	
		impacts c considerat manage e	ion of inflows	developments. s from adjacent a impacts and flo	This will ne areas and propo w routes.	ed to include ose methods to
	•	<ul> <li>Any FRA ways on access appear available</li> </ul>	will need to o and egress ailable.	consider the imp routes, althoug	acts of surface h potential alte	water flooding ernative routes
Indicative Surface	Water Fl	ood Risk Froi Entirety)	m Proposea	Development		
(IOI Designation A		Lininely/				
Proposed developm Greenfield - IH124 I	nent limitir Methodolo	ig runoff rate: gy		3.33% AEP: 1% AEP:	23.08l/s 27.43l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	140.1	0.46Ha 5.57% (0.11Ha 1.28%)
1% AEP Rainfall+40%	48	10857	2370	8487 (1925m <sup>3</sup> of exceedance storage)	171.4	0.57Ha 6.81% (0.13Ha 1.54%)
Climate change	Applicati anticipat volumes	on of the ce ed for climate for the 3.33%	entral (20%) change in the and 1% AEI	and upper ba e table above sh P rainfall events.	and (40%) po ows the estima	tential change ted attenuation

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 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



Designation Area	RC7 Lynn Street
	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.
	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.
	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.

# 2.9 RC11 York Road South

Designation Area F	RC11 York Road South
Site area	3.28Ha
Existing use	Brownfield / urbanised including commercial / retail / residential
Proposed use	Mixed Residential / Commercial
Proposed development flood ri vulnerability classification	sk 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 <sup>10</sup> (m)	Max: 0.6-0.9	Max: 0.6-0.9	Max: -	
	Mean: 0.3-0.6	Mean: 0.3-0.6	Mean: -	
Flood Zone hazard	No data available	No data available	No data available	
Climate change	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. 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			
Historic flooding	From available data, there are no records of historic flood events in this Designation Area.			
Defended	Environment Agency re channel is a maintained the south west corner of Road) is undefended wit to the coast the waterco reported to have a con have built a pumping sta flooding when the outfa modelling undertaken to pumping station. The ca not been confirmed as p	cords indicate that the watercourse which en of the Designation Are th high ground either s urse is culverted as pu siderable (>2m) radiu ation close to the coas all from this watercou derive the flood zones apacity and structural c art of this assessment.	e Burn Valley Beck open ters a culvert upstream of ea (Penrhyn Street / York ide. From Penrhyn Street iblic sewer. The culvert is s. Northumberland Water t to prevent surface water irse is tide locked. The excludes the effects of this condition of the culvert has	
Flood Warning Area	No			
Flood risk	Ground levels across the southeast, reducing from of the site extends out in watercourse) where it be The area is currently urb commercial properties we including the more signif The Designation Area is from the watercourse wh site at Penrhyn Street / Approximately 16% of t flooding and located in F Flood Zone 3a increase line of the watercourse) 0.9m and average depth	ne site generally decline a round 12m OD to 7.3 to a valley bottom (assession of the valley bottom (assession of the valley bottom) anised with a mix of re- rithin a dense network of the icant York and Warwice s at greatest risk of flo- nich enters a culvert imm York Road. It is not a he southern part of the lood Zone 2 and 3a. A towards the valley bott with a very localised as of 0.3-0.6m. Flood 2	ne from the northwest to 3m OD. The southern part sociated with the upstream esidential, retail and of streets and highways k Roads. oding from fluvial flooding mediately southwest of the t risk from Tidal Flooding. e area is at risk of fluvial verage flood depths within om (potentially the historic maximum depth of 0.6 to Zone 2 extents and depths	

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



Designation Area	RC11 York Road South
	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. 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.
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and fluvial flooding.</li> <li>Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access is available.</li> </ul>
Flood Source: Ground Wa	ter
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: Infrastructu	ure Failure – Reservoirs
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.
Flood Source: Infrastruct	ure Failure – Canals
LIOUU IISK. Callai	no canalised watercourses in area. No nood fisk 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)		
Surface water (70)	0.00	0.34	6.00		
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 <sup>11</sup>	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	There is little or no surface water flood risk to the majority of the Designation Area across all events. 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. 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 The flood mapping indicates some but relatively limited potential for 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				
Surface water: mitigation options & site suitability	<ul> <li>Surface water floodi significantly on the or site. However, loca surface water based are subject to a signi water assessments any FRAs for devel mitigate climate or development.</li> <li>Areas subject to su from development or SuDS.</li> <li>The FRAs should impacts on propositions consideration of infloor manage existing offs</li> <li>Any FRA will need to on access and egre appear available.</li> </ul>	ing appears localised development potential lised development are d on location. As part ficant flood hazard a si and drainage strategy opment in these area hange impacts acro frace water flooding s or alternatively flows s assess the potential ed developments. The ows from adjacent area site impacts and flow ro o consider the impacts ass routes, although p	and so should not impact across the majority of the eas will need to consider s of the Designation Area te specific detailed surface will be required as part of . The FRAs will need to oss the lifetime of the hould ideally be kept free hould be redirected using for offsite surface water his will need to include s and propose methods to outes. s of surface water flooding potential alternative routes		

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

Indicative Surface Water Flood Risk From Proposed Development (for Designation Area in its Entirety)						
Proposed developm	nent limiting r	unoff rate:		3.33% AEP:	9.32l/s	
Greenfield QBAR -	IH124 Metho	dology		1% AEP:	11.07l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	132.0	0.18Ha 5.36% (0.04Ha 1.23%)
1% AEP Rainfall+40%	48	4194	956	3238 (734m <sup>3</sup> 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	anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events. 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 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. 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. An FRA and 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.					

# 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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### **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.

Flood Source: Tidal         Flood Zones (%) (of developable area)       Flood Zone 2       Flood Zone 3a       Flood Zone 3b         (of developable area)       6.07       13.10       0.00         Flood Zone depth <sup>12</sup> (m)       Max: 0.3-0.6       Max: 0.3-0.6       Max: -         Mean: 0.0-0.15       Mean: 0.0-0.15       Mean: -         Flood Zone 3 hazard       Max: Significant       Max: Moderate       Max: -         Mean: Low       Mean: Low       Mean: -         Climate change       19% of the developable Designation Area is currently located with Flood Zone and 3a.         Climate change       19% of the developable Designation Area is currently located with Flood Zone and 3a.         Climate change       19% of the GOV.UK Flood Risk Assessments: Climate Change Allowang guidance up to 2115.         The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still was overtopping, wave overtopping or a combination of both. The eastern an fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta 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 extrem sea level overtopping in the cimate change scenario. In the current day, three a narrow strip of coastal flooding in both the 0.5% (FZ3a) and 0.1% (FZ2) events.         There is an area to the south of Jackson Dock which in the current day 0.5       (FZ3a) AEP ev	Designation Area
Flood Zones (%) (of developable area)Flood Zone 2Flood Zone 3aFlood Zone 3bflood Zone depth <sup>12</sup> (m)Max: 0.3-0.6Max: 0.3-0.6Max: -Mean: 0.0-0.15Mean: 0.0-0.15Mean: -flood Zone 3 hazardMax: SignificantMax: ModerateMax: -Mean: LowMean: LowMean: -Climate change19% of the developable Designation Area is currently located with Flood Zone and 3a.Climate change19% of the developable Designation Area is currently located with Flood Zone and 3a.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 Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowand guidance up to 2115.The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still was overtopping, wave overtopping or a combination of both. The eastern at fronting the coast at the Old Harbour, each side of Jackson Dock and the frontat to wards the northern harbour pier is predominantly at risk form wave overtopping in the current day, although it appears that there may also be a risk of extreme sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) on 0.1% (FZ2) AEP events. 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 to flooding from wave overtopping of the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from extreme se level overtopping in the ol.1% (FZ2) AEP emanating from Jackson Dock to north. Under climate change this area is at risk to flooding from bot sources.	Flood Source: Tidal
(of developable area)6.0713.100.00Flood Zone depth12 (m)Max: 0.3-0.6Max: 0.3-0.6Max: -Mean: 0.0-0.15Mean: 0.0-0.15Mean: -Flood Zone 3 hazardMax: SignificantMax: ModerateMax: -Mean: LowMean: LowMean: -Mean: -Climate change19% of the developable Designation Area is currently located with Flood Zone and 3a.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 Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowance up to 2115. The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still was overtopping, wave overtopping or a combination of both. The eastern are fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta towards the onthern harbour pier is predominatily at risk from wave overtopping in the climate change scenario. In the current day, there a narrow strip of coastal flooding in both the 0.5% (FZ3a) and 0.1% (FZ2) A events. In contrast, the inland area surrounding Jackson Dock and The Marina predominately at risk from extreme sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) on 0.1% (FZ2) events. 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 detai review of ground levels there may also be a risk of flooding from both sources.	Flood Zones (%)
Flood Zone depth <sup>12</sup> (m)Max: 0.3-0.6Max: 0.3-0.6Max: 0.3-0.6Max: - Mean: 0.0-0.15Flood Zone 3 hazardMax: Significant Mean: LowMax: ModerateMax: - Mean: -Climate change19% of the developable Designation Area is currently located with Flood Zone and 3a.Climate change impacts have been assessed by reviewing the peak sea lev increasing it by the North East regional allowance for each epoch as identified Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowanc guidance up to 2115. The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still way overtopping, wave overtopping or a combination of both. The eastern and fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta towards the northern harbour pier is predominantly at risk from wave overtopp in the current day, although it appears that there may also be a risk of extre sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) and 0.1% (FZ2). 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 way overtopping of the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from extreme sea level overtopping in the climate there may also be a risk to this area from extreme sea level overtopping of the old town frontage to the south. Dependent upon a detai 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 north. Under climate change this area is at risk of flooding from both sources.	(of developable area)
Mean: 0.0-0.15         Mean: 0.0-0.15         Mean: -           Flood Zone 3 hazard         Max: Significant Max: Significant Mean: Low         Max: Moderate Mean: Low         Max: - Mean: -           Climate change         19% of the developable Designation Area is currently located with Flood Zone and 3a.         Climate change impacts have been assessed by reviewing the peak sea lew increasing it by the North East regional allowance for each epoch as identified Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowand guidance up to 2115.           The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still wa overtopping, wave overtopping or a combination of both. The eastern an fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta towards the northern harbour pier is predominantly at risk from wave overtoppin in the current day, although it appears that there may also be a risk of extrem sea level overtopping in the climate change scenario. In the current day, there a narrow strip of coastal flooding in both the 0.5% (FZ3a) and 0.1% (FZ2) A events. In contrast, the inland area surrounding Jackson Dock and The Marina predominately at risk from extreme sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) events.           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 wa overtopping of the old town frontage to the south. Dependent upon a detai 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 north. Under climate change this area is at risk of flooding	Flood Zone depth <sup>12</sup> (m)
Flood Zone 3 hazardMax: Significant Mean: LowMax: Moderate Mean: LowMax: - Mean: -Climate change19% of the developable Designation Area is currently located with Flood Zone and 3a. Climate change impacts have been assessed by reviewing the peak sea lev increasing it by the North East regional allowance for each epoch as identified Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowand guidance up to 2115. The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still wa overtopping, wave overtopping or a combination of both. The eastern at fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta 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 extrem sea level overtopping in both the 0.5% (FZ3a) and 0.1% (FZ2) A events. In contrast, the inland area surrounding Jackson Dock and The Marina predominately at risk from extreme sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) events.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 wa overtopping of the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from extreme se level overtopping in the climate to be a risk to this area from extreme se level overtopping in the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from extremes se level overtopping in the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from	
Mean: LowMean: LowMean: -Climate change19% of the developable Designation Area is currently located with Flood Zona and 3a.Climate change impacts have been assessed by reviewing the peak sea lea increasing it by the North East regional allowance for each epoch as identified. Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowance guidance up to 2115.The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still way overtopping, wave overtopping or a combination of both. The eastern ar fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta 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 extre sea level overtopping in both the 0.5% (FZ3a) and 0.1% (FZ2) A events. In contrast, the inland area surrounding Jackson Dock and The Marina predominately at risk from extreme sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) events.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 war overtopping of the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from extreme se level overtopping in the 0.1% (FZ2) AEP emanating from Jackson Dock to to north. Under climate change this area is at risk of flooding from both sources.	Flood Zone 3 hazard
Climate change19% of the developable Designation Area is currently located with Flood Zona and 3a.Climate change impacts have been assessed by reviewing the peak sea lea increasing it by the North East regional allowance for each epoch as identified Table 3 of the GOV.UK Flood Risk Assessments: Climate Change Allowance guidance up to 2115.The EA flood map indicates that dependent upon location the Designation Area at risk of flooding as a consequence of either direct extreme sea level still wa overtopping, wave overtopping or a combination of both. The eastern and fronting the coast at the Old Harbour, each side of Jackson Dock and the fronta towards the northern harbour pier is predominantly at risk from wave overtoppi n in the current day, although it appears that there may also be a risk of extre sea level overtopping in the climate change scenario. In the current day, there a narrow strip of coastal flooding in both the 0.5% (FZ3a) and 0.1% (FZ2) A events. In contrast, the inland area surrounding Jackson Dock and The Marina predominately at risk from extreme sea level overtopping. This area is not sho to flood in the current day 0.5% (FZ3a) or 0.1% (FZ2) events. 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 war overtopping of the old town frontage to the south. Dependent upon a detai review of ground levels there may also be a risk to this area from extreme s level overtopping in the 0.1% (FZ2) AEP emanating from Jackson Dock to t north. Under climate change this area is at risk of flooding from both sources.	
<ul> <li>Whilst still water levels have been modelled for climate change inundation, wave overtopping scenarios cannot be updated based on current availa modelling. Updated modelling to assess future wave overtopping extents may required as part of a site-specific FRA and the requirements would need to agreed with the EA.</li> <li>2008 Model</li> <li>Wave overtopping outlines for the current day 0.1% AEP events combined w still water climate change levels has, therefore, been used for climate chan testing (see relevant mapping in Appendices).</li> <li>For areas impacted by wave overtopping, for the purposes of this SFRA in tabsence of modelling the existing Flood Zone 2 wave overtopping outline h been used to provide a representation of the likely change in future flood exter and depths. This indicates that climate change flooding from this source is lik to be limited and similar to the current day, limited to a narrow strip along to coastal frontage with depths up to 0.6m and a Low to locally Significant floot hazard. In addition, localised section of this frontage may become inundated to being overtopped by extreme still water overtopping. These proxy clim change outlines may not be suitable to support development proposed depending on site specific development aspirations and a full assessment climate change impacts will be required within site specific Flood R</li> </ul>	Climate change

<sup>12</sup> Environment Agency Hartlepool Flood Mapping & FWI Study 2012



# Designation Area

**RC12 The Marina** 

# 2012 Model

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).



# 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 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.

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.

 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.

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

Designation Area	RC12 The Marina				
	<ul> <li>specific climate change scenarios and depending on development proposals further investigation may be required.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>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.</li> </ul>				
Flood Source: Ground Wa	iter				
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: Infrastruct	ure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not with	nin published reservoir floor	d mapping extents.		
Flood Source: Infrastruct	ure Failure – Canals				
Flood risk: canal	No canalised watercourse	es in area. No flood risk ide	entified.		
Flood Source: Surface Wa	ater				
Surface Water Flood Risk	to Proposed Developmen	nt Site			
Existing development: risk of flooding from surface water (%)	High RiskMedium RiskLow Risk(3.33% AEP outline)(1% AEP outline)(0.1% AEP outline)				
(of developable area)	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	<ul> <li>Designation Area RC12 is incorporated within Designation Area LT2 and the flood risks are generally as described under that Designation Area.</li> <li>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.</li> <li>Mapping does not indicate significant surface water flows entering the site from the adjacent areas.</li> <li>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.</li> </ul>				
Surface water: mitigation options & site suitability	<ul> <li>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</li> </ul>				



Designation Area	RC12 The Marina
	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.
	• Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS.
	<ul> <li>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.</li> </ul>
	• The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential routes appear available.
	<ul> <li>If discharge to the nearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events.</li> </ul>

# 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 1% AEP:	54.4l/s 64.66l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	139.8	1.09Ha 3.21% (0.25Ha 0.74%)
1% AEP Rainfall+40%	48	25559	5587	19972 (4529m <sup>3</sup> 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	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. 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.					

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.

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



Designation Area	RC12 The Marina
	off site surface water flood impacts attenuation storage will be required, both for the design drainage and exceedance events. An FRA and appropriate drainage / attenuation strategy will be required. There are a variety of appropriate techniques which could be adopted 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.



# 2.11 RC14 Trincomalee Wharf

Designation Area RC14 Tri	ncomalee 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.

Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	9.96	10.49	0.00
Flood Zone depth <sup>13</sup> (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	20% of this Designation 3a. Climate change impacts level, increasing it by the as identified in Table 3 of Change Allowances guid The EA flood map indica risk of flooding as a residuring 0.5% (FZ3a) even the flooding along this arists as a consequence of wo on an undefended coastil levels there may also for overtopping in the 0.1% north. Under climate clisources and the area wit model update. Whilst still water leve inundation, EA wave ove current available modell overtopping extents may the requirements would no of this SFRA in the abse overtopping outline has likely change in future outlines for the current of climate change levels the support development pro- aspirations and a full area.	Area is currently located have been assessed by e North East regional al f the GOV.UK Flood Ris lance up to 2115. tes that in the current da sult of extreme sea levent. A review of the flood rea of coastline, as defin wave overtopping rather ine. Dependent upon a co be a risk to this area is (FZ2) AEP emanating fr hange this area is at ris hin Flood Zone 1 reduce ls have been modelle ertopping scenarios can ing. Updated modelling / be required as part of heed to be agreed with th nce of modelling the exis been used to provide flood extents and dept day 0.1% AEP events co has, therefore, been us limate change outlines oposals, depending on s assessment of climate	d with Flood Zone 2 and y reviewing the peak sea lowance for each epoch ak Assessments: Climate ay the site is not at direct el still water overtopping modelling indicates that ned by the EA flood map than extreme sea levels detailed review of ground from extreme sea levels detailed review of ground from extreme sea level om Jackson Dock to the sk of flooding from both s to 74% within the 2012 ed for climate change not be updated based on g to assess future wave a site specific FRA and ne EA. For the purposes sting Flood Zone 2 wave a representation of the ths. Wave overtopping combined with still water sed for climate change may not be suitable to ite specific development change impacts will be

**RC14 Trincomalee Wharf** 

**Designation Area** 

required within site specific Flood Risk Assessments. 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. **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,

<sup>13</sup> Environment Agency Hartlepool Flood Mapping & FWI Study 2012

Designation Area	RC14 Trincomalee Wharf
	namely Hartlepool Borough Council and PD Ports. 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. 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. 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 be lower inland, potentially due to the storage influence
Flood Warning Area	of the dock.
Flood risk	Designation Area RC14 is incorporated within Designation Area LT2 and the flood risks are generally also as described under that Designation Area.
	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.
	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. 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. The majority of the Designation Area to the west is within Flood Zone 1.

Designation Area	RC14 Trincomalee Wharf		
Mitigation options & site suitability	<ul> <li>Due to the level of risk and depth of nooding 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.</li> <li>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.</li> <li>'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.</li> <li>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.</li> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>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.</li> </ul>		
Flood Source: Ground Wa	iter		
Flood risk: ground water	100% of Designation groundwater emergence of ponding, if it occurs, is tend to flow towards the	Area indicated as have of >75%. Based on a r s likely to be minimal an dock.	ving a susceptibility to eview of LiDAR, the risk id localised as water will
Flood Source: Infrastructu	ure Failure – Reservoirs		
Flood risk: Reservoir	Designation Area not wit	hin published reservoir f	lood mapping extents.
Flood Source: Infrastructu	ure Failure – Canals		
Flood risk: canal	No canalised watercours	ses in area. No flood risl	k identified.
Flood Source: Surface Wa	iter		
Surface Water Flood Risk	to Proposed Developme	ent Site	
Existing development:	High Risk	Medium Risk	Low Risk
surface water (%)	(3.33% AEP outline)	(1% AEP outline)	(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	Max: Moderate	Max: Significant
	Average: Low	Average: Low	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 to development site	l risk De the Th Ris loc In ma 0.6 of inc loc at Th wit roa dra fro gro Su int in ap ac	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.				
<ul> <li>Areas of the Designation Area are subject to localised surface flooding with some more extensive areas of deeper more haze flooding in the more extreme events. A site / development side detailed surface water assessment and drainage strategy required as part of any FRA. The FRA will need to mitigate of change impacts across the lifetime of the development.</li> <li>Areas subject to surface water flooding should ideally be ke from development or alternatively flows should be redirected the site using SuDS.</li> <li>Whilst they appear to be minimal, the FRA should assess the porfor offsite surface water impacts on the proposed development will need to include consideration of inflows from adjacent site propose methods to manage existing offsite impacts and flow redirects and egress routes, although potential routes a available.</li> <li>If discharge to the nearby dockside is proposed the FRA will need to the site using substantiation.</li> </ul>				d surface water hore hazardous opment specific trategy will be nitigate climate t. ly be kept free directed across ss the potential elopment. This acent sites and ind flow routes. water flooding routes appear RA will need to vents.		
Indicative Surface (for Designation A	Water Floo rea in its El	d Risk From ntirety)	n Proposed	Development		
Proposed developm Greenfield - IH124 I	nent limiting Methodology	runoff rate: (I/s)		3.33% AEP: 1% AEP:	17.72l/s 21.06l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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

Designation Area	RC	14 Trincom	alee Wharf			
Rainfall+40%						5.26%
1% AEP Rainfall+20%	48	7145	1820	5325 (1226m <sup>3</sup> of exceedance storage)	140.1	0.34Ha 5.56% (0.08Ha 1.28%)
1% AEP Rainfall+40%	48	8335	1820	6515 (1477m <sup>3</sup> of exceedance storage)	171.4	0.43Ha 6.81% (0.10Ha 1.54%)
Climate change	Application anticipated volumes for	of the ce for climate the 3.33%	entral (20%) change in the and 1% AEF	and upper ba table above sho rainfall events.	and (40%) po ows the estima	tential change ted attenuation
Surface water: flood risk impacts from development site & mitigation	In accordar where gree not exceed previously of rates should a minimum It is recogn specific pro This will ne described Designation proposed if equivalent developme attenuation Attenuation AEP (stand change. To required, bo An FRA an are a varie oversized attenuation presents th total site ar master plan	nce with the nfield sites , and where developed ( d seek to a of 50% of the ised that the posals for r ed to take in above. The n Areas the mpermeab run off rates n Areas the mpermeab run off rates n site area of storage re volumes a lard draina of the for the co d appropria ty of appro- pipes or basins. As e area of a ea. SuDS ming stage	e requirement are to be development brownfield) si chieve greent the existing si is Designatic redevelopment nto account the collustrate table above is le areas of s are applied. as within the equirements. are presented ge design) and ite surface we design drainage ate drainage oppriate techni underground a guide to th 1.5m deep su and attenuati	nts specified by reloped, the surfa- ould reduce the ites are to be det field equivalent r ite run-off rate. on Area site inclu- nt will need to be he Hartlepool Bo the potential a identifies the req the Designation These will need Designation Area d for the critical nd 1% AEP (exi- ater flood impact ge and exceeda / attenuation stra- iques which cou- storage tanks e likely land take urface storage po-	Hartlepool Bo ace water run-o existing run of veloped, surfac run off rates or udes areas of provided as p- prough Council attenuation an juired storage v n Area if limi d to be proport ea to provide a storm duration ceedance) events attenuation and the pe s should be con	brough Council off rates should f rates. Where be water run-off be reduced by brownfield and art of any FRA. s requirements d storage for volumes for the ting greenfield ioned to actual an indication of for the 3.33% ents for climate storage will be equired. There d ranging from echniques and th this the table rcentage of the nsidered at the



# 2.12 LT2 The Marina

Designation Area LT2 The I	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.

LT2 The Marina		
Flood Zone 2	Flood Zone 3a	Flood Zone 3b
6.93	11.33	0.00
Max: 0.3-0.6	Max: 0.3-0.6	Max: -
Mean: 0.0-0.15	Mean: 0.0-0.15	Mean: -
Max: Significant	Max: Moderate	Max: -
Mean: Low	Mean: Low	Mean: -
19% of the developable Zone 2 and 3a.	Designation Area is cur	rently located with Flood
as identified in Table 3 c Change Allowances guid The EA flood map indica Area is at risk of flooding level still water overtopp The eastern area fronti Jackson Dock and the predominantly at risk fro it appears that there may in the climate change sc of coastal flooding in bo In contrast, the inland ar predominately at risk fro not shown to flood in the The area to the south of	of the GOV.UK Flood Ris dance up to 2115. tes that dependent upon g as a consequence of e ing, wave overtopping o ng the coast at the Old frontage towards the r m wave overtopping in t y also be a risk of extrem enario. In the current da th the 0.5% (FZ3a) and ea surrounding Jackson om extreme sea level over current day 0.5% (FZ3a) f Jackson Dock (RC14)	k Assessments: Climate location the Designation either direct extreme sea or a combination of both. I Harbour, each side of northern harbour pier is the current day, although ne sea level overtopping by, there is a narrow strip 0.1% (FZ2) AEP events. Dock and The Marina is vertopping. This area is a) or 0.1% (FZ2) events. in the current day 0.5 %
(FZ3a) AEP event prima wave overtopping of the a detailed review of gro from extreme sea level from Jackson Dock to the	arily appears to be risk old town frontage to the und levels there may als overtopping in the 0.1%	from overland flow from south. Dependent upon so be a risk to this area 6 (FZ2) AEP emanating hange this area is at risk

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.

**Designation Area** 

Flood Source: Tidal Flood Zones (%) (of developable area) Flood Zone depth<sup>14</sup> (m)

Flood Zone hazard

**Climate change** 

of flooding from both sources.

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<sup>14</sup> Environment Agency Hartlepool Flood Mapping & FWI Study 2012

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 Contains OS data © Crown copyright and database right (2017)         Contains Environment Agency information © Environment Agency and/or database right.         The areas adjacent to the Jackson Dock / Marina are undefended and subject to flooding from extreme still water overtopping under climate change.
	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
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	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. 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.
Flood Warning Area	Approximately <5% of Designation Area (eastern edge of site) within <b>North Sea at West of Hartlepool</b> Flood Warning Area
Flood risk	Designation Area LT2 incorporated Designation Area RC12 and RC14 and the flood risks are generally as described under those Designation Areas. 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. 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. 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 boundary. Immediately west of the Designation Area, the A179 Marina Way is slightly elevated at between 6 and 13m OD. 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. It appears that the whils 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 boun

Designation Area	LT2 The Marina				
	The majority of the Designation area is within Flood Zone 1.				
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>'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).</li> <li>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.</li> <li>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.</li> </ul>				
	is available to the west.				
Flood Source: Ground Wa	iter				
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: Infrastructo	ure Failure – Reservoirs				
Flood risk: Reservoir	Designation Area not wit	hin published reservoir f	lood mapping extents.		
Flood Source: Infrastructo	ure Failure – Canals				
Flood risk: canal	No canalised watercours	ses in area. No flood risl	k identified.		
Flood Source: Surface W	ater				
Surface Water Flood Risk	to Proposed Developm	ent 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)		
(of developable area)	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	Designation Area LT2 incorporated Designation Area RC12 and RC14 and the flood risks are generally as described under those Designation Areas. 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. 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	<ul> <li>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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS.</li> <li>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.</li> <li>The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential routes appear available.</li> <li>If discharge to the nearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events.</li> </ul>

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

(IUI Designation A		linely/				
Proposed developm Greenfield - IH124 I	nent limiting r Methodology	unoff rate:		3.33% AEP: 1% AEP:	86.08l/s 102.31l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	140.1	1.73Ha 2.88% (0.40Ha 0.66%)
1% AEP Rainfall+40%	48	40507	8840	31667 (7181m <sup>3</sup> 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	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. 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 to provide an indication of attenuation / storage requirements. Attenuation volumes are presented for the critical storm duration for the 3.33% AEP (standard drainage design) and 1% AEP (exceedance) events for climate					
	required, bo An FRA an	oth for the d d appropria	esign drainage	ge and exceeda	nce events. ategy will be re	equired. There

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.

### 2.13 RC17 Late Night Uses Areas

Designation Area RC17 I	ate 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.

JBA

Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	1.71	15.52	0.00
Flood Zone depth <sup>15</sup> (m)	Max: 0.6-0.9	Max: 0.6-0.9	Max: -
	Mean: 0.3-0.6	Mean: 0.3-0.6	Mean: -
Flood Zone hazard	Max: Significant	Max: Significant	Max: -
	Mean: Moderate	Mean: Moderate	Mean: -
Climate change	17.2% of this site is curr Climate change impacts level, increasing it by th as identified in Table 3 of Change Allowances guid The EA flood map indica a result of extreme sea le or 0.1% AEP events. A flooding along this area of a consequence of wave undefended coastline. Based on comparison of levels relative to the exit the primary flood mecha day wave overtopping et 0.1% AEP (Flood Zone extents. Whilst still wate inundation, EA wave ove current available modell combined with still wate for climate change testin Updated modelling to a required as part of a site to be agreed with the EA of modelling the existing used to provide a repr extents and depths. Th suitable to support deve development aspirations will be required within sit Flood Zone 3a extents u current day Flood Zone the Designation Area. I with localised deeper are The hazard rating will b change flood zone, rising	ently located with Flood have been assessed h e North East regional a of the GOV.UK Flood R dance up to 2115. ates that the site is not a evel still water overtopp a review of the flood m of coastline, as defined overtopping rather than of the relative height of tame sea levels, over anism under climate ch xtents for both the 0.5% e 2) scenarios show a er levels have been mo ertopping scenarios can ing. Wave overtopping r climate change level a. For the purposes of Flood Zone 2 wave over esentation of the likel nese proxy climate change along and a full assessment te specific Flood Risk A nder climate change ar 2. Flooding will be lim Mean flood depths will eas (0.6-0.9m) to the et along to Significant in the et along are no records of h	d Zone 2 and 3a. by reviewing the peak sea allowance for each epoch isk Assessments: Climate at direct risk of flooding as bing during either the 0.5% odelling indicates that the by the EA flood map is as n extreme sea levels on an of the undefended ground topping is likely to remain mange scenarios. Current 6 AEP (Flood Zone 3) and a slight variation in flood odelled for climate change mot be updated based on g for the 0.1% AEP event has, therefore, been used ertopping extents may be requirements would need this SFRA in the absence ertopping outline has been by change in future flood ange outlines may not be epending on site specific of climate change impacts assessments. The likely to be similar to the ited to the eastern part of be on average 0.3-0.6m, ast. the majority of the climate astern area.
Defended	Designation Area. The Environment Agence coastal erosion protect frontage and the Desig protected on the Environ There are however defensite. This network of	y does not own or main tion assets along nor gnation Area is, there ment Agency Flood Ma nces along the coastal flood defences and c	ntain any flood defence or thern Hartlepool coastal fore, not identified to be ap for Planning. frontage which protect the oastal erosion protection
	structures are owned a Hartlepool Borough Co	and maintained by a uncil and PD Ports.	range ot bodies, namely This frontage is generally

<sup>15</sup> Environment Agency Hartlepool Flood Mapping & FWI Study 2012

Designation Area RC17 Late Night Uses Areas

Designation Area	RC17 Late Night Uses Areas
	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 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.
Flood Warning Area	No
Flood risk	<ul> <li>Designation Area RC17 is incorporated within Designation Area RC2 and the flood risks are generally also as described under that Designation Area.</li> <li>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.</li> <li>Designation Area RC17 is also contained within the extents of the larger RC2 Designation Area.</li> <li>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.</li> <li>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 northeastern boundary. There is a Moderate to Significant hazard rating within the area of flood risk.</li> <li>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.</li> </ul>
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>'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.</li> <li>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.</li> </ul>



Designation Area	RC17 Late Night Uses Ar	reas		
	<ul> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access</li> </ul>			
	is available to the we	est.		
Flood Source: Ground Wa	iter			
Flood risk: ground water	100% of Designation groundwater emergence a fall in level across th ponding if encountered across the site following are towards the adjacent	Area indicated as h of >75%. Comparison ie area in an easterly is likely to be minimal i topography. It is idei t site RC7 and may res	aving a susceptibility to with LiDAR data indicates direction, indicating that as water will tend to flow ntified that the flow routes ult in ponding in that area.	
Flood Source: Infrastructu	ure Failure – Reservoirs			
Flood risk: Reservoir	Designation Area not wit	hin published reservoi	r flood mapping extents.	
Flood Source: Infrastructu	ure Failure – Canals			
Flood risk: canal	No canalised watercours	ses in area. No flood ri	sk identified.	
Flood Source: Surface W	ater			
Surface Water Flood Risk	to Proposed Developm	ent Site		
Existing development:	High Risk	Medium Risk	Low Risk	
risk of flooding from surface water (%)	(3.33% AEP outline) 0.53	(1% AEP outline) 1.38	(0.1% AEP outline) 8.96	
risk of flooding from surface water (%) Surface water flooding depths (m)	(3.33% AEP outline) 0.53 Max: 0.15-0.3m Average: 0.15-0.3m	(1% AEP outline) 1.38 Max: 0.3-0.6m Average: 0.15- 0.3m	(0.1% AEP outline) 8.96 Max: 0.3-0.6m Average: 0.15-0.3m	
risk of flooding from surface water (%) Surface water flooding depths (m) Surface water hazards <sup>16</sup>	(3.33% AEP outline) 0.53 Max: 0.15-0.3m Average: 0.15-0.3m Max: Moderate Average: Low	(1% AEP outline) 1.38 Max: 0.3-0.6m Average: 0.15- 0.3m Max: Moderate Average: Low	(0.1% AEP outline) 8.96 Max: 0.3-0.6m Average: 0.15-0.3m Max: Significant Average: Low	
risk of flooding from surface water (%) Surface water flooding depths (m) Surface water hazards <sup>16</sup> Climate change Surface water: flood risk to development site	(3.33% AEP outline) 0.53 Max: 0.15-0.3m Average: 0.15-0.3m Max: Moderate Average: Low The current day 0.1% A increase in depth and consequence of climate Designation Area RC17 the flood risks are gene	(1% AEP outline) 1.38 Max: 0.3-0.6m Average: 0.15- 0.3m Max: Moderate Average: Low AEP outline provides extent of the more change impacts. is incorporated within I erally also as describe	(0.1% AEP outline) 8.96 Max: 0.3-0.6m Average: 0.15-0.3m Max: Significant Average: Low an indication of the likely e frequent events as a Designation Area RC2 and ed under that Designation	

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



Designation Area	l	RC17 Late Nig	ht Uses Area	S		
	to S ir n ir	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				
Surface water: mitig options & site suita	gation bility •	<ul> <li>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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS.</li> <li>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.</li> <li>The FRA will need to consider the impacts of surface water flooding on access and egress routes, although potential alternative routes appear available.</li> </ul>				
Indicative Surface (for Designation A	Water Flo rea in its	ood Risk Froi Entirety)	m Proposed	Development		
Proposed developm Greenfield - IH124 I	nent limiting Methodolog	g runoff rate:		3.33% AEP: 1% AEP:	20.93l/s 24.87l/s	
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 (1446m³ of exceedance storage)		6287 (1446m <sup>3</sup> of exceedance storage)	140.1	0.42Ha 5.57% (0.10Ha 1.28%)	
1% AEP Rainfall+40%	48	9842	2149	7693 (1744m <sup>3</sup> of exceedance storage)	171.4	0.51Ha 6.82% (0.12Ha 1.55%)
Climate change	Application anticipate volumes	on of the ce ed for climate for the 3.33%	entral (20%) change in the and 1% AEF	and upper ba table above sho rainfall events.	nd (40%) po ows the estima	tential change ted attenuation
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
	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.
	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.
	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.

# 2.14 RC16 Northgate / Union Street Local Centre

Designation Area Northgate	e / 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:
- 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.

Flood Source: Tidal			
Flood Zones (%)	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
	1.33	97.66	0.00
Flood Zone depth <sup>17</sup> (m)	Max: 0.3-0.6	Max: 0.3-0.6	Max: -
	Mean: 0.15-0.3	Mean: 0.15-0.3	Mean: -
Flood Zone hazard	Max: Moderate	Max: Moderate	Max: -
	Mean: Low	Mean: Low	Mean: -
Climate change	99% of this Designation 3a.	Area is currently locate	d with Flood Zone 2 and

17 Environment Agency Hartlepool Flood Mapping & FWI Study 2012

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Designation Area	Northgate / Union Street Local Centre
	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. 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. 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 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.
Historic flooding	From available data, there is 1no record of historic event from Hartlepool Fire Service in this Designation Area, although there is insufficient information to determine the flood source.
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 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. 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.
Flood Warning Area	100% of Designation Area in North Sea Coast at Victoria Harbour Flood Warning Area
Flood risk	Designation Area RC16 is incorporated within Designation Area LT1 and the flood risks are generally as described under that Designation Area. 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.

Designation Area	Northgate / Union Street Local Centre				
	The area is currently urbanised with a mix of residential, retail and commercial properties within a dense network of streets and highways. 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 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. Approximately 100% of the Designation Area is at risk of tidal 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. 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.				
Mitigation options & site suitability	<ul> <li>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.</li> <li>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.</li> <li>'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.</li> </ul>				
	<ul> <li>enable flow across the area and maintain these so that they do not increase flood risk.</li> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>Access (including emergency access) across the site will need to take account of future flood levels, however it appears that suitable access</li> </ul>				
Flood Source: Ground Wa	is available to the west.				
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	nation Area Northgate / Union Street Local Centre					
	tend to flow towards the dock.					
Flood Source: Infrastructure Failure – Reservoirs						
Flood risk: Reservoir	Designation Area not wit	hin published reservoir f	flood mapping extents.			
Flood Source: Infrastruct	ure Failure – Canals					
Flood risk: canal	No canalised watercours	ses in area. No flood ris	k identified.			
Flood Source: Surface W	ater					
Surface Water Flood Risk	k to Proposed Developm	ent 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	Max: Moderate	Max: Significant			
	Average: Low	Average: Low	Average: Moderate			
Climate change	The current day 0.1% A increase in depth and consequence of climate	AEP outline provides an I extent of the more change impacts.	n indication of the likely frequent events as a			
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. 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. 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. Mapping indicates potential surface water flows entering the site from the adjacent areas. Topography dictates potential flow routes from higher ground to the east. 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					
Surface water: mitigation options & site suitability	<ul> <li>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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS.</li> <li>The FRAs should assess the potential for offsite surface water impacts on proposed development.</li> </ul>					

Designation Area	Northgate / Union Street Local Centre
	<ul> <li>consideration of inflows from adjacent areas and propose methods to manage existing offsite impacts and flow routes.</li> <li>Any FRA will need to consider the impacts of surface water flooding on access and egress routes.</li> </ul>

# 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: 1% AEP:	0.99l/s 1.17l/s			
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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 <sup>3</sup> of exceedance storage)	133.7	0.02Ha 5.36% (0.00Ha 1.25%)
1% AEP Rainfall+40%	48	447	101	346 (79m <sup>3</sup> of exceedance storage)	164.0	0.02Ha 6.56% (0.01Ha 1.50%)
Climate change	Application anticipated volumes for	of the ce for climate the 3.33%	entral (20%) change in the and 1% AEF	and upper ba table above sho rainfall events.	and (40%) por ows the estima	tential change ted attenuation
Surface water: flood risk impacts from development site & mitigation	anticipated for climate change in the table above shows the estimated attenuation volumes for the 3.33% and 1% AEP rainfall events. 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 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. 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. 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					



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 H	leadland
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 <sup>18</sup> (m)	Max: 0.9-1.2m	Max: 0.9-1.2m	Max: -				
	Average: 0.15-0.3m	Average: 0.15-0.3m	Average: -				
Flood Zone hazard	Max: Significant	Max: Significant	Max: -				
	Average: Moderate	Average: Moderate	Average: -				
	6.1320.310.00Max: 0.9-1.2mMax: -Max: -Average: 0.15-0.3mAverage: 0.15-0.3mAverage: -Max: SignificantMax: SignificantMax: -Average: ModerateAverage: ModerateAverage: -26.44% of this Designation Area is currently located with Flood Zone 2and 3a.Climate change impacts have been assessed by reviewing the peak sealevel, increasing it by the North East regional allowance for each epochas identified in Table 3 of the GOV.UK Flood Risk Assessments: ClimateChange Allowances guidance up to 2115.The EA flood map indicates that the Designation Area is at risk of floodingas a consequence of either direct extreme sea level still water overtopping.or wave overtopping. In the current day flooding from the west (HartlepoolDock) appears to be driven primarily by extreme sea level still waterovertopping. The Designation Area is also impacted by wave overtoppingfrom 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 theDesignation Area and a strip of overland flow across the headland.Whilst still water levels have been modelled for climate changeinundation, EA wave overtopping scenarios cannot be updated based oncurrent available modelling. Updated modelling to assess future waveovertopping outlines for the current day 0.1% AEP events combined withstill water climate change levels has, therefore, been used for climatechange testing. For areas impacted by wave overtopping, for thepurposes of this SFRA in the						
Historic flooding	From available data, the Hartlepool Fire Service insufficient information to	here are 5no records in this Designation A o determine the flood so	of historic events from Area, although there is urce.				

Designation Area	LT1 The Headland
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 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. 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.
Flood Warning Area	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
Flood risk	Designation Area LT1 incorporates Designation Area RC16 - Local Centre 13 and the flood risks are generally as described under that Designation Area. 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. The area is currently urbanised with a mix of residential, retail and commercial properties within a dense network of streets and highways. 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). 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. 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. 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 M

Designation Area	LT1 The Headland					
Mitigation options & site suitability	<ul> <li>Due to the level of Development Area ( be required as part specific development be effectively manag increasing risk elsew and within Flood Zor part of the Exception to proceed.</li> <li>Given the depth of f covered by Flood Zor layout, mitigation m reduction in flood sto</li> <li>'More Vulnerable' D outside of higher ris would be considered</li> <li>Provision will need to enable flow across t increase flood risk.</li> <li>Provision for climate site will remain safe mitigated. Current specific climate chai proposals further inv</li> <li>The FRA should also between surface wat</li> <li>Access (including em account of future floor is available to the weighted</li> </ul>	risk and depth of flood Flood Zone 3a and 2) a of the development stra t proposals and to demon ged over the lifetime of t where. As the proposed he 3a, the FRA will have Test has been satisfied looding, More Vulnerab he 2 and 3a may be diffic easures such as land orage. Development should be k flood zones. Approxit suitable for redevelopm o be made to confirm at he area and maintain th change should be made e in the future, assum wave overtopping moo nge scenarios and dep estigation may be requir focus on the risk associa- ter and tidal flooding. hergency access) across od levels, however it apprest.	ling across parts of this a more detailed FRA will ategy to reflect the site- nstrate that flood risk can the development without use is More Vulnerable to show that the second in order for development le development in areas sult and given the existing raising may result in a e directed to the areas mately 73% of the area nent. ny drainage paths which hese so that they do not e in the FRA ensuring the ing current risk can be delling does not include ending on development red. ated with the interactions is the site will need to take ears that suitable access			
Flood Source: Ground Wa Flood risk: ground water	ater 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					
Flood Source: Infrastruct	re Failure – Reservoirs					
Flood risk: Reservoir	Designation Area not wit	hin published reservoir f	flood mapping extents.			
Flood Source: Infrastruct	ure Failure – Canals					
Flood risk: canal	No canalised watercours	es in area. No flood risl	k identified.			
Flood Source: Surface W	ater					
Surface Water Flood Risk	to Proposed Developm	ent 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         Max: 0.3-0.6m         Max: 0.6-0.9m           Average: 0.15 - 0.3m         Average: 0.15-0.3m         Average: 0.3-0.6m					
Surface water hazards	Max: Moderate Average: Low	Max: Moderate         Max: Significant         Max: Significant           Average: Low         Average: 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.					



Designation Area	LT1 The Headland
Surface water: flood risk to development site	Designation Area LT1 incorporates Designation Area RC16 - Local Centre 13 and the flood risks are generally as described under that Designation Area. The area consists of developed areas of existing buildings, with
	undeveloped greenfield areas to the east. 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.
	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.
Surface water: mitigation options & site suitability	<ul> <li>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.</li> </ul>
	• Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected across the site using SuDS.
	<ul> <li>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.</li> <li>The FRA will need to consider the impacts of surface water flooding</li> </ul>
	on access and egress routes, although potential routes appear available.
	In discharge to the hearby dockside is proposed the FRA will need to consider outfall capacity during high tides / extreme events.
Indicative Surface Water I (for Designation Area in it	Flood Risk From Proposed Development ts Entirety)

Proposed development limiting runoff rate: Greenfield - IH124 Methodology			3.33% AEP: 1% AEP:	123.29l/s 146.54l/s		
Design flood event (incl climate change)	Critical storm duration Hrs	Inflow volume m <sup>3</sup>	Outflow volume m <sup>3</sup>	Attenuation required m <sup>3</sup>	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	LT	1 The Head	and			
100yr Rainfall+20%	48	47519	12661	34858 (8013m <sup>3</sup> of exceedance storage)	131.8	2.32Ha 5.31% (0.53Ha 1.22%)
100yr Rainfall+40%	48	55439	12661	42778 (9683m <sup>3</sup> of exceedance storage)	161.7	2.85Ha 6.52% (0.65Ha 1.48%)
Climate change	Application anticipated volumes for	of the ce for climate r the 3.33%	entral (20%) change in the and 1% AEF	and upper ba table above sho rainfall events.	nd (40%) po ows the estima	tential change ted attenuation
Surface water: flood risk impacts from development site & mitigation	volumes for the 3.33% and 1% AEP rainfall events. 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 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. 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. 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.					

# 2.16 RC16 Seaton Front Local Centre

Designation Area RC16 Seaton Fr	ont 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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Designation Area	RC16 Seaton Front Loo	cal Centre		
Flood Source: Fluvial	Elood Zono 2	Flood Zono 2a	Elood Zono 2h	
Flood 2011es (76)				
Flood Zone depth <sup>19</sup> (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	Provided model does not indicate flooding to Area       Provided model does not indicate flooding to Area         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.         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.         Indicative Flood Extents for 0.5% AEP & 0.1% AEP Climate Change Scenarios         Based On 2011Tidal Tees Model Update of Extreme Sea Level Still Water Level Contains OS data © crown copyright and database right (2017)         Contains Environment Agency information © Environment Agency and/or database right.         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			
Historic flooding	From available data, th Fire Service in this information to determin	nere is 1no record of hist Designation Area, alth ne the flood source.	toric events from Hartlepool lough there is insufficient	

19 Tidal Tees Integrated Flood Modelling Study 2011

Designation Area	RC16 Seaton Front Local Centre
Defended	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. 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. 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 event seven 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. 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. 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.
Flood Warning Area Flood risk	No Ground levels across the Designation Area are relatively level over the
	<ul> <li>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.</li> <li>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 ant the A178.</li> <li>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.</li> </ul>
Mitigation options & site suitability	• 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



Designation Area	RC16 Seaton Fro	ont Local Centre		
	<ul> <li>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.</li> <li>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.</li> <li>'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.</li> <li>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.</li> <li>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.</li> <li>The FRA should also focus on the risk associated with the interactions between surface water and tidal flooding.</li> <li>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 wort.</li> </ul>			
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: Infrastruc	cture Failure – Reservoirs			
Flood risk: Reservoir	Designation Area not within published reservoir flood mapping extents.			
Flood Source: Infrastruc	ture Failure – Canals			
Flood risk: canal	No canalised watercourses in area. No flood risk identified.			
Flood Source: Surface V	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)	
Curfooo motor fig!!	0.00	1.2U	3.27 May 0.0.00	
Surface water flooding depths (m)	Wax: - Average: -	Max: 0.3-0.6m Average: 0.15-0.3m	Wax: 0.3-0.6M Average: 0.15-0.3m	
Surface water hazards	Max: -	Max: Moderate	Max: Significant	
	Average: -	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	The Designation adjoining The Fr be impacted by therefore flood e the coverage are extents appear t and drainage in	Area consists of rows of build ont road. These buildings and v surface water flooding from extents over these areas, while eas above are described below to be influenced by the present frastructure these extents are	dings along the seafront on the Designations Area will the adjoining roads and st not generally included in w. The surface water flood ice of the existing buildings likely to change if the site	



Designation Area	RC	C16 Seaton Fro	ont Local Ce	entre			
	lay The floc haz lim 0.3 ave Ma adj Su into ind pro the	out is change ere is no floo oding to The F zard increase ited to The F ard, maximum erage Low, bu pping indicate acent areas. rface water floo o account in c icates flood do bability even erefore off-site	d. ding indica front in the in the 1% ront roadwa depths and t rise locall es limited si The ground boding of the consideration epths of 0.3 hts, howev impacts or	ted in in the 3.3 1% AEP event. AEP event alth ay. Whilst avera to Significant in urface water flow d profile of the an the surrounding h on of emergency B-0.6m to surround er alternative m access and eg	33% AEP event w The flood extents hough generally a age depths are be at 0.3-0.6m. Haz h the 0.1% AEP ev vs entering the site rea is relatively lev highways will need access and egree hding highways du routes appear manage	rith localised and depths / ppear to be etween 0.15- cards are on vent. from the el to be taken es. Mapping ring the Low vailable and geable.	
Surface water: mitigation options & site suitability		<ul> <li>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.</li> <li>Areas subject to surface water flooding should ideally be kept free from development or alternatively flows should be redirected using SuDS.</li> <li>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</li> </ul>					
		<ul> <li>Any FRA will need to consider the impacts of surface water flooding on access and egress routes.</li> </ul>					
Indicative Surface Water		od Risk Fron	n Propose	d Development			
Proposed development lim		runoff rate:		3.33% AEP:	10.4l/s		
Greenfield - IH124 Design flood	Methodolog	ly Inflow	Outflow	1% AEP: Attenuation	12.36l/s Time to	Total	
event (incl climate change)	storm duration Hrs	volume m <sup>3</sup>	volume m³	required m <sup>3</sup>	empty (assuming no infiltration) Hrs	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 <sup>3</sup> of exceedance storage)	36.2	0.05Ha 3.73% (0.01Ha 0.99%)	
1% AEP Rainfall+40%	18	1393	400	993 (258m <sup>3</sup> of exceedance storage)	44.5	0.07Ha 4.59% (0.01Ha 1.19%)	
Climate change	Application for climate the 3.33%	of the central change in the and 1% AEP	(20%) and table abov rainfall eve	upper band (40%) ve shows the esti nts.	%) potential change imated attenuation	e anticipated volumes for	

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Designation Area	RC16 Seaton Front Local Centre
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 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 provide an indication of attenuation / storage requirements. 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. An FRA and 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.



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