Level 2 Strategic Flood Risk Assessment
Technical Element

Weymouth & Portland Borough Council

December 2009

Final Report

9T3285

Commercial-in-Confidence

ROYAL HASKONING

HASKONING UK LTD.
COASTAL & RIVERS

Stratus House
Emperor Way
Exeter
Devon EX1 3QS
United Kingdom
+44 (0)1392 447999 Telephone
+44 (0)1392 447999 Fax
info@exeter.royalhaskoning.com E-mail
www.royalhaskoning.com Internet

Document title	Level 2 Strategic Flood Risk Assessment Technical Element
Document short title	
Status	Final Report
Date	December 2009
Project name	Weymouth & Portland Level 2 SFRA
Project number	9T3285
Client	Weymouth & Portland Borough Council
Reference	

Drafted by	Rachel Bird, Tessa Brooks, Michaela Murphy	
Checked by	Julie Davies	
Date/initials check	………………….	……….
Approved by	Steve Edwards	
Date/initials approval	……………..	……….

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EXECUTIVE SUMMARY

This Level 2 Strategic Flood Risk Assessment (SFRA) for Weymouth & Portland Borough Council (W&PBC) provides the technical information to enable W&PBC to assess criterion (c) of the Exception Test at a strategic level for the lifetime of a proposed development at a series of specific potential development sites (listed below). It also provides the background information necessary that Flood Risk Assessments can draw upon to inform planning applications in the future.

The sites assessed as part of the Level 2 SFRA were identified by W&PBC using the original Level 1 SFRA. These locations were potential areas for development which were either at risk of flooding, or where there could be an impact on the flood risk elsewhere. The sites are as follows:

- Area 1: Chickerell North - Urban Extension Option 1
- Area 2: Chickerell East - Urban Extension Option 2
- Area 3: Littlemoor - Urban Extension Option 3
- Area 4: Preston Downs strategic development site
- Area 5: Markham and Little Francis strategic development sites
- Area 6: Easton strategic development site, Portland
- Area 7: Wey Valley strategic development site
- Area 8: Town centre strategic development sites
    - Site A: Train Station & Jubilee Sidings
    - Site B: Swannery Car Park
    - Site C: Bus Depot
    - Site D: Melcombe Regis Car Park
    - Site E: Park Street Car Park
    - Site F: Harbourside Car Park
    - Site G: Post Office Sorting Office
    - Site H: The Loop Car Park
    - Site J: Ten Pin Bowling Alley
    - Site K: Multi-Story Car Park
    - Site L: Pavilion and Ferry Terminal
    - Site M: Gasholder, Magistrates Court, Fire Station and Council Offices
    - Site N: Governors Lane Car Park
- Area 9: Land west of Southill – Urban Extension Option 4

Key findings

For potential development sites outside the town centre (Areas 1 to 7 and Area 9, see above) no major constraints were identified due to the minimal fluvial or tidal flood risk experienced by the sites. Some sites have minor watercourses running either through or adjacent to the site therefore the Sequential test should be applied within each site prior to any allocation, and measures identified to resolve any issues. The risk of the development increasing flood risk elsewhere has also been considered, and SUDS recommended where required. The main issue identified as a result of the Level 2 SFRA was the level of flood risk to the town centre sites.

While some of the town centre sites have been included in full or in part within Weymouth & Portland Borough Council's Strategic Housing Land Availability

Assessment (July 2008) including sites A, C, E, G, J, L and N as deliverable sites this will require reassessment based upon the new evidence contained within this report.

Figures 6.6 and 6.7, contained within this report, show the Flood Hazard for a 1 in 200 year tidal flood event plus climate change, with wave overtopping for 2086 and 2126 if existing flood defences are not raised and extended. 2086 and 2126 respectively represent the potential development life for commercial and residential development which may be proposed as part of Weymouth & Portland Borough Council's Core Strategy.

Section 6.4 of the report concludes that 'As it currently stands, by 2086 only sites A (Train Station & Jubilee Sidings), M (Gasholder, Magistrates Court, Fire Station and Council Offices), N (Governors Lane Car Park) and possibly L (Pavilion and Ferry Terminal), display potential for safe access and egress according to the hazard maps (Figure 6.6); by 2126 this is reduced to sites M (Gasholder, Magistrates Court, Fire Station and Council Offices) and possibly N (Governors Lane Car Park)(which would rely on access / egress along the Esplanade). New and improved defences would therefore be required to allow development of all of the sites due to the lack of access and egress. The esplanade has a moderate hazard during the 2126 event therefore confirming that it would not be a suitable safe access / egress route. This is primarily due to the large velocities in this area due to wave overtopping.

An investigation into the defences in the town centre area is currently being undertaken by the Environment Agency. The outcomes of this will help determine what defences are needed and when, and will therefore aid W&PBC when determining what development can proceed.

New development situated within close proximity of formal defences will require a detailed breach assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Environment Agency.

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1 INTRODUCTION

1.1 Commission award

Royal Haskoning were commissioned in February 2009 by Weymouth & Portland Borough Council (W&PBC) to provide the technical information necessary to update the existing Level 1 Strategic Flood Risk Assessment (SFRA) and complete a Level 2 Strategic Flood Risk Assessment to meet the requirements of Planning Policy Statement 25: Development and Flood Risk (PPS25). This report details the Level 2 SFRA information.

1.2 Background

A Level 1 SFRA is required by PPS25 so that the risks of flooding can be understood before allocating land for development. PPS25 sets out a procedure called the Sequential Test which aims to ensure that land is allocated for development in lower flood risk zones in preference to high risk zones.

However, it is not always possible to allocate all proposed development and infrastructure in accordance with the Sequential Test for various reasons and it may be necessary to extend the scope of the SFRA. PPS25 therefore sets out another procedure called the Exception Test, which if passed means that subject to a satisfactory site specific Flood Risk Assessment detailing appropriate mitigation measures which make the proposal acceptable, development can take place in higher flood risk areas.

In order to undertake the Exception Test for specific locations as identified in the Level 1 SFRA, PPS25 requires quantifiable information regarding flood risk and possible mitigation measures to understand the flood risks at each site and the drainage requirements necessary. This is to assess whether it is appropriate for proposed development to take place. The technical information provided in this Level 2 report will enable Weymouth & Portland Borough Council to draft criteria based policies against which to consider planning applications for these sites. This will be done by outlining policies in the Level 2 SFRA that the supporting Flood Risk Assessments (FRAs) should adhere to in order to satisfy criterion (c) in paragraph D9 (The Exception Test) in PPS25; “a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall”.

A Level 1 SFRA was completed by Royal Haskoning for Weymouth & Portland Borough Council in July 2006. This was prior to the finalisation of PPS25 and therefore has been updated during this study. A separate Level 1 update report has been produced.

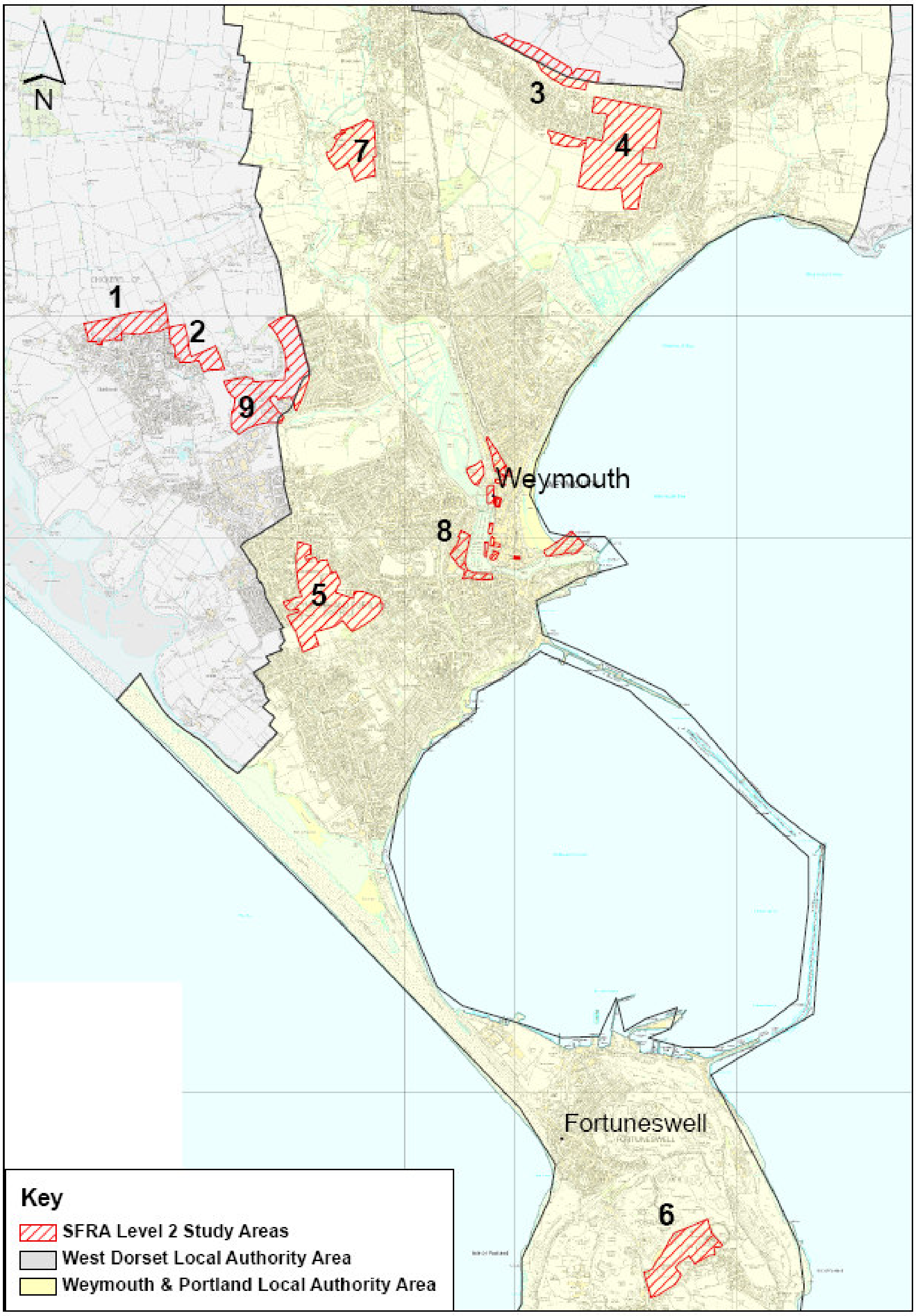
Using the original Level 1 SFRA Weymouth & Portland Borough Council identified the need for a Level 2 SFRA analysis at specific locations. These locations were potential areas for development which were either at risk of flooding, or where there could be an impact on the flood risk elsewhere. This information was required to provide an evidence base for their Local Development Framework (LDF).

Throughout this study the Level 1 SFRA data has been used as a basis for the assessment. Where possible, other existing studies undertaken by the Environment Agency have also been used including the River Wey S105 study (Capita Symonds, October 2003), Littlemoor Stream Standard of Protection study (Capita Symonds, 2007), SW797 Tidal Compliance Project (Royal Haskoning, November 2007) and SW816 Tidal ABD Project (Royal Haskoning, October 2008).

1.3 Study Area

This Level 2 SFRA focuses on locations (as shown in Figure 1.1) where there is a need to consider additional development on land within existing flood risk areas or where development could increase run-off affecting existing floodplains and vulnerable land.

Figure 1.1: Level 2 study areas



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The areas to be assessed during this study are:

- Area 1: Chickerell North - Urban Extension Option 1
- Area 2: Chickerell East - Urban Extension Option 2
- Area 3: Littlemoor - Urban Extension Option 3
- Area 4: Preston Downs strategic development site
- Area 5: Markham and Little Francis strategic development sites
- Area 6: Easton strategic development site, Portland
- Area 7: Wey Valley strategic development site
- Area 8: Town centre strategic development sites
- Area 9: Land west of Southill – Urban Extension Option 4

This report will cover the SFRA Level 2 elements for all nine areas shown in Figure 1.1.

1.4 Scope of Work

1.4.1 Overview

Environment Agency Flood Zones have been used in the Level 1 SFRA to determine Sequential testing and which sites require further analysis in the Level 2 SFRA in order to undertake the Exception Test. Environment Agency Flood Zones do not consider the beneficial effects of existing flood risk management infrastructure, such as raised defences, in influencing the extent and severity of flooding from rivers and the sea.

The Level 2 SFRA does consider the beneficial effects of existing flood risk management infrastructure in order to further understand the flood risks to each site.

The majority of the sites covered by this Level 2 study are not within the Environment Agency Flood Zones, therefore only the impact of the development on flood risk elsewhere needs to be considered. For areas that are within the Environment Agency Flood Zones e.g. the Town Centre sites, the increased scope of the Level 2 SFRA will enable the production of mapping showing flood outlines for different probabilities, impact, speed of onset, depth and velocity variance of flooding taking account of the presence and likely performance of flood risk management infrastructure.

The information will not be sufficient to be used to support individual planning applications; rather it will provide the background information necessary that FRAs can draw upon to inform planning applications in the future. The information will also allow Weymouth & Portland Borough Council to assess criterion c) of the Exception Test at a strategic level for the lifetime of a proposed development through the provision of high-level information on flood risk now and in 100 years time to account for climate change. Climate change assessments will be based on the shelf life of the Core Strategy i.e. up to 2026, plus the required 100 year design life for residential development. The assessment will therefore consider levels for 2126.

This Level 2 SFRA takes into account paragraph D4 contained in annex D of PPS25 which advises that the SFRA refines information on the probability of flooding, taking the impacts of climate change into account. The SFRA provides the basis for applying the Sequential Test, using the zones in Table D1. Where Table D3 indicates the need to apply the Exception Test, the SFRA considers the impact of the flood risk management infrastructure on the frequency, impact, speed of onset, depth and velocity of flooding both now and in the future.

1.4.2 Assessment of flood probability, depth and velocity

Royal Haskoning have previously undertaken modelling studies on behalf of the Environment Agency for the tidal areas within Weymouth & Portland Borough Council and we have obtained permission from the Environment Agency to use these models and the associated extreme tide level data. The Town Centre sites are the main sites currently within the Environment Agency Flood Zones 2 or 3 and therefore detailed 2 dimensional hydraulic modelling is required only for these sites. A small part of the Preston Downs area is within the flood zone and therefore some basic hydraulic modelling has been undertaken. This was based on a previous 1 dimensional hydraulic model of the Preston Brook. No modelling work has been undertaken for any of the other sites. As part of Phase 2 of this study, for the Town Centre sites we have used the existing model outputs to produce grid based maps of depth and velocity. This has been undertaken for current flood risk and also considers the impact of climate change on fluvial and tidal flood risk in both 60 and 100 years time to take into account the expected lifetime of commercial and residential development respectively.

In order to estimate the 1 in 100 year fluvial flows (and other return periods), we have used the Flood Estimation Handbook (FEH), which is the Environment Agency approved method. At the strategic level we have not used observed data to improve flow estimates beyond those generated using catchment descriptors. We have used the FEH Rainfall Runoff Method along with the Institute of Hydrology (IoH) report 124 and the Wallingford Procedures / Modified Rational Method as these methods are the best suited to deal with the highly urbanised catchments. An allowance of an increase in flows of 20% has been added to the estimate to account for climate change (fluvial), as required by PPS25.

Extreme tide levels have been obtained from the Report on Regional Extreme Tide Levels (Royal Haskoning 2003), which is the standard now used by the Environment Agency for extreme tide predictions in the South West Region. These 2002 extreme tide levels have been updated to take account of sea level rise for up to 2126 in order to undertake analysis of the effects of climate change. This has been carried out with reference to the Defra FCDPAG3 Economic Appraisal Note to Operating Authorities – Climate Change Impacts October 2006. In accordance with the PPS25 Practice Guide, residential developments have been considered for a lifetime of 100 years and commercial developments for 60 years. When taking into account the shelf life of the Core Strategy this relates to 2086 for commercial developments and 2126 for residential developments.

The scope of this study does not include modelling of groundwater or surface water flooding. Based on historic information ground water flooding is not thought to be an issue in this area. Known surface water flooding issues were highlighted as part of the Weymouth & Portland Borough Council Level 1 SFRA Update (Royal Haskoning, 2009) and therefore this information along with historic incidents (where information exists) will be highlighted where applicable.

1.4.3 Verification of Defences and Areas Benefiting from Defences (ABDs)

Information about existing defences has been taken from the National Flood and Coastal Defence database (NFCDD). As part of the tidal ABD study undertaken for the Environment Agency crest level surveys were undertaken of some of the main defences. This has been used to update the NFCDD information where necessary. The Environment Agency have also reviewed the NFCDD data prior to its use to confirm it is accurate.

Where raised defences are present flooding scenarios have taken account of the ‘with defences’ and ‘without defences’ scenarios as it is possible to remove defences from the model geometry. This was undertaken for Weymouth Town Centre as part of the Tidal ABD study for the Environment Agency, where the modelling results were used to make an assessment of the broad scale defended area to show where flood defences provide protection to a 200 year standard (tidal). This is primarily to identify residual risk areas to further emergency planning or future defence enhancements.

1.4.4 Impact of flooding: Flood Risk to People

Using the depth and velocity information (where available from 2D modelling) with an appropriate debris factor built into the equation we have determined and categorised the flood hazard for the current situation. Flood hazard for a 1 in 200 year tidal flood event with wave overtopping plus the effects of climate change has also been categorised for the years 2086 and 2126 as set out in section 6.4. The assessment of flood hazard follows the guidance as set out in technical report FD2320 and will be assessed for the 1 in 100 year (fluvial) event defended situation and the 1 in 200 year (tidal) event defended situation along with the two climate change scenarios. The risk to vulnerable people including children, the elderly and the infirm requires a low or no flood hazard rating. While FD2320 acknowledges that the general public, excluding the above vulnerable group, will be at an acceptable risk by entering into flood water with a moderate hazard rating it is not desirable due to the potential for unseen trips or other hazards being present below the murky water. In addition it may not be practicable and/or desirable to refuse entry to the vulnerable group which would include physically disabled people to most new development. An extreme flood hazard rating would pose a danger for all, which would include the emergency services. We will also make an assessment of the likely speed of onset of flooding which can be used to inform flood warning procedures and guidelines, where appropriate.

1.4.5 Data sources

All of the data collected and produced as part of the Level 1 SFRA has been utilised during this study. Two of the main sources of information were the Environment Agency Flood Zones, which were re-issued for this study to ensure that the most up-to-date information was being used, and LiDAR data. LiDAR stands for Light Detection and Ranging and provides a Digital Terrain Model (DTM) for an area. It was used as an input into the hydraulic modelling for the Town Centre sites and to provide an idea of the topography in the other areas. The LiDAR used for this study was flown in three batches: 30th March 1998, 3rd May 2001 and 14th July 2003. The July 2003 LiDAR has a resolution of 0.5m whilst the other two batches have a resolution of 2m. Where possible the most up-to-date LiDAR was used. The LiDAR used for the model was flown between

January and March 2006. *'Appendix F – Overtopping Summary Sheets'* in the *Wessex Tidal Areas Benefiting from Defences* study give the summary of the LiDAR tiles used.

1.4.6 Current policy for flood defences – as set by the Environment Agency strategically

The need for defences along the coast covered by Weymouth and Portland Borough Council will increase in the future with increasing fluvial flood risks, rising sea levels and a potential increase in storm surge frequency and magnitude. The Environment Agency advocate a strategic approach to flood risk management on a 'whole catchment' basis, and have adopted the Catchment Flood Management Plan (West Dorset CFMP; Environment Agency) policy to 'take further action to sustain the current scale of flood risk into the future' for the urban areas within the Wey catchment including Upwey, Nottington, Broadwey and Weymouth, and also the Preston Brook and River Jordan. For Portland the policy will be to take no active intervention.

Along the coast, the consultation draft April 2009 Durlston Head to Rame Head Shoreline Management Plan Review (SNP2) policy for this area range between short term preferred policies of 'hold the line' to long term preferred policies of 'no active intervention'. With no intervention erosion of the coast can be expected. For Preston Beach (Rock Groyne) to Portland Harbour (North Breakwater) which includes Weymouth Harbour in the short, medium and long term is to 'hold the line' which will continue to protect the extensive commercial, social, and tourism features of this area against the increased risks of flooding and erosion as sea levels rise by continuing to hold the existing line of defence. This will require raising and maintaining the level of defences along both the open coast and harbour frontages over the next 100 years in order to achieve this reduction in flood risk.

For Weymouth the implementation of these policies allow the standard of protection currently provided to existing property to be continued. There are currently no plans to improve defences but the Environment Agency will not object to others undertaking the works, but may not upgrade the defences themselves. In assessing priorities the Environment Agency consider defences for existing development, not future needs.

1.4.7 Flood risk management policy

Weymouth and Portland Borough Council are currently in the process of preparing its Local Development Framework with the Core Strategy Development Plan Document due in April 2010.

The complex range of issues that result from this Level 2 Strategic Flood Risk Assessment have wide ranging implications for future planning in Weymouth & Portland. The emerging Local Development Framework will require detailed policies to ensure development takes place in safe and sustainable locations, while making the best use of the borough's developable land.

Policies are likely to be too detailed for inclusion in the Core Strategy alone and the Environment Agency, with Council involvement, has committed to preparing a Flood Risk Management Strategy. This document will provide clarity on a range of issues covered by this report including the potential for time limited consents for commercial development and developer contributions for flood defences. It will be produced in tandem with the Core Strategy as it will form part of the evidence base which will demonstrate that the Core Strategy is sound. Until the Flood Risk Management Strategy has been produced each development is expected to mitigate its own flood risk, including the provision for safe access and egress.

Should Weymouth & Portland Borough Council have aspirations to regenerate areas which will be subject to increased flood risk, current planning practice allows the Council to consider a Local Development Framework policy for developer contributions which takes the form of a ‘roof tax’ type charge for all development affected by flood risk, to facilitate the pooling of funds for future defence improvements. This charge could be included within a schedule of infrastructure funded through the Government’s proposed Community Infrastructure Levy.

In a location where the level of development are such that it would not be possible to pool sufficient contributions to build adequate defences ahead of that development going ahead, it will be necessary for the Flood Risk Management Strategy to set out how the area will be adequately defended in the future, in order to permit development to take place in the short term. The Flood Risk Management Strategy will provide information on other possible funding routes for any shortfall in funding to deliver the defences when required.

1.5 Overview of proposed development

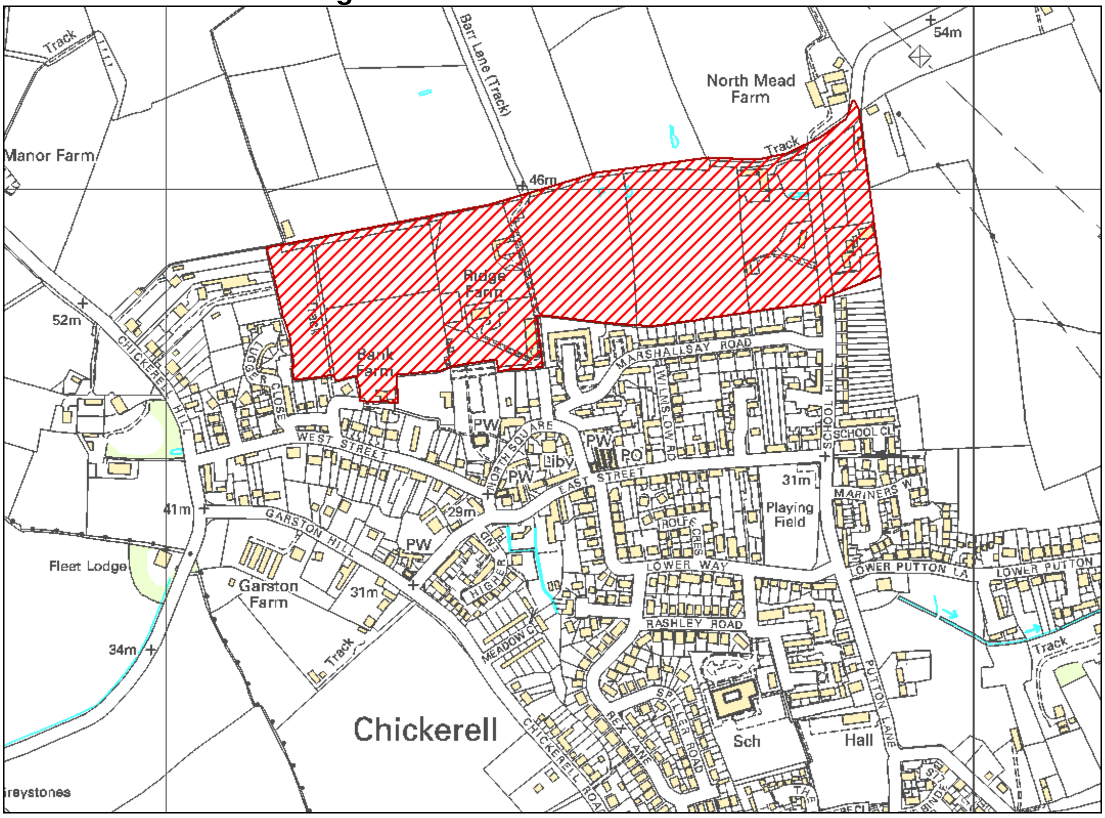
Weymouth & Portland Borough Council provided details of the proposed development for each of the 9 areas. These areas are split into two types:

1. Options for the Weymouth Urban Extension
2. Strategic development sites

The urban extension involves 700 dwellings, although no information has been provided regarding the density of the dwellings. Each option of the urban extension has been tested based on 700 dwellings and then a number of combinations e.g. 350 on one site and 350 on another site. For the strategic development sites e.g. Markham and Little Francis more details on the number of dwellings and possible density has been provided, and in some cases this has included a Master plan for the site. In addition, for a number of the areas a range of development scenarios have been tested. Details for each site are provided below. The information used for the assessment of each site has been taken from the Weymouth & Portland Borough Council Strategic Housing Land Availability Assessment July 2008 and confirmed with Weymouth & Portland Borough Council planners.

1.5.1 Area 1: Chickerell North Urban Extension

Figure 1.2 – Chickerell North outline

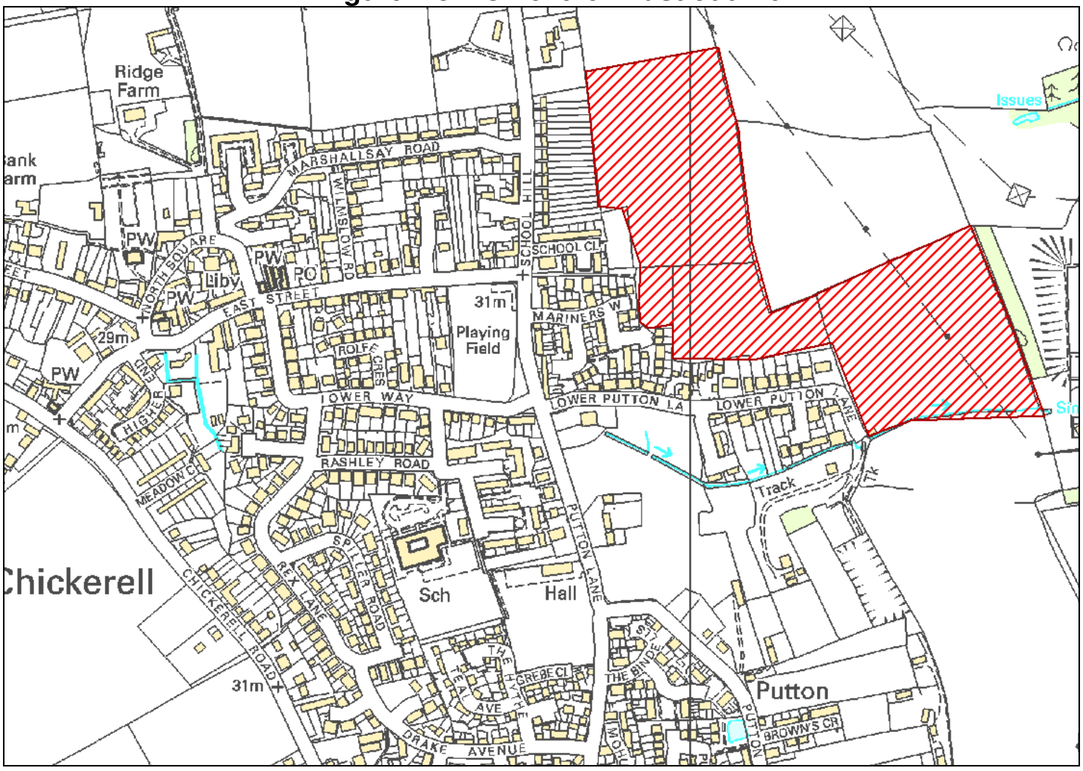


This is one of the options for the Weymouth Urban Extension involving 700 dwellings. The total area of the site is approximately 14.1 hectares, which drains into the catchments of two tributaries feeding into the River Wey catchment, one to the north and one to the south (visible to the south-east in Figure 1.2).

1.5.2 Area 2: Chickerell East Urban Extension

This is another of the options for the Weymouth Urban Extension involving 700 dwellings. Areas 1 & 2 have been tested individually and combined based on a 50:50 split of the proposed dwellings on each site. The site covers an area of approximately 8.7 hectares, which drains into the catchment of a tributary of the River Wey.

Figure 1.3 – Chickerell East outline



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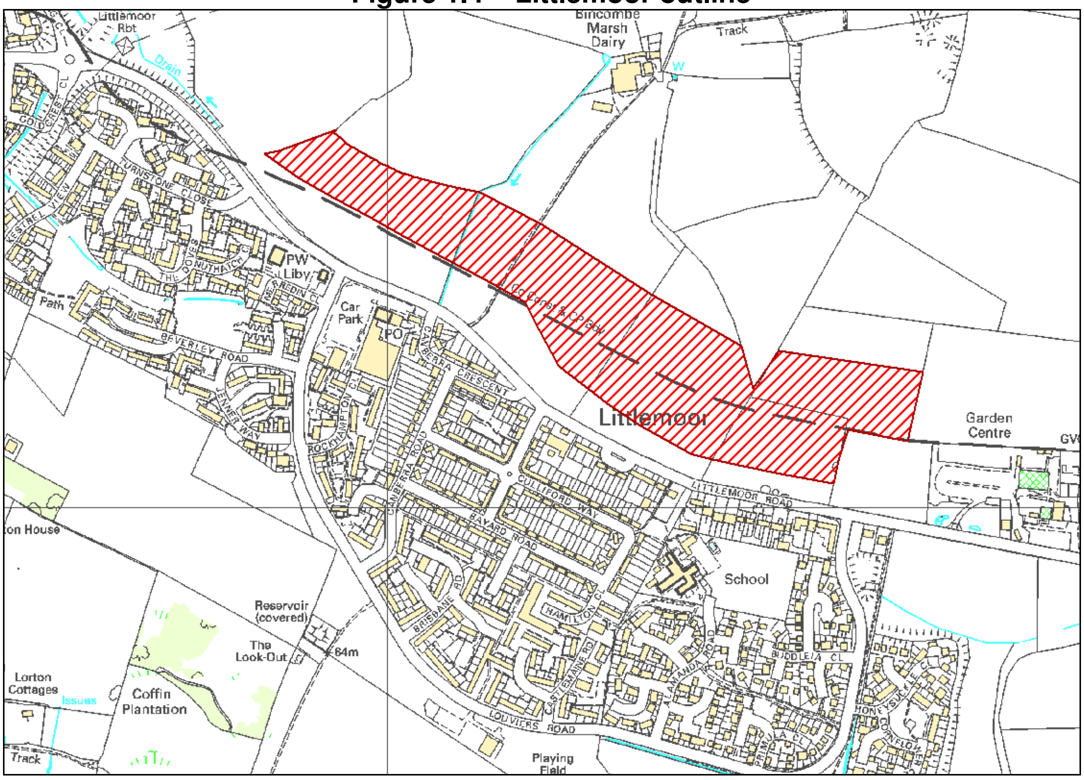
1.5.3 Area 3: Littlemoor Urban Extension

Figure 1.4 – Littlemoor outline



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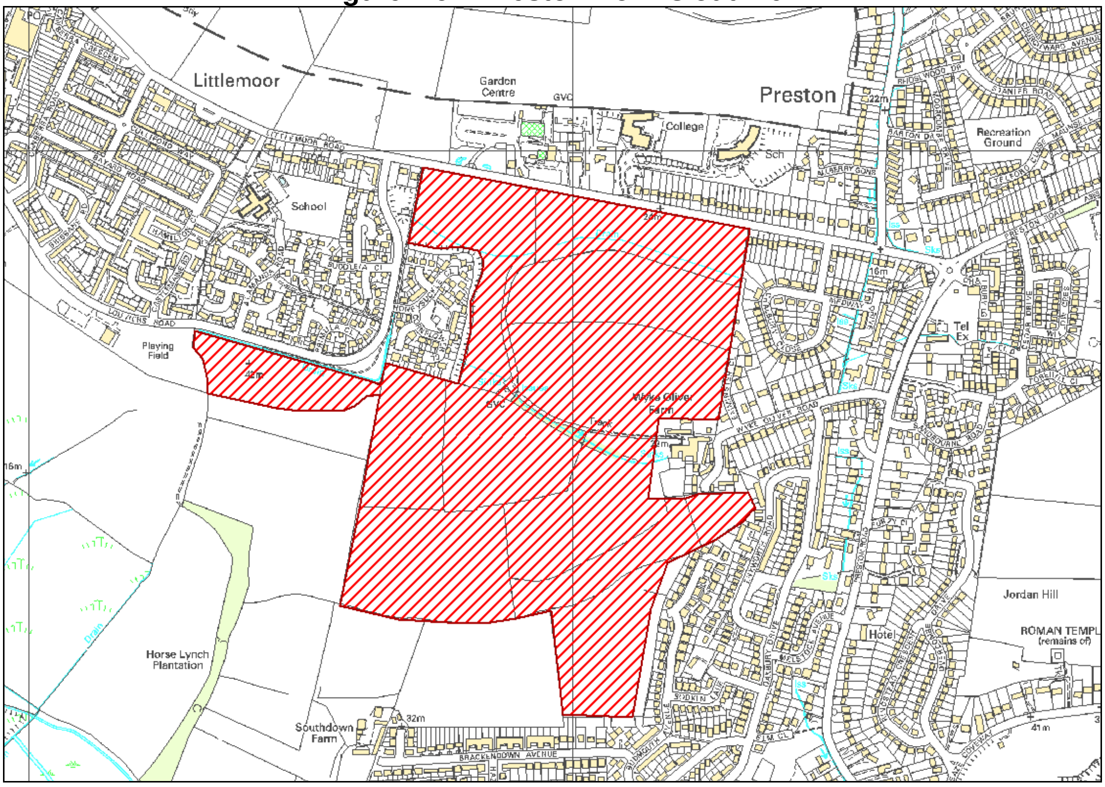
This is another of the options for the Weymouth Urban Extension involving 700 dwellings. This area falls within a different catchment to the Chickerell sites and therefore the combined effect of developing this site and one of the Chickerell sites is not required, although this site has been tested based on 700 dwellings and 350 dwellings to determine the impact if the urban extension was split over two sites.

The site covers an area of approximately 12.5 hectares, which drains into the catchments of the Broadwey Stream NW of Littlemoor and a tributary of the Preston Brook to the SE.

1.5.4 Area 4: Preston Downs strategic development site

Figure 1.5 – Preston Downs outline



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This is a strategic development site submitted by a developer. Two possible scenarios have been tested for this site:

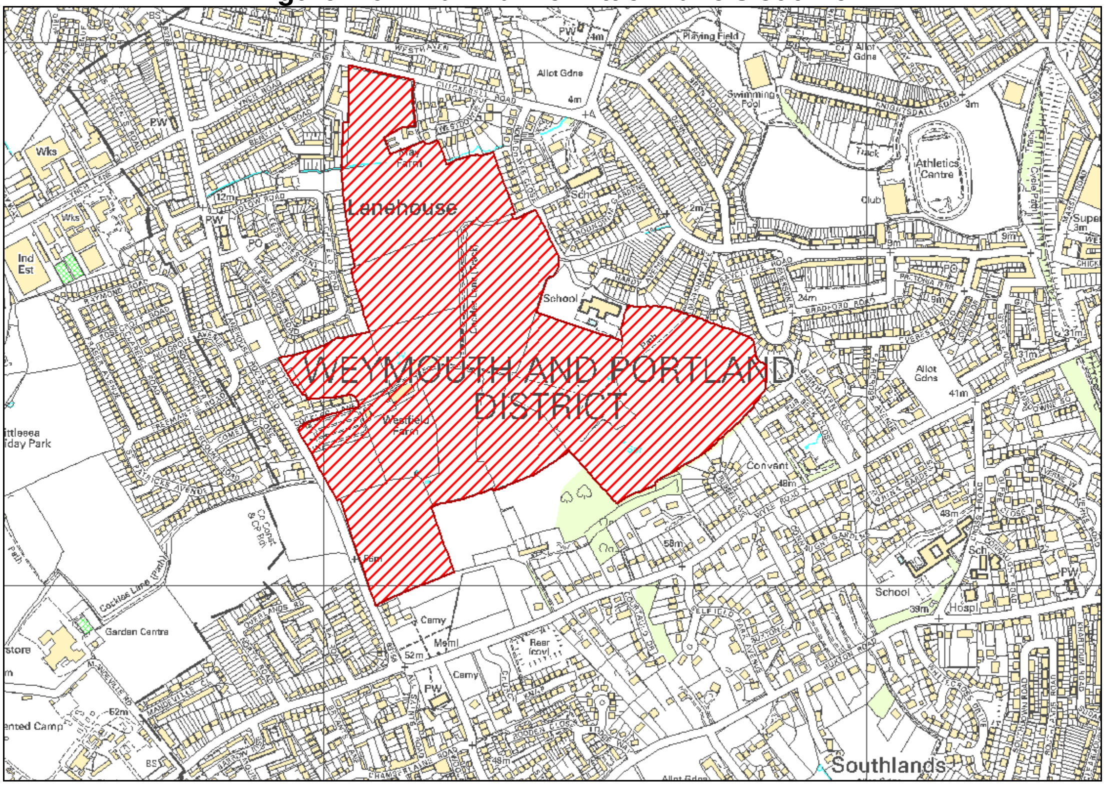
- Best case = 300 dwellings
- Worst case = 400 dwellings

The density of dwellings for each scenario is not known.

The total site area is approximately 49.3 hectares, which drains into the Preston Brook catchment. There will also be some run-off from the Littlemoor area into the Preston Brook catchment therefore the impact of these two areas have been tested individually and combined.

1.5.5 Area 5: Markham and Little Francis strategic development site

Figure 1.6 – Markham & Little Francis outline



This is a strategic development site submitted by a developer. Three possible scenarios have been tested for this site:

- Best case = 100 units, 7 dwellings per hectare (dph)
- Middle case = 475 units, 35dph
- Worst case = 850 units, unknown density

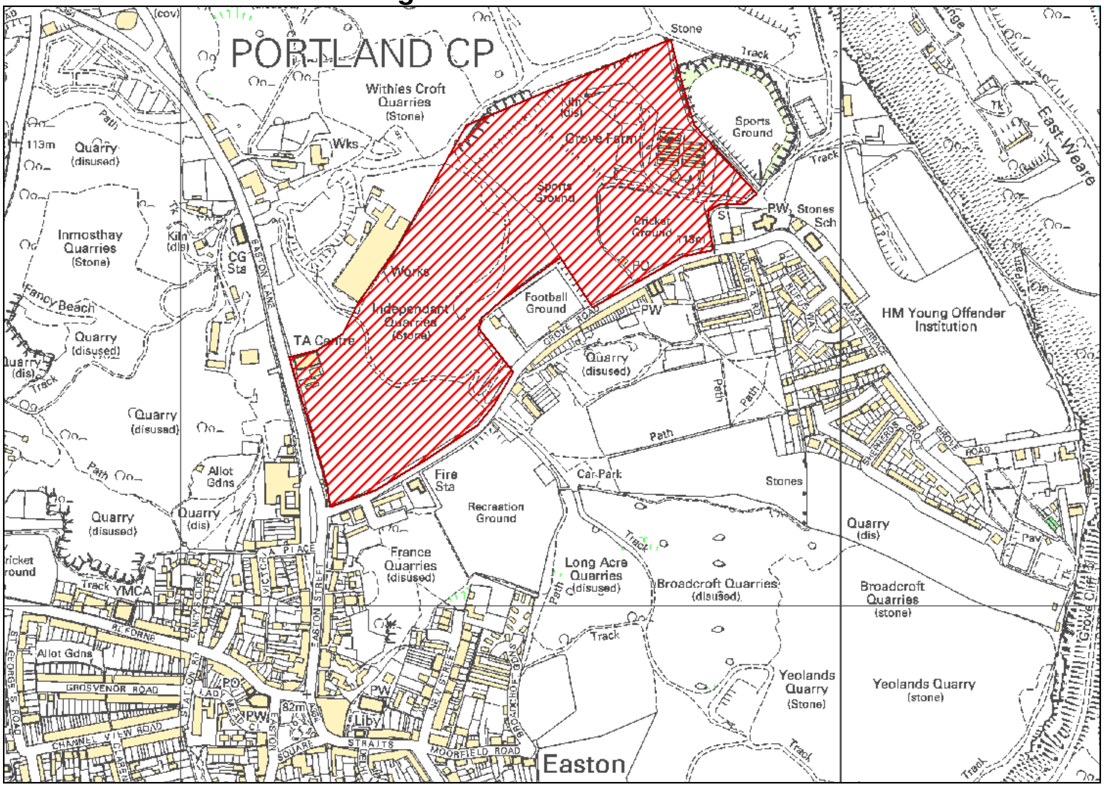
A Master plan has also been provided for this area, which splits the area up into 5 categories as detailed below, along with the proposed size of each land use. The total area of the site is 37.8 hectares, which drains into the Lanehouse Stream catchment.

• Residential	20.65 hectares
• Local centre	0.3 hectares
• General recreation	10.48 hectares
• Site of Nature Conservation Interest	4.27 hectares
• Formal recreation	2.11 hectares

For the purposes of the SFRA, we have considered the impact of the residential development only (20.65 hectares) because we have been advised that the remainder of the land use will not change significantly.

1.5.6 Area 6: Easton Development Sites, Portland

Figure 1.7 – Easton outline



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This is a strategic development site at an independent quarry at Easton on Portland and is described within the tables as 'Academy'. This 20 hectares site includes an application for the following:

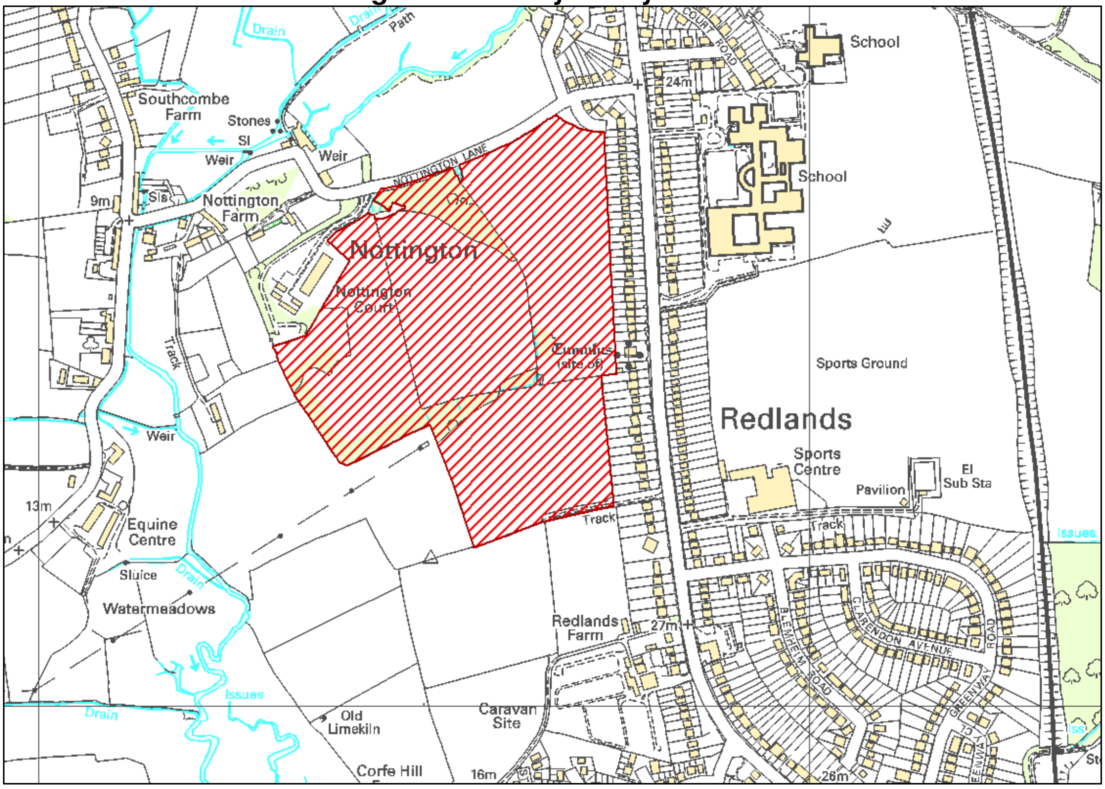
- Residential led mixed use (200 dwellings at a density of 30dph) 8 hectares
- Portland Academy 4 hectares
- Existing sports pitches to be used in conjunction with Portland academy employment purposes / additional housing 5 hectares
- Public Open Space/nature conservation 3 hectares

A Master plan has been obtained for the site via the Weymouth & Portland planning application website.

The whole of this area drains into a drain which we will call the 'Easton Drain'. Due to the nature of the drainage in this area a basic review of the geology has been undertaken using geology maps. This assessment highlighted the site is comprised of the following geology: 40% Lower Purbeck and 60% Portland Stone.

1.5.7 Area 7: Wey Valley strategic development site

Figure 1.8 – Wey Valley outline



This is a strategic development site submitted by a developer. Two possible scenarios have been tested for this site:

- Best case = 75 units
- Worst case = 350 units

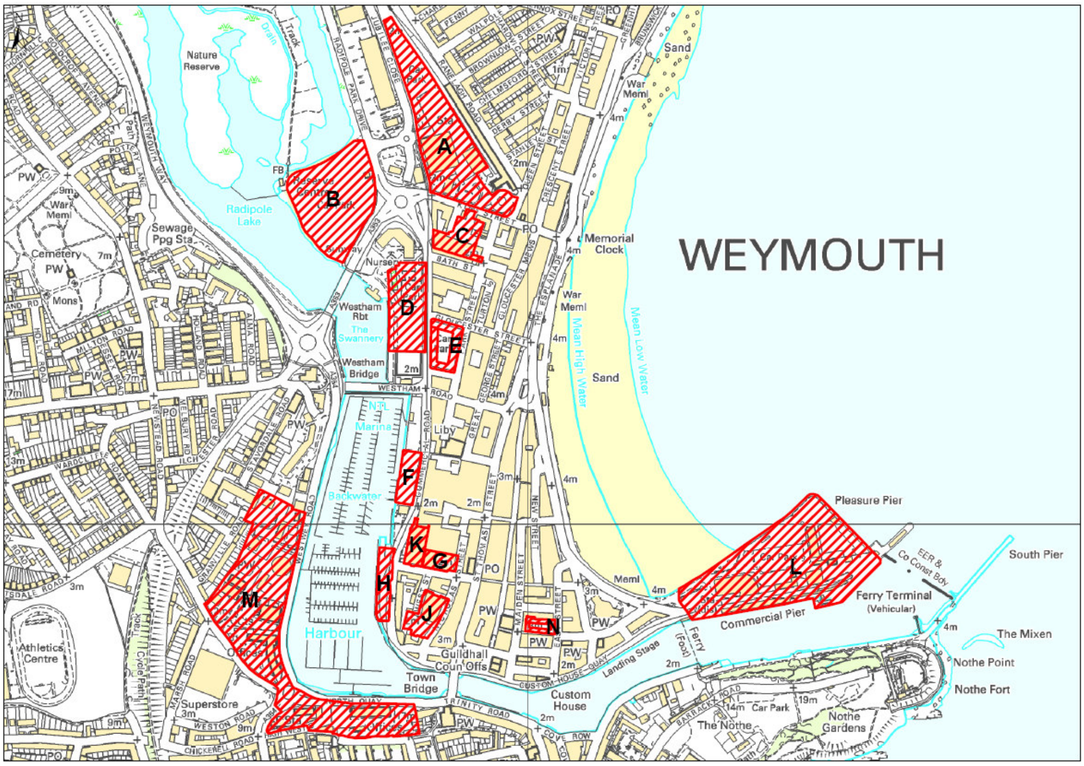
For both scenarios the density of dwellings is unknown. The site covers an area of approximately 15.9 hectares, which drains into the River Wey catchment.

1.5.8 Area 8: Town centre strategic development sites

The Town Centre strategic development sites are:

- South of Westham Bridge (includes (F) Harbouside Car Park, (G) Post Office Sorting Office, (H) Loop Car Park, (K) Multi-Storey Car Park, (N) Governors Lane car park and existing (J)Ten Pin Bowling centre)
- Westham Bridge to King Street (includes (B) Swannery Car Park, (C)Bus Station, (D) Melcombe Regis Car Park and (E) Park Street Car Park)
- North of King Street (includes (A) Jubilee Sidings and Train Station)
- Outer harbour (includes (M) Gasholder, Magistrates Court, Fire Station and Council Offices)
- Pavilion (includes (L) Pavilion & Ferry Terminal)

Figure 1.9 – Town centre outlines



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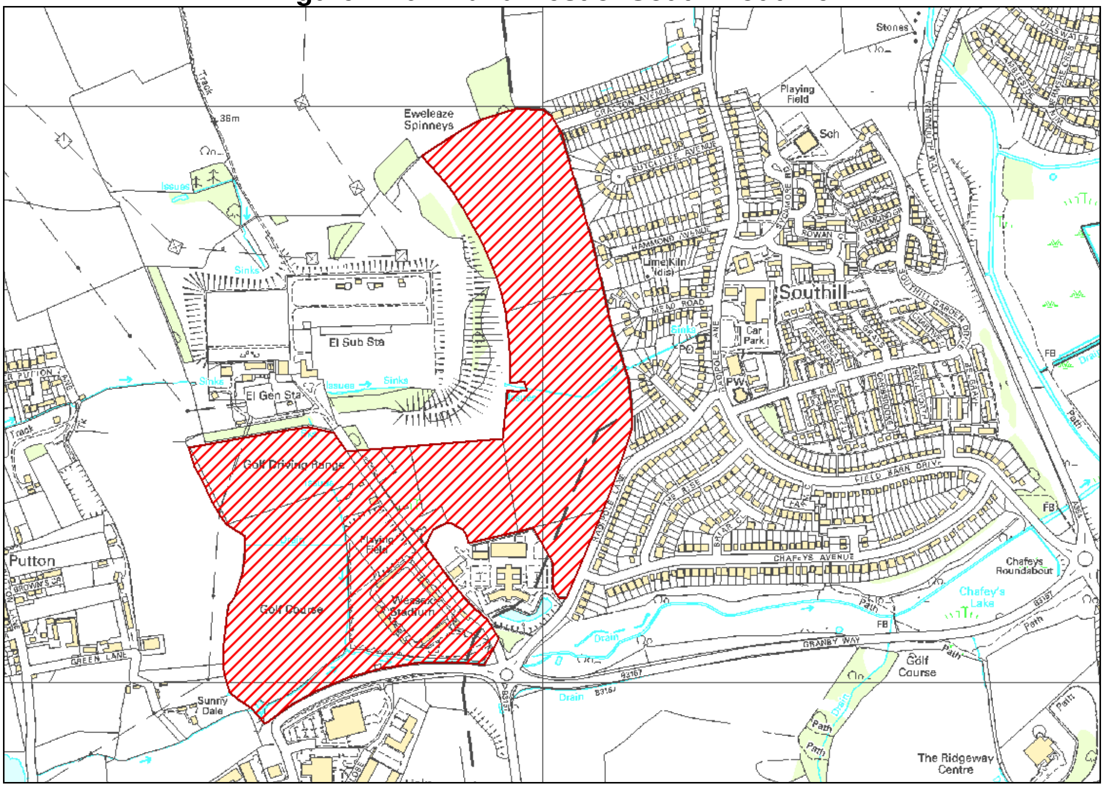
All of the Town Centre sites are on previously developed land and are therefore a redevelopment rather than building on green field sites.

The total cumulative size of the development areas is approximately 17.0 hectares, although this ranges from large sites of approximately 5 hectares (Outer Harbour) down to very small sites 0.1 hectares in size (Governors Lane car park). The River Wey catchment covers the Town Centre sites although generally the main source of flood risk to these areas is tidal flooding.

1.5.9 Area 9: Land west of Southill for Urban Extension

This is an additional option for the Weymouth Urban Extension for 700 dwellings. The site covers an area of approximately 33.7 hectares, which drains into two catchments, a tributary of the River Wey to the north and the Chafey's Stream to the south. Note that Chafey's Stream is also a tributary of the River Wey. Both Chickerell North and Chickerell East also input into the tributary of the River Wey but the urban extension will either be on the Chickerell sites or the this site on the land west of Southill site. The combined effect of development on this site and one of the Chickerell sites has therefore not been considered.

Figure 1.10 – Land west of Southill outline



2 SITE SUMMARY TABLE

Below is an overview of the findings of this investigation. Details of the assessments undertaken and modelling results can be found in the following 4 sections of this report.

Area	Current Flood risk	Future Flood Risk	Access & Egress	Potential for development		Additional considerations
Chickerell North as shown in Figure 1.2	Entire area within Flood Zone (FZ) 1. Surface water / foul sewage flooding in Chickerell but not within the development area. Low risk of flooding directly from rivers or the sea. No defences present.	No FZ nearby therefore unlikely to be affected by increased flows due to climate change.	No issues – area in FZ 1. Surrounding roads also in FZ1.	High potential	Urban extension option covering 0.14km^2. 350 unit option has minimal impact on flow regime. 700 unit option causes less than 2.5% increase in SPR, flow or run-off volume. Generally suitable for all types of development.	As the site is currently rural, development needs to ensure surface water managed on site. This can be through adequate drainage and SuDS to minimise any impact on the settlement of Chickerell which is at a lower elevation than the development area.
Chickerell East as shown in Figure 1.3	Entire area within FZ 1. Surface water / foul sewage flooding in Chickerell but not within the development area. Low risk of flooding directly from rivers or the sea. No defences present.	No FZ nearby therefore unlikely to be affected by increased flows due to climate change.	No issues – area in FZ 1. Surrounding roads also in FZ1.	High potential	Urban extension option covering 0.09km^2. 700 unit option causes less than 4.5% increase in SPR, flow or run-off volume. Remaining options have minimal effect on flow regime. Generally suitable for all types of development.	Further investigation of flood risk relating to drain at southern end of site recommended prior to development. SUDS will be required to minimise any impact on the settlement of Chickerell.

Area	Current Flood risk	Future Flood Risk	Access & Egress	Potential for development		Additional considerations
Littlemoor as shown in Figure 1.4	Entire area within FZ 1 although close to FZ 2 and 3 and a minor watercourse in the site. No recorded historic events in area, although surface and foul water flooding in adjacent road. Low risk of flooding directly from rivers or the sea. No defences present.	Land currently 5m above nearest FZ therefore unlikely to be affected by increased flows due to climate change.	No issues – area in FZ 1. New relief road can provide access and egress route.	Moderate potential	Urban extension option covering 0.13km^2. Significant impact on flow and run-off volume for Area 3 if maximum proposed development pursued for both Area 3 and 4 due to natural drainage from one area to the next. Moderate impact of 700 unit option with no development on Area 4 and minimal impact for 350unit option with no development on Area 4 (less than 4.2% increase in flow due to development). Generally suitable for all types of development.	Surface water issues in Littlemoor Road likely to be improved by development of relief road but a detailed study assessing the capacity of the balancing ponds is recommended if the urban extension goes ahead at this site. Mitigation options could include extensive use of SuDS onsite and provision of additional storage through increasing the capacity of Bincombe Marsh balancing pond. Investigate the flood risk from the currently un-modelled minor watercourses.

Area	Current Flood risk	Future Flood Risk	Access & Egress	Potential for development		Additional considerations
Preston Downs as shown in Figure 1.5	Relatively high risk of flooding as ~12% of area in FZ 3. No historic events recorded in the area, several surface water flooding / overland flow incidents reported adjacent to area. Small extents of flooding observed through modelling two watercourses within the site, although the majority of the flooding is contained by the balancing ponds in the area. No formal defences present.	North of the site is low-lying. The rest is much steeper therefore the main area at risk from climate change is the north of the site although the modelling shows that climate change does not noticeably change the extent of the flood risk area.	Area of FZ 3 in north of site – access / egress will need to be outside this zone. E.g. connecting to Brachendown Avenue or Budmouth Avenue.	Low potential	Development area covers 0.49km^2. Significant impact on flow and run-off volume with increases greater than 10% were recorded for all development options, the most significant relating to maximum proposed development pursued for both Area 3 and 4. Types of suitable development will vary across the site dependent on proximity to watercourses.	If development pursued, it should be sited away from potential flood risk areas around the watercourses and drainage managed onsite. Any extra surface water generated could impact both the current surface water situation in Littlemoor Road and the stream draining to Preston Brook and could affect Lodimoor Nature Reserve. Similarly, development should avoid adding flow to Wyke Oliver stream, which could also affect the nature reserve.

Area	Current Flood risk	Future Flood Risk	Access & Egress	Potential for development		Additional considerations
Markham & Little Francis as shown in Figure 1.6	Entire area within FZ 1, however could be some risk of flooding in Lanehouse Stream vicinity including surface water flooding. No historic events within the area itself, some adjacent relating to Lanehouse Stream. No defences present.	May be increased risk due to the insufficient drainage capacity or blockages of Lanehouse Stream. Therefore higher risk due to climate change around these areas.	No issues – area in FZ 1 although access and egress routes should potentially avoid Lanehouse Stream area where possible.	Moderate potential	Development area covers 0.38km^2. Three development options were investigated. Worst case has significant impact on catchment >16% increases in SPR, flow and run-off volume, whilst best case shows minor impact on flow regime with increases <2.5% due to development. Types of suitable development will vary across the site dependent on proximity to Lanehouse Stream.	Recommend that blockages in Lanehouse Stream and the drainage capacity of the Industrial Estate are investigated further as part of an FRA prior to any allocation and measures identified to resolve issues. Works shall be implemented as part of a planning obligation. SUDS should be used, along with maintaining open space to reduce the impact, and where possible reduce the flood risk, to the surrounding area.
Easton as shown in Figure 1.7	Entire area within FZ 1. No reported historic events of surface water / foul sewage flooding. Low risk of flooding directly from rivers or the sea. No defences present.	Land currently 100m above the nearest FZ therefore unlikely to be affected by increased sea level due to climate change.	No issues – area in FZ 1.	Moderate potential	Development area covers 0.20km^2. SPR, flow and run-off volume estimated to increase >70% due to development indicating major impact on the catchment. Generally suitable for all types of development.	Infill site on permeable geology, if development pursued flow regime would change considerably so extensive use of SuDS required to manage additional surface water e.g. permeable paving, infiltration drainage.

Area	Current Flood risk	Future Flood Risk	Access & Egress	Potential for development		Additional considerations
Wey Valley as shown in Figure 1.8	Area entirely within FZ 1. No historic events within the area itself, some adjacent incidents resulting in road closures and internal flooding. Low risk of flooding directly from rivers or the sea. No defences present.	Land ~ 2m higher than adjacent flood zone and topography suggests that the extents of the River Wey would increase downstream prior to entering the site. Therefore unlikely to be affected by climate change.	Recent surface water flooding issues / previous closure of Nottington Lane due to flooding indicates access / egress best sited away from the north of the development area.	High potential	Development area covers 0.16km^2 which is approximately 2.2% of the River Wey catchment. Development has minimal impact on the catchment with SPR, flow and run-off increasing by ~1% as a result. Generally suitable for all types of development.	Downstream impacts required to be negligible should development go ahead as Radipole Nature Reserve has no capacity for additional run-off / flow. Surface water to be managed onsite through mitigation including use of SuDS. It is recommended that if development is proposed a detailed study of potential downstream effects should take place.
Town Centre as shown in Figure 1.9	See town centre site summary tables					
Land West of Southill as shown in Figure 1.10	Moderate risk of flooding to south of area in relation to Chafeys Stream where area in close proximity to FZ 3. Remainder of area in FZ 1. Extensive drainage / small watercourse network through the site. Surface water issues to east of area. No defences present.	Flood risk is likely to increase due to climate change. Site is very flat and low-lying therefore an increase in flooding of Chafeys Stream may extend onto site, particularly if tide locking is increased.	Minimal access / egress issues, routes should potentially be sited away from Chafeys Stream area where historic flood events area reported to have occurred.	Moderate potential	Urban extension option covering 0.34km^2. 700 unit option causes moderate increases of between 4-6% in SPR, flow or run-off volume. Remaining options have minimal effect on flow regime. Types of suitable development will vary across the site dependent on proximity to Chafeys Stream due to climate change.	Known surface water issues to east of site. Current capacity of culverts and potential to exacerbate surface water issues would also require additional investigation prior to development. This study has been undertaken, see section 3.1.9.

Town Centre Site Summary Tables

To meet the requirements of the Exception Test part c, a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall. This must be assessed over the lifetime of the development and therefore account for the impacts of climate change.

This includes determining any flood mitigation measures that will need to be used, including the proposed floor levels for a development. With climate change all of the sites are at risk of flooding, therefore all of the sites will need to consider the impacts of climate change over the lifetime of the development. Access and egress routes also need to take into account climate change.

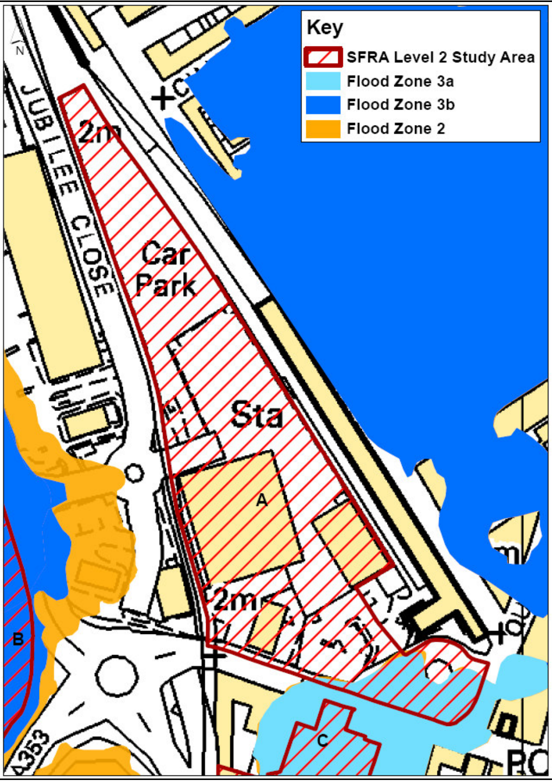
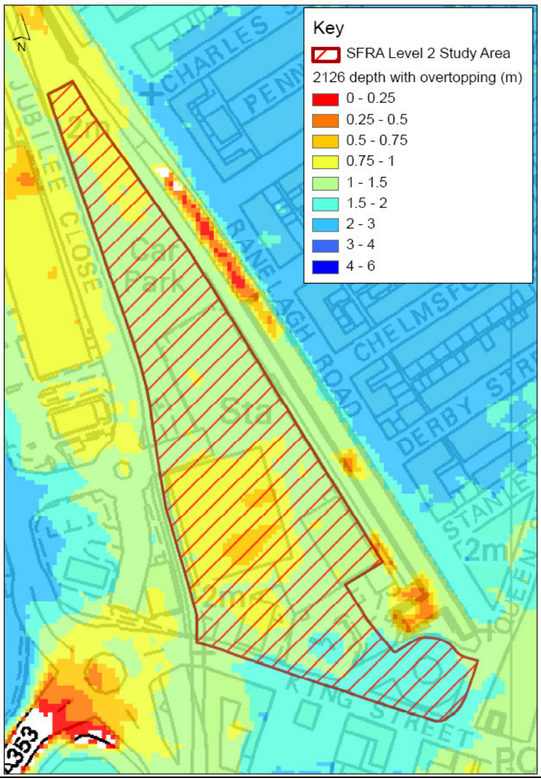
Currently the flood risk to the town centre is relatively low. This is because of existing flood defences which are in place. However when climate change is taken into account, assuming that flood defences remain at their existing crest levels, significant flooding could occur across a large proportion of the town centre on a more frequent basis that would be expected today. The following site summary tables look at both the existing flood risk and the predicted flood risk in 2086 and 2126.

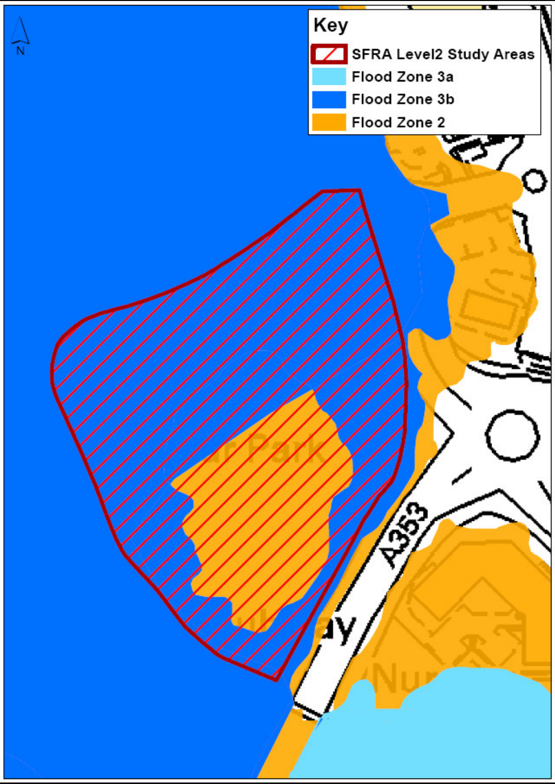
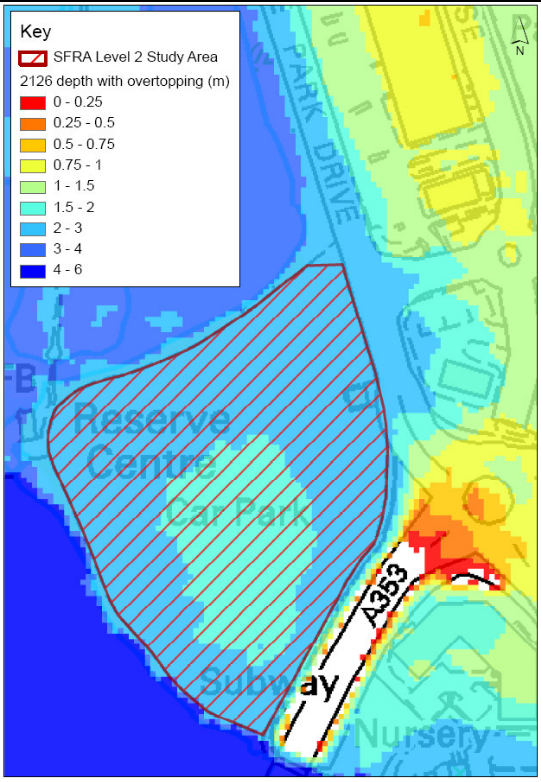
While a number of the sites have been included within the Strategic Housing Land Availability Assessment 2008 Report it is considered that this Level 2 SFRA has idenitified that safe access for the majority of the town centre sites will experience an extreme flood hazard if improvements / new flood defences are not factored into the allocation process. This hazard may also prove a significant obstacle in the demonstration of all parts of the Exception Test. To ensure that any development within the town centre is viable further work is needed to identify how flood risk to the area can be sustainably managed in the future. This is currently being undertaken by the Environment Agency with cooperation from W&PBC.

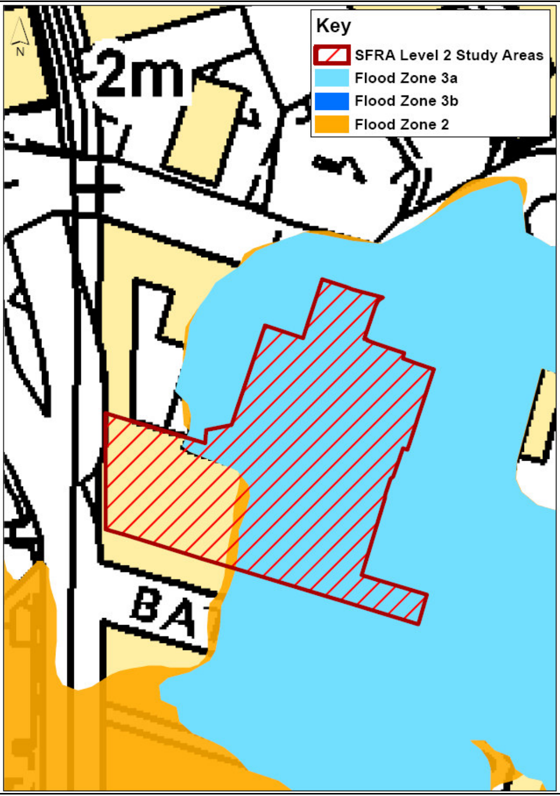
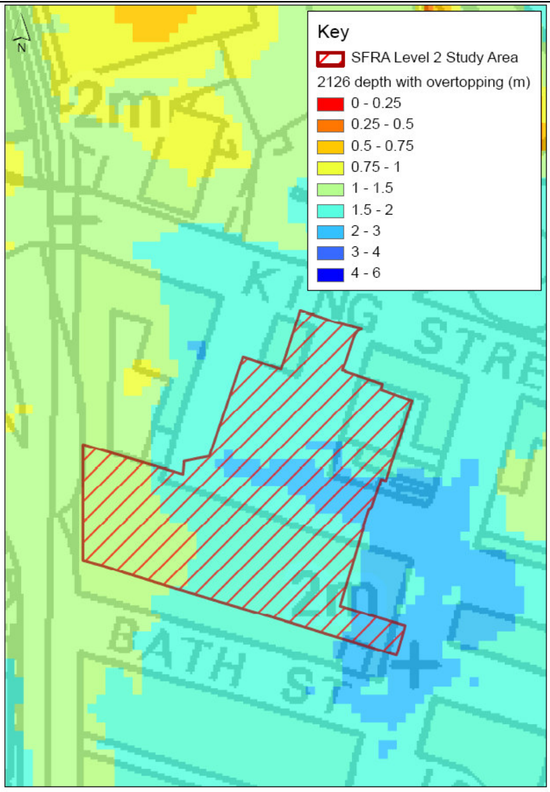
This additional work will not only facilitate new development, but also manage flood risk for the existing community. This study will need to determine the most appropriate infrastructure to provide a 1 in 200 year standard of protection in 2126. If this strategy can show that it is possible to provide a 1 in 200 year standard of protection by 2126 and a plan is put in place to undertake the works, then it is likely that most of the town centre sites would be suitable for some form of development which may include either more vulnerable development such as dwellings or less vulnerable development such as shops and offices at some stage.

The Level 2 SFRA has shown that site B, the Swannery Car Park forms part of the future functional flood plain. As such there would be a general presumption against its development for anything other than water compatible development, such as marine or outdoor recreation.

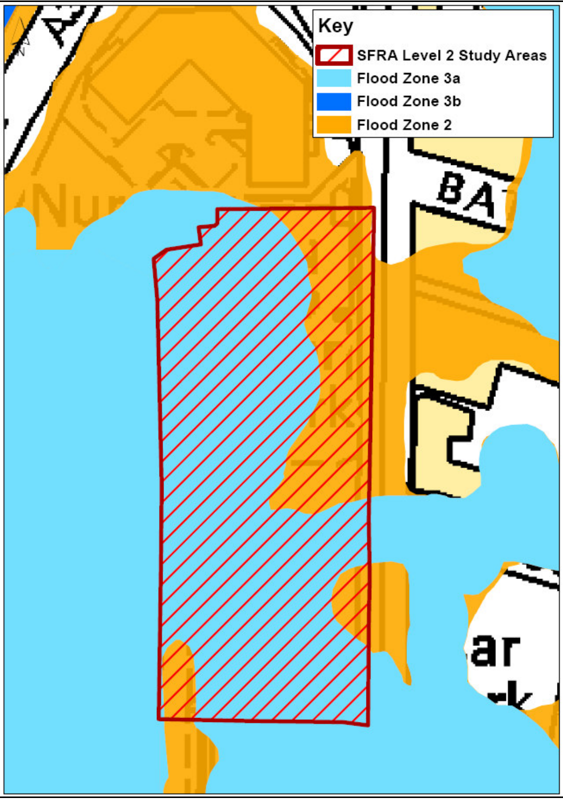
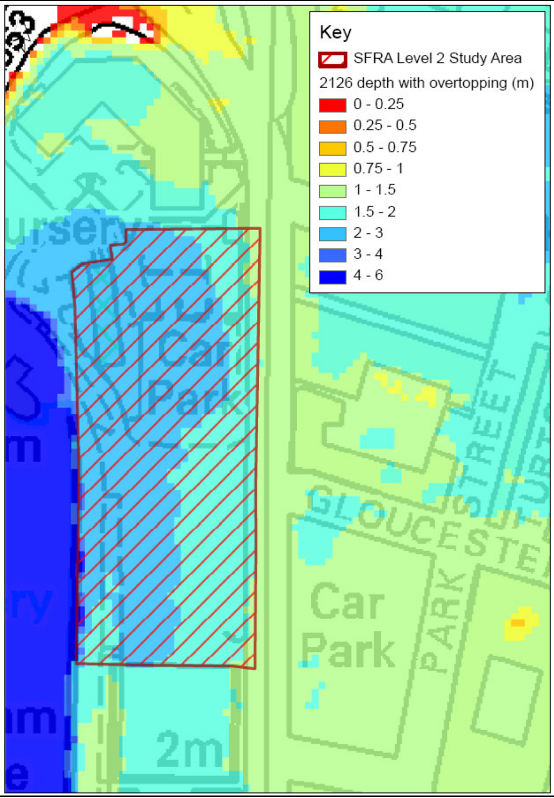
Note that for the following tables Hazard Rating is based on categories from Flood Risk Assessment Guidance for New Development Phase 2, Framework and Guidance for Assessing and Managing Flood Risk For New Development (FD2320/TR2) HR Wallingford (October 2005).

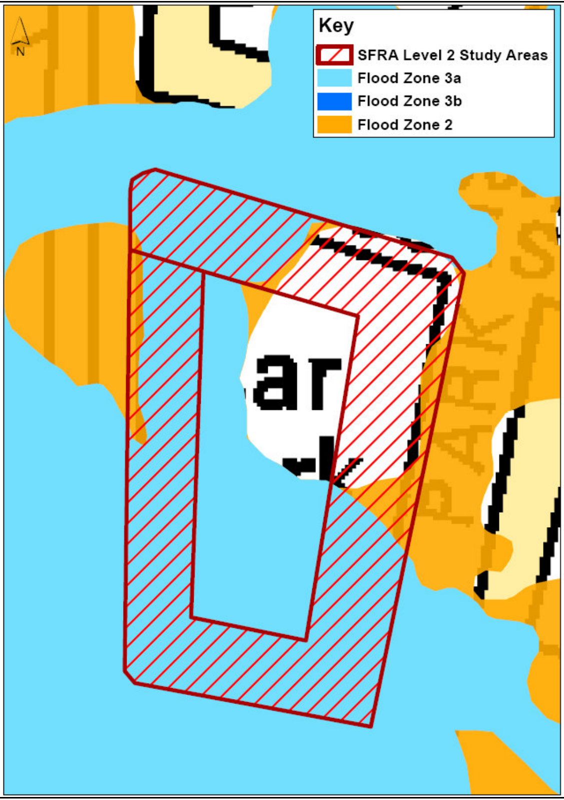
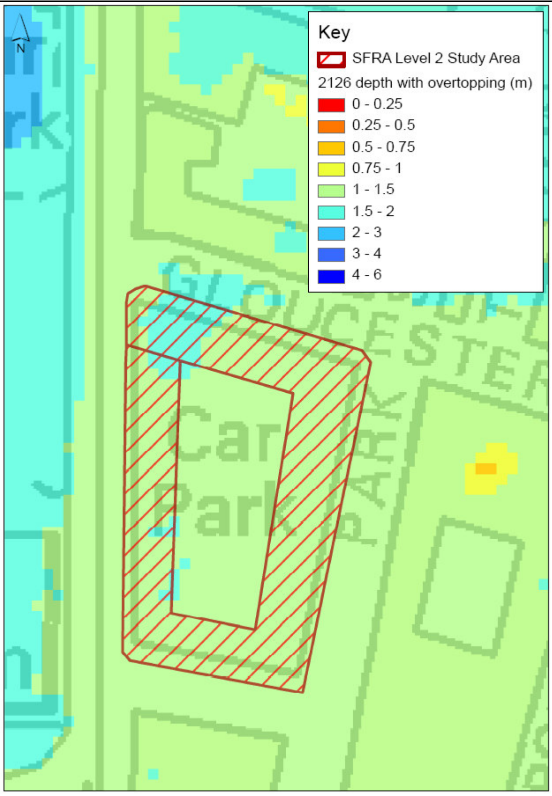
Site A Train Station & Jubilee Sidings	Current	Future
		
Summary of Risk	Moderate to high risk of flooding, SW corner of site in FZ 3, where modelling with defences indicates tidal flooding, onset at 1 in 100 year event. No recorded historic flood incidents.	Approx. 50% of the site at risk by 2086 and 100% at risk by 2126 with maximum flood depths from wave overtopping and tidal flooding of up to 1.90m as a result of increases in sea level due to climate change.
Hazard Rating	Significant	Extreme
Access & Egress	FZ 3 to east and south of site, tidal flooding indicated to SE: access / egress needs to be outside these zones. Access / egress potential to SW / NW of site on Jubilee Close.	Access / egress to north west of site (Jubilee Close) only in 2086, no access / egress by 2126 as minimum depths across site of 0.5m. Duration of no access during 2126 flood event approximately 8 hours.
Potential for Development	Development area of 0.025km^2 proposed adjacent to and in tidal flood risk areas. Current flood hazard significant but confined to SE of site which is site currently shown to experience tidal flooding. However significant flooding by 2086 due to effects of climate change with potentially complete inundation by 2126 indicates that most development will be inappropriate, especially residential.	
Types of Development	For development with a 100 year horizon (i.e. 2126) only water compatible development is currently appropriate for this site because not only must the development be safe, but, access and egress must also be safe. There is no safe access and egress for the 1 in 200 year event when considering the effects of climate change for 2126. Commercial development may be suitable provided the exception test is passed as access is retained to NW of site for 2086 event. Land in the SE of site would need to be raised to make it safe and this would only be acceptable if flood risk is not consequently increased elsewhere.	

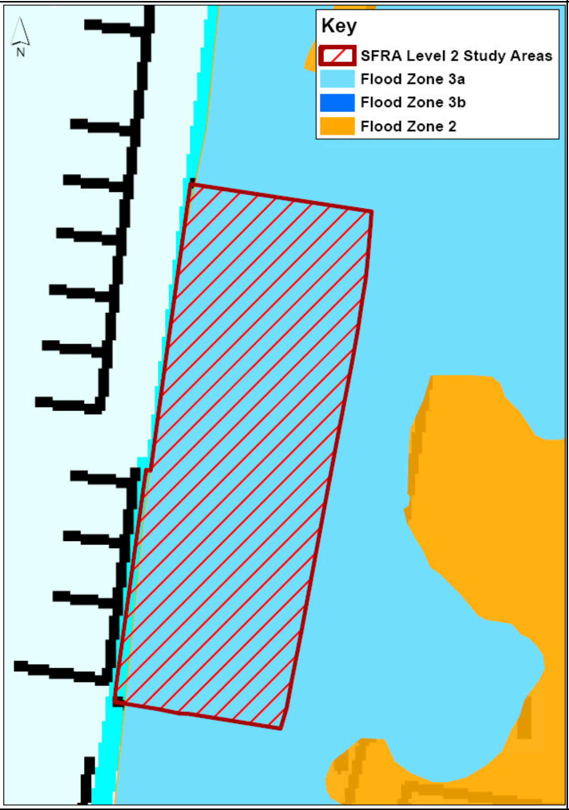
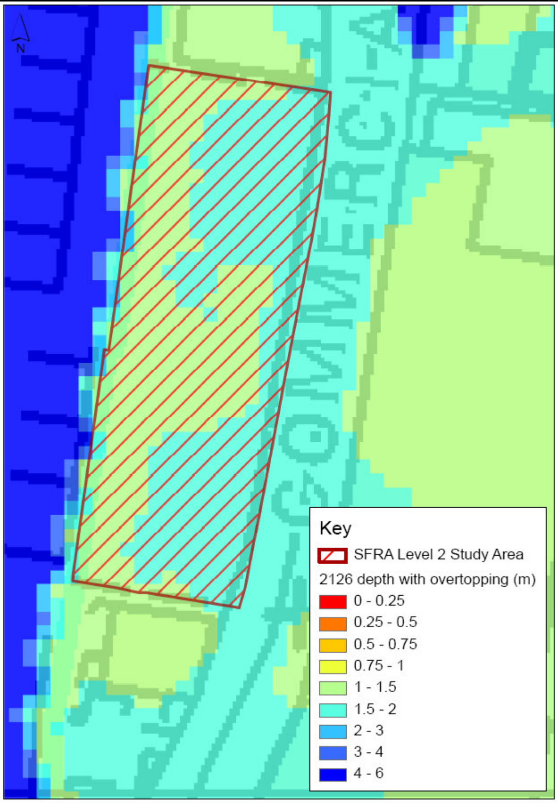
Site B	Current	Future
Swannery Car Park		
Summary of Risk	No risk of tidal flooding. At risk of fluvial flooding – 90% of site within FZ3 b – functional floodplain. Depths are expected to be ~ 0.3 – 0.8m.	Depths will increase due to increased flows. Defence required. 50% of site at risk by 2086, depths 0.3-0.6m from tidal flooding and wave overtopping; 100% of site at risk by 2126, maximum depth 2.55m.
Hazard Rating	Significant	Extreme
Access & Egress	Site is within FZ3. Access / egress routes may need to be raised above this level in order to link up with the A353 along SE of site which is in FZ1.	Perimeter of site flooded during 2086 and then the whole site by 2126, although velocities minimal and depths shallow for 2086 (~0.1-0.2m next to A353). No access / egress by 2126, minimum depths 1.8 – 2m around perimeter of site. Duration of no access during 2126 flood event approximately 23.5 hours.
Potential for Development	Development area of 0.022km^2. Impact of development on adjacent nature reserve would require detailed investigation, also consideration of effect of fluvial FZ3 not accounted for by tidal model and any potential impact of water level variation in Radipole Lake. However, extensive tidal flooding projected to occur by 2126 means that many types of development are likely to be inappropriate for this site, especially residential. Location of site in functional floodplain limits development options to water compatible or essential infrastructure.	
Types of Development	For development with a 100 year horizon (i.e. 2126) only water compatible development is currently appropriate for this site. Shallow depths and low velocities combined with a short duration of 'no access' (1hr for the 1 in 200yr event in 2086) suggest if exception test passed, commercial development could be acceptable. However, other factors to be considered include the fact that the time between onset and maximum flood depth is very short (in the order of 1-2hrs in 2086) in addition to unknown fluvial inputs during a tidal flood event.	

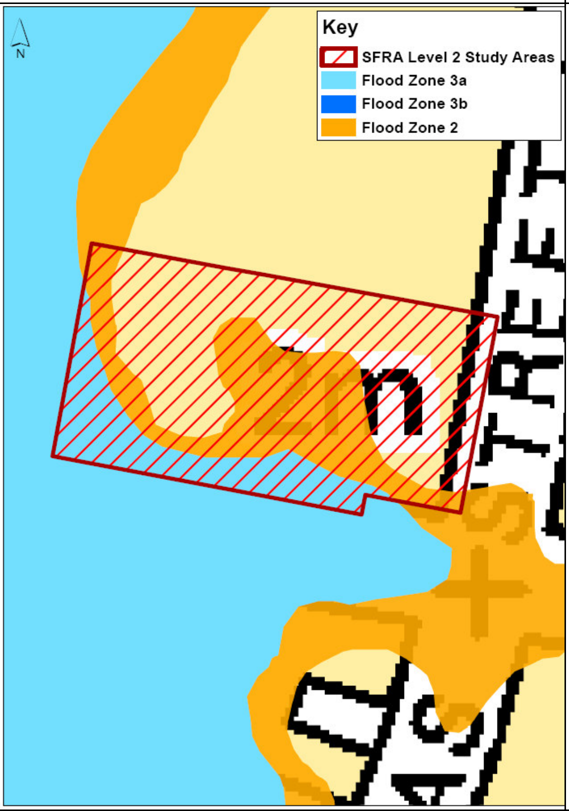
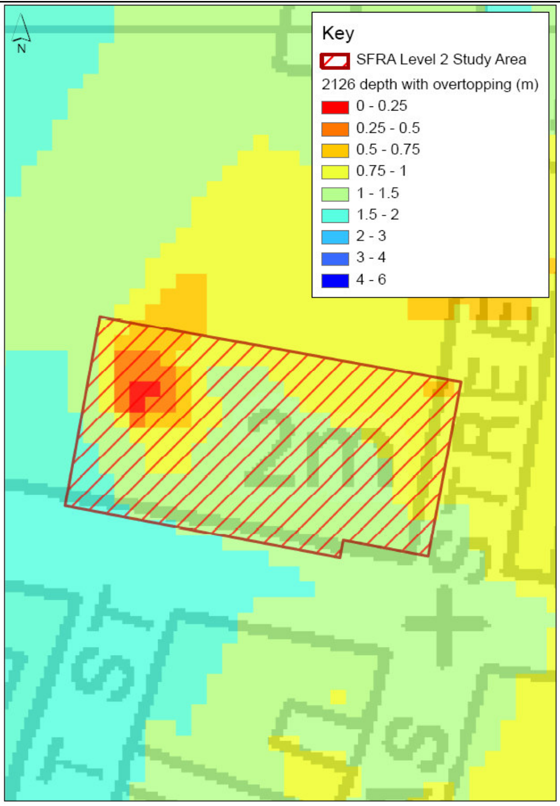
Site C **Bus Depot**	**Current**	**Future**
		
Summary of Risk	High risk of flooding, ~50% of site in FZ 3, tidal modelling with defences indicates flooding across most of site by the 1 in 200 year event with depths of 0.3 – 0.45m. No recorded historic flood incidents.	100% of site at risk by 2086 with depths of 0.9 – 1.25m from tidal flooding with wave overtopping. By 2126 these have increased to 1.80 – 2.10m.
Hazard Rating	Moderate	Extreme
Access & Egress	Tidal flooding and FZ3 in east of site. Access / egress should be outside this zone, to the west of the site such as through Bath Street and Commercial Road, parts of which are in FZ1.	No access / egress by 2086 unless elevate SW corner of site but would have to ensure flood risk not increased elsewhere. By 2126 no access / egress, significant flood depths in and around site. Duration of no access during 2126 flood event approximately 10.75 hours.
Potential for Development	Development area of 0.005km^2. Impermeable surface, development could reduce current flood risk through use of SuDS. Flood hazard currently moderate due to flood depth and velocity, becoming extreme by 2126 as depths increase. This, in combination with limited access / egress to site by 2086 and no access potential by 2126, indicates that most development will be inappropriate at this site.	
Types of Development	Water compatible development only unless exception test passed for commercial development if safe access / egress can be created, without increasing flood risk elsewhere, in SW of site linking up with Commercial Road where 2086 flood depths decrease to 0.2m.	

<table>
<tr><th>Site D

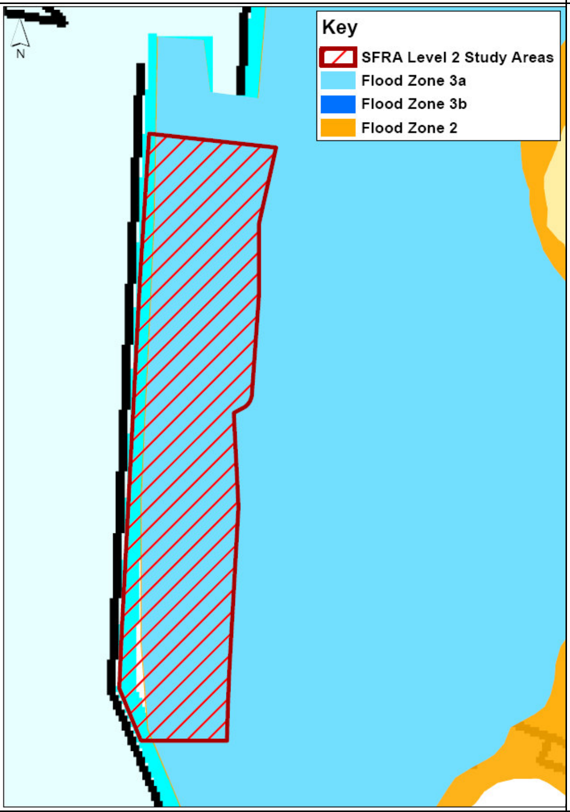
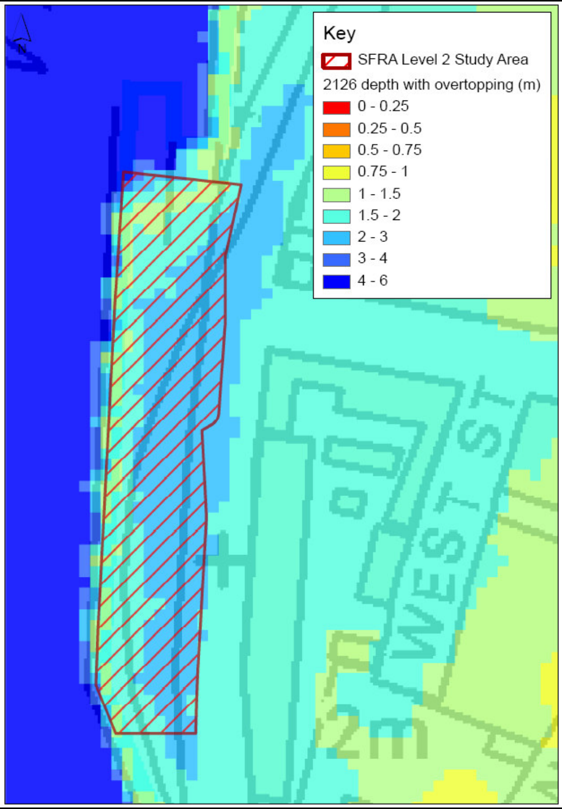
Melcombe Regis Car Park</th><th>Current</th><th>Future</th></tr>
<tr><td></td><td>
</td><td>
</td></tr>
<tr><td>Summary of Risk</td><td>Onset of flooding occurs at the 1 in 200 year event with low depths. Approximately 75% of the site is in FZ 3 with the remaining areas in FZ 2. No recorded historic flood incidents.</td><td>Entire site flooded for both future scenarios. Depths show considerable increase by 2086 to maximum of 1m from tidal flooding and wave overtopping. Further increases to 2.1-2.5m by 2126.</td></tr>
<tr><td>Hazard Rating</td><td>Low - moderate</td><td>Extreme</td></tr>
<tr><td>Access & Egress</td><td>Most of site in FZ3, model indicates that the NE of the site is free from tidal flooding as well as being in FZ2. This may represent the best location for access / egress onto Commercial Road.</td><td>No reasonable access / egress for future scenarios. Duration of ‘no access’ during 2126 flood event approximately 20.75 hours.</td></tr>
<tr><td>Potential for Development</td><td colspan="2">Very low-lying development area of 0.01km2. Most of site in FZ3 coupled with increased flood risk for future scenarios with depths of over 2m and negligible safe access / egress indicates that most development will be inappropriate for this site.</td></tr>
<tr><td>Types of Development</td><td colspan="2">Water compatible development only.</td></tr>
</table>

Site E	Current	Future
Site E **Park Street Car Park**		
Summary of Risk	High risk of flooding, ~75% of site is in FZ 3. Tidal modelling with defences shows onset of flooding at 1 in 200 year event affecting west of site with maximum depth 0.28m. No historic flood incidents.	100% of site at risk by 2086 with depths of 0.6-0.7m increasing to 1.3-1.6m by 2126 from tidal flooding and wave overtopping.
Hazard Rating	Low	Extreme
Access & Egress	Limited options for access / egress since most of the site floods and is in FZ3. Main potential for access / egress is to the NE onto Park Street / Gloucester Street in FZ2.	Access lost almost at onset of flooding for 2086 and velocities relatively high therefore no reasonable access / egress for 2086. No access / egress by 2126 due to depth of flooding on and around site. Duration of no access during 2126 flood event approximately 11.5 hours.
Potential for Development	Development area of 0.003km^2. Flood hazard currently low due to late onset of flooding and relatively small flood depths, becoming extreme by 2126 as depths and flow velocities increase. This, in combination with limited access / egress to site by 2086 and no access potential by 2126, indicates that most development will be inappropriate at this site.	
Types of Development	Water compatible development only. Even if safe access / egress could be developed, most of the land around the site is projected to experience considerable depths of flooding (min.0.35m) for both 2086 and 2126 scenarios suggesting that there would be difficulty in linking up an access route with land outside of the tidal flood extents.	

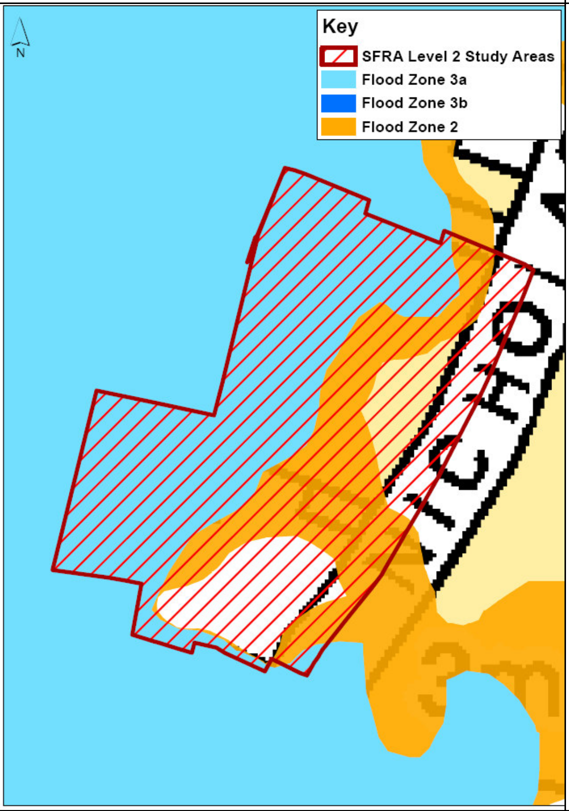
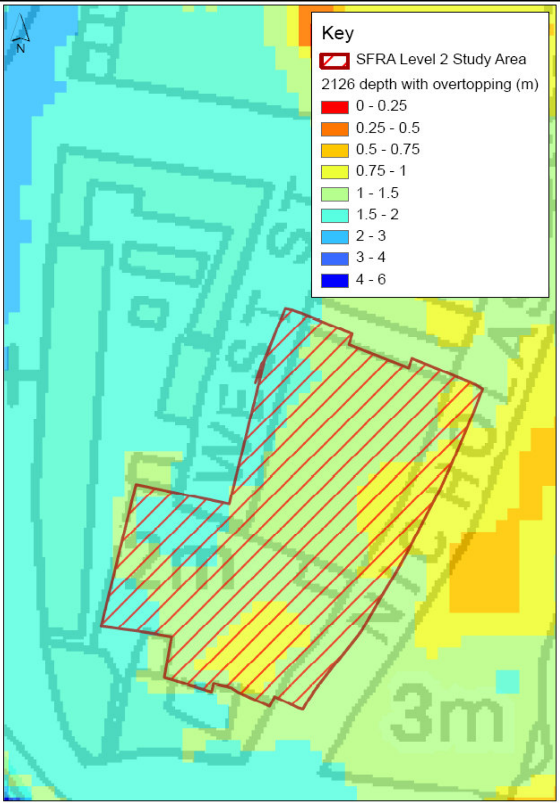
Site F Harbour-side Car Park	Current	Future
		
Summary of Risk	High flooding risk to western edge of site. 100% of site in FZ3. Modelling with defences indicates flooding onset at 1 in 200 year event, significant maximum depths. Tidal flooding reported in 1954/2005 next to site.	100% of site at risk, tidal flood depths (including wave overtopping) of 0.95-1.10m by 2086 and 1.50 – 1.85 m by 2126.
Hazard Rating	Low	Extreme
Access & Egress	Entire site in FZ3 and flooded at 1 in 200 year tidal event. Access / egress routes would need to be raised above these levels both on site and surrounding area. Currently no obvious safe route.	No access / egress for current or future scenarios. For both 2086 and 2126 any access to site is inundated within short time of flood onset. Duration of no access during 2126 flood event approximately 20 hours.
Potential for Development	Development area of 0.003km^2. Defences likely to require re-evaluation and improvement if development pursued. No access / egress route currently available therefore low potential for development.	
Types of Development	Water compatible development only.	

Site G	Current	Future
Post Office Sorting Office		
Summary of Risk	Moderate risk of flooding in south and west of site. ~ 15% of site is in FZ 3 (and ~ 50% in FZ 2). Modelling with defences indicates onset at 1 in 200 year event with depths up to 0.4m. No recorded historic flood incidents	100% of site at risk by 2086 with average depths of 0.55m (max. 1.10m) increasing to 0.95m and 1.65m average and maximum respectively by 2126 from tidal flooding with wave overtopping.
Hazard Rating	Low	Extreme
Access & Egress	Tidal flooding in south and west of site, also in FZ3. Access / egress should be outside this zone. Potential for access / egress to east of site onto Nicholas Street.	No dry access / egress by 2086 although shallow depths suggest possible route to NE onto Nicholas Street if can link to land outside flood extent. No access / egress by 2126. Duration of no access during 2126 flood event approximately 4.5 hours.
Potential for Development	Development area of 0.002km^2. Flood hazard currently low due to late onset of flooding and relatively small flood depths, becoming extreme by 2126 as depths increase. This, in combination with limited access / egress to site by 2086 and no access potential by 2126, indicates that most development will be inappropriate at this site.	
Types of Development	Water compatible development only unless exception test passed for commercial development if safe access / egress can be created in NE of site linking up with Maiden Street where 2086 flood depths decrease to <0.2m. Note that land may need to be raised in order to accommodate this. An assessment would be required to ensure that that the risk of flooding was not increased on the site or elsewhere.	

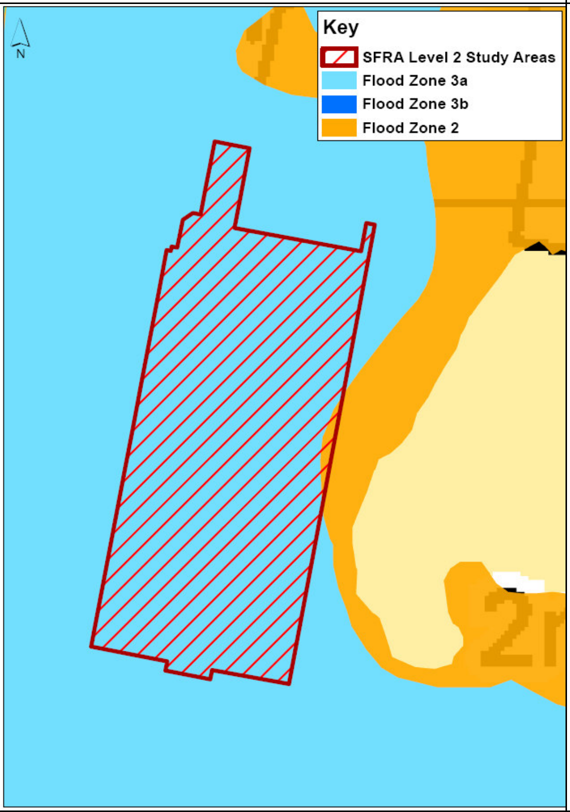
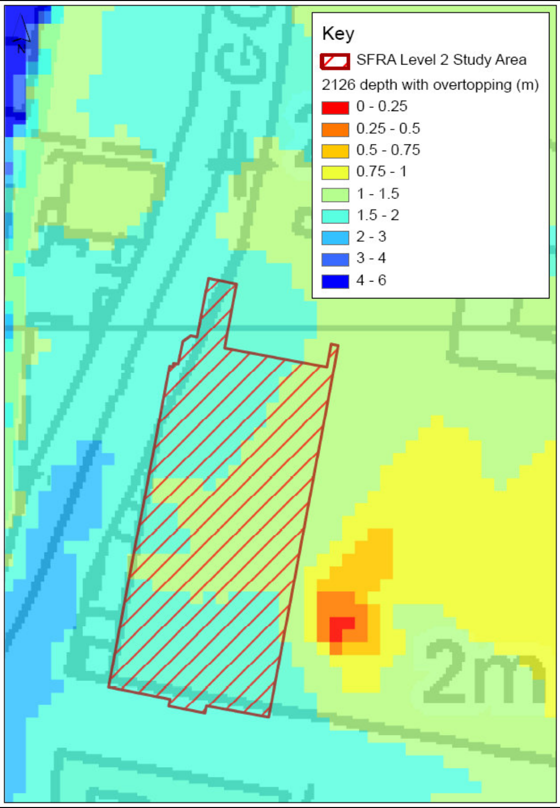
<table>
<tr><th>Site H

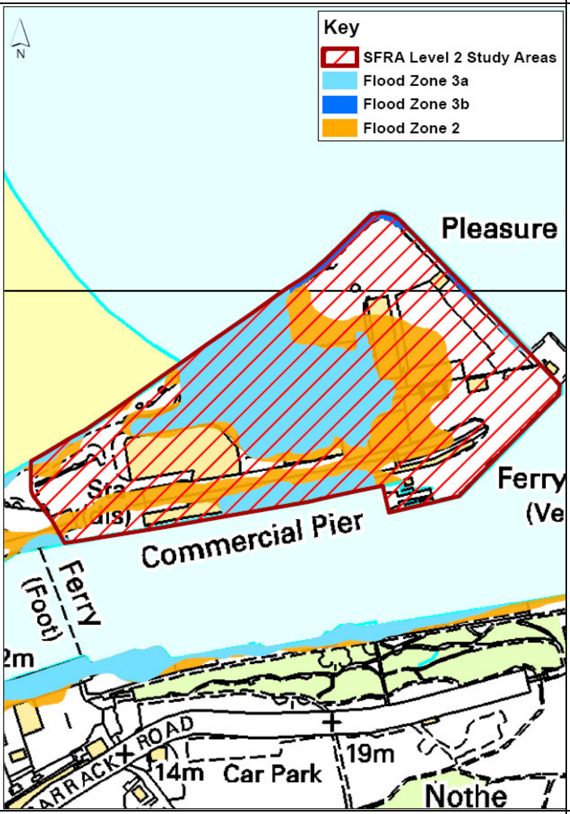
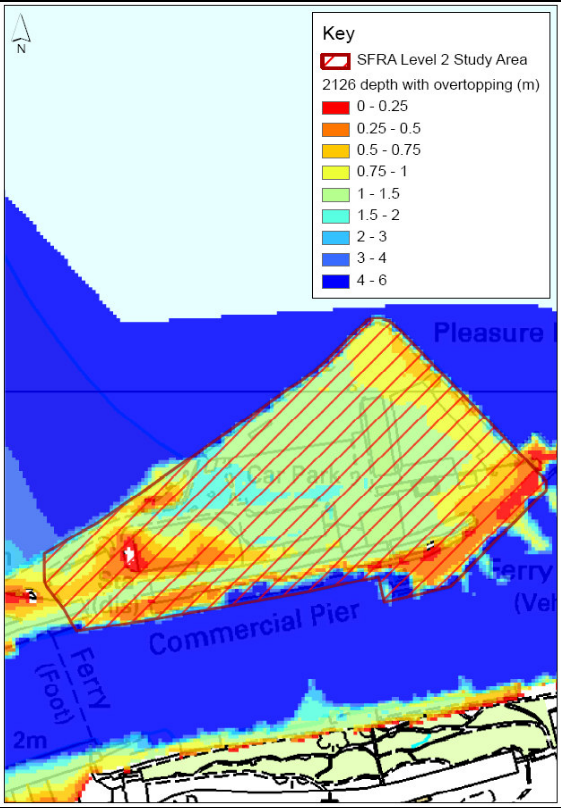
The Loop Car Park</th><th>Current</th><th>Future</th></tr>
<tr><td></td><td>
</td><td>
</td></tr>
<tr><td>Summary of Risk</td><td>Risk of flooding to north and western edges of site where modelling with defences indicates flooding onset at 1 in 200 year event with significant maximum depths. Also 100% of the site is in FZ 3. No recorded historic flood incidents.</td><td>100% of site at risk for future scenarios; by 2086 depths ~1.50 – 1.95 and by 2126 depths >2m therefore increasing the hazard rating to extreme.</td></tr>
<tr><td>Hazard Rating</td><td>Significant</td><td>Extreme</td></tr>
<tr><td>Access & Egress</td><td>Entire site in FZ3 and flooded at 1 in 200 year tidal event. Access / egress routes would need to be raised above these levels both on site and surrounding area.</td><td>No access / egress for 2086 and 2126. Duration of no access during 2126 flood event more than 40hours (access was not observed to be regained throughout the duration of the model run after flood onset).</td></tr>
<tr><td>Potential for Development</td><td colspan="2">Development area of 0.003km^2. Extreme hazard rating due to large flood depths for both 2086 and 2126 events. Recommend only water compatible development if development pursued.</td></tr>
<tr><td>Types of Development</td><td colspan="2">Water compatible development only. Even if safe access / egress could be developed, most of the land around the site is projected to experience considerable depths of flooding (min.1m) for both 2086 and 2126 scenarios suggesting that there would be difficulty in linking up an access route with land outside of the tidal flood extents.

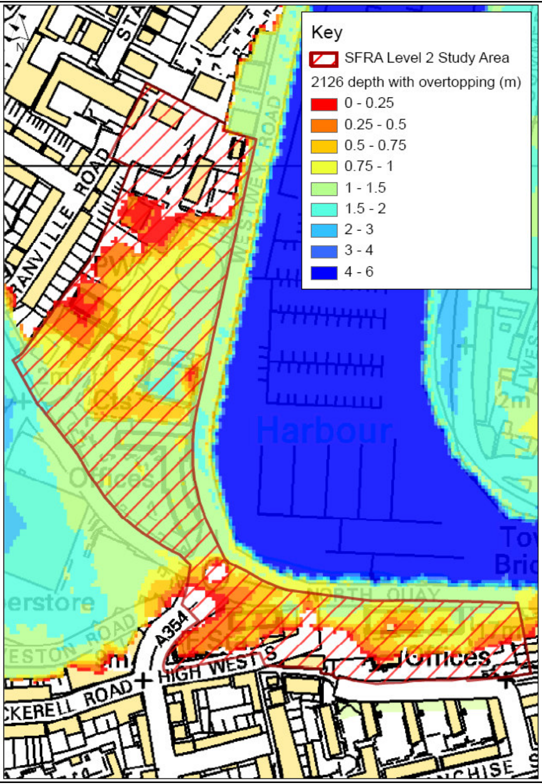
Additionally the site is a low point within the town centre and it is indicated by the model results that the site appears to act as a flood storage area because it remains flooded for a long time after water has receded from most of the town centre area.</td></tr>
</table>

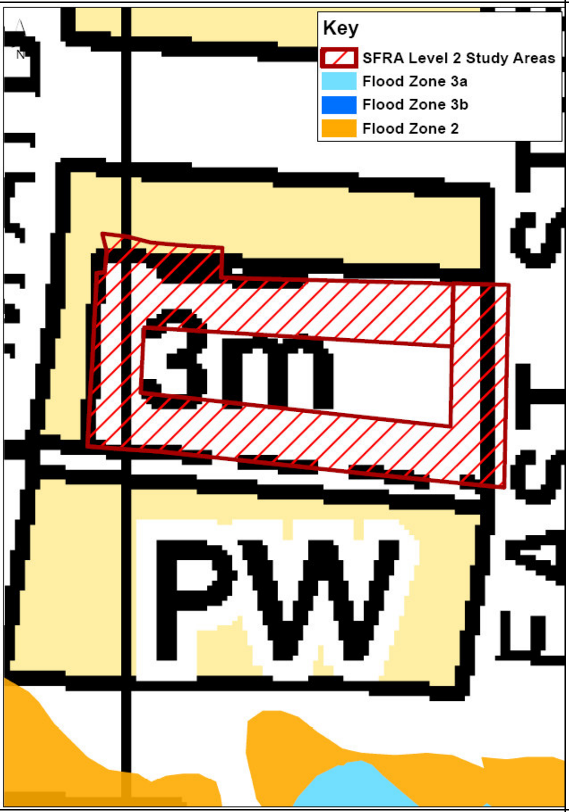
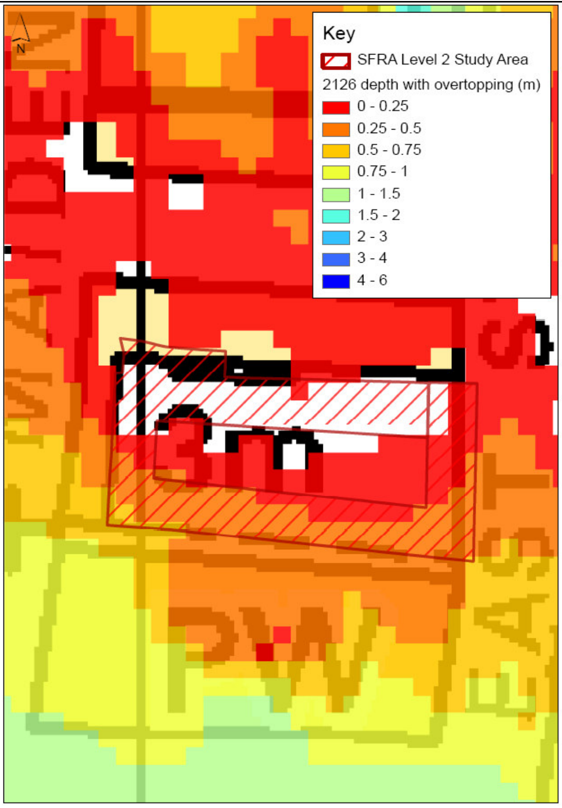
Site J Ten Pin Bowling Alley	**Current**	**Future**
		
Summary of Risk	High risk of flooding to west of site. ~ 50% of site is in FZ 3 (~ 75% in FZ 2). Modelling with defences indicates onset at 1 in 200 year event with maximum depths of 0.5m. No recorded historic flood incidents.	100% of site at risk by 2086 with average depths of 0.65m (max. 1.25m) increasing to 1.20m and 1.70m average and maximum depth respectively by 2126 from tidal flooding with wave overtopping.
Hazard Rating	Low	Extreme
Access & Egress	Tidal flooding in south and west of site, also in FZ3. Access / egress should be outside this zone. Potential access / egress to east of site onto Nicholas Street.	Currently no safe access / egress for 2086 without raising land levels. No access / egress by 2126. Duration of no access during 2126 flood event approximately 4.5 hours.
Potential for Development	Development area of 0.004km^2. Flood hazard currently low due to late onset of flooding and relatively small flood depths, becoming extreme by 2126 as depths increase. This, in combination with no access / egress to site by 2086, indicates that most development will be inappropriate at this site.	
Types of Development	For development with a 100 year horizon (i.e. 2126) only water compatible development is currently appropriate for this site. Low velocities combined with a short duration of 'no access' (2.75hrs for the 1 in 200yr event in 2086) suggest if exception test passed, commercial development could be acceptable if a safe access / egress route can be created. However, other factors to be considered include the fact that the time between onset and maximum flood depth is very short (in the order of 0.5hrs in 2086) therefore providing limited warning. Additionally model results suggest that even if safe access / egress could be developed, there could be difficulty in linking up an access route with land outside of the tidal flood extents.	

<table>
<tr><th>Site K

Multi-Storey Car Park</th><th>Current</th><th>Future</th></tr>
<tr><td></td><td>
</td><td>
</td></tr>
<tr><td>Summary of Risk</td><td>High risk of tidal flooding. >90% of site is in FZ 3. Modelling with defences indicates onset at 1 in 200 year event affecting entire site with maximum depths of 0.53m. No recorded historic flood incidents.</td><td>100% of site at risk by 2086 with depths of 0.9 – 1.20m increasing to 1.4 -1.75m by 2126 from tidal flooding and wave overtopping.</td></tr>
<tr><td>Hazard Rating</td><td>Moderate</td><td>Extreme</td></tr>
<tr><td>Access & Egress</td><td>Entire site in FZ3 and flooded at 1 in 200 year tidal event. Access / egress routes would need to be raised above these levels both on site and surrounding area.</td><td>No access / egress by 2086.
Duration of no access during 2126 flood event approximately 7.5 hours.</td></tr>
<tr><td>Potential for Development</td><td colspan="2">Development area of 0.002km^2. Low development potential due to large proportion of site currently experiencing flooding at 1 in 200yr in addition to flood hazard becoming extreme by 2126 as flood depths increase considerably. This, in combination with no access / egress to site by 2086, indicates that most development will be inappropriate at this site.</td></tr>
<tr><td>Types of Development</td><td colspan="2">Water compatible development only. Even if safe access / egress could be developed, most of the land around the site is projected to experience considerable depths of flooding (min.0.6m) for both 2086 and 2126 scenarios suggesting that there would be difficulty in linking up an access route with land outside of the tidal flood extents.</td></tr>
</table>

Site L Pavilion and Ferry Terminal	Current	Future
		
Summary of Risk	High risk of flooding due to low onset return period (1 in 10yr with additional extents after 1 in 50yr) with significant maximum depths around edge of site. No recorded historic flood incidents.	75% of the site at risk by 2086 with depths of ~ 0.15-0.40m. 100% of site at risk by 2126 with depths of 1.25-1.65m from tidal flooding and wave overtopping.
Hazard Rating	Low	Extreme, small areas of 'Significant'
Access & Egress	Access / egress potential to west of site only, onto The Esplanade in FZ1.	Potential for access / egress in 2086 to west of site onto esplanade - shallow flood depths (<0.2m). No access / egress by 2126 unless land elevated to create route linking to land west of site. Duration of no access during 2126 flood event approximately 3.5 hours.
Potential for Development	Development area of 0.043km^2. Defences likely to require re-evaluation and potentially improvement if development pursued. Currently parts of the site experience little or no flooding; however these are projected to flood by 2086, with effectively the entire site becoming inundated by 2126. Extreme hazard due to the 2126 flood depths in addition to lack of safe access / egress suggests most types of development will be inappropriate at this site.	
Types of Development	For development with a 100 year horizon (i.e. 2126) only water compatible development is currently appropriate for this site because not only must the development be safe, but according to PPS25, access and egress must also be safe. It is not for the 1 in 200 year event when considering the effects of climate change for 2126 unless a route is elevated above the tidal flood extents and can be linked to land outside the extents without increasing the risk of flooding elsewhere. Commercial development may be suitable provided the exception test is passed and safe access and egress can be demonstrated.	

Site M Gasholder, Magistrates Court, Fire Station and Council Offices	Current	Future
		
Summary of Risk	Low flooding risk ~20% site in FZ2, minimal area FZ3. Tidal modelling with defences indicates no tidal flooding. Historic flood events west of site include surface water ponding, river flooding, runoff from fields.	50% of site at risk by 2086 with average and maximum depths of 0.45m and 1.10m respectively. 75% of site by 2126 with depths of 1.15– 1.70m from tidal flooding and wave overtopping.
Hazard Rating	Low	Mostly 'Extreme', none at NW & southern edge
Access & Egress	Site in FZ1 / FZ2. Tidal flooding limited to area along North Quay road. Access / egress therefore restricted along North Quay and West Wey Road but adequate potential for safe routes to south and west of site.	Access retained in NW corner and along southern edge of site during 2086 and 2126 flood events.
Potential for Development	Development area 0.049km2. Currently some risk of flooding along North Quay and West Wey Road but much of site in FZ1 with no tidal flooding and good access/egress. Further flooding by 2086 across centre of site with increased extents by 2126 indicates that development may not be appropriate in this part of the site. However there are areas in the NW and along the southern edge of site which experience little or no flooding by 2126 where certain types of development could be sited.	
Types of Development	Flood extents vary significantly across the site a 1 in 200yr event currently and in 2086 and 2126. In addition to the retention of access / egress throughout, this suggests that a range of uses would be appropriate for the site. A sequential approach should be used to locate higher risk development in areas of lowest flood risk. Lower risk / some types of commercial development could be located in areas above the 2086 extent but within the 2126 extent, however ground levels may then need to be raised locally to ensure safe access and egress for these locations and flood risk must not be consequently increased elsewhere. The northern end of the site is above the 2126 tidal flood extent, has safe access / egress and may therefore be suitable for residential development. Similarly the southern edge of the site is above the tidal flood extent, however this area is small and a mixed development approach may make best use of this part of the site (with residential above the area of 2126 flood extent).	

Site N	Current	Future
Governors Lane Car Park		
Summary of Risk	Low risk of flooding, site in FZ 1, modelling with defences indicates no flooding. No recorded historic flood incidents.	Not at risk in 2086. 50% of site at risk by 2126 with depths of 0.2-0.7m from tidal flooding and wave overtopping.
Hazard Rating	None	Significant (2126), None (2086)
Access & Egress	In FZ 1, no flooding indicated by model therefore no access / egress issues.	Access / egress available in 2086 as no flooding. By 2126 access / egress potential to N of site but issue of linking route to land outside tidal flood extent. Duration of no access during 2126 flood event approximately 2 hours.
Potential for Development	Development area of 0.0009km2. Site in FZ1, currently no recorded tidal flooding, no access / egress issues until 2126. This suggests that commercial development may be appropriate at this site, however safe access / egress would need to be demonstrated and the exception test passed to allow residential development. Investigation regarding impact of development on surrounding area recommended prior to any development.	
Types of Development	Site is above the 2086 tidal flood extent and partly outside the 2126 flood risk area which suggests that it could be suitable for commercial development. However, although access and egress is safe to and from the site, there is no safe access / egress beyond the immediate area due to flood extents covering most of the town centre. This means that unless a safe route can be created without increasing flood risk to the site or elsewhere, only water compatible development is currently appropriate for this site.	

Hazard Rating: based on categories from Flood Risk Assessment Guidance for New Development Phase 2, Framework and Guidance for Assessing and Managing Flood Risk For New Development (FD2320/TR2) HR Wallingford (October 2005).

3 SITE SUMMARIES AND RECOMMENDATIONS

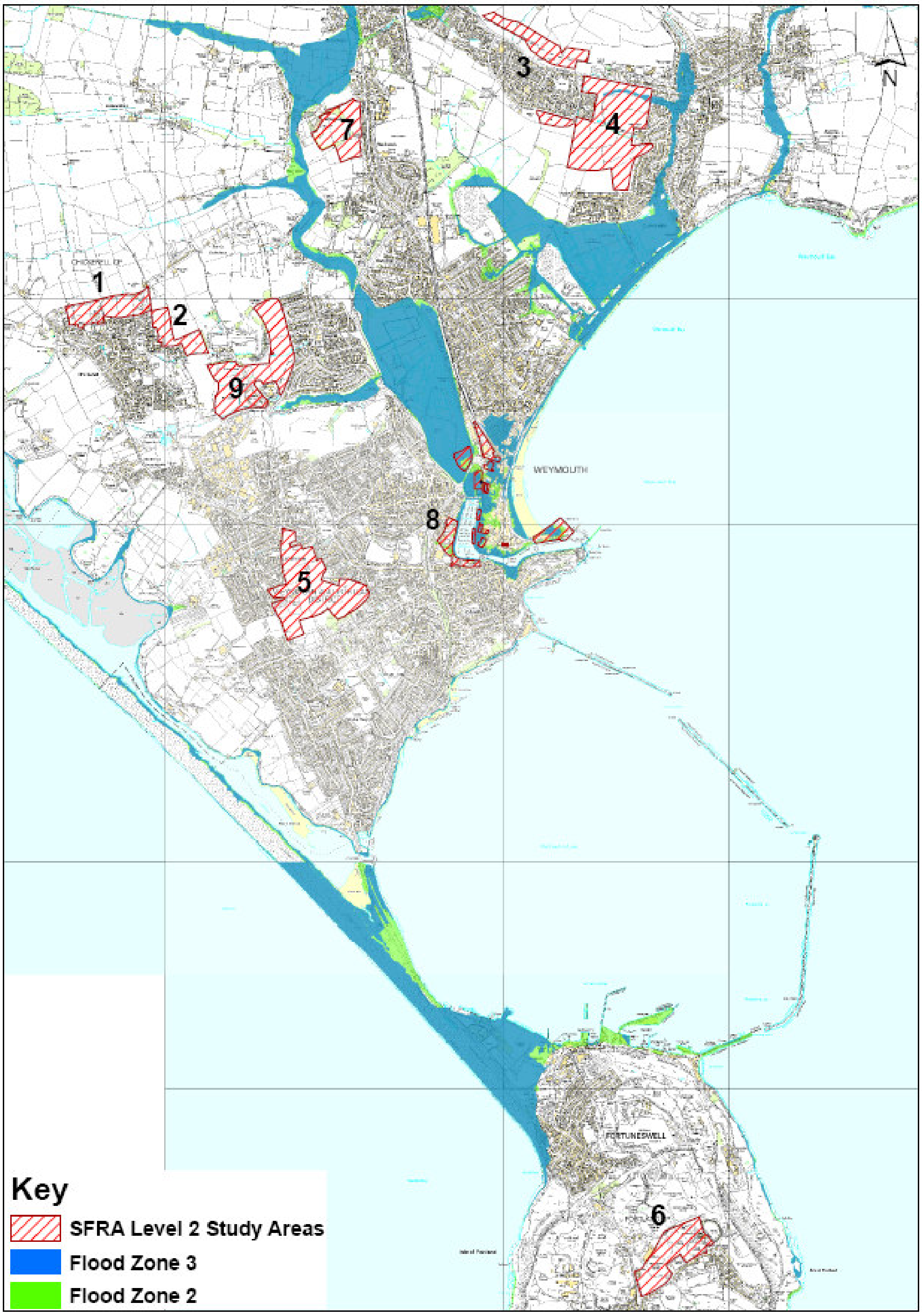
3.1 Overview of existing flood risk and inundation (based on Level 1 SFRA)

Figure 3.1 shows the Environment Agency Flood Zones 2 and 3. These represent the areas of medium and high flood risk respectively due to fluvial and tidal flooding. The medium flood risk is areas that may flood from a 1 in 1000 year event i.e. with an annual probability of 0.1%, whilst high flood risk represents areas that may flood from a 1 in 100 year fluvial or 1 in 200 year tidal events, i.e. with an annual probability of 1% or 0.5% respectively. Any areas not shown as Environment Agency Flood Zones 2 or 3 are classed as Environment Agency Flood Zone 1, low fluvial and tidal flood risk. As stated in Section 1.4.1, the Environment Agency Flood Zones do not take account of the beneficial impacts of flood risk management infrastructure,

Where study area sites are close to Environment Agency Flood Zones 2 or 3 a smaller scale figure of the area has been provided. Figures have not been provided for the Chickerell North and East Urban Extensions or for the Markham and Little Francis and Easton strategic development areas due to their distance from Environment Agency Flood Zones 2 and 3 as indicated in the relevant text.

The historic flooding information collected during the Level 1 SFRA has also been considered when reviewing the flood risk to the areas. This historic data is not conclusive and only indicates data recorded by Weymouth & Portland Borough Council or the Environment Agency. Other incidents of flooding may have occurred but not been recorded and therefore not shown on the figures below.

Figure 3.1 – Existing Flood Risk to SFRA Level 2 areas



3.1.1 Area 1: Chickerell North Urban Extension

The Chickerell North Urban Extension is entirely contained within Environment Agency Flood Zone 1. Environment Agency Flood Zones 2 and 3 are approximately 0.85km distant at their nearest point to the extension site. LiDAR data confirms that there is little flood risk to the area as the ground levels are significantly higher than the nearest area covered by the flood zone.

West Dorset SFRA Level 1 highlights that there is a land drainage issue in Chickerell and there have been a number of incidents of flooding from surface water flooding and foul sewage flooding within the town of Chickerell. There have been no recorded incidents of this nature in the development area, but the impacts of the development on the drainage network in Chickerell will need to be assessed to ensure that it does not increase the flood risk to the surrounding area.

Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk needs to be considered further (Section 3.2)

3.1.2 Area 2: Chickerell East Urban Extension

The Chickerell East Urban Extension is entirely contained within Environment Agency Flood Zone 1. Environment Agency Flood Zones 2 and 3 are approximately 0.80km distant at their nearest point to the extension site. LiDAR data confirms that there is little flood risk to the northern extent of the site, however the site is very low-lying at the southern end and further investigation may be useful in order to clarify the impact of development on flood risk in relation to the capacity of the drain along the southern border of the site.

As stated in section 3.1.1 above West Dorset SFRA Level 1 study highlights a number of surface water and foul sewage flooding incidents in Chickerell. It is thought that none of these fall within the development area.

Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2)

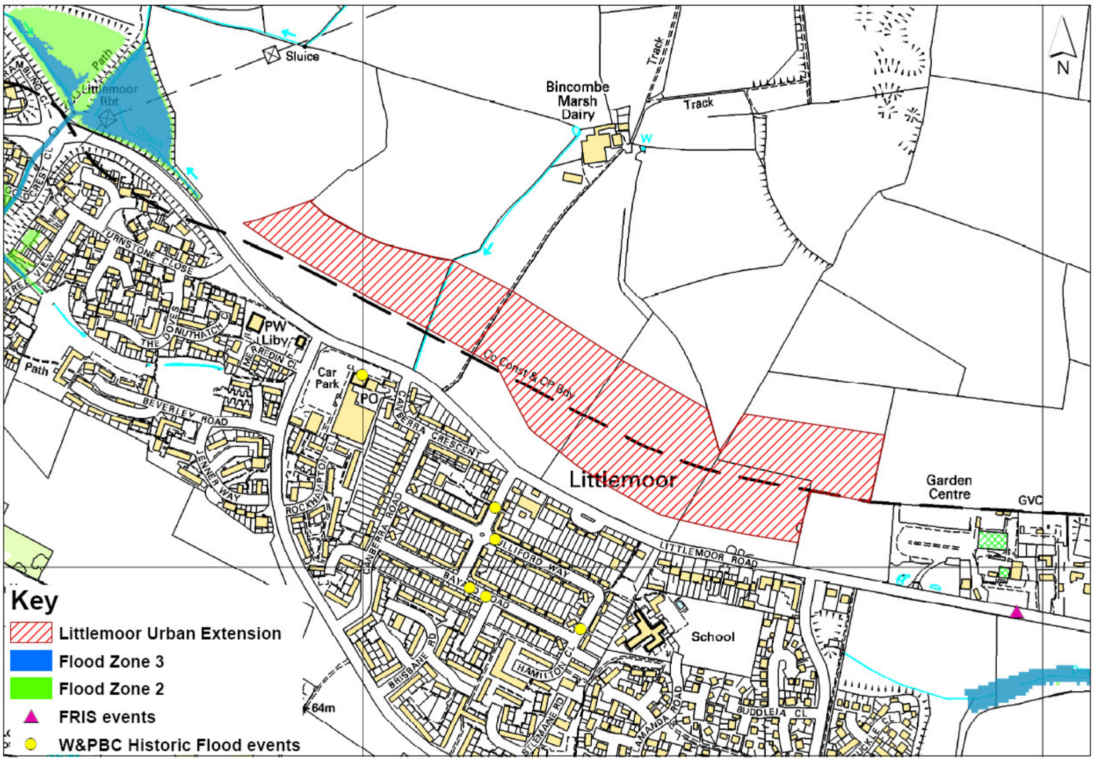
3.1.3 Area 3: Littlemoor Urban Extension

The Urban extension site at Littlemoor is entirely contained within Environment Agency Flood Zone 1. However, there is a small un-named watercourse that runs through the centre of the site from Bincombe Marsh Dairy and the Environment Agency Flood Zones 2 and 3 are in close proximity to the site – approximately 0.08km distant at the nearest point which incorporates Littlemoor roundabout and 0.33km distant in the area between Littlemoor and Preston.

The contours for the area show that the lowest point on the site is in the North West corner, although this is still approximately 5m higher than the land covered by the Environment Agency Flood Zones 2 and 3 at Littlemoor roundabout. The land then rises, with the highest part of the proposed area being at the west of the site, which is approximately 10m higher than the Environment Agency Flood Zone from the Preston area. This suggests that even if the flood zones increased due to climate change it is very unlikely that the proposed site will be affected. To take a precautionary approach we suggest that if any areas are to be designated as open space then these would be most appropriate in the North West part of the area and adjacent to existing ordinary watercourses.

There are no recorded historic flood events relating to the site itself. Adjacent to the site surface flooding and overland run-off were reported to occur on Littlemoor road due to inadequate drains in addition to surface and foul water flooding in both 1977 and 1993 on the Littlemoor estate to the south of the urban extension site.

Figure 3.2 – Flood Risk to Littlemoor Urban Extension



Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2)

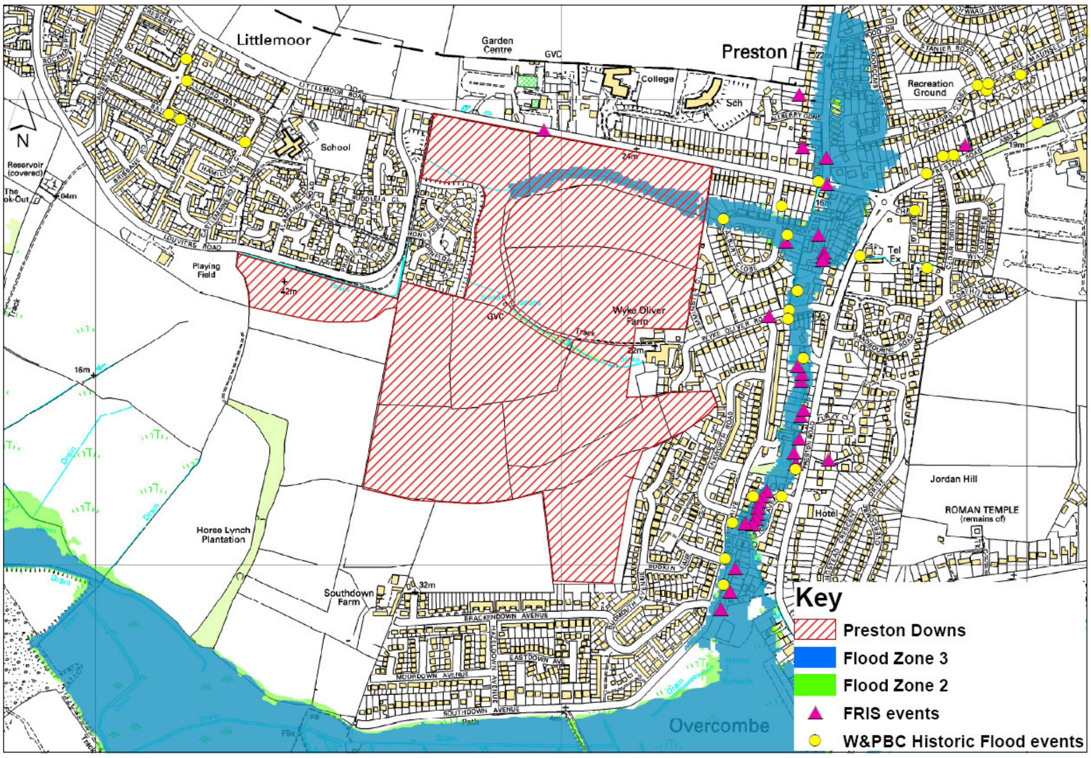
3.1.4 Area 4: Preston Downs strategic development site

The majority of the Preston Downs site is contained within Environment Agency Flood Zone 1; however at the northern end of the site there is an area within Environment Agency Flood Zone 3 (figure 3.3) relating to a tributary of the Preston Brook. LiDAR data shows that the northern end of the site is low-lying in comparison to the steeper mid to southern parts of the site and therefore verifies the flood risk indicated by the Environment Agency Flood Zones.

Part of the Environment Agency Flood Zones, shown in Figure 3.3, cover the Chalbury detention basin which is used to store water and reduce flood risk to Preston. Residential development should therefore be located away from this area, ideally to the south of the site where the ground levels are higher.

There are no recorded historic flood events on the site itself. Adjacent to the site, surface flooding and overland run-off were reported to occur on Littlemoor road due to inadequate drains, in addition to surface and foul water flooding in both 1977 and 1993 on the Littlemoor estate to the west of the urban extension site. There are several recorded incidents in the residential area of Preston to the east of the site from events in 1979 and 1993 where flooding occurred primarily as a result of inadequate drainage and culverts.

Figure 3.3 – Flood Risk to Preston Downs Development Area



Improvements / modifications to the balancing ponds in this area are now being made as part of Weymouth Relief Road.

In order to further investigate the flood risk to the Preston Downs development area, particularly given the presence of two small watercourses only one of which is identified within the EA Flood Zones, a 1D HEC-RAS hydraulic model was used to evaluate potential flood extents. This model was based on previous work carried out for the Preston Brook Flood Feasibility Study (Posford Haskoning, June 2002). Plans for the Weymouth Relief Road were reviewed and relevant information such as culvert dimensions and the gradient for Chalbury detention basin were included in the model.

The results are displayed in Figure 3.4 which shows mapped flood extents for the 1 in 100 year event pre and post development, with and without the effects of climate change.

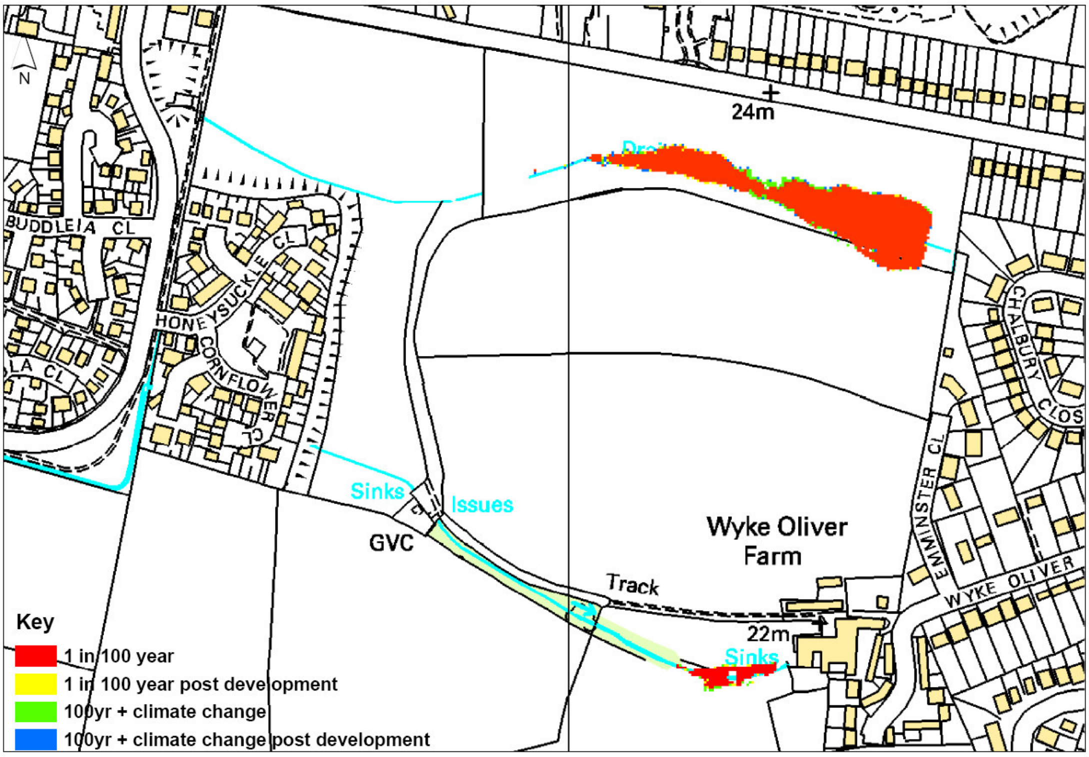
Results show that the extent of flooding for both watercourses at the 1 in 100 year event was minor. For this reason no further return periods were tested.

Littlemoor stream flood extents were entirely contained within the Chalbury detention basin with maximum depths of approximately 1.65m increasing to 1.8m post development. No further increases in depth or extent were observed in relation to the effects of climate change.

The Wyke Oliver Stream is a small watercourse (too small for capture within the EA Flood Zones) draining to the Preston Brook with a culverted section between Wyke Oliver Farm and Preston Brook. Flood extents were minimal, the greatest lateral extent covering approximately 640m^2, however the maximum flood depths are significant at 1.5m for all scenarios. Extents and depths were not observed to increase as a result of climate change.

These results indicate that development would have a very minor effect on flood risk originating from the Littlemoor and Wyke Oliver streams. However, should the timing of any flooding and its subsequent inflow to the Preston Brook coincide with flooding in Preston Brook itself, the downstream consequences could be substantial and therefore prior to development potential impacts of this kind should be considered.

Figure 3.4 – Mapped flood extents for Littlemoor stream (north) and Wyke Oliver stream (south)



Based on this assessment we are assuming flood risk to the Preston Downs site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2)

3.1.5 Area 5: Markham and Little Francis strategic development site

The Markham and Little Francis development site is entirely contained within Environment Agency Flood Zone 1. Environment Agency Flood Zones 2 and 3 are approximately 0.75km distant at their nearest point to the site. LiDAR data confirms that there is little flood risk to the area.

Lanehouse Stream is within the north of the site but no flood zone is shown for this area. This is because it is too small to be covered by the Environment Agency Flood Zone. However, there is still a risk of flooding here, although generally recorded flooding in this area does not seem to be as a result of the stream overtopping. Most of the problems tend to be as a result of blocked drains and gullies, surface water run-off, and tidal flap valve malfunctions. There are screens in place along the stream. It is known that these screens can become blocked and cause flooding during a high flow event. The screens are subject to high maintenance, as they must be visited when heavy rainfall is predicted to ensure they are not blocked, to enable the structures to operate efficiently.

Historic events show that flooding from surface water is an issue in the Lanehouse Stream area and affects several houses on Overbury Close. This flooding is due to overland flows from the Littlesea Industrial Estate following heavy, localised storms. A flood risk assessment was undertaken by Royal Haskoning in June 2005 to investigate the existing capacity of the Lanehouse Stream and its structures downstream of Lanehouse Rocks Road. Following the study, predictions were made regarding the downstream effect of any improvements to drainage works in the area, with the aim to reduce the risk of internal property flooding.

As part of the assessment a hydrological study was carried out, followed by 1 dimensional hydraulic modelling. The modelling highlighted the insufficient capacity of the culverts downstream of Lanehouse Rocks Road. New developments therefore need to implement Sustainable Drainage systems (SUDS) to ensure that any development does not make flood risk worse downstream and where possible reduces flood risk.

Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2) although we would recommend that the blockages in the Lanehouse Stream and the drainage capacity of the Industrial Estate are investigated in more detail as part of a FRA prior to any development going ahead and included as part of a planning obligation.

3.1.6 Area 6: Easton strategic development site, Portland

The Easton development site is entirely contained within Environment Agency Flood Zone 1. Environment Agency Flood Zones 2 and 3 are approximately 0.73km distant at their nearest point to the extension site. LiDAR data confirms that there is little flood risk to the area. There are no rivers on Portland due to the type of geology. It is composed of highly permeable rock from the Jurassic period.

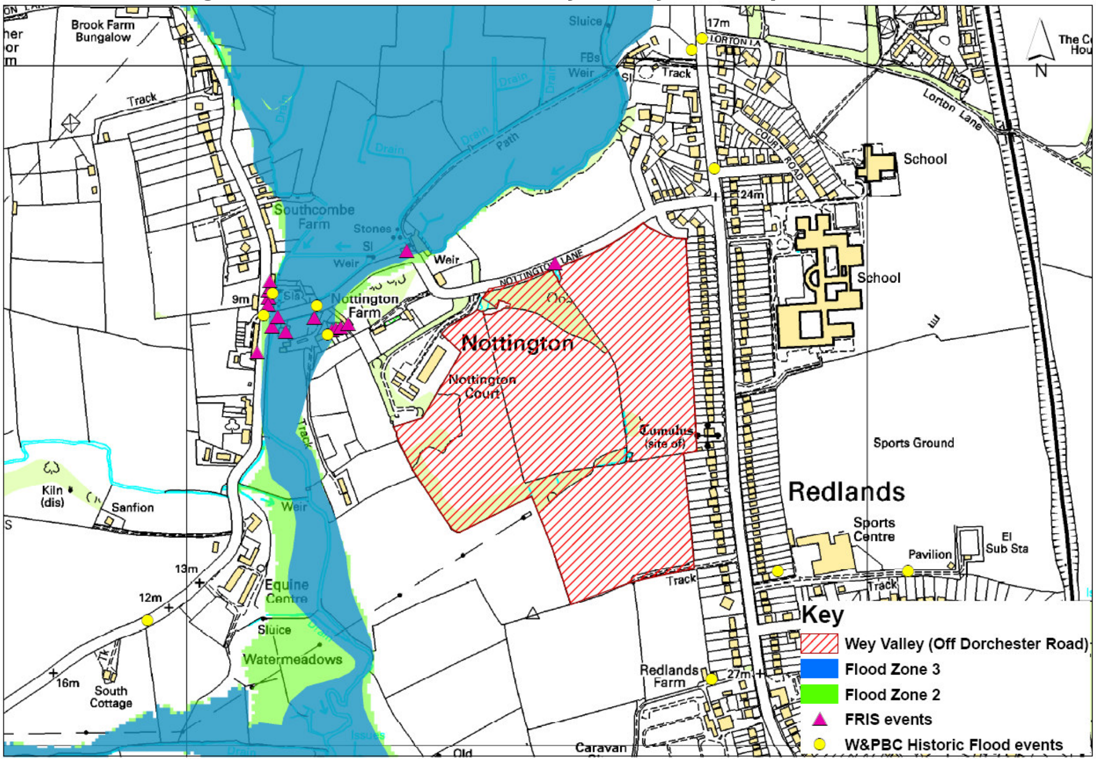
Currently there are no reported instances of historic flooding within the catchment.

Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2)

3.1.7 Area 7: Wey Valley strategic development site

The Wey Valley development site is entirely contained within Environment Agency Flood Zone 1. Environment Agency Flood Zones 2 and 3 are approximately 0.09km distant at their nearest point to the site. LiDAR data indicates that the Wey Valley site is relatively flat and low-lying.

Figure 3.5 – Flood Risk to Wey Valley Development Area



The lowest point on the site is along the northern edge which is approximately 12.5mOD, which is approximately 2m higher than the Environment Agency Flood Zone to the north of the site. It is therefore unlikely that, even including climate change, water levels will increase enough to affect the proposed site. The south of the proposed site is much higher and therefore at an even lower risk.

There are no recorded historic flood events on the site itself. Flood incidents are recorded to have occurred both east and west of the site to the extent of causing internal flooding to properties surrounding Nottington Farm and in Redlands (1977 and 1993). More recently flooding in 2002 resulted in the closure of Nottington Lane to the north of the site.

Downstream of this area there are a number of critical areas along the River Wey, namely Radipole Lake and Westham Bridge. The RSPB are currently reviewing the Water Level Management Plan for Radipole Lake, possibly with the aim to reduce water levels. Additional flow can therefore not be input into Radipole Lake due to the development. Westham Bridge is a sensitive area where there is a limited capacity, particularly during high tides. Any increase in flow in the River Wey could impact on the capacity of the bridge and therefore affect the surrounding area and Radipole Lake.

Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2)

3.1.8 Area 8: Town centre strategic development sites

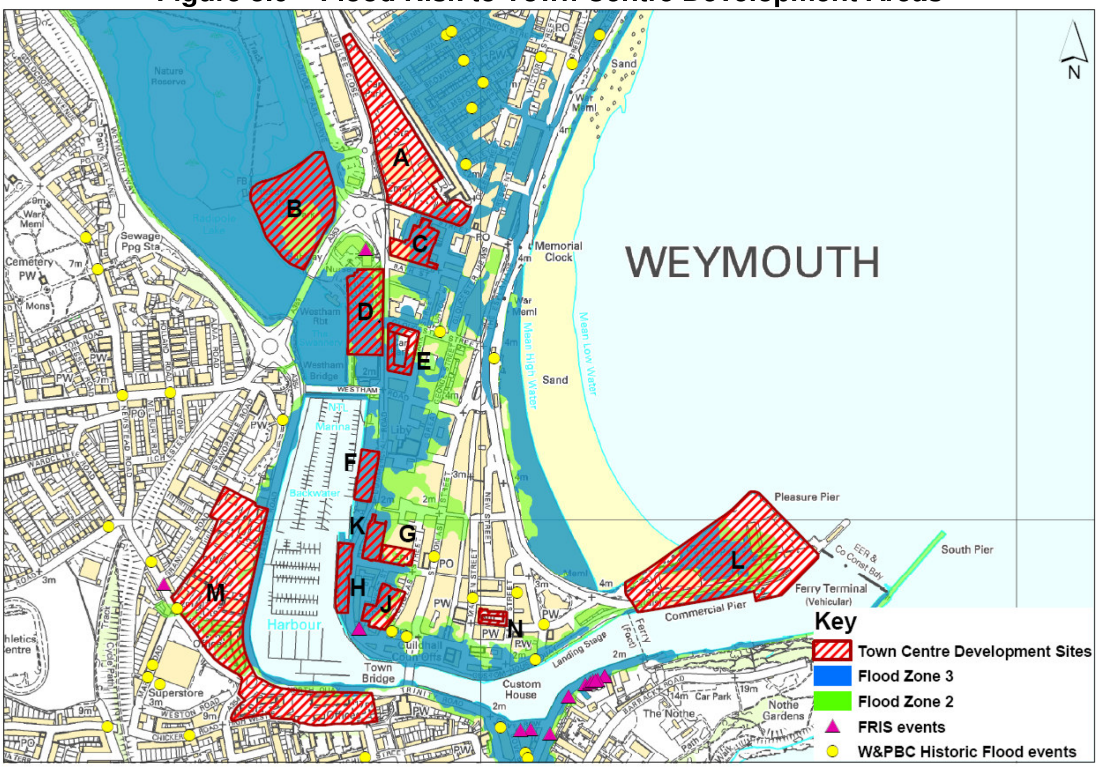
Several of the town centre development sites are within Environment Agency Flood Zones 2 and 3, details can be found in Table 3.1.

Table 3.1 – Overview of flood risk to town centre sites

Flood Zones	Sites
Entirely within Flood Zone 3	Harbourside Car Park (F), The Loop Car Park (H)
Partly within Flood Zone 3	Swannery Car Park (B), Melcombe Regis Car Park (D), Park Street Car Park (E), Multi-Story Car Park (K), Post Office Sorting Office (G), Pavilion and Ferry Terminal (L), Train Station and Jubilee Sidings (A), Bus Depot (C), Ten Pin Bowling Alley (J)
Partly within Flood Zone 2	Gasholder, Magistrates Court, Fire (M)
Entirely within Flood Zone 1	Governors Lane Car Park (N)

LiDAR data confirms that the town centre area is very flat and low-lying which corroborates the potential flood risk indicated by the Environment Agency Flood Zones. All of the town centre sites are within the tidal Flood Zone with the exception of site B, the Swannery car park which is partly within the fluvial Flood Zone.

Figure 3.6 – Flood Risk to Town Centre Development Areas



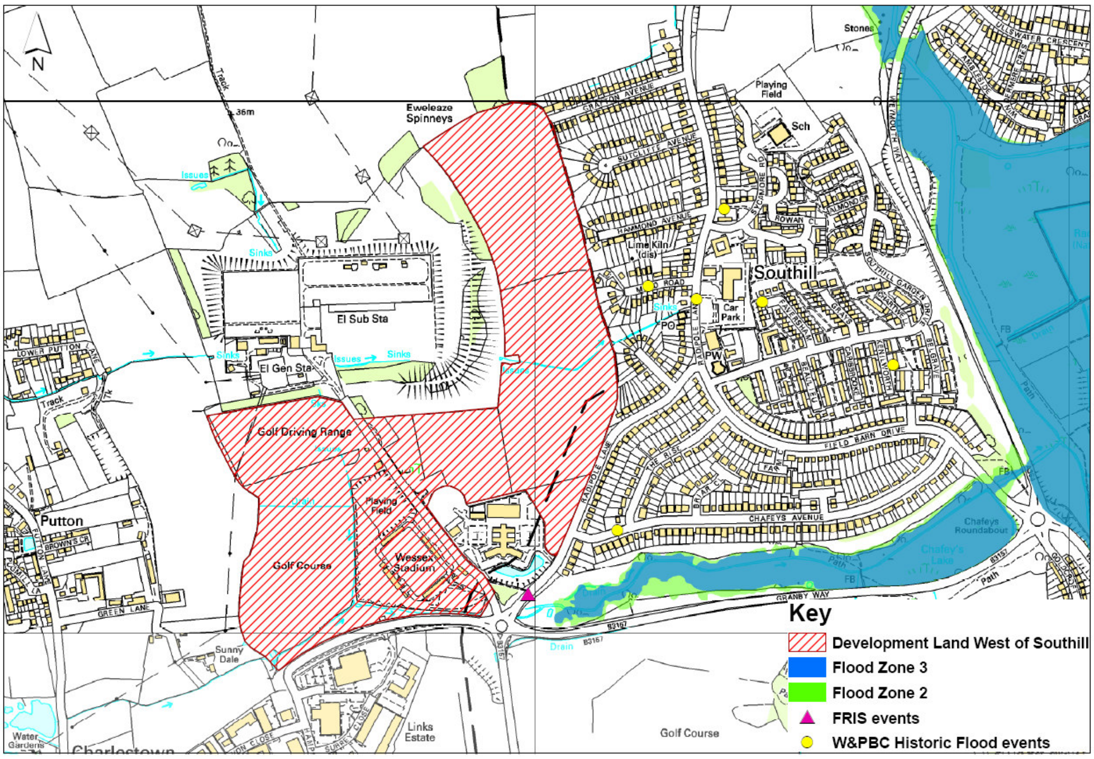
There are defences present in this area, these along with areas benefiting from defences will be discussed in later sections of the report.

There are no recorded incidents of historical flooding on the sites although there are several on adjacent land relating to events in 1955, 1977, 1979 and 1983 which resulted in a mixture of tidal, fluvial and surface water flooding. Some of the historic flooding events are recorded as occurring particularly close to the Ten Pin Bowling Alley and Magistrates Court sites. These sites may therefore require further investigation to assess the impact of their development on flood risk to the sites and to surrounding areas.

Given that a large proportion of the town centre sites are located within Flood Zones 2 and 3 and are at risk from tidal flooding, a hydraulic model has been used to undertake an assessment of the probability, depth and velocity of flooding for these sites. The results are detailed in section 4.

3.1.9 Area 9: Land west of Southill for Urban Extension

Figure 3.7 – Flood Risk to Land West of Southill – Chickerell Urban Extension



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The Urban Extension site west of Southill is entirely contained within Environment Agency Flood Zone 1. However, Chafeys Stream runs through the southern end of the site. Consequently Environment Agency Flood Zones 2 and 3 are in close proximity to the site, approximately 0.11km distant at the nearest point. LiDAR data indicates that the Southill site is very flat and low-lying.

There are no recorded historic flood events on the site itself. Incidents are recorded to have occurred to the east of the site causing flooding to roads and properties on Radipole Lane and other locations within Southill (1977, 1979 and 1993).

In December 2008 and January 2009 there have been a number of incidents of flooding of properties in Southill due to heavy rainfall events and limited culvert capacity. The culvert is situated upstream of Radipole Lane in Southill. Up to this point the watercourse is open. A feasibility study has been produced regarding this culvert and watercourse entitled *Feasibility Study Report for Southill Watercourse, Weymouth, August 2009.* The results of this study indicate that the current maximum capacity of the culvert corresponds to a 1 in 50 year flood event and that during a 1 in 100 year event it would be expected to see flooding at least equivalent to that experienced by the Southill area on 13th December 2008. We therefore recommend that no development is located adjacent to this watercourse otherwise the new properties may be at risk from flooding, or impact on the flooding of properties in Southill.

The north of the site is higher than the south and therefore if open space is planned this would be best suited towards the south of the site, therefore keeping the residential developments further from the flood zone.

Based on this assessment we are assuming flood risk to the site is minimal and therefore only the impact of the development on flood risk has been considered further (Section 3.2)

3.2 Overview of impact of development on flood risk elsewhere

In order to assess the current potential impact of development within the Level 2 study sites on flood risk to the surrounding areas, hydrological assessments of the catchments in which the study sites are located were performed. This was undertaken to show at a strategic level which sites could have the most impact on increasing flood risks elsewhere (i.e. away from the development site itself). This approach allowed an assessment of pre and post development flows to be made at each site, which then could be compared to the other sites to demonstrate which development sites have the most potential to increase food risk through increasing flows through comparing relative change. This information is then used to understand the relative level of mitigation measures that each site may need to use in order to meet the requirements of PPS25.

To undertake the assessment the FEH Rainfall Runoff method in combination with ISIS and standard percentage runoff (SPR) adjustment for the 1 in 100 year event was used. SPR was adjusted in order to account for the increase in run-off normally associated with development through increasing the proportion of impermeable land within the catchment. The modified SPR is then applied to pre-development Rainfall Runoff results to determine percentage increases in flow and run-off volume due to development.

SPR adjustment was based on the percentage of the total catchment area to be developed. Land use coefficients for impermeable land/roofs/tarmac and greenfield/open space were used in conjunction with the assumption that for the worst case scenario (maximum proposed number of units), 75% of the developed land would be impermeable (tarmac, roofs etc) and 25% permeable (open space, gardens etc). For alternative scenarios such as mid or best case the percentage of impermeable / permeable land was altered to represent the scenario.

It was also considered that due to the small and in some cases urban nature of the catchments the Institute of Hydrology (IOH) Report NO.124 Small Catchment method and Wallingford Procedure/Modified Rational Method for estimating flows should be performed for the study areas for pre and post development scenarios and used as a comparison to the FEH Rainfall Runoff results. We have used the FEH Rainfall Runoff results as it was considered that these were more representative, robust results than the IOH Report No.124 and Modified rational method which are relatively approximate in evaluating rainfall ratios used to derive the flow rates, leading to some uncertainty in their results. Additionally the Flood Studies Report (FSR) maps used to acquire catchment details, such as average annual rainfall, for the IOH Report No.124 and Modified rational method are of such a large scale that it was found that differences in flow estimates were largely dependent on catchment area and urban extent alone, compared with the FEH Rainfall Runoff method which takes account of a larger range of catchment descriptors unique to each catchment.

FEH Rainfall Runoff and SPR adjustment results can be observed in Table 3.2 in section 3.2.10. Results for the IOH Report No.124 and Modified Rational Method flows can be found in Appendix B.

3.2.1 Area 1: Chickerell North Urban Extension

Two scenarios were tested for the Chickerell North Urban Extension site:

- 700 units
- 350 units – i.e. half of the requirement for the Urban Extension leaving scope to locate the remaining 350 on an alternative Urban Extension site

As would be expected the largest impact is created by placing all 700 units at this location. However the percentage increases in SPR, flow and run-off volume for this scenario are all less than 2.5%. For the remaining scenario the percentage increases are consistently less than 0.5% which represents a minimal impact of development on the catchment. The reason for this includes the fact that the proposed development site occupies only 5% of the Chickerell North catchment, (which combines a very small urban catchment with a rural catchment approximately four times the size of the urban catchment) therefore a change in land use to the 5% will have a relatively small impact on the rest of the catchment.

3.2.2 Area 2: Chickerell East Urban Extension

Three scenarios were tested for the Chickerell East Urban Extension site:

- 700 units
- 350 units – i.e. half of the requirement for the Urban Extension leaving scope to locate the remaining 350 on an alternative Urban Extension site
- 350 units at Chickerell East and 350 units at Chickerell North. This scenario was tested because approximately 50% of the Chickerell North site drains into the Chickerell East catchment.

As would be expected the largest impact is created by placing all 700 units at this location. The percentage increases in SPR, flow and run-off volume for this scenario are all less than 4.5%. For the remaining two scenarios the percentage increases are consistently less than 1% which represents a minimal impact of development on the catchment. These increases are higher than those for Chickerell North, primarily because the area of the catchment to be developed is higher at 8.9% therefore any adjustments to land use will have a more obvious effect.

3.2.3 Area 3: Littlemoor Urban Extension

Three scenarios were tested for the Littlemoor Urban Extension site:

- 700 units
- 350 units – i.e. half of the requirement for the Urban Extension leaving scope to locate the remaining 350 on an alternative Urban Extension site
- 700 units at Littlemoor and 400 units at Preston Downs strategic development site. This scenario was tested because approximately 15% of the Preston Downs site drains into the Littlemoor catchment. The above numbers of units were used to represent the worst case scenario and therefore assess the maximum potential impact on the Littlemoor catchment resulting from development at both sites.

With 700 units at Littlemoor the SPR was observed to increase by 8.3% and the flow and run-off volume by 6.6% and 6.5% respectively. For scenario two, reducing the development to 350 units had the effect of halving the percentage increases.

In considering the effect of maximum development at both Littlemoor and Preston Downs, significant increases in both flow (11.5%) and run-off volume (9.8%) were observed for the Littlemoor catchment. Mitigation measures would therefore be required if both of these developments went ahead, as discussed in Section 2.8.

The proposed Urban Extension area occupies 7.1% of the Littlemoor catchment.

3.2.4 Area 4: Preston Downs strategic development site

Three scenarios were tested for the Preston Downs site:

- 400 units (worst case)
- 300 units (best case)
- 400 units at Preston Downs and 700 units at Littlemoor. This scenario was tested because approximately 30% of the Littlemoor site drains into the Preston Downs catchment. The above numbers of units were used to represent the worst case scenario and therefore assess the maximum potential impact on the Preston Downs catchment resulting from development at both sites.

The increases in SPR, flow and run-off volume (19%, 15% and 14.8%) demonstrate that worst case development at the Preston Downs site has a significant impact on the catchment. When the number of units is reduced to 300, there are reductions in the effect on SPR, flow and volume, however the percentage increases caused by development are still more than 10%.

In considering the effect of maximum development at both Preston Downs and Littlemoor, increases in both flow (15.9%) and run-off volume (16%) were observed for the Preston Downs catchment. This shows that when the effects of development on the adjacent sites of Littlemoor and Preston Downs are taken into account there is less impact on the Littlemoor catchment and surrounding area than on the Preston Downs catchment. This may be due in part to the fact that percentage increases are already elevated for Preston Downs due to the proposed development site occupying over 16% of the catchment as opposed to the 7.1% of the Littlemoor catchment, therefore changes in land use, particularly where impermeable land proportions are increased, have a significant effect on flood risk for the site and surrounding area.

3.2.5 Area 5: Markham and Little Francis strategic development site

Three scenarios were tested for the Markham and Little Francis site:

- 850 units (worst case)
- 475 units at 35 dwellings per hectare (dph) (mid case)
- 100 units at 7 dph (best case)

As might be expected the impact on flood risk represented by the increase in SPR, flow and run-off volume increases with increasing proportions of development, from an average increase of 2-2.5% for the best case, to a 21.3% increase in SPR and 16% increases in flow and run-off volume for the worst case scenario where the development was estimated to cover up to 18% of the total catchment area.

3.2.6 Area 6: Easton Development Site, Portland

The land cover of the Easton catchment contains, open grass, arable, exposed rock and woodland, it is assumed that these will encourage rainfall to percolate to the bedrock. The impermeable surfaces found on land are used for housing, industry and car parks that prevent water percolating the bedrock by obstruction and increase the speed and volume of run-off.

FEH catchment descriptors for the Easton catchment reveal a very low SPR indicating absorption of the water into the bedrock. It is very evident that the bedrock plays a major role in conveying water in the Easton Catchment and since the catchment area is only 1.7km^2 any development will have a significant impact on the catchment water cycle.

The Technical Data Sheet from the British Stone List reports that Portland Perryfield Shelly Limestone has the following Porosity and Water Absorption properties.

1) Porosity	15.8%
2) Saturation	0.63
3) Water Absorption	4.4%

Considering this data it would be ideal to quantify what volume of water the underlying rock can hold. However, the depth of the bedrock is unknown and since the top strata have been weathered and quarried this is also unknown. The level of the water table also varies and therefore this cannot be calculated at this strategic overview stage.

The development site covers 22.6% of the Easton catchment, a change in the current land use (predominantly open space) will therefore have significant consequences to the flow regime both at the site and downstream. The SPR, flow and run-off volume were estimated to increase by 92.4%, 74% and 71% respectively due to the increase in impermeable surfaces through development of the site. Significant mitigation measures would therefore be required for this development to proceed, see section 2.8.

3.2.7 Area 7: Wey Valley strategic development site

Two scenarios were tested for the Wey Valley site:

- 350 units (worst case)
- 75 units (best case)

Results for the worst case scenario show that there is a 1% increase of all three parameters (SPR, flow and run-off volume) across the catchment, which indicates that the proposed development at this site will have a minimal impact on flood risk on the surrounding catchment area. Percentage increases for the best case scenario are less than 0.25%. The impact of development on this site and surrounding area is observed to be low because even for the worst case scenario only 2.2% of the catchment would be represented by the new development therefore any land use changes would have a minimal impact on flood risk for the catchment as a whole.

3.2.8 Area 8: Town centre strategic development sites

The majority of the town centre strategic development sites are currently tarmac car parking areas or contain buildings. It is therefore suggested that development of these sites will not adversely affect SPR, flow or run-off volume since the surface already appears to be 100% impermeable. For this reason SPR analysis has not been performed for these sites. Development of these sites could improve the flow regime and lower flood risk to the sites and surrounding area by incorporating SuDS techniques in the development to reduce overland flow and surface water ponding.

Site D (Melcombe Regis Car Park) currently contains two very small strips of trees bordering the car park. It may be beneficial to consider maintaining any green spaces and where possible incorporating them into site-wide SuDS schemes in order to reduce flood risk for the site and surrounding area as recommended in PPS25.

Site M is the largest of the town centre strategic development sites and has the most diverse land use. The south-east part of the site comprises mostly buildings and car parking areas but approximately 25% of this area contains trees and open space (in the order of 1950m^2 in area). It is considered that the effect of this green space on SPR, flow and run-off volume would be limited but as with site D, maintenance and enhancement of existing green areas should be considered in the development of the site. Where possible this could be incorporated into site-wide SuDS schemes in order to reduce flood risk for the site and surrounding area.

3.2.9 Area 9: Land west of Southill for Urban Extension

Two scenarios were tested for the Southill site:

- 700 units
- 350 units – i.e. half of the requirement for the Urban Extension leaving scope to locate the remaining 350 on an alternative Urban Extension site

The development of 700 units at the Southill Urban Extension site was estimated to increase the SPR, flow and run-off volume by 5.60%, 4.54% and 4.48% respectively. A reduction of the development to 350 units (i.e. placing 350 units on an alternative Urban Extension site) significantly minimises the impact on the catchment indicated by the reduction of the percentage increases of SPR, flow and run-off volume to less than 1%.

The proposed Urban Extension area occupies 10.38% of the Southill catchment.

3.2.10 Summary

To be compliant with the requirements of PPS25, all greenfield development sites will be required to limit peak surface water discharge from the site to existing green field run-off rates for all storm intensities up to and including that with an annual probability of 1%, both now and in the future. Table 3.2 below shows a summary of the flows and volumes with and without development for each of the scenarios and areas detailed above. It should be noted that these results are for the 1 in 100 year event, impacts on flood risk due to the developments would be less for lower return period events, however likely to occur more frequently.

Of the four Urban Extension options tested Chickerell North has the smallest effect on both flow and run-off volume. Chickerell East has a slightly higher impact, whilst the land west of Southill and Littlemoor show higher increases to both flow and run-off volume, although these are still relatively insignificant. If the Preston Downs development is also included then the affect on flow and volume in the Littlemoor catchment is more significant i.e. approximately a 10% increase.

Of the Strategic Development Sites, Easton shows the largest impact on the surface water run-off. This is due to the geology of the area and can therefore be mitigated against through the use of SuDS. See Section 3.7 for more details.

The worst case scenario for Markham & Little Francis shows a significant impact on both flow and run-off volume, although the best case shows only a minor increase. This highlights that the area is suitable for development but the number of dwellings and amount of open space needs to be balanced against the level of mitigation required. A smaller number of properties may only require minimal mitigation, compared to more a larger development where a significant SuDS scheme would be required including maintenance.

Preston Downs has a similar impact as Markham & Little Francis and therefore the size of the development must be considered along with the required mitigation measures.

The Wey Valley has the lowest impact of the Strategic Development Sites, most likely due to the size of the catchment. The increase in flow and run-off is minor and therefore the impact on Radipole Lake and Westham Bridge will be insignificant.

For the Town Centre Strategic Development sites, little or no change is expected in the flow regime as a result of development because current land use for all of the sites mostly comprises impermeable surfaces in the form of buildings or car parks, although there are opportunities here to improve the situation by adding in areas of permeable land. This may benefit the surrounding areas as well as the development sites which is a desirable element of criterion c) of the Exception Test.

Table 3.2 - Summary table of impacts of development for each area

			Standard Percentage Runoff			Flow (cumecs)				Runoff volume (m3)			
Location	**Scenario**	**Units**	**Before development**	**After development**	**% increase**	**Before development**	**After development**	**Increase due to development**	**% increase due to development**	**Before development**	**After development**	**Increase due to development**	**% increase due to development**
Chickerell North Urban Extension Area	1	700	50.98	52.17	2.34	7.73	7.89	0.16	2.11	112,029.70	114,363.10	2,333.40	2.08
	2	350	50.98	51.05	0.15	7.73	7.74	0.01	0.13	112,029.70	112,176.10	146.40	0.13
Chickerell East Urban Extension Area	1	700	49.56	51.74	4.40	5.14	5.32	0.19	3.60	26,690.10	27,644.90	954.80	3.58
	2	350	49.56	49.81	0.50	5.14	5.16	0.02	0.41	26,690.10	26,799.60	109.50	0.41
	3	350 + 350 at Chickerell North	49.56	49.81	0.50	-	-	0.03	0.51	-	-	182.70	0.68
Chickerll Urban Extension Area Land West of Southill	1	700	48.78	51.51	5.60	9.37	9.79	0.42	4.54	105,476.60	110,203.30	4,726.70	4.48
	2	350	48.78	49.17	0.80	9.37	9.43	0.06	0.64	105,476.60	106,144.40	667.80	0.63
Littlemoor Urban Extension Area	1	700	34.68	37.56	8.30	4.00	4.27	0.26	6.60	45,593.00	48,557.00	2,964.00	6.50
	2	350	34.68	35.95	3.66	4.00	4.12	0.12	2.92	45,593.00	46,900.00	1,307.00	2.87
	3	700 + 400 at Preston Downs	34.68	35.56	8.30	-	-	0.46	11.46	-	-	4477.65	9.82
Preston Downs Development Area	1	300	34.54	39.18	13.43	8.68	9.60	0.91	10.53	68,376.20	75,480.30	7,104.10	10.39
	2	400	34.54	41.13	19.07	8.68	9.98	1.30	14.95	68,376.20	78,467.20	10,091.00	14.76
	3	400 + 700 at Littlemoor	34.54	41.13	19.07	-	-	1.38	15.86	-	-	10980.20	16.06
Markham & Little Frances Development Area	1	100, 7dph	34.83	35.70	2.50	6.35	6.47	0.12	1.92	19,259.90	19,629.70	369.80	1.92
	2	475, 35dph	34.83	38.95	11.83	6.35	6.93	0.58	9.14	19,259.90	21,011.20	1,751.30	9.09
	3	850	34.83	42.23	21.25	6.35	7.39	1.04	16.41	19,259.90	22,405.40	3,145.50	16.33
Easton Development Area	1	Academy	14.76	28.40	92.41	0.55	0.96	0.41	74.18	5,780.50	9,927.70	4,147.20	71.74
Wey Valley Development Area	1	75	50.90	51.01	0.22	35.38	35.45	0.08	0.21	204,037.10	204,463.40	426.30	0.21
	2	350	50.90	51.43	1.04	35.38	35.74	0.36	1.01	204,037.10	206,091.90	2,054.80	1.01

3.3 Surface water drainage

The hydrology assessments undertaken for the catchment area have been derived from Flood Estimation Handbook (FEH) catchment characteristics and where large scale development is proposed would have assumed that run-off from these proposed areas is based on greenfield run-off estimations. Following development of the site the increased impermeability will lead to an increased volume and run-off duration. Surface water flooding is difficult to predict and frequently develops quickly. For new developments, the best way of avoiding and managing surface water flooding is to manage the water at source through Sustainable Drainage Systems (SuDS).

SuDS are designed to mimic natural drainage processes, along with treating the water to reduce the amount of pollutants entering the watercourse. They can be located as close as possible to where the rainwater falls (at 'source') and provide varying degrees of treatment for the surface water, using the natural processes of sedimentation, filtration, adsorption and biological degradation. Guidance about the use of SuDS techniques can be found in Section 3 of the Weymouth & Portland Borough Council Level 1 SFRA Update and has also been appended to this report (see Appendix A). SuDS can also bring environmental, ecological and social benefits to residents and users of developments, contributing towards criterion a) of the Exception Test to "...demonstrate that the development provides wider sustainability benefits to the community that outweigh flood risk."

Traditionally existing surface water drainage systems generally have an infiltration capacity based on a 30 year design storm and therefore care should be taken when assessing the interaction of flood extents for a 1 in 100 year event with potential surface water drainage systems.

Where the proposed surface water drainage system does not have the capacity to convey flows from a storm event with an annual probability of 1% plus the 30% allowance for peak rainfall intensity contained in table B.2 of PPS25, overland conveyance routes should be identified and areas of the site defined for the storage of flood water which will not put life or assets at risk or allow excess run-off onto adjacent land. In general CIRIA's good practice publication C635 Designing for exceedance in urban drainage should be complied with.

The development of Surface Water Management Plans (SWMPs) is being explored by the Government as part of the Water Strategy Future Water (Defra 2008). They will focus on managing flood risk and optimising the provision of SuDS and are envisaged to inform Local Planning Authorities in their preparation of Core Strategy documents, allowing appropriate policies on flooding and surface water drainage to be incorporated.

As detailed in the flood risk section there are limited areas of known surface water flooding and less than 10 reported incidents of solely groundwater flooding across the whole borough (to date). We do not believe the incidents of surface water flooding to be significant enough to warrant the preparation of a SWMP within any of these areas, although it may be advantageous for Weymouth & Portland Borough Council to develop a flood risk management policy for infill development within areas prone to surface water flooding, particularly in the Town Centre or other areas that may come to light in the near future.

Generally across the nine areas there are a limited number of locations where drainage has been the major factor in causing flooding in the past. The most critical drainage location falls in the land to the west of Southill where the culvert capacity is known to cause flooding of properties, as detailed in Section 3.1. If this culvert is exceeded, as it has been recently, then both the existing properties and proposed development could be at risk of flooding. Further investigation would be required for this area were development to go ahead, although the pre-feasibility study for this area should be considered before any additional assessment is carried out.

There could also be a drainage issue at Littlemoor roundabout. Currently a culvert flows into a balancing pond to the east of Littlemoor. If the culvert became blocked then due to the topography of the land it is unlikely that the development would be affected, but if any additional run-off from the development increased the water level in the pond then the properties upstream of the pond may be at risk. The potential storage volume of the balancing pond and further investigation of the run-off from the Littlemoor development may be required to ensure that flood risk elsewhere is not increased.

We are not aware of any critical drainage locations within the Town Centre area.

3.4 Consequences of infilling floodplain

Environment Agency Flood Zone 3 can be split into Flood Zone 3a (high probability) and Flood Zone 3b (functional floodplain). Functional floodplain is defined as land where water has to flow or be stored in times of flood or for SFRAs purposes as land which would flood with an annual probability of 1 in 20 (5%) or greater in any year. Out of the nine areas the only area where Environment Agency Flood Zone 3 has been split is in the Town Centre, as this is the main area of flood risk. Details of the split are found in Section 4.2.2.

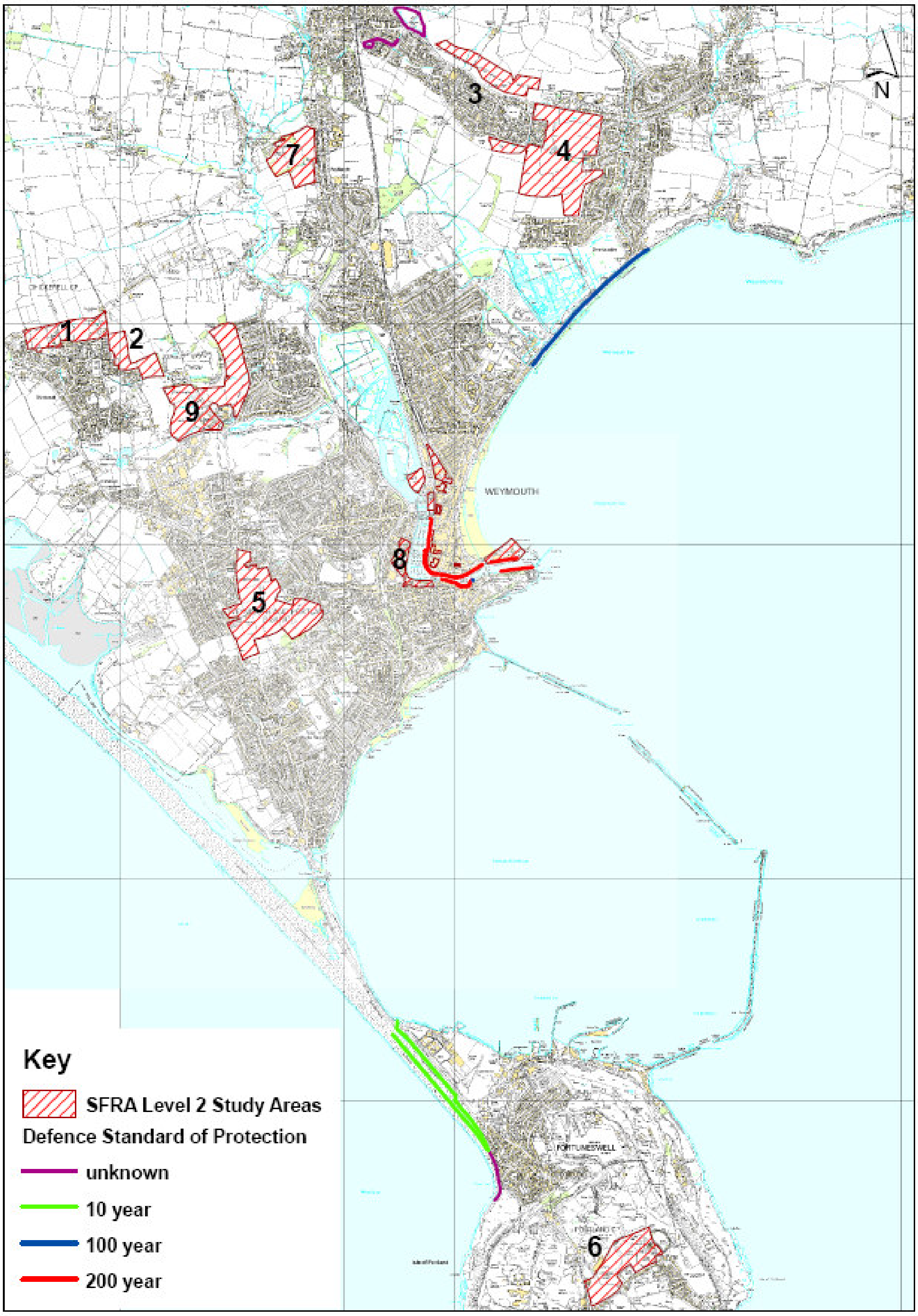
The residential developments under PPS25 are classified as More Vulnerable. Development of More Vulnerable allocations is not permitted within Flood Zone 3b and the Exception Test is required to allow for development within Flood Zone 3a. The provision of Essential Infrastructure such as highway routes to allow for evacuation of the site, is permitted within both Flood Zone 3a and 3b providing the Exception Test can be satisfied. Public Open Space is designated as Water compatible development and therefore development is appropriate within all Flood Zones. Commercial operations requiring waterside locations such as docks, marinas and wharves are also classified as water compatible developments.

Under a fluvial or tidal event, the effects of raising land for development in order to mitigate flood risk, could increase flood risk elsewhere. The Environment Agency will oppose any infilling of the fluvial floodplain on grounds of loss of conveyance and / or loss of flood storage unless suitable compensation lowering is carried out. At a local level, under any flooding scenario, raising the ground levels may change the direction of flow. In tidal flood risk areas we recommend that the impact of raising ground for development is considered within site-specific flood risk assessments. This requires a reasonably accurate development Masterplan layout of the site, with estimated build and landscaping elevations detailed. An assessment of the consequences of infilling of the floodplain is a requirement under criterion c) of the Exception Test - “a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall" and should be undertaken as part of the detailed site specific Flood Risk Assessment.

3.5 Existing defences (based on NFCDD data)

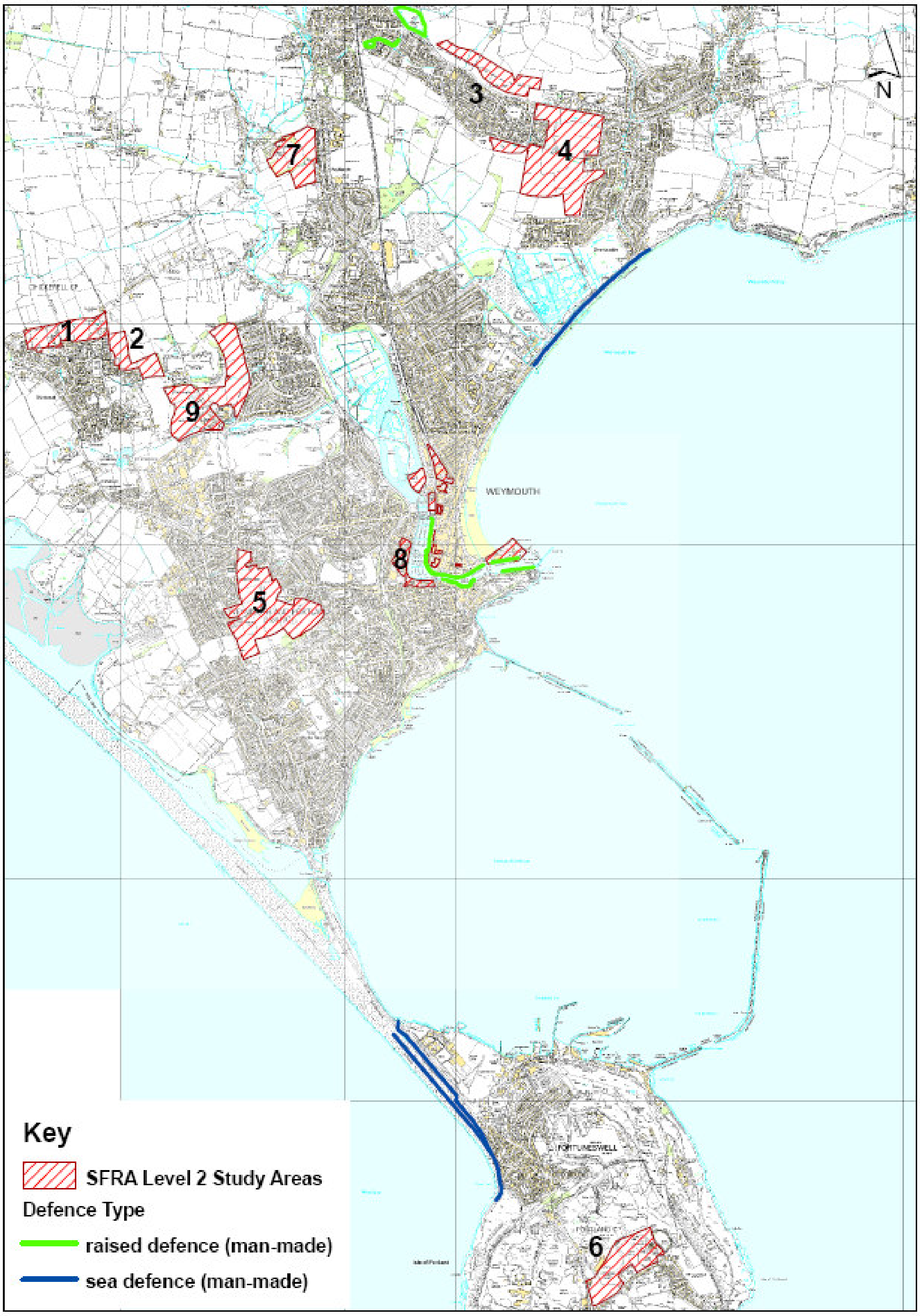
Figure 3.8 shows the standard of protection of any defences including those in the National Flood and Coastal Defence database (NFCDD) for the Weymouth & Portland Borough Council area, whilst Figure 3.9 shows the type of the defences e.g. raised defence or maintained channel.

Figure 3.8 – Standard of protection for all NFCDD defences in the borough



Where study area sites are close to defences a smaller scale figure of the area has been provided. Figures have not been provided for the Chickerell North and East Urban Extensions, Preston Downs Strategic development site, Markham and Little Francis, Wey Valley, Easton strategic development and Land west of Southill for Urban Extension areas due to their distance from defences included in NFCDD as indicated in the relevant text. There may be other private or informal defences not included in the database and therefore not shown on the figures.

Figure 3.9 – Defence type for all NFCDD defences within the borough



3.5.1 Area 1: Chickerell North Urban Extension

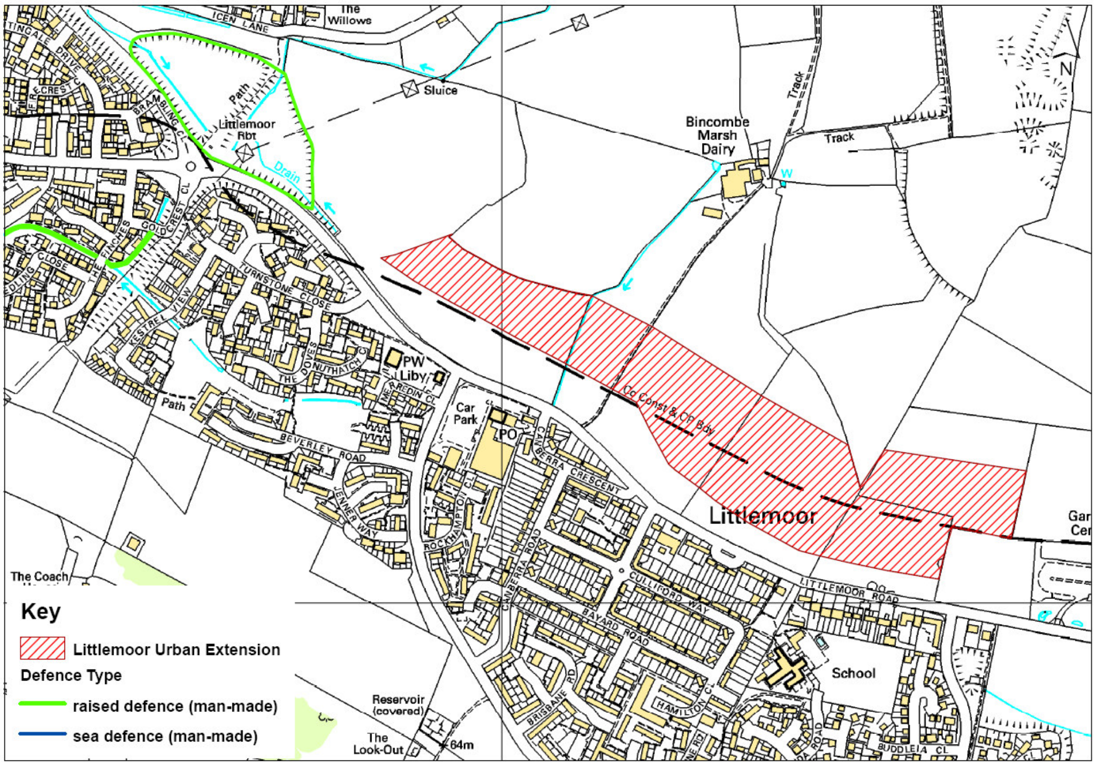
There are no watercourses in the area and therefore no existing defences are shown on NFCDD for this area.

3.5.2 Area 2: Chickerell East Urban Extension

There is no known risk of flooding in this area. There are no existing defences shown on NFCDD for this area.

3.5.3 Area 3: Littlemoor Urban Extension

Figure 3.10 – Defence types in the Littlemoor area



There are no existing defences shown in the NFCDD for the proposed Littlemoor site. However, 0.1km to the NW at the site of Littlemoor roundabout there is approximately 810m of man-made raised defences. There is also an estimated 415m of man-made raised defence (embankment) approximately 0.3km NW of the site between Goldcrest Close and Broadwey Close. The maintainer and standard of protection for these defences are not recorded in NFCDD.

The Weymouth Relief Road is currently under construction. As part of the road network there are a number of flood mitigation measures to take account of the additional highway drainage and run-off, and to try and improve the situation for the residents of Littlemoor. The Weymouth Relief Road will directly impact the Littlemoor development site and flood mitigation measures proposed for the road such as the balancing ponds 'Littlemoor East Pond', 'Bincombe Marsh Pond' and 'Chalbury detention basin' could enhance flood defence for the Littlemoor site. Figure 3.12 shows the flood mitigation measures being carried out as part of the Weymouth Relief Road. Because this is currently under construction we have assumed that the ponds are in place when undertaking our assessment. These ponds may provide storage for some of the additional surface water run-off due to the development but this must not result in any negative impacts elsewhere. This is addressed further in Section 3.7.

Figure 3.11 - Standard of protection of defences in the Littlemoor area

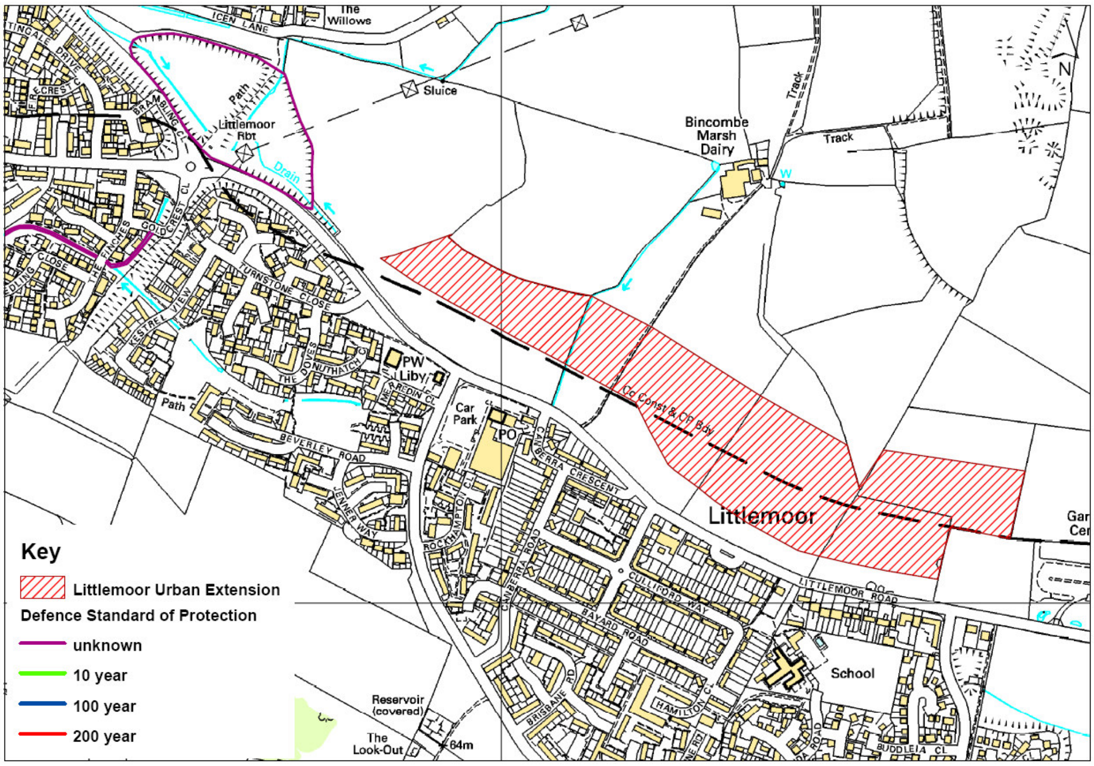
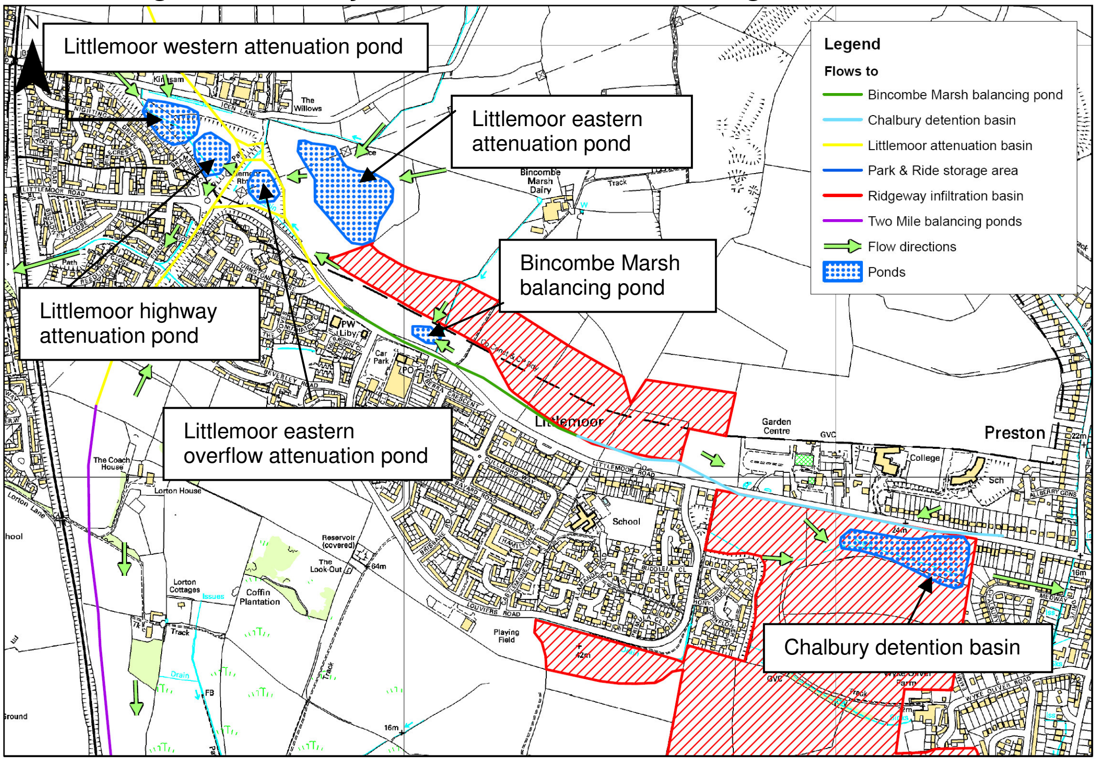


Figure 3.12 – Weymouth Relief Road flood mitigation measures



3.5.4 Area 4: Preston Downs strategic development site

There are no existing defences shown on NFCDD for this area.

As detailed in Section 3.5.3 above and shown in Figure 3.12 the development of the Weymouth Relief Road will directly impact the Preston Downs development site and flood mitigation measures proposed for the road such as the balancing pond 'Chalbury detention basin' will enhance flood defence for the Preston Downs site, although this must not result in a negative impact elsewhere, as discussed further in Section 3.7.

3.5.5 Area 5: Markham and Little Francis strategic development site

There are no known issues of flood risk in the area. There are no existing defences shown on NFCDD.

3.5.6 Area 6: Easton Development Sites, Portland

There are no known issues of flood risk in the area. There are no existing defences shown on NFCDD.

3.5.7 Area 7: Wey Valley strategic development site

There are no known issues of flood risk in the area. There are no existing defences shown on NFCDD.

3.5.8 Area 8: Town centre strategic development sites

Figure 3.13 – Defence types in the Town Centre area

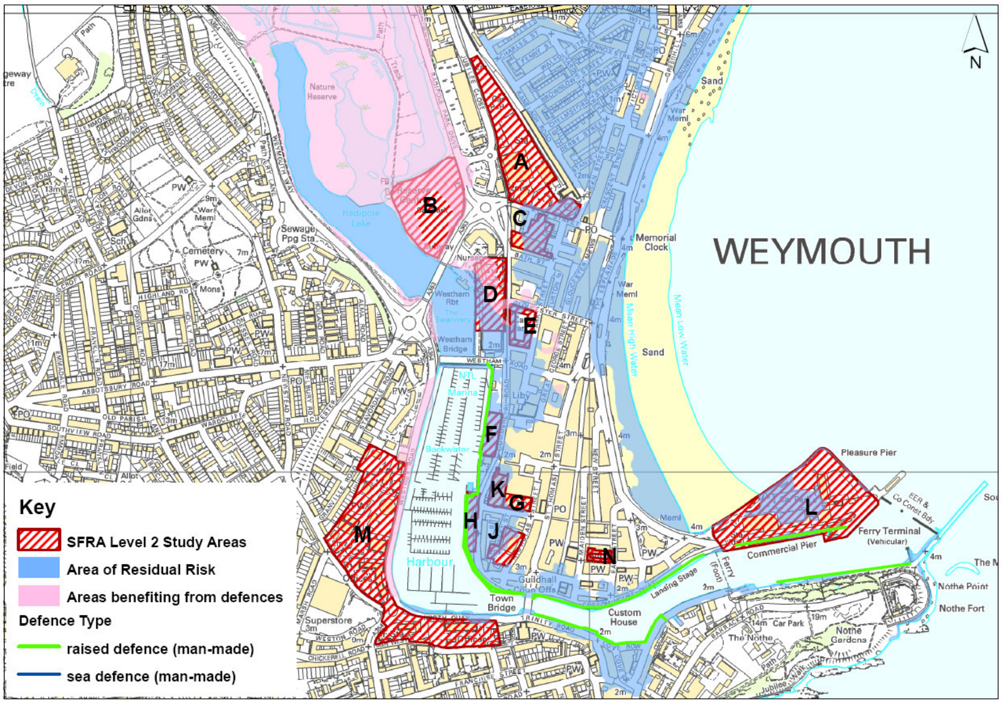
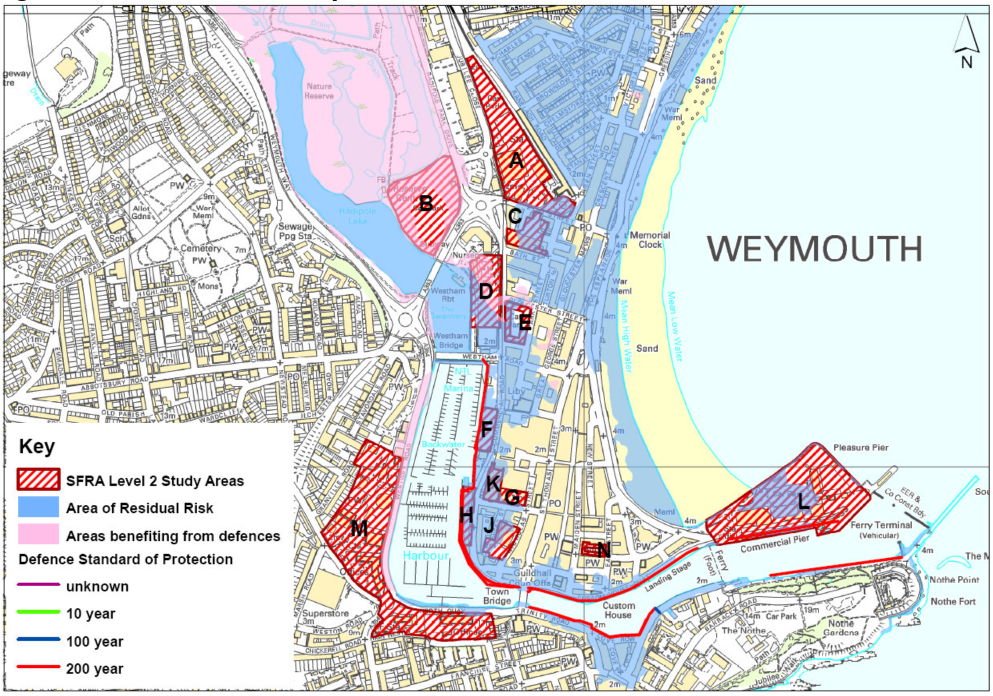


Figure 3.14 – Standard of protection of the defences in the Town Centre area



The harbour defences were designed and built in 1995. They allowed for a 1 in 200 year water level of 2.13mOD and 0.17m for 50 years of sea level rise. Since that study was undertaken both the estimated 1 in 200 year water level and the guidance on sea level rise has been updated. The 1 in 200 year water level is now thought to be 2.37mOD and therefore the modelling shows that the defences in the harbour are overtopped with the current 1 in 200 year water level, even with the previous allowance for climate change. The required coastal standard of protection is therefore currently not met in the harbour area of Weymouth.

Although the current standard of protection of man-made raised defences from the coast upstream to Westham bridge shows levels of protection just less than the 1 in 200 year event, these defences still benefit several of the town centre development sites including the Swannery Car Park (B), Governors Lane Car Park (N) and Pavilion (L). There are also substantial areas of residual risk affecting at least 9 of the 13 town centre sites as illustrated in Figure 3.14. These areas remain at risk due primarily to wave overtopping of the Esplanade.

The Pavilion (L) site is additionally exposed to wave action from Weymouth Bay and will require further analysis to determine the worst case joint probability flood level which combines wave action with extreme sea levels.

Areas benefiting from defences (ABD) are generally limited to the region upstream of Westham bridge although it can be seen from Figure 3.14 that the Magistrates Court (M) site has an area of ABD between the quay and the site. Further information regarding areas benefiting from defences can be found in the study ‘Wessex Tidal Areas Benefiting from Defences, South Coast Summary Report (SW816)’, conducted by Royal Haskoning for the Environment Agency (October 2008) from which the information displayed in Figures 3.13 and 3.14 originates.

A number of the defences are maintained by the Environment Agency and the Local Authority, however the majority are maintained privately.

Due to climate change, sea levels are expected to rise by approximately 1.26m by 2126 (based on guidance from PPS25). This is a significant increase and does result in additional flooding of properties. Details of the increases in extent, depth and velocity are provided in Section 4.

3.5.9 Area 9: Land west of Southill for Urban Extension

There is no known flood risk at this site. There are no existing defences shown on NFCDD.

3.6 Access and Egress

PPS25 states that development in flood risk areas should be protected from fluvial and/or tidal flood risk over the lifetime of the development (100 years for residential development and 60 years for commercial development). Access and egress routes should be above likely flood levels, and therefore access to any development sites should be considered with dry alternatives offered if appropriate to ensure safe access and egress for emergency vehicles and residents. Specific safe routes for access and egress from the site have been identified as part of the SFRA, whilst links within the development are to be addressed as part of a site specific FRA.

Developments which include flood risk areas need to provide appropriate flood warning and emergency plans so that users and residents are informed and can take appropriate action should a flood occur. Flood warning systems (such as Flood Warnings Direct operated by the Environment Agency) should not be solely relied on as responses to flooding should also be a result of active planning. Planning conditions can be used to cover the maintenance of signs and keeping evacuation routes clear, details of which should be provided in a site specific FRA.

The only sites currently at risk of flooding are the Town Centre sites. Using the velocity and depths maps safe access and egress routes have been highlighted. These should be investigated further as part of a detailed site Flood Risk Assessment. The potential for safe access and egress specific to each town centre site is identified within the town centre site summary table located in section 2. Many of the sites have at least some access to a route contained within Flood Zone 1, with the exception of the Swannery, Harbourside, Loop and Multi-Storey Car Park sites which would require elevated routes to provide safe access and egress above the Flood Zone 3 and tidal flood extent levels. Access and egress is significantly reduced when considering the effects of climate change on flood risk, many sites were found to retain safe access and egress up to 2086 but by 2126 only site M (Gasholder, Magistrates Court, Fire Station and Council Offices) displayed definite access to land above the flood extent levels. Site N (Governors Lane Car Park) while not in an area with a significant flood hazard will be cut off from areas outside the flood plain.

3.7 Potential mitigation and management of residual risk

Mitigation measures for development at any of these sites would need to be considered within a site specific FRA to demonstrate the site will be safe, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall, therefore satisfying criteria c) of the Exception Test. The adoption of flood resistant and resilient design and construction, where appropriate, should also be included as part of the site specific FRA in order to manage residual flood risk. As resilience measures still allow water to enter a building, these should not normally be considered for new development. Specific resilience measures that can be undertaken are detailed in Appendix A.

PPS25 states that the volume of run-off leaving a site should not increase after development, and where possible the drainage should mimic that of the natural drainage of the area. SUDS will therefore be required for all developments, although the type and space required will be dependent on the effect the development has on the volume of surface water leaving the site. Where the impact is small only minor work will be required e.g. permeable paving and vegetation where possible, whereas in areas where the impact is higher storage and attenuation may be required which could affect the viability of the site.

Even where a high frequency of flooding exists across the site sufficient economic benefit for the justification of further mitigation works needs to be identified in order to apply for Government funding. The Environment Agency’s remit relates to the provision of defences which protect existing assets. They do not provide defences to facilitate new development. Should new or improved defences be required to allow development to occur, the provision of these works would be the responsibility of the developer or the local authority if they wish to promote the development. Further measures to manage residual risk could include the use of developer contributions towards flood mitigation schemes and the management of surface water discharge from the site. These contributions are normally achieved through Section 106 agreements implemented by the Local Planning Authority or via the emerging Infrastructure Levy process. Specific mitigation measures would be identified through a Flood Risk Management Strategy and in the site specific FRA.

3.7.1 Areas 1, 2 & 7: Chickerell North, Chickerell East and the Wey Valley

Chickerell North, Chickerell East and the Wey Valley all show only minimal impacts on increasing flow and runoff volumes due to development. These could be mitigated against by optimising the area of permeable land within the development. It is unlikely that any other measures would be required. There is no flood risk from rivers or the sea to the development itself.

3.7.2 Area 3: Littlemoor Urban Extension

The mitigation option explored for this development is the use of balancing ponds being designed and relocated as part of the Weymouth Relief Road. Previously there were two ponds in the Littlemoor area, one attenuating flow from the west of the Knoll and another on the east attenuating run-off from the main valley. As part of the Weymouth Relief Road these ponds have been relocated and two additional ponds have been designed; the Highway pond and the East Overflow pond. Modelling was undertaken to calculate the reaction of the ponds during various events in order to identify the potential of the ponds to store runoff from the development. Table 3.3 summarises the size of storage volumes of each of pond and the discharge rate (litres per second) for the 1 in 100 year event, along with a measure of how full the ponds were.

Table 3.3 – Details of the Littlemoor balancing ponds

Pond	Maximum storage (m^3)	Discharge rate (l/s)	% full during 100 year event	% full during 100 year & climate change
West pond	9,257	369	88	88
East pond	24,730	694	97	97
East Overflow pond	7,139	615	95	95
Highway pond	11,022	29	24	29

Table 3.3 shows that there is some spare capacity in the Highway pond and West pond although the East pond and overflow pond are almost at capacity during the 1 in 100 year event.

Part of the Littlemoor site also falls into the Bincombe catchment where a balancing pond has also been installed which will provide online storage which can attenuate $600m^3$.

For the worst case scenario approximately $3,000m^3$ of volume needs to be stored between the Littlemoor, Bincombe and Preston Downs catchment. There is limited capacity in the East and overflow ponds, but there may be potential to provide additional storage in the Bincombe marsh pond. The potential for storage within the Preston Downs catchment will depend on whether or not the Preston Downs development goes ahead.

3.7.3 Area 4: Preston Downs strategic development site

The mitigation option explored for this development is the use of the attenuation ponds being designed as part of the Weymouth Relief Road. A Micro Drainage assessment was made of the Preston area and Chalbury detention basin (see Figure 3.12 in section 3.5.3 for location) as part of the Weymouth Relief Road Flood Risk Assessment. This states that the attenuation pond will be a maximum of 3.32 metres deep and will provide a permanently stored volume of 1,374m^3, with the capacity to attenuate 18,780m^3. During dry weather conditions, the depth of water at the deepest point will be 1.02 metres. The attenuation pond has been designed to discharge attenuated water at a maximum rate of 400l/s which is maintained using a Hydrobrake. If the capacity of the pond is exceeded, water will be discharged via an overflow weir. The modelling showed that the pond will not overflow during a 1 in 100 year event plus climate change, therefore providing protection to properties downstream.

The modelling shows that during a 1 in 100 year event the pond is only 50% full, and when climate change is included the pond is 51% full.

This highlights the potential for additional surface water flow to be directed towards the balancing pond, although a detailed assessment will be required to show that this will not increase the flood risk to the properties downstream of the pond outfall. Enlargement of the Chalbury detention basin could be one alternative. Another option would be an additional pond upstream of Chalbury detention basin along with attenuation measures e.g. swales or infiltration strips. This would then ensure that the current operational regime of the Chalbury detention basin is not affected and therefore no change would be made to the flood risk downstream.

3.7.4 Area 5: Markham and Little Francis strategic development site

The mitigation required for this area will be very sensitive to the number of dwellings and area of impermeable land. It is recommended that areas of open space are maintained as these will assist in attenuating the flow and allowing surface water to infiltrate. If the worst case scenario were to go ahead then on site storage would be required, in the order of 3,000m^3 to provide a 1 in 100 year standard of protection. Further work would be required to confirm a more accurate volume estimate. Overtopping scenarios would also be required due to the proximity to residential developments. This volume could be reduced if measures to attenuate the flow were also adopted. The site is relatively steep with the highest point at the south of the site and the lowest in the north. Any storage would therefore be best located to the north of the site, as that would follow the natural flow paths.

If the best case scenario were to go ahead then only minor attenuation measures would be required due to the low impact the development would have on the flow and run-off volumes. Further investigation may be required in this area to optimise the number of dwellings against the mitigation measures required.

3.7.5 Area 6: Easton Development Sites, Portland

Considering the geology of this catchment it will be crucial to provide a path for water to percolate the bedrock, this can be achieved using various SuDS techniques in the site design.

SuDS can offer various solutions to over come an increase to the amount of impermeable surfaces due to development. Since the majority of water within the Easton Drain catchment moves within the bedrock unlike more conventional rivers which flow overland, any impermeable surfaces will be reducing the holding capacity of the bedrock. This could result in instances of surface water flooding.

The following SuDS may be used in this area:

- Permeable Surfaces - A porous surface can be specified as the material for car parking spaces.
- Soakaways - These are subsurface structures into which surface water is conveyed to allow infiltration to occur.
- Filter Strips - Filter strips and drains are examples of source control. Source control measures deal with run-off at, or close to, the surface where rainfall lands. Additional flow may be directed to the strips.
- Storage of grey water run-off from houses can be stored and be re-used.
- Roadside Swales - It may be necessary to consider the use of small roadside swales at the entrance to a development after heavy rainfall. The grill is set above the base of the swale to encourage infiltration.

3.7.6 Area 8: Town centre strategic development sites

For the current situation sites M (Gasholder, Magistrates Court and Fire) and N (Governors Lane Car Park) are not at risk from flooding, whilst the remaining sites are not significantly at risk until the 1 in 200 year tidal event. This suggests that where defences exist they are only slightly below the required standard.

Due to the existing flood risk, mitigation will be essential for any new developments in the town centre area. When climate change is taken into account the risk across all of the sites and the existing buildings is increased considerably. Individual protection would therefore not be recommended for these sites as the protection in one area may affect the flow routes and cause other areas to flood. Instead, a Flood Risk Management Strategy is recommended for the entire town centre area to consider the risk to existing buildings and infrastructure as well as the proposed developments. This would ensure that all flow routes are considered.

In terms of the particular sites the 2126 flood extent is extensive and a large number of areas will be at significant or extreme flood hazard. Residential development therefore would not be suitable for these areas due to the lifetime of the development. The hazard by 2086 is generally moderate to significant, with some areas of extreme hazard and therefore commercial development, which has a lifetime of 60 years, may be acceptable provided the exception test is met. The flood risk could be mitigated against by ensuring the finished floor levels are above the predicted water level with climate change taken into account, although safe access and egress routes will still be required out of the flooded area.

All of the town centre sites are brownfield sites and therefore through the use of SUDS the surface water flood risk could be improved for the site and the surrounding area, e.g. by providing areas of open space as part of the development or using permeable paving.

3.7.7 Area 9: Land west of Southill for Urban Extension

Mitigation will be essential for any new development at Southill due to existing problems with surface water and the proximity of Radipole Lake. These issues mean that development could have more of an impact than is indicated by the small percentage increases in flow and run-off volume due to development detailed in Section 3.2. Since the site is currently a greenfield site, if development goes ahead it is recommended that the maximum amount of open space is maintained as this will assist in attenuating the flow and allowing surface water to infiltrate.

There are three main mitigation options for Southill. The first comprises extensive use of SuDS techniques in association with any new development in order to attenuate all surface water and improve the current situation. This may also present an opportunity to enhance the biodiversity of the site through habitat creation as part of the SuDS design. There are three possible locations for sites of attenuation:

- the field west of the Southill site,
- within the National Grid site, and
- the field east of Chickerell (east of the substation).

A second option would be to convey all excess water into Chafeys Lake through enlargement of culverts through the golf course, however the effect of this on both Chafeys Lake and Radipole Lake would require thorough investigation to minimise ecological and hydrological impacts. A third option would be to implement a combination of the first and second options, conveying some water through the golf course using a bifurcation cut-off device, whilst the rest drains to SuDS facilities in the Southill site.

Plans currently exist to install an interim measure in the form of a pond in the field immediately to the west of Southill. Future SUDS design could incorporate this temporary pond.

The Southill site is very flat and low-lying with a steeper region to the north, therefore in the design of SuDS for the site, should development be proposed, any storage options might be best located either in the centre of the site where there is a small watercourse that drains to Southill, or in the south of the site towards Chafeys Stream as this would follow natural flow paths.

4 ASSESSMENT OF FLOOD PROBABILITY, DEPTH AND VELOCITY

As detailed in Section 3 only the Town Centre strategic development sites are currently at risk of flooding directly from rivers or the sea, therefore the flood probability, depth and velocities will only be considered for this area.

4.1 Hydrological overview

4.1.1 Area 8: Town centre strategic development sites

Due to the low-lying coastal position of the town centre the area is at risk of tidal flooding.

In October 2008 Royal Haskoning wrote the 'Wessex tidal areas benefiting from defences' report for the Environment Agency. This report assessed extreme water levels considering the volume of overtopping. Results from this project have been used to assess flood risk at the town centre strategic development sites. The Areas Benefitting from Defences and Residual Risk Areas shown in Figure 3.14 are taken from this previous study.

Overtopping from waves is also a major source of flood risk to the town centre sites. Within the tidal Areas Benefiting Defences (ABD) project (SW816) wave overtopping was modelled at two locations: profile 322 - Memorial Clock and profile 326 - Weymouth Esplanade, using the Royal Haskoning in-house software package 'AMAZON'. The results of the combinations of sea levels and wave overtopping have also been included in this assessment.

The tidal still water levels used for each return period in the ABD model are displayed in Table 4.1.

Table 4.1 – Tidal Still Water Level for Base Year 2002 model inputs

Return Period	Tidal Still Water Level (mOD)
1 in 1 year	1.77
1 in 5 year	1.95
1 in 10 year	2.03
1 in 25 year	2.13
1 in 50 year	2.21
1 in 100 year	2.29
1 in 200 year	2.37

4.2 Flood Probability

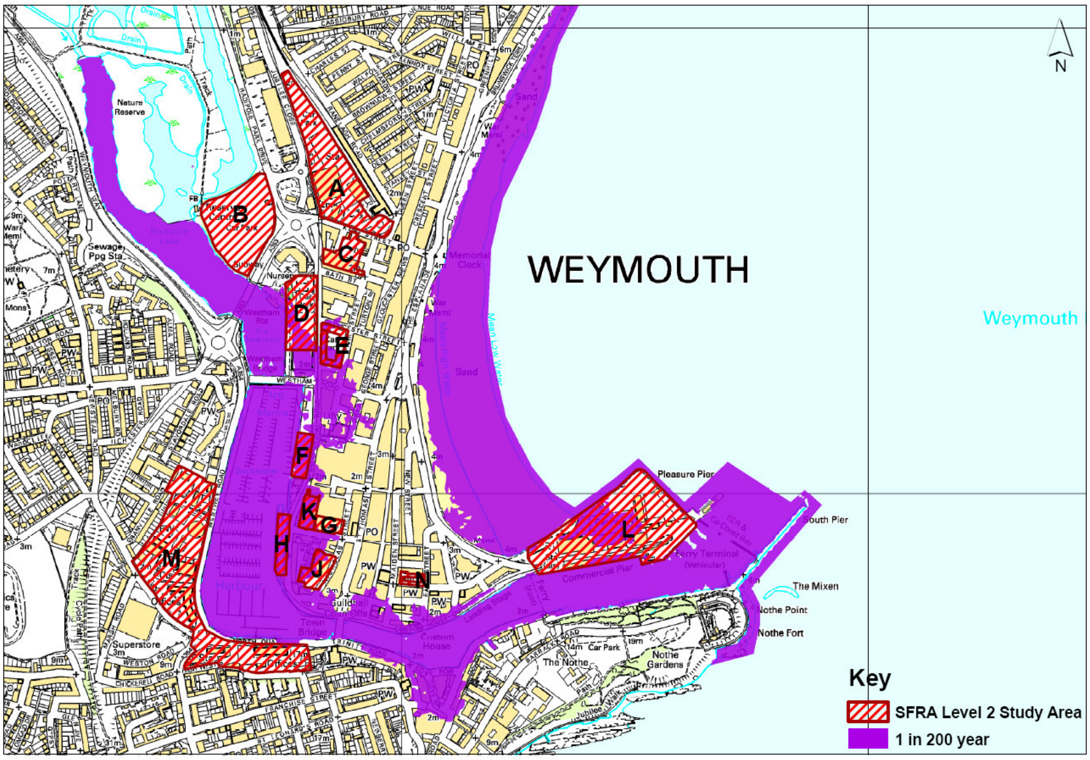
For this section, flooding has been assessed for the 'with defences' scenario for the Town Centre sites (Area 8). This shows the current situation assuming the defences are maintained at the current crest level for the lifetime of the development and work as designed. The tidal ABD study described in Section 3.1 explored tidal flooding and associated wave overtopping for the Weymouth area including the town centre. Results have been extracted from this study and flood probability mapped for flood events with 1 in 10, 1 in 25, 1 in 50, 1 in 75, 1 in 100 and 1 in 200 year return periods.

When comparing the flood extents to the Environment Agency flood zones and taking into account climate change only still water tidal flooding is considered, but when reviewing the flood risk to the area wave overtopping has been included. This is to provide a more realistic overview of the flood risk.

4.2.1 Area 8: Town centre strategic development sites

Figure 4.1 provides an overview of the flood extents for the town centre sites for the 1 in 200 year tidal event only, whilst Figure 4.2 provides an overview of the flood extents for the town centre sites for all modelled return periods with wave overtopping included.

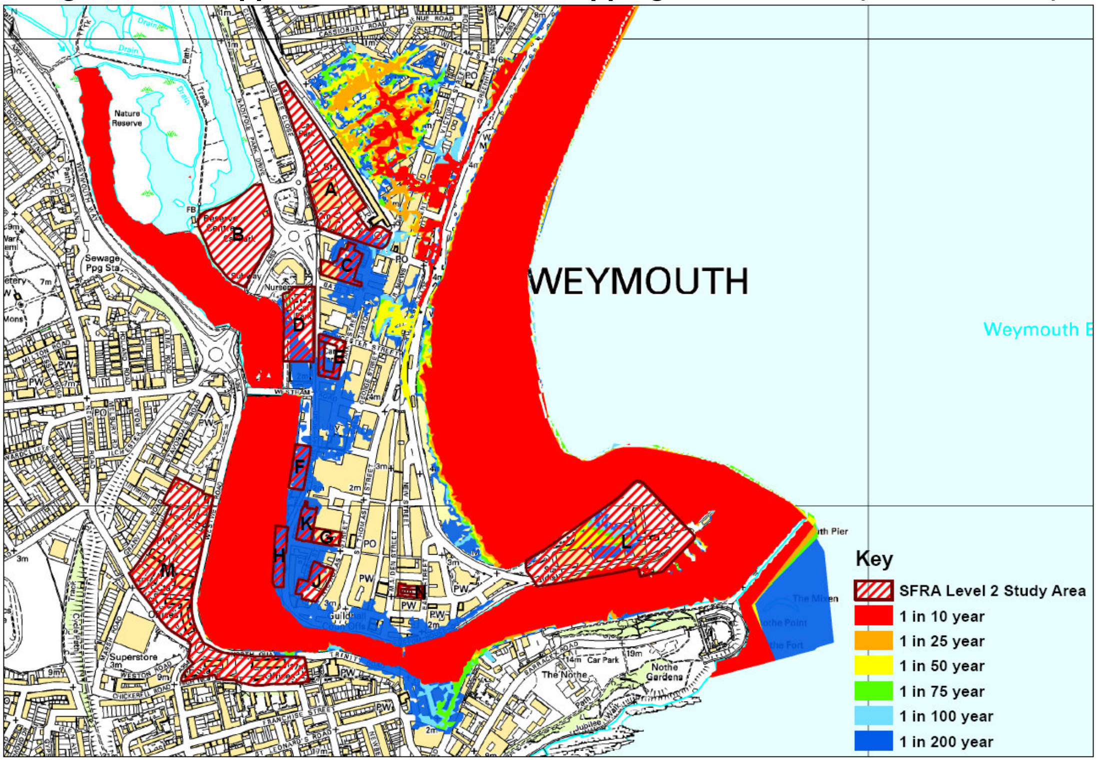
Figure 4.1 – 1 in 200 year tidal flood extent (with defences)



The main difference when comparing the extents with and without wave overtopping is in the area adjacent to Preston Beach in the north of the figure. This covers the area between Ranelagh Road and Victoria Road and then parts of the Esplanade down to almost Gloucester Street. These areas are not expected to be at risk from the still water tide levels alone but are at risk when wave overtopping is considered in combination with a high tide.

To ensure all of the flood risk is considered the sites have been assessed based on tidal events in combination with wave overtopping.

Figure 4.2 – Mapped tide and wave overtopping flood extents (with defences)



Site A – Train Station and Jubilee Sidings

Results indicate that flooding commences at the 1 in 100 year event in the southeast corner of the site. This extent increases by the 1 in 200 year event but is still restricted to the southeast. Flooding is also recorded to occur adjacent to the site along the eastern edge commencing at the 1 in 10 year event.

Site B – Swannery Car Park

No tidal flooding is recorded by the model for site B. However it should be noted that most of the site is within the fluvial Flood Zone 3, the implications of which must be considered alongside potential tidal flooding from events greater than the 1 in 200 year event should development be pursued.

Site C – Bus Depot

Model results indicate that flooding commences at the 1 in 200 year event with up to 75% of the site being flooded. Flooding also occurs adjacent and to the east of the site commencing at the 1 in 100 year event.

Site D – Melcombe Regis Car Park

Flooding is recorded along the quayside at the western edge of the site from the 1 in 10 year event, although this is minimal with approximately a 2m lateral extent into the site. Flooding does not increase with increasing return period until the 1 in 200 year event when extents expand significantly across the site.

Site E – Park Street Car Park

Results indicate that flooding commences at the 1 in 200 year event and inundates approximately 60% of the site including the surrounding roads.

Site F – Harbourside Car Park

There is a privately owned flood defence along the western edge of this site, which is stated to have a 1 in 200 year standard of protection. The model results indicate that the site is protected up to and including the 1 in 100 year flood event although the whole site is recorded to become inundated at the 1 in 200 year event. The modelling suggests that the actual standard of defence is lower than stated, although it is at least a 1 in 100 year standard. The crest level of this private defence will need to be raised to provide the required standard, particularly once climate change is taken into account.

Site G – Post Office Sorting Office

Flooding is recorded at the 1 in 200 year event only and is limited to the south and west of the site.

Site H – The Loop Car Park

As with Site F, a 1 in 200 year standard of protection defence runs along the western edge of Site H. Model results indicate this defence prevents flooding of the site up to and including the 1 in 100 year event. The whole site is recorded to become inundated at the 1 in 200 year event, once again suggesting that the defence crest level will need to be raised to meet the required standard of protection.

Site J – Ten Pin Bowling Alley

Flooding commences at the 1 in 200 year event and covers approximately half of the site to the west.

Site K – Multi-Storey Car Park

Flooding commences at the 1 in 200 year event inundating most of the site.

Site L – Pavilion and Ferry Terminal

At the 1 in 50 year event flood extents cover a small proportion of the site. This is from the north west of the site. These extents then increase with each increasing return period, covering approximately 25% of the site by the 1 in 200 year event. There is a raised defence along the southern edge of the site with a 200 year standard of protection. This defence appears to prevent flooding from the south of the site, although as detailed above the site is still at risk from the north west.

Site M – Gasholder, Magistrates Court, Fire

Results indicate that flooding commences at the 1 in 75 year event on North Quay south of the harbour and increases with increasing return period although extents are minimal extending less than 10m into the site.

Site N – Governors Lane Car Park

No flooding is recorded by the model for site N.

4.2.2 Flood Zone 3a & 3b

PPS25 states that Flood Zone 3 can be split into two zones: Flood Zone 3a – High probability of flooding, and Flood Zone 3b – Functional Floodplain. Functional floodplain is land where water has to flow or be stored in times of flood. This area is usually identified as the area which floods at a 1 in 20 year event or lower. For the purposes of this SFRA we have used the 1 in 25 year flood extent to aid our identification of the flood zone split. Figure 4.3 below shows the split for the town centre sites.

Figure 4.3- Flood Zone 3a and 3b

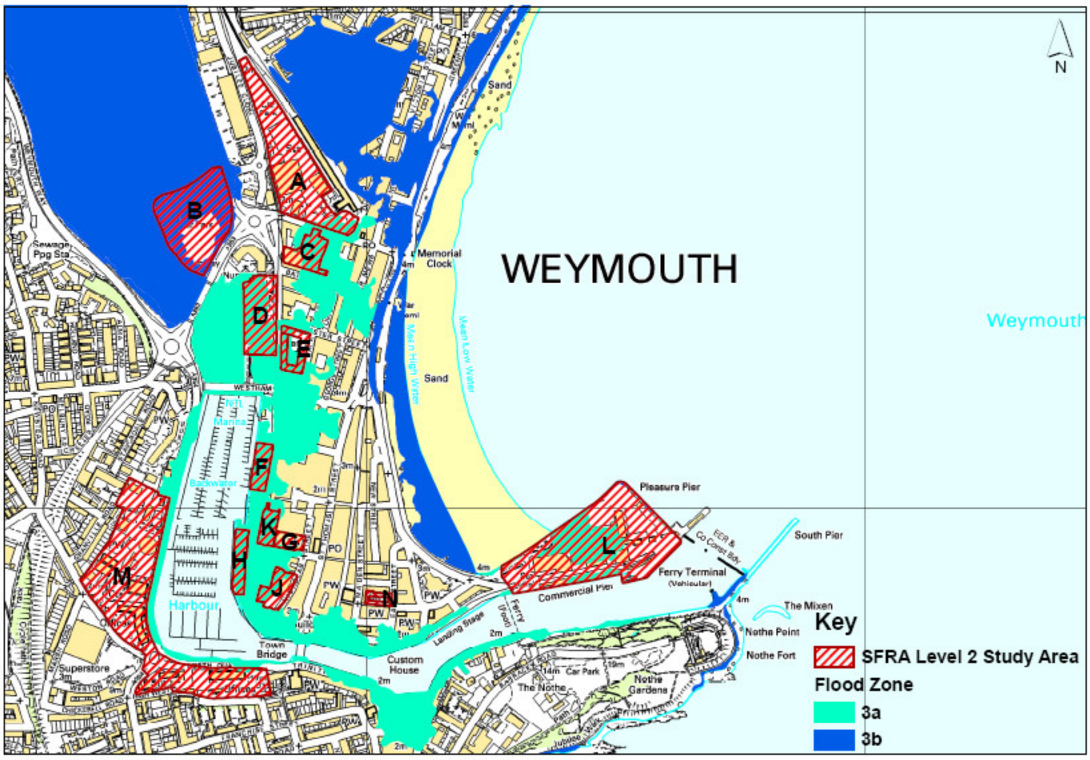


Figure 4.3 shows that sites M and N are not within either Flood Zone 3a or 3b, whilst site B is the only site within Flood Zone 3b. All of the remaining sites are partly or entirely within Flood Zone 3a. This means that in principle any development is appropriate for sites M and N, provided the exception test is passed for highly vulnerable uses. Site B is only appropriate for water compatible uses and, provided the exception test is passed, essential infrastructure. The remaining sites in principle are suitable for water compatible and less vulnerable uses, and provided the exception test is passed, essential

infrastructure and more vulnerable uses. In general the majority of the town centre sites will not be suited to uses classified as highly vulnerable. For those sites which are partly within Flood Zone 1 or 2 throughout the developments design life a Sequential Approach may be applied within the boundary of the site. See Appendix A for guidance on applying the exception test.

4.3 Flood Depth

For this section, flooding has been assessed for the 'with defences' scenario for the Town Centre sites. Using the modelled outputs extracted from the hydraulic models for each return period, we have produced grids of maximum depths of flooding across each of the Town Centre sites. The effect of raised defences on flood depth for the 1 in 200 year event is also detailed, where applicable.

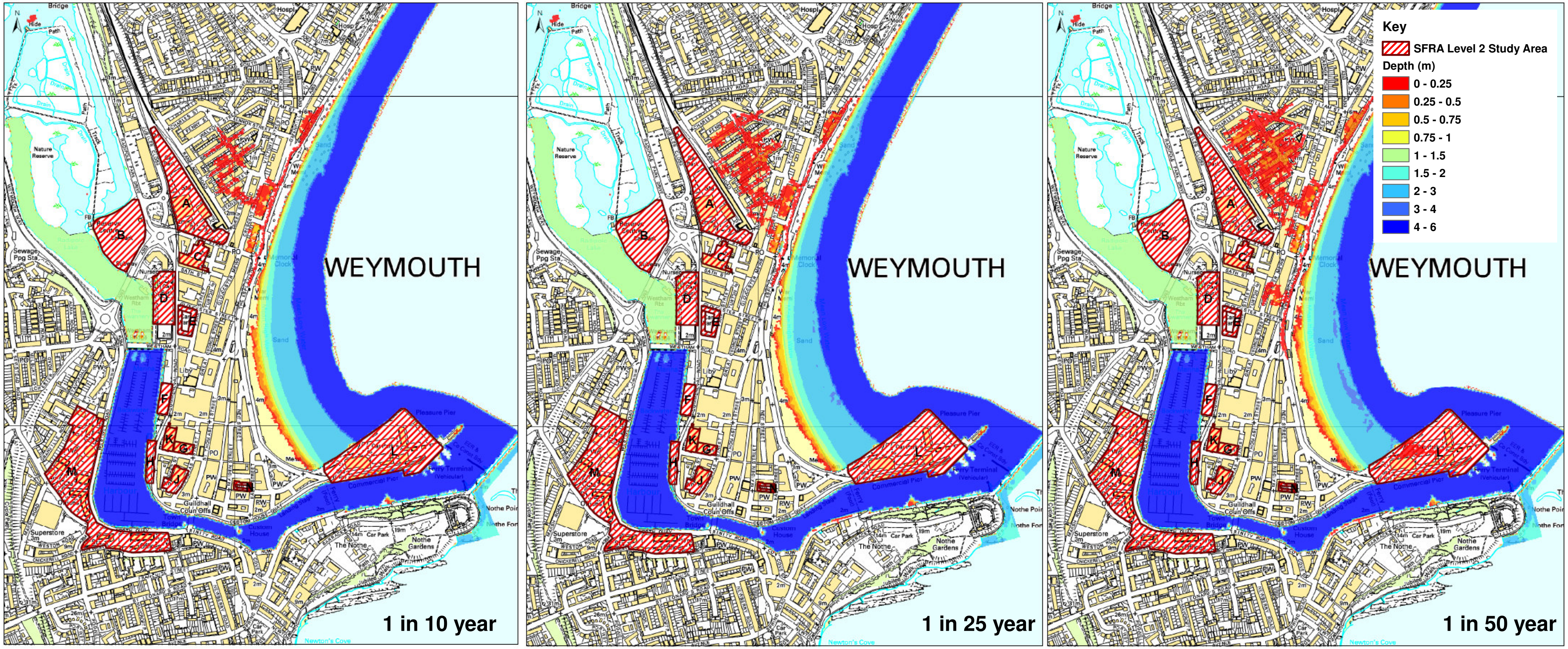
In general, the deeper the flood waters the higher the hazard. To help put the depths into context, assuming low velocities of flow, the hazard rating discussed in Section 5.2 has been used to assign low, medium and high depth classifications to the varying depth levels shown across the sites. Note that the hazard rating discussed in Section 5.2 does take into account both the modelled depth and velocity.

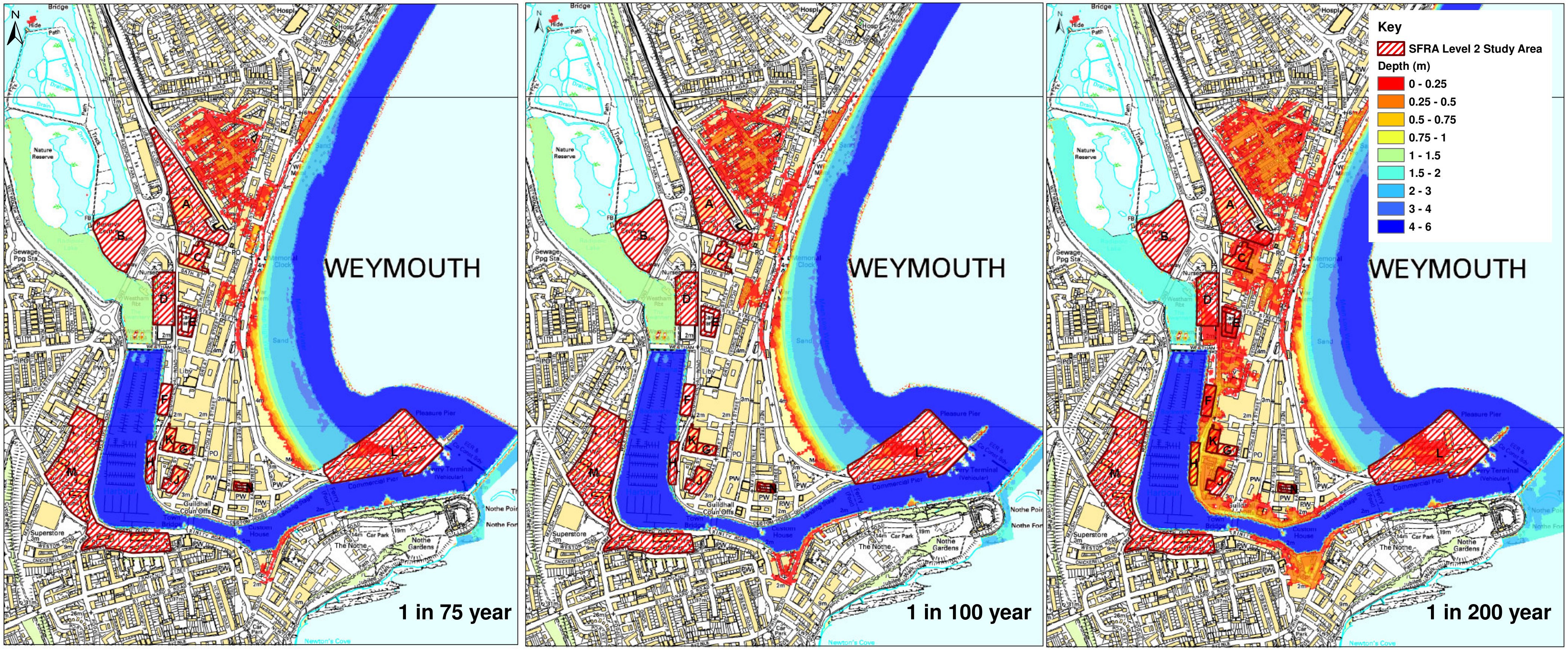
- No flooding, route remains dry – No Danger
- Low flood depth < 0.3m – Very low hazard
- Moderate flood depth between 0.3 and 0.6m – Danger for some – includes children, the elderly and the infirm
- High flood depth between 0.6 and 2m – Danger for most – includes the general public
- Extremely high flood depth > 2m – Danger for all - includes emergency services

4.3.1 Area 8: Town centre strategic development sites

Figure 4.4 illustrates the mapped flood depths extracted from the tidal ABD model results for all of the town centre sites for each return period modelled.

Figure 4.4 – Mapped flood depths (with defences)




WEYMOUTH
1 in 75 year
WEYMOUTH
1 in 100 year
WEYMOUTH
1 in 200 year
Key
SFRA Level 2 Study Area
Depth (m)
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 6
A
B
C
D
E
F
H
J
K
L
M
Nature Reserve
Pleasure Pier
Commercial Pier
Custom House
Superstore
The Nothe
Nothe Gardens

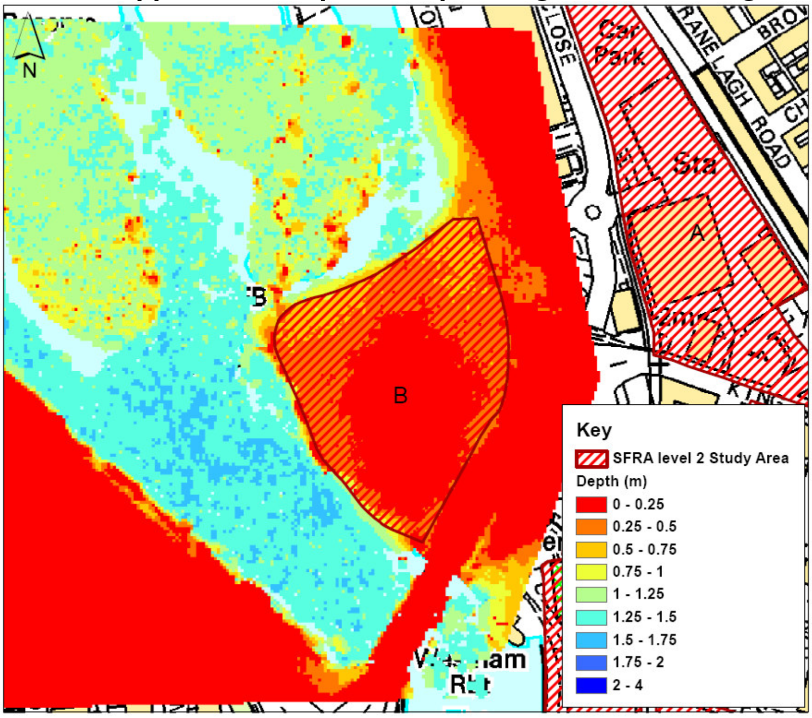
Site A – Train Station and Jubilee Sidings

Flooding remains shallow throughout with maximum depths of 0.1m (low) at the 1 in 100 year event remaining relatively shallow at 0.27m (low) by the 1 in 200 year event in the south-eastern corner of the site.

Site B – Swannery Car Park

Model results indicate that no tidal flooding occurs at this site. There is a risk of fluvial flooding in this area therefore based on the Environment Agency Flood Zone 3 the depths in this area are on average 0.3 – 0.4 m (moderate) with a maximum depth of approximately 0.8m (high). There is also an island in the centre of this site which is not flooded.

Figure 4.5 – Mapped flood depth incorporating fluvial flooding at Site B



Site C – Bus Depot

Flooding commences adjacent to the site at the 1 in 100 year event with maximum depths of less than 0.1m (low). At the 1 in 200 year event most of the site is flooded with moderate depths, on average 0.3m in the south and 0.4m in the north of the site. The maximum depth reached is 0.47m (moderate).

Site D – Melcombe Regis Car Park

The car park is not affected until the 1 in 200 year event, where the maximum depth is 0.42m (moderate) and the average is 0.1m (low), although it is much shallower in the South East of the site.

Site E – Park Street Car Park

Flooding is recorded to occur only at the 1 in 200 year event with a low depth. On average the depth is 0.20m across the site and reaches a maximum of 0.28m.

Site F – Harbourside Car Park

Model results indicate that at the 1 in 200 year event the flood depth is on average 0.2 – 0.3m (low), with a maximum of approximately 0.39m (moderate). The undefended scenario shows that for the 1 in 200 year event the maximum depth is approximately 0.41m and the average is between 0.25 – 0.35 (moderate), therefore suggesting that even though the defence is overtopped for the 1 in 200 year event, the defence has the effect of reducing depths by approximately 50 – 100mm and maintains the depths as moderate to low.

Site G – Post Office Sorting Office

Flooding commences at the 1 in 200 year event with an average depth of 0.15m (low) and maximum of 0.41m (moderate).

Site H – The Loop Car Park

At the 1 in 200 year event the flood depth behind the defence is on average 0.8m with a maximum of 0.86m (high). The undefended scenario shows that on average the depth does not change, although on the western edge of the site (where the defence is located) the depth is significantly higher (~2m). This shows that the defence does protect the site but once it is overtopped it does not have a significant impact on the depths of flooding.

Site J – Ten Pin Bowling Alley

Flooding commences at the 1 in 200 year event with an average depth of 0.1 – 0.2m (low) and maximum of 0.5m (moderate). For the undefended scenario the average depth is approximately the same.

Site K – Multi-Storey Car Park

Flooding commences at the 1 in 200 year event with an average depth of 0.1 – 0.2m (low) and maximum of 0.56m (moderate). For the undefended scenario the average depth is approximately 100mm higher.

Site L – Pavilion and Ferry Terminal

There is some flooding on the water side of the defence for the 1 in 10 year event, and this increases in depth as the return period increases. Flooding first occurs across the rest of the site during the 1 in 50 year event where the average and maximum depths are both low at 0.20m and 0.27m respectively. Depths increase further with increasing return period, details are shown in Table 4.2 below. Generally the average across the site is a low depth, whilst the maximum is classified as a moderate depth.

Table 4.2 – Average and Max. flood depths for Site L - 1 in 50 to 1 in 200 year event.

Return period	Maximum flood depth (m) (commercial quay)	Average flood depth (m) (centre of site)	Maximum flood depth (m) (centre of site)
1 in 50 year	4.00	0.20	0.27
1 in 75 year	4.25	0.12	0.32
1 in 100 year	4.29	0.15	0.35
1 in 200 year	4.37	0.15 – 0.3	0.44

For the undefended scenario the average depth across the centre of the site is approximately 0.2 – 0.3m therefore showing that the defence to the south of the site reduces the flood depths by approximately 50 – 100mm.

Site M – Gasholder, Magistrates Court, Fire

Model results indicate that no flooding occurs at this site.

Site N – Governors Lane Car Park

Model results indicate that no flooding occurs at this site.

4.4 Flood Velocity

For the Town Centre a 2D model has been used and therefore velocities were directly extracted from the model outputs.

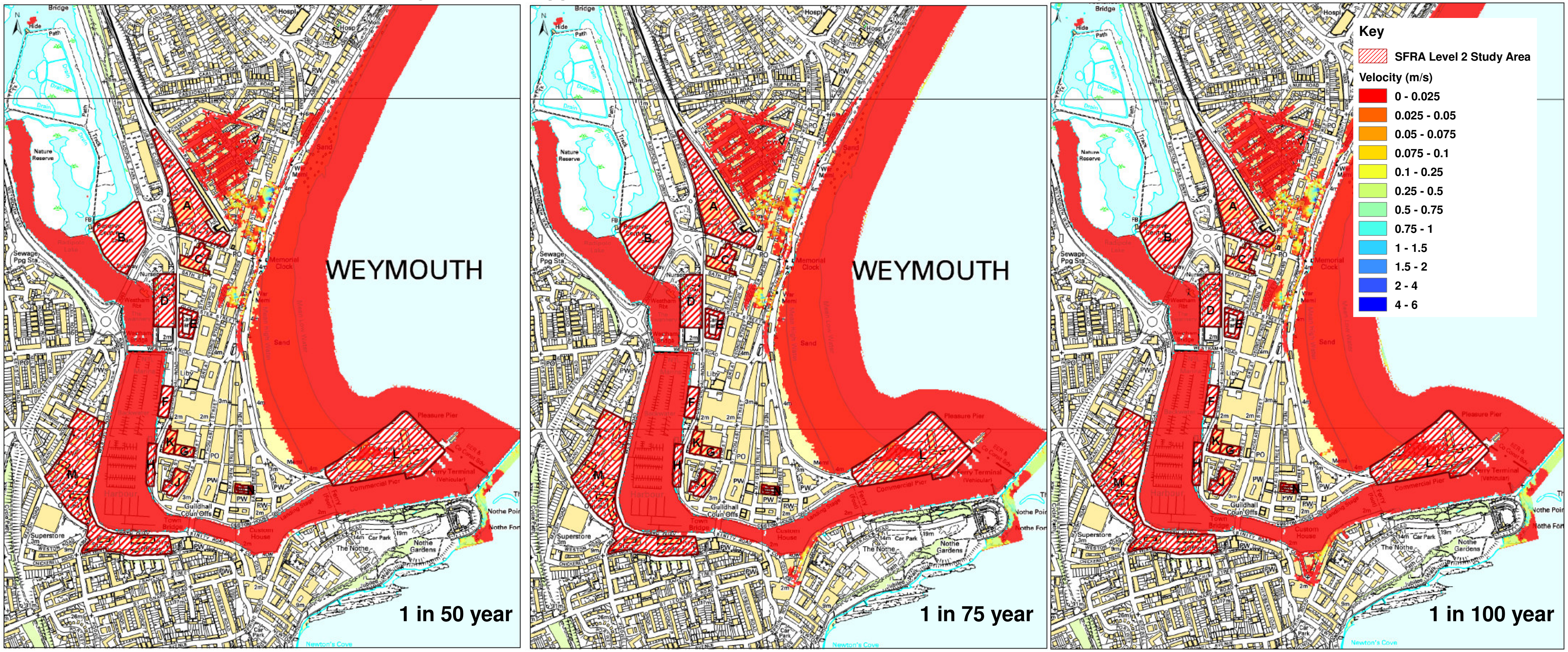
In general, the faster the flood waters the higher the hazard. To help put the velocities into context the hazard rating discussed in Section 5.2 has been used to assign low, medium and high velocity classifications to the varying velocities shown across the sites.

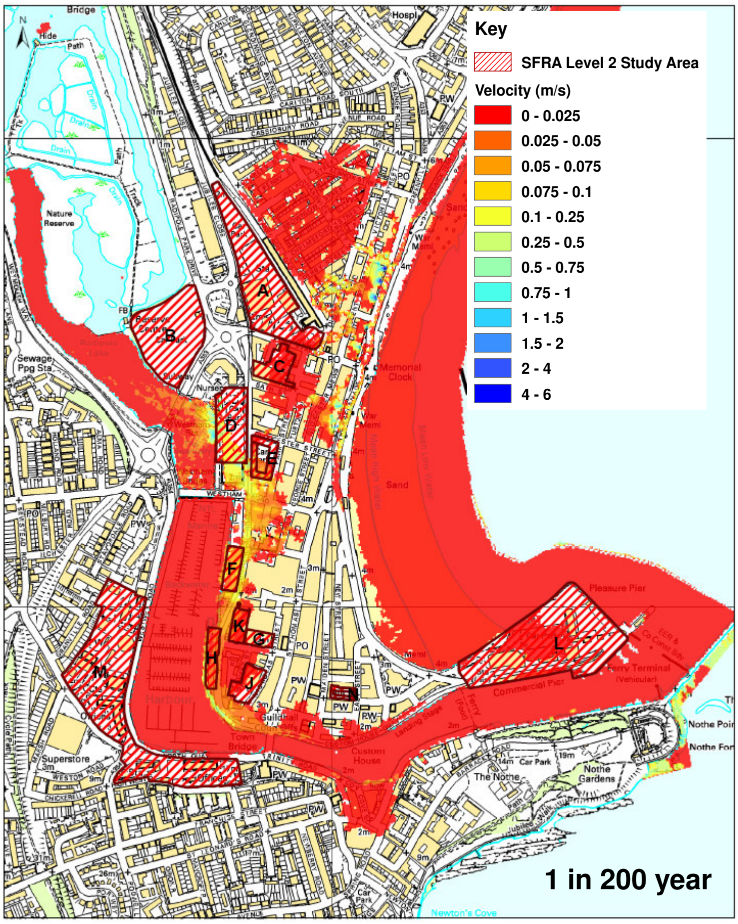
- Low velocity < 0.5m/s
- Moderate velocity between 0.5 and 1.5m/s
- High velocity > 1.5m/s

4.4.1 Area 8: Town centre strategic development sites

Figure 4.6 shows mapped flood velocities for all town centre sites for 1 in 50 to 1 in 200 year return periods. Maps for 1 in 10 and 1 in 25 year velocities are not displayed because velocity was not observed to exceed 0.0002m/s for all sites at these return periods. The variation in velocity across the town centre development sites is discussed below for 1 in 50 to 1 in 200 year events.

Figure 4.6 – Mapped velocities for town centre sites (1 in 50 to 1in 200 year events)





Site A – Train Station and Jubilee Sidings

Flooding does not occur until the 1 in 100 year event for which maximum velocity is recorded at 0.31m/s (low) from the model results. At the 1 in 200 year event maximum velocity decreases to 0.23m/s (low) in the south-east corner of the site.

Site B – Swannery Car Park

Results indicate that no tidal flooding occurs at this site. There is a fluvial risk which for this study has been assumed to be a moderate velocity.

Site C – Bus Depot

Flooding commences at the 1 in 200 year event. Velocity does not exceed 0.001m/s (low).

Site D – Melcombe Regis Car Park

Flood velocity at Site D does not exceed 0.0002m/s (low) until the 1 in 200 year event when average velocity across the site is recorded to be approximately 0.18m/s (low) with a maximum at the centre of the site of 0.64m/s (moderate).

Site E – Park Street Car Park

Results indicate that flooding commences at the 1 in 200 year event. Velocities are generally low with an average velocity across the site of approximately 0.04m/s and a maximum of 0.43m/s on the western edge of the site.

Site F – Harbourside Car Park

Flood velocity at the lowest modelled return period (1 in 10 year event) is very low and remains at less than 0.001m/s for all return periods up to and including the 1 in 100 year event. At the 1 in 200 year event the fastest velocities are recorded at the east and west edges of the site, although these are still classified as low. The average flood velocity at the 1 in 200 year event is 0.06m/s with a maximum of 0.27m/s along the quay to the west of the site.

Site G – Post Office Sorting Office

Results indicate that flooding does not occur until the 1 in 200 year event and the velocities are low. The average flood velocity is 0.014m/s and the maximum is 0.015m/s across the site.

Site H – The Loop Car Park

Flooding commences at the 1 in 10 year event but velocity is recorded to be less than 0.001m/s for all return periods up to and including the 1 in 100 year event. At the 1 in 200 year event flood velocity is on average 0.03m/s (low) across the site with a maximum of 0.60m/s (moderate) along the western edge.

Site J – Ten Pin Bowling Alley

Results indicate that flooding does not occur until the 1 in 200 year event and the velocities are low. The average flood velocity across the site is 0.008m/s and the maximum is 0.033m/s in the south-west corner.

Site K – Multi-Storey Car Park

Flooding commences at the 1 in 200 year even and the velocities are low. The average flood velocity is 0.019m/s and the maximum is 0.055m/s in the west of the site.

Site L – Pavilion and Ferry Terminal

Flood velocity is insignificant for the lower return periods of 1 in 10 and 1 in 25 years and stays low for the higher order events. For the remaining return period events, flood velocity continues to be less than 0.0004m/s along the southern edge of the site. To the north and centre of the site maximum velocities are recorded to be 0.062m/s for the 1 in 50 year event, decreasing to 0.041m/s by the 1 in 75 year event and 0.02m/s at the 1 in 100 year event, then increasing up to 0.14m/s by the 1 in 200 year event.

Site M – Gasholder, Magistrates Court, Fire

Flood velocity is consistently less than 0.001m/s for all return periods.

Site N – Governors Lane Car Park

Results indicate that no flooding occurs at this site.

5 IMPACT OF FLOODING

5.1 Speed of onset of flooding

The speed of onset of flooding is an important factor in flood management as a rapid onset of flooding increases risk to life. The speed of onset affects how much time people have to react to rising water levels and possible flooding

Where tidal flooding is dominant over fluvial flooding it is considered a moderate onset. This is because it would be reasonable to expect at least 6 hours forecast of a significant tide level, although the actual tide and wave condition will be determined closer to the time of high tide. Once again this assessment has only been undertaken for the Town Centre sites as these are the only areas currently at risk of flooding.

5.1.1 Area 8: Town centre strategic development sites

Section 3 highlighted that in relation to the Town Centre Strategic Development sites, tidal flooding presents a greater threat than flooding from fluvial sources. Therefore the speed of onset of flooding is considered to be moderate for all return periods.

5.2 Flood Hazards

Flood Hazard Mapping brings information on flood depth and speed (velocity) of floodwater together with a debris factor to create a hazard rating for people for each area that experiences flooding. The hazard rating we have used is set out in the report Flood Risk Assessment Guidance for New Development Phase 2, Framework and Guidance for Assessing and Managing Flood Risk For New Development (FD2320/TR2) HR Wallingford (October 2005).

The hazard rating categorises flood risk in terms of Caution, Danger for Some, Danger for Most and Danger for All, with the hazard becoming dangerous to more kinds of people as depths and velocity increase. This is described in Table 5.1.

The Flood Hazard Mapping presented in this report is based on the hazard rating and colour coding as shown in Table 5.1 and is given below;

- Low flood hazard (green): **Caution**
- Moderate flood hazard (yellow): **Danger for Some** (includes children, elderly and the infirm)
- Significant flood hazard (orange): **Danger for Most** (includes the general public)
- Extreme flood hazard (red): **Danger for All** (includes the emergency services)

Table 5.1: Flood Hazard Matrix*

Velocity (m/s)	Depth (m)											
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.00	Green	Green	Green	Yellow	Yellow	Yellow	Orange	Orange	Orange	Orange	Red	Red
0.10	Green	Green	Green	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	Red	Red
0.25	Green	Green	Green	Yellow	Orange	Orange	Orange	Orange	Orange	Red	Red	Red
0.50	Green	Green	Green	Orange	Orange	Orange	Orange	Orange	Orange	Red	Red	Red
1.00	Green	Green	Yellow	Orange	Orange	Orange	Orange	Red	Red	Red	Red	Red
1.50	Green	Green	Yellow	Orange	Orange	Orange	Red	Red	Red	Red	Red	Red
2.00	Green	Yellow	Yellow	Orange	Orange	Red	Red	Red	Red	Red	Red	Red
2.50	Green	Yellow	Yellow	Orange	Red	Red	Red	Red	Red	Red	Red	Red
3.00	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Red	Red	Red	Red
3.50	Green	Yellow	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red
4.00	Green	Yellow	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red
4.50	Yellow	Yellow	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red
5.00	Yellow	Yellow	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red

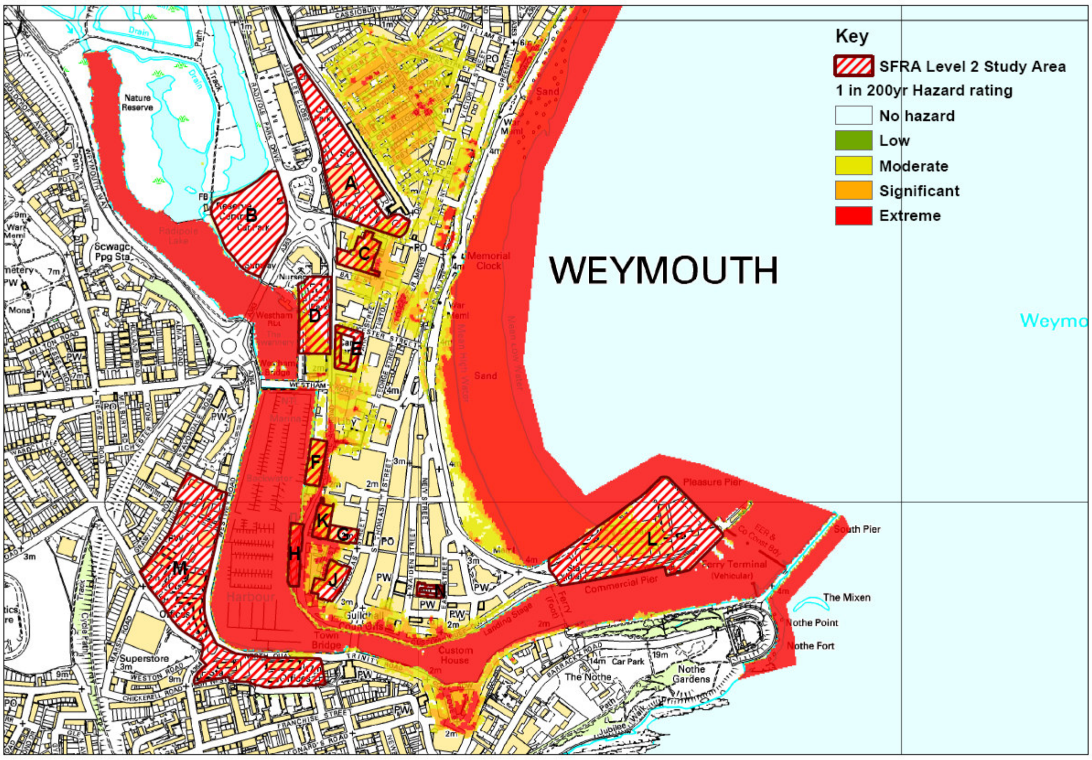
*The hazard "Caution" (green) is not specified in FD2320/TR2 and has been employed within this SFRA to show maximum flood extent

The hazard mapping has only been undertaken for the town centre sites as this is the only area where depths and velocities were required.

5.2.1 Area 8: Town centre strategic development sites

Figure 5.1 shows the hazard mapping for the 1 in 200 year tidal and wave event with defences, with the colours as detailed above.

Figure 5.1 – Flood hazard for the 1 in 200 year tidal flood event



Generally the only areas of extreme flood hazard are the beach and harbour areas. Commercial Road, Cove Row, West Street, Custom House Quay and the roads around Hardwick Street and Walpole Street have areas of extreme flood hazard whilst significant flood hazard covers areas adjacent to the harbour on both sides. This includes Guildhall Council Offices, parts of East Street and Maiden Street, and more of Commercial Road. If possible, certain parts of Commercial Road therefore should not be used for safe access and egress routes from any new developments. There is also a moderate flood hazard for parts of Gloucester Mews, the roads around Kings Street and Bath Street. It should be noted that any depth and speed of floodwater is hazardous because of hidden dangers such as blown manhole covers.

Site A – Train Station and Jubilee Sidings

There are areas of moderate flood hazard rating in the south east corner of the site. The adjacent road is not at risk and therefore immediate access and egress should not be a problem. It should be noted that there is a large area of moderate and significant hazard adjacent to the site.

Site B – Swannery Car Park

Tidal results indicate no hazard to this site but it is known to be at risk of fluvial flooding. Based on the Environment Agency Flood Zone 3 there is a small island of little to no risk in the centre of the site, and then the rest of the site is at significant flood hazard (assuming depths of 0.2 – 0.7m and moderate velocities). Access and egress route could be provided by the A353 along the south east of the site.

Site C – Bus Depot

The majority of the site is at significant flood hazard, with some areas of no hazard on the west side of the site. The adjacent road is also classified as having a significant flood hazard rating and therefore access and egress will need to be provided to the west of the site.

Site D – Melcombe Regis Car Park

The majority of this site has a low to moderate flood hazard rating. Access and egress route available from Commercial Road.

Site E – Park Street Car Park

Flood depths and velocities are both low over this area and therefore the whole site is given a low to moderate flood hazard rating. Access and egress route available via Gloucester Street and Park Street.

Site F – Harbourside Car Park

Primarily this area has a moderate flood hazard rating, although on the east side of the site there are areas of significant flood hazard which impacts the safe access and egress for the site. There is also an area of extreme hazard on the west side of the site and along Commercial Road adjacent to the site.

Site G – Post Office Sorting Office

Primarily this area has a low flood hazard rating, although on the south west side of the site there are areas of moderate flood hazard. Access and egress can be provided via Nicholas Street.

Site H – The Loop Car Park

The whole of this site is classed as having an extreme flood hazard with areas of extreme flood hazard adjacent to the site. Safe access and egress will therefore be a problem for this site.

Site J – Ten Pin Bowling Alley

Approximately 50% of the site is classed as a moderate flood hazard, with an area of no flood hazard to the east. Access and egress via Nicholas Street.

Site K – Multi-Storey Car Park

Approximately 50% of this site has a significant flood hazard rating with areas of extreme hazard in the south and west of the site. The remaining 50% has a moderate flood hazard rating. The adjacent road (Commercial Road) is classed as an extreme flood hazard and therefore to provide a safe access and egress route a new road will be required to the north east of the site.

Site L – Pavilion and Ferry Terminal

The centre of the site is at moderate hazard, with small areas of significant flood hazard. There is also a small area of extreme hazard adjacent to the defence along the south of the site. Access and egress can be provided via the south west corner of the site.

Site M – Gasholder, Magistrates Court, Fire

Results indicate that no flooding occurs at this site. This is confirmed by reviewing the Environment Agency Flood Zone 3, therefore this site has no flood hazard.

Site N – Governors Lane Car Park

Results indicate that no flooding occurs at this site. This is confirmed by reviewing the Environment Agency Flood Zone 3, therefore this site has no flood hazard.

5.3 Summary of impact

Table 5.2 below summarises the average depth, velocity and hazard rating information for each site and highlights if there may be problems providing safe access and egress routes.

Table 5.2– Hazard summary for town centre sites – current situation

Site	Depth (m)	Velocity (m/s)	Hazard	Safe access & egress
A – Train Station & Sidings	Low	Low	Low	Yes
B – Swannery Car Park	Moderate	Moderate	Significant	Yes
C – Bus Depot	Moderate	Low	Significant	Yes
D – Melcombe Regis Car Park	Low	Low/Mod	Low	Yes
E – Park Street Car Park	Low	Low	Moderate	Yes
F – Harbourside Car Park	Low	Moderate	Moderate	No
G – Post Office Sorting Office	Low	Low	Low	Yes
H –The Loop Car Park	High	Moderate	Extreme	No
J – Ten Pin Bowling Alley	Moderate	Low	Moderate	Yes
K – Multi-storey Car Park	Moderate	Low	Significant	Yes (new route)
L – Pavilion & Ferry Terminal	Low	Low	Low	Yes
M – Gasholder, Magistrates & Fire	No risk	No risk	No risk	Yes
N – Governors Lane Car Park	No risk	No risk	No risk	Yes

6 IMPACT OF CLIMATE CHANGE

PPS25 states that climate change needs to be considered in terms of both fluvial and tidal flooding. For the Town Centre sites the main source of flood risk is from tidal flooding and so we have considered the net sea level rise over the lifetime of the developments. The other areas are not currently at risk from either tidal or fluvial flooding and are generally far enough away from areas of existing risk that climate change will not have an impact on these sites.

The current guidelines for sea level rise are detailed in PPS25 and summarised in Table 6.1 below.

Table 6.1 – Sea level rise allowance

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
South West	3.5	8.0	11.5	14.5

Source: Table B.1 Planning Policy Statement 25: Development and Flood Risk

The climate change allowance can produce dramatic changes in inundation in flat areas. Changes in sea level will increase the frequency of which potential flood levels will be reached, with increased storminess creating wave conditions that could exacerbate this. The resulting frequency and depth of flooding can have implications for the type of development that is appropriate, according to its vulnerability to flooding, due to the potential re-classification of the level of flood risk.

The assessment of climate change has been made using the ‘with defences’ scenario to represent the current situation. It is assumed that defences will continue to be maintained to their current standard of protection.

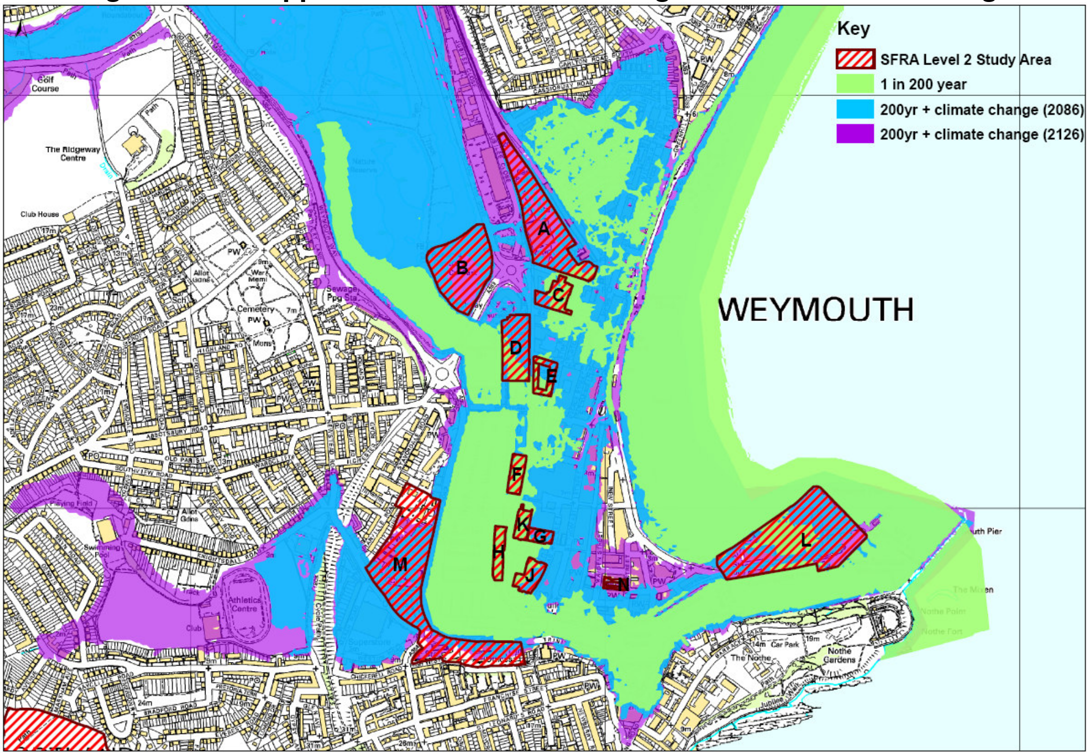
The impact of increased tidal levels on flood extents, depths and velocities has been assessed for the 1 in 200 year return period event and then compared with the current situation. This allowed us to assess the impact of an extreme flood event on the site now, and to use this as a baseline through which we can then make judgements about current flood risk and how this may change in the future with climate change. The tidal climate change modelling takes into account still tidal levels and has been undertaken for both with and without wave overtopping scenarios. A detailed site Flood Risk Assessment may need to consider wave action if an area is particularly vulnerable to the effects of climate change.

The tidal ABD study described in Section 4.1.1 was used to model the effects of climate change on tidal flooding for the town centre sites for the 1 in 200 year event, the 1 in 200 year event plus climate change up to 2086 to account for the life of commercial development, and the 1 in 200 year event with climate change up to 2126 to account for the life of residential development. Sites A, B, C, G, M and N are the main sites where the flood risk is currently low but increases due to climate change. Other sites are already at risk of flooding and therefore the impacts of climate change are primarily on the depths of flooding rather than the extents.

6.1 Flood Extents

6.1.1 Area 8: Town centre strategic development sites

Figure 6.1 – Mapped flood extents indicating effects of climate change



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A significant increase in tidal flood extents has been identified for Weymouth town centre as a result of climate change. Figure 6.1 illustrates the extents for the 1 in 200 year, 200 year plus climate change to 2086 and 200 year plus climate change to 2126 tidal flood events inclusive of the effects of wave overtopping. The results discussed in this section focus primarily on the scenarios which include wave overtopping, as it was agreed with the Environment Agency that this presented the worst case, which should be taken into account when considering development of any kind.

The effect of climate change on flooding at site A (Train station & Jubilee sidings) is significant since minimal flooding is recorded for the 1 in 200 year tidal event. By 2086 the 1 in 200 year event is predicted to flood up to half of the site with complete inundation by 2126.

Figure 6.1 shows that site B experiences no tidal flooding at the 1 in 200 year event but is 75% flooded by 2086 and completely inundated by 2126. Site B is also shown to be at risk from a 1 in 100 year fluvial event (Section 4) and therefore increased flows due to climate change will further increase this risk.

Sites C, D E, G and J (Swannery Car Park, Bus Depot, Melcombe Regis and Park Street car parks, Post Office Sorting Office and Ten Pin Bowling Alley) all demonstrate varying extents of flooding at the 1 in 200 year tidal event increasing to complete inundation as a result of climate change by 2086.

Sites F, H and K (Harbourside, Loop and Multi-Storey Car Parks) experience flooding over the entire site at the 1 in 200 year tidal event. Therefore flood risk would only increase for these sites as a result of increased depth or velocity, and therefore hazard, caused by the effects of climate change.

Site L (Pavilion & Ferry Terminal) exhibits significant flooding at the 1 in 200 year tidal event, this extent increases to cover most of the site by 2086 with complete inundation by 2126.

Site M (Gasholder, Magistrates Court, Fire) displays only marginal flooding at the 1 in 200 year tidal event. By 2086 this is predicted to extend over most of the site with a further ~70m increase in lateral extent by 2126. The NW corner and southern edge of the site remain free from flooding for all scenarios tested.

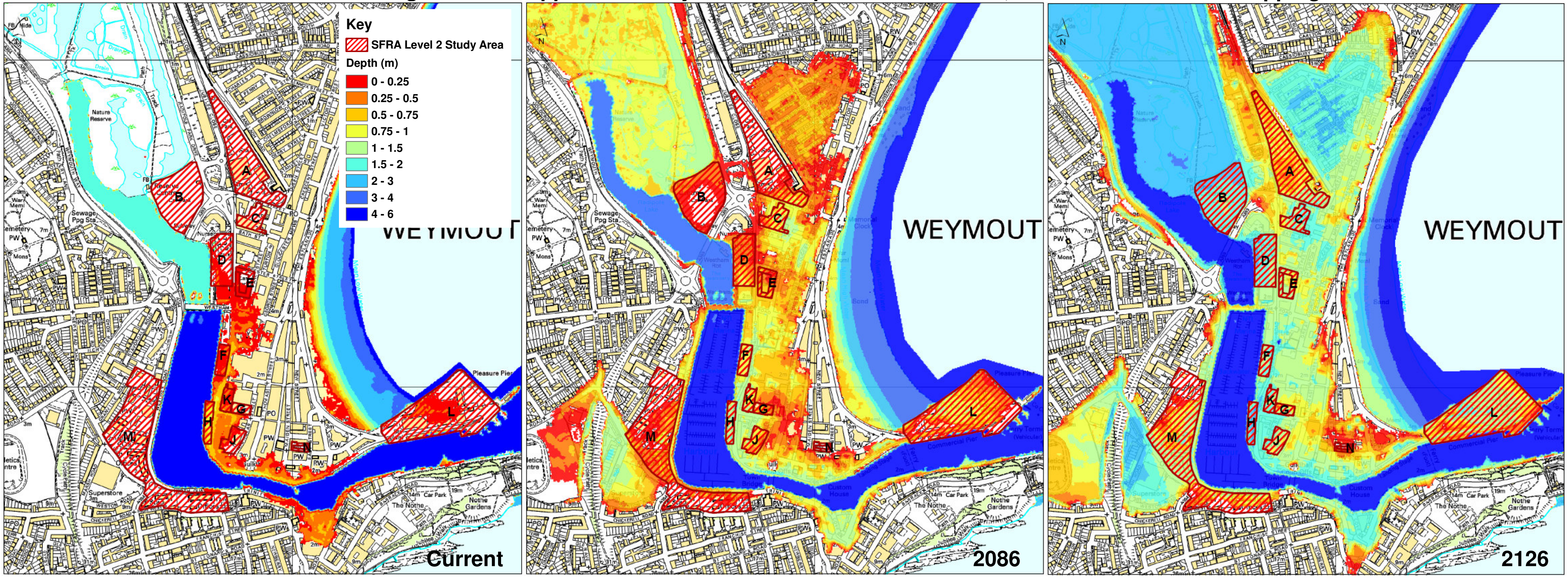
Site N (Governors Lane Car Park) is the least affected by climate change only experiencing flooding at the 1 in 200 year event in 2126. This therefore suggests that commercial developments would not be affected by climate change in this area although safe access and egress routes would need to be considered.

In addition to the effects of climate change on flood risk to each town centre site, extensive flooding is recorded by the model results for much of the land surrounding the sites as a result of climate change. This is in the order of a lateral increase of 530m to the north of site A, 190m to the east of sites K and G, and between 630 and 925m by 2126 to the west of site M. This severely compromises the potential for safe access and egress from the town centre sites which will have to be accounted for in any proposed development. Figure 6.1 highlights that by 2126, only site M of out of all the town centre sites displays safe access and egress. There is a possibility of access and egress to some of the town centre sites along the esplanade although it can be seen from Figure 6.5 that although the depths are low the velocities high, due to wave overtopping, and therefore this would not be a safe access / egress route.

6.2 Flood Depth

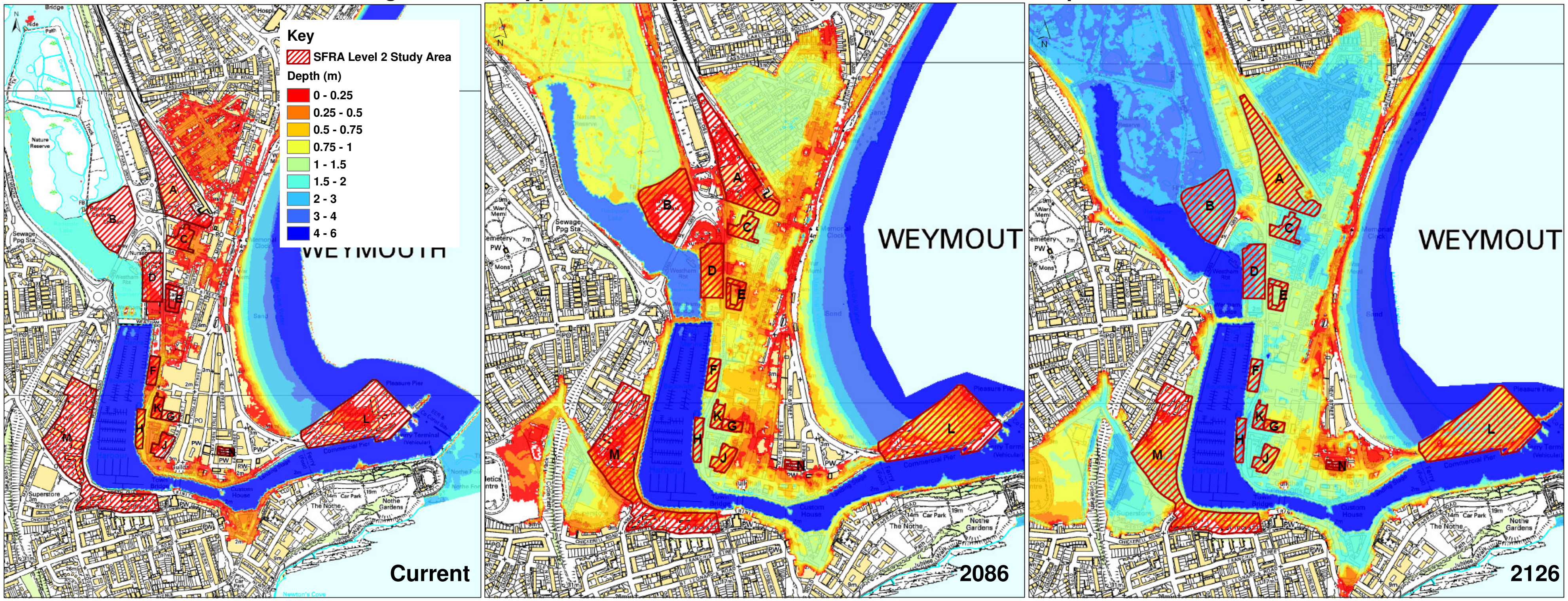
6.2.1 Area 8: Town centre strategic development sites

Figure 6.2 – Mapped 1 in 200 year flood depths with defences, tide with no wave overtopping



ROYAL HASKONING

Figure 6.3 – Mapped 1 in 200 year flood depths with defences, tide plus wave overtopping



The effects of climate change are projected to increase flood depths across all town centre sites to a varying degree, with the exception of site N (Governors Lane Car Park) at which no flooding was indicated until 2126.

In general the sites exhibiting the largest increases in depth are those which at the 1 in 200 year event display little or no flooding which then are predicted to flood by 2086 and 2126. Sites A, B and C (Train station & Jubilee Sidings, Swannery Car Park and Bus Depot) are an example of this where flood depths were predicted to increase by at least 0.5m by 2086 and a further 1-2m by 2126 (see table 6.2) due to the effects of climate change.

Sites which already show considerable flooding at the 1 in 200 year event with little or no further increase in extent by 2086 and 2126, such as sites F, H and K (Harbourside, Loop and Multi-Storey Car Parks) tended to show more consistent increases in depth of approximately 0.6-0.7m by 2086 with a further 0.6-0.7m by 2126. This is most likely due to other areas becoming flooded, therefore providing storage for the water rather than substantially increasing the flooding to these low areas.

Site D (Melcombe Regis car park) is one of the lowest-lying sites and displayed some of the largest increases in depth due to the effects of climate change. Increases in maximum depth of 0.7m to 2086 and a further 1.5m by 2126 were observed, while average depths increased from a negligible level for the 1 in 200 year event to 0.45m by 2086 followed by a significant increase to 2.10m by 2126.

Site E (Park Street car park) displayed an increase of 0.4-0.5m in both average and maximum flood depths by 2086 with a further 0.7m and 0.9m increase in average and maximum depths respectively by 2126.

A number of sites demonstrated significant initial increases in flood depth by 2086 followed by smaller increases by 2126. For example sites G (Post Office Sorting Office), J (Ten Pin Bowling Alley), L (Pavilion & Ferry Terminal) and M (Gasholder, Magistrates Court, Fire) showed increases in depth of between 0.7m and 0.8m by 2086 with further increases on average of 0.5m by 2126 presenting maximum depths of 1.65-1.7m. At site M it is suggested that the smaller increases in depth between 2086 and 2126 is because although the flood extent only shows minor increases on site between 2086 and 2126, extents expand significantly to the west of the site which could account for the reduced increase in depth onsite between 2086 and 2126. Similarly at sites G and J extents are noted to expand laterally to the east of the two sites which could account for the smaller increase in flood depth between 2086 and 2126 in comparison to the initial increase between the 200 year event and 2086.

Table 6.2 – Climate change flood depths and duration

NB Throughout duration of the modelling most sites have at least two significant periods of flooding due to the tidal cycle and therefore to represent the worst case the onset of the first period of flooding is noted in the table below and the 'duration of no access during flood event' is noted as the longest period of inundation of each site.

Site	Results / Event	Onset (hrs from start of model)	Maximum depth (m)	Average depth (m)	Time of max. depth (hrs from start of model)	Duration of no access during flood event (hrs)
A Train station & Jubilee Sidings	2086 with wave overtopping	6.25	1.00	0.30	31.75	Access throughout
	2126 with wave overtopping	5.75	1.90	1.10	32.75	8.00
B Swannery Car Park	2086 with wave overtopping	31.00	0.60	0.30	32.25	1.00
	2126 with wave overtopping	19.25	2.55	2.15	32.75	23.50
C Bus Depot	2086 with wave overtopping	6.50	1.25	0.90	31.75	3.00
	2126 with wave overtopping	5.75	2.10	1.80	32.50	10.75
D Melcombe Regis car park	2086 with wave overtopping	30.00	1.00	0.45	32.00	5.50
	2126 with wave overtopping	8.00	2.50	2.10	32.50	20.75
E Park Street car park	2086 with wave overtopping	30.00	0.70	0.60	31.75	4.50
	2126 with wave overtopping	7.75	1.60	1.30	32.50	11.50
F Harbourside car park	2086 with wave overtopping	29.50	1.10	0.95	31.00	7.00
	2126 with wave overtopping	20.00	1.85	1.50	31.25	20.00
G Post Office Sorting Office	2086 with wave overtopping	30.00	1.10	0.55	31.50	2.25
	2126 with wave overtopping	29.25	1.65	0.95	31.25	4.50

Site	Results / Event	Onset (hrs from start of model)	Maximum depth (m)	Average depth (m)	Time of max. depth (hrs from start of model)	Duration of no access during flood event (hrs)
H Loop car park	2086 with wave overtopping	18.50	1.95	1.50	31.25	40+
	2126 with wave overtopping	18.25	2.10	2.00	31.25	40+
J Ten Pin Bowling Alley	2086 with wave overtopping	29.75	1.20	0.65	31.50	2.75
	2126 with wave overtopping	29.00	1.70	1.20	31.25	4.50
K Multi-Storey car park	2086 with wave overtopping	29.75	1.20	0.90	31.50	4.00
	2126 with wave overtopping	29.00	1.75	1.40	31.25	7.50
L Pavilion & Ferry Terminal	2086 with wave overtopping	29.25	1.10	0.60	31.25	Access throughout
	2126 with wave overtopping	19.50	1.65	1.25	31.25	3.50
M Gasholder, Magistrates Court, Fire	2086 with wave overtopping	29.75	1.10	0.45	31.75	Access throughout
	2126 with wave overtopping	29.00	1.70	1.15	31.50	Access throughout
N Governors Lane Car Park	2086 with wave overtopping	No flooding				
	2126 with wave overtopping	30.00	0.70	0.20	31.50	2.00

Table 6.2 provides some more detail to the depth maps in Figure 6.3, particularly regarding the timing and duration of the flooding including the onset. The main risk to this area is tidal flood risk and therefore the tidal cycle needs to be considered. The tide curve used for the modelling is shown in Appendix B, where the initial peak is after 7 hours and the maximum peak after 31.5 hours.

Some areas are only actually flooded during the highest peak of the cycle, whilst others are at risk across the majority of the cycle. For example, in 2086 the Bus Depot (site C) is only without access for approximately 3 hours during the highest peak water level, whereas the Loop Car Park (site H) cut off for the majority of the modelled scenario. This could have an impact on planning of the development, particularly in terms of safe access and egress routes.

Safe access and egress does not have to be entirely dry land, although it must be classified as having a low hazard i.e. depths less than 0.2m and low velocities. It then must lead to an area outside of the flood risk area. This is the main problem for the sites in Weymouth Town Centre. By 2126 the whole area is at risk of flooding and therefore no routes are available to ground outside of the flood risk area. To investigate this further a strategy study looking at the Flood Risk Management Infrastructure is being completed by the Environment Agency, with W&PBC co-operation, to determine what infrastructure may be required by 2126 to provide protection and access and egress to Weymouth Town Centre. The strategy will highlight what funding may be required and possible funding routes for the required defences to ensure that new development will remain safe throughout its design life. Note that for development to be classed as safe there must be routes for unaided access / egress into the future.

6.3 Flood Velocity

6.3.1 Area 8: Town centre strategic development sites

Figure 6.4 – Mapped 1 in 200 year flood velocities with defences, tide with no wave overtopping

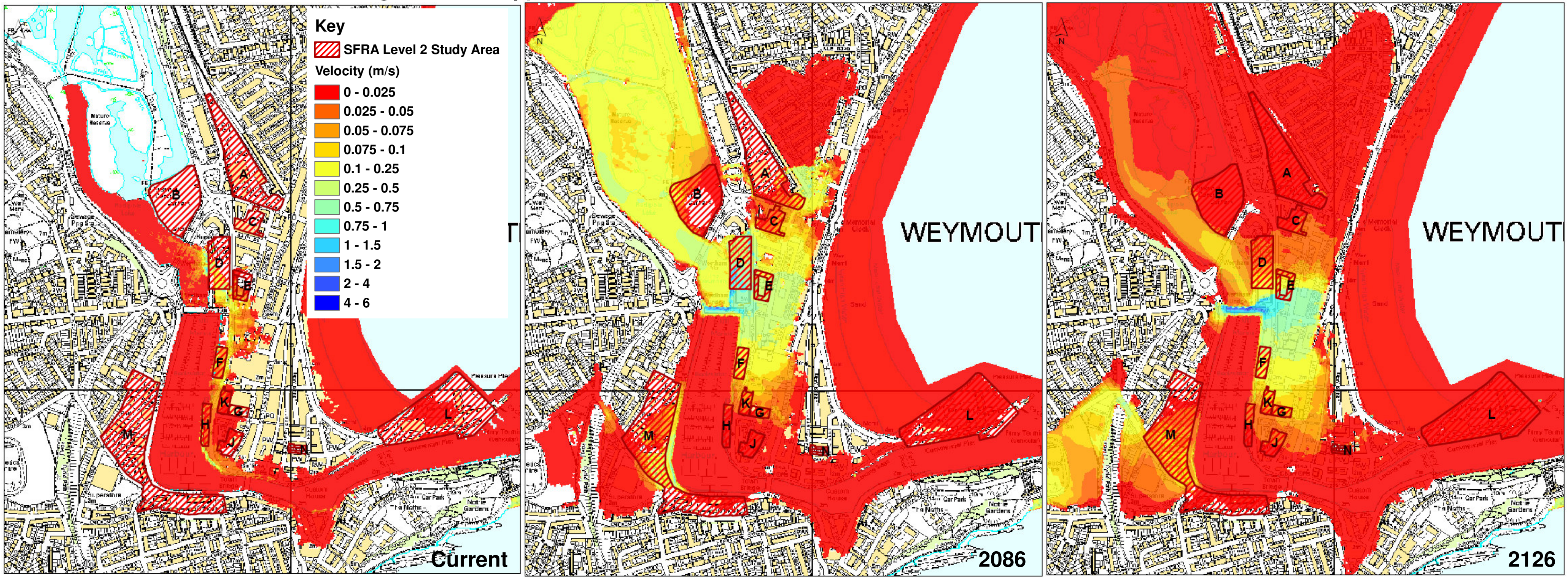
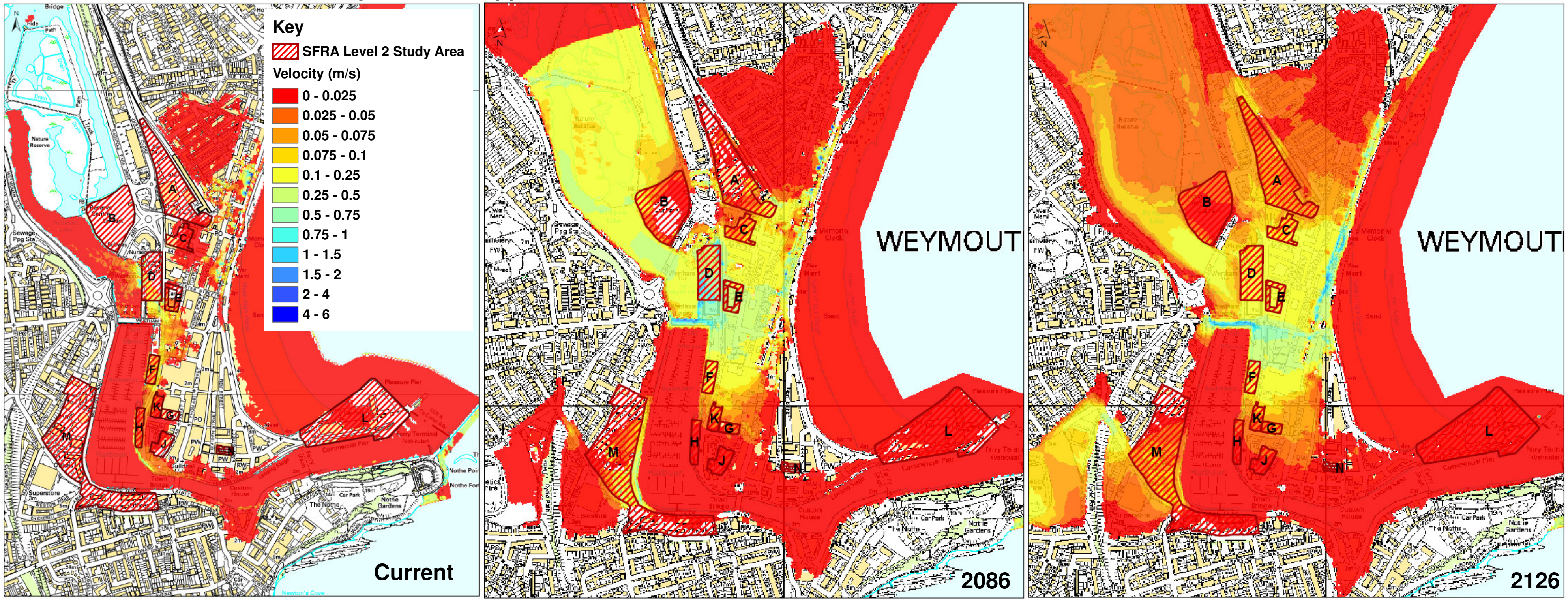


Figure 6.5 – Mapped 1 in 200 year flood velocities with defences, tide with wave overtopping



Figures 6.4 and 6.5 show that flood velocity increases for all town centre sites by the year 2086. By 2126 almost half the town centre sites display a reduction in velocity, with increases on the remaining sites. This shows that generally climate change is impacting on the depths and extents of flooding rather than the velocities.

Table 6.3 shows the average changes in velocity across each of the sites for the two climate change horizons for tidal flooding with wave overtopping which represents the worst case scenario.

Table 6.3 –Velocity (m/s) for the 1 in 200 year event due to climate change with wave overtopping

	Velocity		
Site	**Current**	**2086**	**2126**
A	0.23	0.12	0.07
B	No flooding	0.12	0.035
C	<0.001	0.10	0.10
D	0.50	1.30	0.12
E	0.10	0.50	0.15
F	0.25	020	0.25
G	0.01	0.03	0.06
H	0.15	0.015	0.02
J	0.01	0.015	0.025
K	0.04	0.06	0.08
L	0.002	0.0015	0.0015
M	<0.001	0.33	0.08
N	No flooding	No flooding	0.004

6.4 Flood Hazard

6.4.1 Area 8: Town Centre strategic development sites

Figure 6.6 – Flood Hazard for 1 in 200 year tidal flood event plus climate change (2086), with wave overtopping

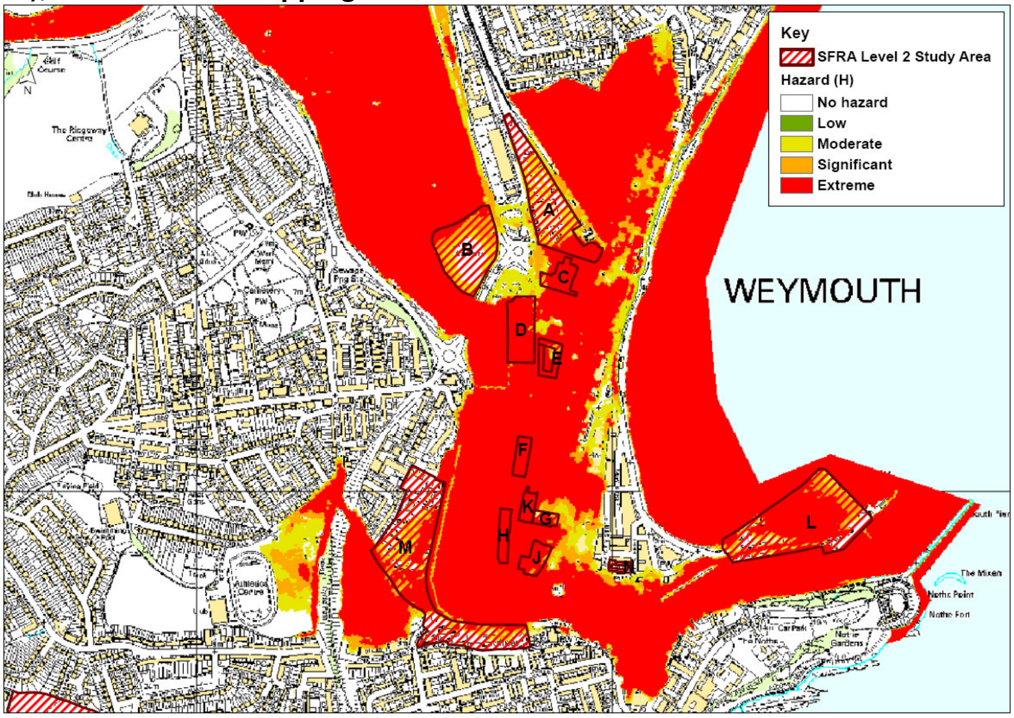
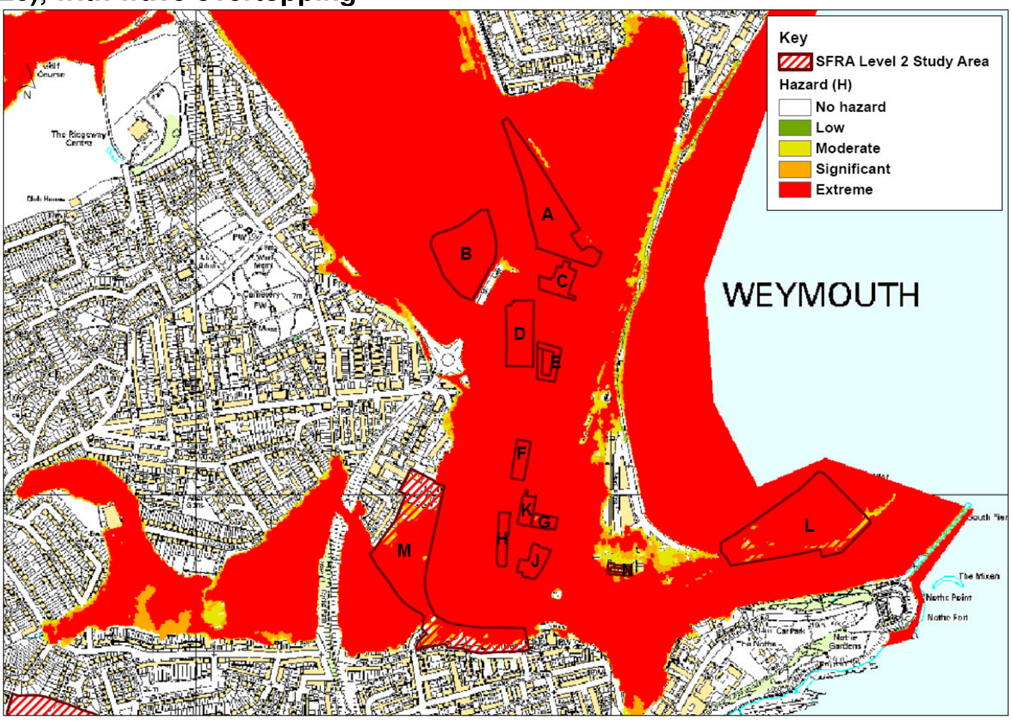


Figure 6.7 – Flood Hazard for 1 in 200 year tidal flood event plus climate change (2126), with wave overtopping



Figures 6.6 and 6.7 show the flood hazard for the town centre strategic development sites for a 1 in 200 year tidal flood event with wave overtopping plus the effects of climate change for the years 2086 and 2126. The increase in hazard rating is significant between the 1 in 200 year event and the year 2086. Areas which currently experience a low or moderate hazard have generally become areas of extreme hazard by 2086 and further increases in the extent of the region of extreme hazard are expected by 2126. This has implications for safe access and egress to the development sites. As it currently stands, by 2086 only sites A, M, N and possibly L, display potential for safe access and egress according to the hazard maps; by 2126 this is reduced to sites M and possibly N. New and improved defences would therefore be required to allow development all of the sites due to the lack of access and egress.

The biggest changes are observed in relation to sites D, E, F, G and J, which have a low hazard rating for the current situation but which by 2086 are predicted to have an extreme hazard rating across the entire area of each site during the 1 in 200 year flood event.

Sites A and B have areas of little or no hazard under current conditions and by 2086, but by 2126 flooding is predicted to present an extreme hazard to the whole site. This also applies to sites M and N, although by 2126 there are still regions of 'no hazard' for both sites.

The esplanade has a moderate hazard during the 2126 event therefore confirming that it would not be a suitable safe access / egress route. This is primarily due to the large velocities in this area due to wave overtopping.

6.5 Exception Test

The Exception Test should be applied by decision-makers only after the Sequential Test has been applied and in the circumstances shown in Table D.3 of PPS25 when 'more vulnerable' development and 'essential infrastructure' cannot be located in Zones 1 or 2 and 'highly vulnerable' development cannot be located in Zone 1. The zones being those determined within this Level 2 SFRA to incorporate climate change and wave overtopping.

As part of the allocation process for part (a) of the Exception test, as set out in PPS25, it should be demonstrated in a transparent means that the positive contribution to the community of development on the site is so great that they firmly outweigh the concerns about the risk of flooding and safety. For part (c) of the Exception test to be passed the Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall in the future. The Emergency Services (Fire & Rescue) will need to be formally consulted for their consideration on whether they will be able to rescue people from development for all flood events up to an annual probability of 0.1% (FD2320 advises that due to the extreme hazard rating that future flooding would present there is an additional risk to life to the emergency services if they attempted to rescue people from new development in the majority of the town centre). Weymouth & Portland Borough Council should also consult their Emergency Response Office to confirm that systems will be able to assist people displaced during a major flood event.

7 POSSIBLE WINDFALL SITE ASSESSMENT

As part of the Core Strategy Weymouth &Portland Borough Council need to assess possible windfall sites. These are sites which are not specifically designated for development in the 'development plan' but which become available for development during the life time of the plan. The sites tend to be small parcels of land for a small number of dwellings.

Using historic trends Weymouth &Portland Borough Council have predicted the number of proposed windfall sites for each ward. Specific site locations are unknown and therefore an assessment has been made based on the following criteria to assess the suitability of land for the development of the windfall sites. This criteria was developed following consultation with both the Environment Agency and Weymouth & Portland Borough Council

1. Density of potential properties – The impact on flood risk through development of potential windfall sites will vary from ward to ward. A development with a higher density will have a more significant effect on flood risk than one with a lower density using the same area.

2. Geology - A cartographic assessment of the underlying bedrock has been carried out for the wards within Weymouth & Portland Borough Council to understand the role it has on the hydrology. Any increase in impermeable land due to development will increase the rate of surface water run-off. However where the underlying geology is currently impermeable the flow regime generated by development would be comparable. A new planning application would be advised to use SUDS techniques which could improve the situation downstream. When developments are proposed on permeable geology the aim of the design would be to specify permeable surfaces to allow water to pass to the bedrock or to store water on site.

Within the SFRA Level 2 study area the main geological formations include:

- Upper Chalk
- Portland Stone (and sand)
- Kimmeridge Clay
- Corellian beds
- Oxford Clays
- Cornbrash
- Forest Marble
- Fuller's Earth

Where the majority of a ward comprises clay-based geology the flow regime could be expected to be flashy as the clay presents a relatively impermeable surface. This would suggest that further development, although having some impact (which is not quantifiable at this strategic level), might be expected to have a lesser effect than development within a ward comprising mostly chalk. In a predominantly chalk area development would cause a significant change in the permeability of the land surface and subsequently the flow regime.

3. Newly Defended Areas – Due to the location of the main proposed development sites no new flood defences will be recommended in the SFRA. This means there will be no

windfall gains to be made from a newly defended area. However, some of the proposed town centre strategic development sites are sited within locations that are currently within areas benefiting from defences. Given that climate change is expected to increase flood levels by 1.26m, flood defences are likely to require raising and extending to tie into higher ground to facilitate safe development should allocation of the town centre sites be pursued.

4. Spatial location - In urban areas, it is assumed that any new development will have its own site specific drainage that will not adversely affect the current flow regime. However where this is adjacent to, or flows into, existing drainage, further assessment will be required since existing drainage is unlikely to have the capacity to convey flows of the intensity considered in PPS25. The adoption of standards for highway and surface water drainage schemes are likely to be exceeded by the storm intensities considered under PPS25, this will result in overland flows and surface water ponding. The significance of these problems will be exacerbated by the increased rainfall intensity which can be expected as a result of climate change (PPS25 table B.2).

Where new development is on predominantly rural land, it cannot be assumed that a drainage network will exist and whilst it is simple to direct water off-site, the downstream impact this will cause requires consideration. Therefore in this situation the implementation of suitable SUDS techniques is important to ensure the development has no adverse effect downstream of the site.

5. Flood Zones – The extent of Flood Zones within each ward will determine which locations are suitable to accommodate windfall developments. The search area for alternative sites to be considered in the application of the Sequential test shall be the whole of the Borough, unless it can be demonstrated that the development is required within a restricted search area to meet a particular demand. Following the application of the Sequential test, the Exception test will need to be applied dependent on compatibility considerations as set out in table D.3 of PPS25. Part C of the Exception test requires that ‘a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.’ In evaluating if the development is safe the Environment Agency will consider if the premises is adequately flood resistant (this is best achieved by setting finished floor levels a minimum of 600mm above future design flood levels) and considering if safe egress as determined by reference to FD2320 is available from the property throughout its design life.

The PPS25 Practice Guide (Section 4.47 – 4.61) provides further guidance on ensuring that a development is safe, and as part of this, advises that in some ‘exceptional cases’ developments or redevelopments might be acceptable if the building remains safe, but safe access cannot be guaranteed during a flood (section 4.58).

Where safe access to a site cannot be guaranteed during a flood, the site should only be considered as a last resort once Weymouth & Portland Borough Council are convinced that the need for development overrides the flood risk. An ‘exceptional case’ could be where the development is on a dry island (the site is in Flood Zone 1) and can provide a safe refuge or to manage residual flood risk where a site is appropriately defended throughout its design life (from fluvial and/or tidal flooding) with residence living above the future flood level on a raised ground floor level or on the first floor and above (the ground floor is only used for car parking).

Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points and any venting are situated 600mm above the 1 in 100 year (fluvial) and 1 in 200 year (tidal) flood level plus climate change for the life of the development. Near the coast an allowance for wave action should also be made.

6. Topography – The topography of the Weymouth &Portland Borough Council area varies from ward to ward and influences the potential for development. Steep topography will affect where development can be located for example, placing additional properties in a steep-sided valley will increase the risk of ponding at the bottom of the valley due to the collection of surface water on impermeable surfaces. On the other hand, location of development on top of a hill will increase the risk of flooding to existing developments downhill by increasing the volume and speed of surface water run-off from impermeable surfaces. Where the topography is very flat, similar considerations need to be applied, in addition to there being less opportunity for flood water to drain away. Generally land has been classed as low-lying where it is approximately 10mOD or lower.

Proposed development should be set-back from a watercourse with a minimum 8m wide undeveloped buffer zone, to allow for a wildlife corridor and the formation of appropriate access for maintenance and emergency clearance.

Wards

Figure 7.1 shows the wards of Weymouth and Portland with the Flood Zones (as published by the Environment Agency Spring 2009) highlighted. For the purposes of a SFRA the effects of climate change on the extents of Flood Zones is simplified by considering that the current fluvial Flood Zone 3 will become the functional floodplain which will preclude the area being used for all development except that considered to be water compatible as set out in table D.2 of PPS25 and Essential Infrastructure, subject to passing the exception test (ref paragraph D.9 PPS25). The existing fluvial Flood Zone 2 will become Flood Zone 3 for purposes of the sequential test. Highly vulnerable development would be inappropriate in this area and the exception test would be required for both essential infrastructure and more vulnerable development. It would not be appropriate to use current Flood Zones generated from tidal flooding as the 2126 Flood Zone 3 will extent significantly into Flood Zone 1. The extents from the climate change scenarios modelled during this study have therefore been used. Figure 7.2 provides an indication of the topography across the whole area.

Figure 7.1 – Wards and Flood Zones.

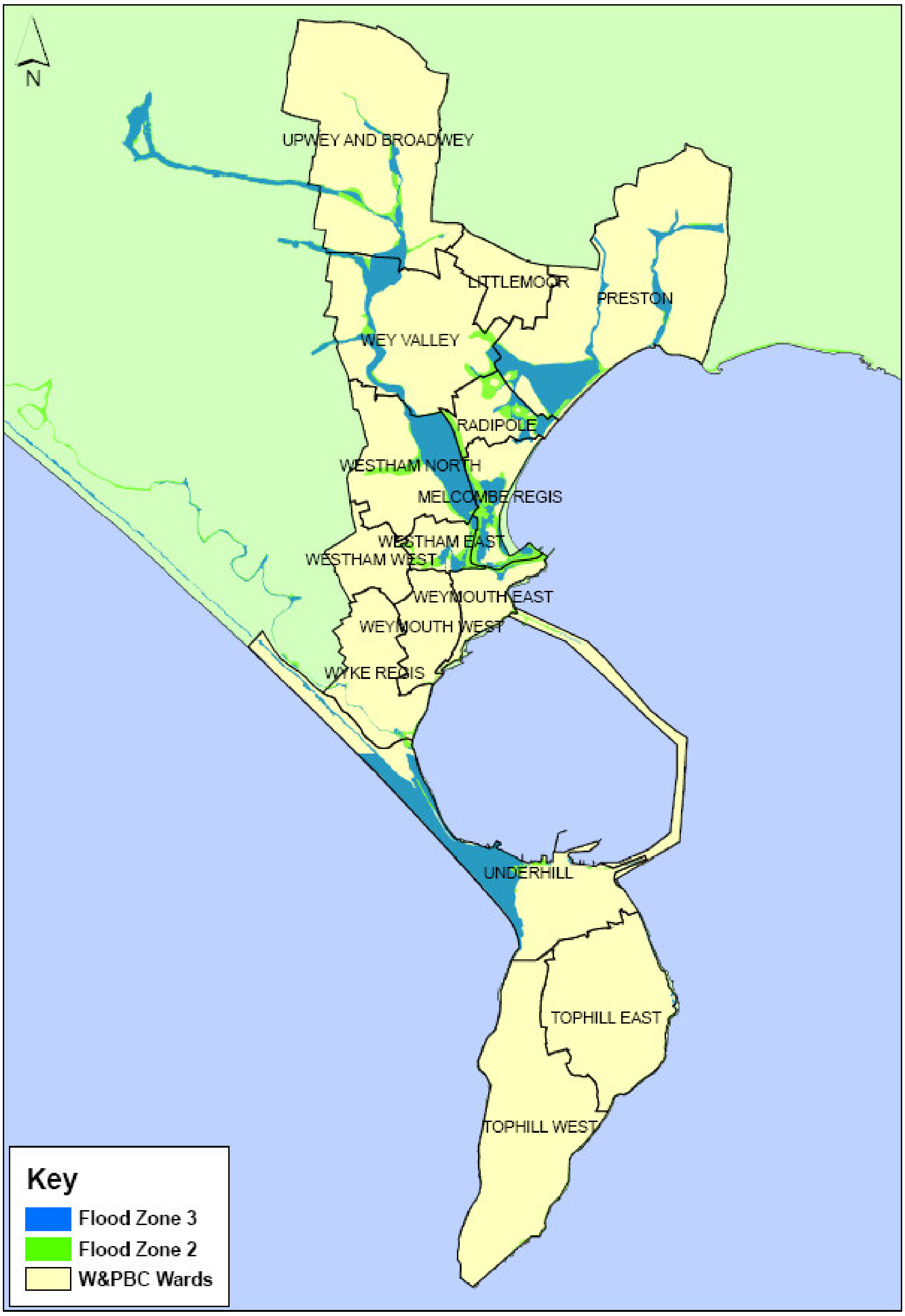
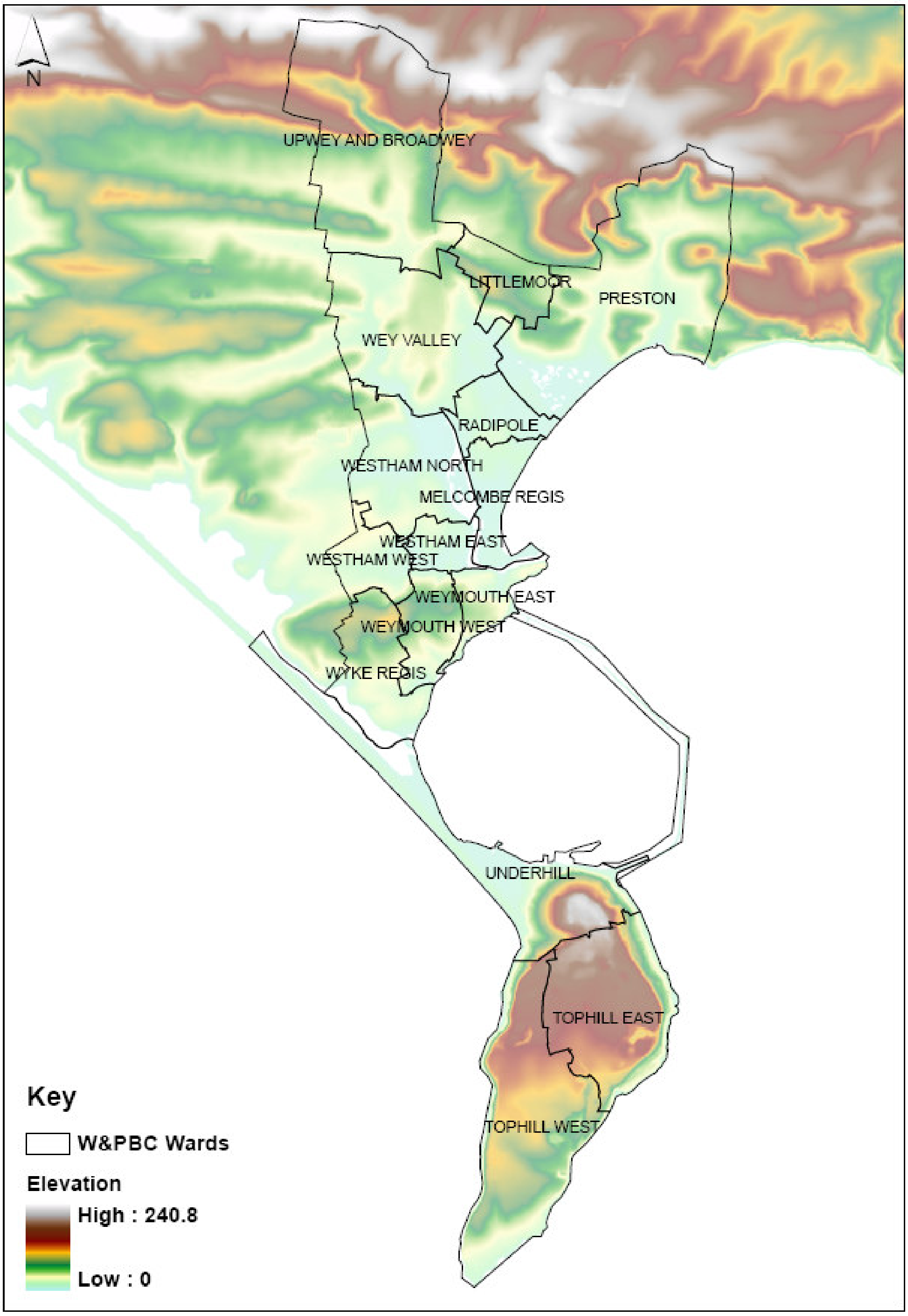


Figure 7.2 – Topography.



7.1 Upwey and Broadwey

This is one of the larger wards within the Weymouth & Portland Borough Council area (645ha). The ward forms part of the Pucksey Brook, Broadwey Stream and River Wey catchments. Both the Pucksey Brook and Broadwey Stream discharge into the River Wey within the ward boundary. It is very steep in the north of the ward with undulating topography to the south; approximately 5% of the ward is low-lying land. The northern extent of the ward comprises Upper Chalk followed by Portland beds, with Kimmeridge Clay, Corellian sub-layers and Oxford Clays further south.

It is anticipated the ward will gain 105 properties by 2023 this is an increase of 6.5%, the average density in 2023 will be ~ 2.67dph. It should be noted that currently the majority of housing is confined to the south eastern quarter of this ward between, and in the case of some properties within, the Flood Zones associated with the River Wey and Broadwey Stream. Environment Agency Flood Zones 2 and 3 account for approximately 10% of the ward land area.

The geological and topographical characteristics of this ward indicate that the steepness of the ward to the north may impede development in that area especially given that the region comprises mostly permeable land, the extent of which is likely to be reduced should development take place. The steepness of the northern part of the ward means that should development occur, unless major SUDS techniques are employed, the reduction in permeable land could adversely affect existing developments further downstream through increased surface water run-off.

Windfall sites could be located within the ward. The topography indicates that there may be more potential for development in the south of the ward than in the north, however for all locations further investigation will be required to assess suitability of site and potential impacts on surface water and flood risk for the ward and areas downstream.

7.2 Littlemoor

This is one of the smaller wards (123ha) within the Weymouth & Portland Borough Council area. The ward is hilly throughout; approximately 2% of the ward is considered low-lying land. The ward comprises Oxford Clays, Correllian bed and Kimmeridge clay and is therefore relatively impermeable.

It is anticipated the ward will gain 45 properties to 2023 this is an increase of 2.84%, and the density in 2023 will be 1.33dph. It should be noted that currently the majority of housing is confined to the Northern half of this ward and that Environment Agency Flood Zones 2 and 3 account for approximately 1% of the ward land area.

Development of this ward could have a hydrological effect on the source of one of two catchments (Broadwey Stream and a tributary to Preston Brook), the consequence of which may potentially cause flooding downstream.

Windfall sites could be located in the ward. Further investigation would be required into impact of flooding downstream and to recommending appropriate SUDS techniques at Littlemoor. Is it suggested that there appears to be opportunity to develop in the centre of the ward however at present this location is under review as an Urban Extension site for Weymouth & Portland Borough Council, which is discussed in Section 1 of this report.

7.3 Preston

This is the largest ward within the Weymouth & Portland Borough Council area with an area of 716ha. The ward is very steep in the north and more flat to the south;

approximately 45% of the ward is low-lying land. The northern extent of the ward comprises Upper Chalk followed by Portland beds, with Kimmeridge Clay further south.

The urban area of Preston extends north of Lodmoor Nature reserve in the south west of the region to the north east district of Sutton Pontyz. It is anticipated the ward will gain 219 properties by 2023, this is an increase of 9.1%. The density in 2023 will be 3.36dph. Environment Agency Flood Zones 2 and 3 account for approximately 20% of the ward land area.

There are three catchments within the Preston Ward. The River Jordon is to the East of the ward and discharges to the sea at Bowleaze Cove. There are numerous properties within Flood Zone 2 and 3 for the River Jordan. Preston Brook is to the west of the River Jordon. Here Flood Zone 2 and 3 almost follows the entire length of the ward and properties are within the Flood Zones. The third watercourse flows into Lodmoor Nature Reserve. Within the ward the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

It is suggested that windfall sites could be located within the ward. The topography indicates that there may be more potential for development in the south of the ward than in the north, however for all locations further investigation will be required to assess suitability of site and potential impacts on surface water and flood risk for the ward and areas downstream. An area in the south-east of the ward has been selected as an option for strategic development. This is discussed in Section 1 of this report.

7.4 Wey Valley

The Wey Valley is a relatively large ward (434ha) with variable topography. Approximately 45% is considered to be low-lying in association with the River Wey floodplain, which encourages drainage to the River Wey. In contrast to many of the wards, the geology is mostly permeable comprising Forest Marble, Cornbrash, Fuller's Earth, Oxford Clay and Plateaux Gravel.

It is anticipated the ward will gain 27 properties by 2023 through windfall sites, this is an increase of 1.8% with a density of 3.4dph. It should be noted that currently the majority of housing is confined to the eastern side of this ward between the Flood Zones associated with the River Wey and tributary to the Preston Brook. Environment Agency Flood Zones 2 and 3 account for approximately 15% of the ward land area relating entirely to the River Wey catchment. Only a very small number of properties are located within or adjacent to these zones in the ward. Within this area the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

The geological and topographical characteristics of the ward indicate that should any appropriate sites be identified, development could be an option. However, any proposed development will require further investigation into the suitability of the sites and of impacts on surface water and flood risk to the ward and areas downstream. Given the permeability of the ward it is recommended that the application of SUDS techniques will be essential for any development within the ward.

Is it suggested that there appears to be opportunity to develop in the centre of the ward however at present this location is under review as a strategic development site for Weymouth & Portland Borough Council, which is discussed in Section 1 of this report.

7.5 Radipole

At 106ha this is one of the smaller wards. It has relatively flat topography, 100% of the ward is considered to be low-lying. It also comprises impermeable geology consisting entirely of Oxford Clays.

It is anticipated the ward will gain 207 properties by 2023 through windfall sites, this is an increase of 13.1% with a density of 1.7dph. Flood Zones 2 and 3 account for approximately 25% of the ward area. The Flood Zones within the Radipole ward relate to two main catchments. The River Wey is not within the ward itself but the related Flood Zones affect the entire eastern boundary of the ward. Similarly the Preston Brook is not within the ward but several drains to the Preston Brook flow north-eastward through the ward joining the watercourse in the adjacent Preston ward. Within the ward the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

Should a windfall site planning application be submitted in Radipole thorough investigation will be required into the effects development will have on the surrounding area considering the density of existing housing and existing flood risk. There are no obvious locations within the ward for windfall site allocation. Recommending appropriate SUDS techniques will be vital in the planning of new development at Radipole especially given its location between Lodmoor and Radipole Lake Nature Reserves. The Water Level Management Plan for both of these areas are currently under review and will therefore need to be considered before development is assessed.

7.6 Westham North

The ward area is 274ha. It has very flat topography, approximately 80% of the ward comprises low-lying land. This is reflected in the proportion of the ward that is located within Environment Agency Flood Zones 2 and 3 (40%) associated with the River Wey and Chafeys Stream (which drains into the River Wey) catchments. Radipole Lake nature reserve is also located within the ward. The ward contains a mixture of impermeable and permeable geology, primarily Oxford Clays and permeable earthy limestone ‘Cornbrash’. Within the ward the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

This ward has the highest density of housing (8.7dph). It is anticipated that the ward will experience an increase of 2.4% in number of properties through windfall allocation by 2023.

Much of the ward is already developed leaving only the option of infill. Where surfaces are already impermeable, this will have limited impact on the hydrological regime of the ward. Where permeable sites are to be developed, consideration must be given to the proximity and adequacy of existing drainage networks. This must include potential additions to, and provision for, changes in surface water run-off through implementing mitigation measures such as SUDS so that the development does not adversely impact flood risk within or adjacent to the ward.

It is suggested that the possibility exists to develop windfall sites within the existing urban area of this ward. However, no specific locations have been identified by this study within the ward for windfall site allocation. Further investigation is required to identify specific sites and the impact of developing these sites on potential increases in surface water run-off and flood risk to the ward and surrounding area especially regarding any potential impacts for Radipole Lake. The Water Level Management Plan for Radipole Lake is currently under review and therefore should be reviewed prior to any development going ahead.

7.7 Melcombe Regis

Melcombe Regis is a relatively flat ward with an area of 115ha, all of which is low-lying land. The ward comprises Oxford Clays and Cornbrash.

This is a very urban ward with residential areas in the north of the region and town centre in the south. Environment Agency Flood Zones 2 and 3 account for approximately 50% of the ward. This includes both tidal flood risk and fluvial flood risk from the River Wey. It is anticipated the ward will gain 552 properties to 2023 this is an increase of 15.85%, the density in 2023 will be 3.5dph.

Many properties are currently located within Flood Zones 2 and 3 and therefore increased development on the proposed scale is likely to increase the risk of flooding for much of the ward and potentially laterally extend the areas at risk. Within the ward the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

It is expected that windfall sites in this area would have a significant impact on the surrounding flood risk. Therefore should a windfall site planning application be submitted in Melcombe Regis, thorough investigation will be required into the effects development will have on the surrounding area considering the density of existing housing and existing flood risk. Recommending appropriate SUDS techniques will be vital in the planning of new development at Melcombe Regis. No specific locations for windfall site development have been identified.

7.8 Westham East

This is the smallest ward within the Weymouth & Portland Borough Council area. It is relatively flat throughout; approximately 90% of the 69ha of the ward is low-lying land. The geology of the ward comprises solely Oxford Clays and is therefore relatively impermeable.

It is anticipated the ward will gain 360 properties by 2023 this is an increase of 20.4%, making the density in 2023 3.1dph. This is a very urban ward with housing over most of the land surface. Westham East has 10% of the ward area displayed as Flood Zone 2 and 3, this land is adjacent to marinas within Weymouth Harbour and is associated with the River Wey. There are a very small number of properties within Flood Zones 2 and 3.

As shown by the percentage increase in properties, this urban ward is predicted to become increasingly urban due to windfall sites. Whilst 90% of the property is outside Flood Zone 2 and 3, development may increase risk of flooding and extend the area at risk. Within the ward the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

Should a windfall site planning application be submitted in Westham East, thorough investigation will be required into the effects development will have on the surrounding area considering the density of existing housing and existing flood risk. Recommending appropriate SUDS techniques will be vital in the planning of new development at Westham East. No specific locations for windfall site development have been identified.

7.9 Westham West

The ward is similar in topography to Westham North where approximately 80% of the total ward area (104.6ha) is low-lying land. The land rises to the south of the ward on the boundary with the Weymouth West ward. The geology of the ward is impermeable consisting entirely of Oxford Clay.

A 24% increase in housing is anticipated for the ward through windfall sites by 2023 with an estimated density of 1.83dph. In contrast to Westham North there are no Flood Zones present within this ward.

The geological, topological and hydrological characteristics of the ward indicate that should any appropriate sites be identified, development could be an option. However, any proposed development will still require adequate consideration of the impacts on surface water and flood risk to the ward and areas downstream. There appears to be opportunity to develop in the south of the ward however at present this location is under review as a strategic development site for Weymouth & Portland Borough Council, which is discussed in Section 1 of this report.

7.10 Weymouth East

The topography is variable throughout the 88.6ha of the ward, rising from sea level at the coast to the east and north (quayside) of the ward, to approximately 50mOD elevation inland to the west of the ward. Only 5% of the ward is considered to by low-lying. The geology comprises a mixture of Corellian beds (grit and clay) and Kimmeridge Clay presenting a relatively impermeable surface.

An increase in properties of 4.7% by 2023 is anticipated through windfall allocation for this ward with a density of 2.3dph. Environment Agency Flood Zones 2 and 3 account for approximately 5% of the ward area in relation to the River Wey catchment. Within this area the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

The geological, topological and hydrological characteristics of the ward suggest that should any appropriate sites be identified, development could be an option. However, no specific sites have been identified for windfall site development within this ward although the potential for small scale development may exist in a limited number of locations. Any proposed development will require further investigation into the suitability of site, potential impacts of the development on surface water and flood risk to the ward and surrounding areas and evaluation of appropriate SUDS techniques.

7.11 Weymouth West

The topography is variable throughout the ward, only 5% of the total area of the ward (123ha) is considered to by low-lying. The geology comprises a mixture of Corellian beds (grit and clay) and Kimmeridge Clay presenting a relatively impermeable surface.

An increase in properties of 7.3% by 2023 is anticipated through windfall sites for this ward with a density of 1.8dph. There are no flood zones present within the ward.

The geological, topological and hydrological characteristics of the ward indicate that should any appropriate sites be identified, development could be an option. However, specific sites have been unable to be identified within the scope of this study although it is suggested that potential for small scale development may exist in a number of locations. Any proposed development will still require adequate consideration of the impacts on surface water and flood risk to the ward and adjacent areas.

7.12 Wyke Regis

Wyke Regis has an area of 202ha. The topography is low-lying at the coast to the south of the ward, rising steeply to the north. The ward comprises mostly a mixture of Corellian beds (grit and clay) and Kimmeridge Clay providing a relatively impermeable surface.

An increase in properties of 4.4% by 2023 is anticipated through windfall sites for this ward with a density of 1.3dph. There are no Flood Zones present within the ward, however the East Fleet Nature Reserve is on the southern border and caution must be exercised to ensure there are no adverse impacts on the reserve.

The geological, topological and hydrological characteristics of the ward indicate that should any appropriate sites be identified, development could be an option. However, no specific locations have been identified in this study although it is suggested that potential for small scale development may exist in a number of locations. Any proposed development will still require adequate consideration of the impacts on surface water and flood risk to the ward and adjacent areas.

7.13 Underhill

This is one of the larger wards (382ha) within the Weymouth & Portland Borough Council area, located primarily in Portland. The ward is very steep in the north with undulating topography to the south; approximately 50% of the ward is low-lying land. The northern region of the ward comprises Lower Purbeck with Portland stone and Kimmeridge clay which forms the north western head of Portland.

It is anticipated the ward will gain 165 properties by 2023, this is an increase of 9.36%, the density in 2023 will be 5.0dph. It should be noted that a large part of this ward is shingle beach and unsuitable for development and currently the majority of housing is confined to land on Portland. Tidal Flood Zones account for approximately 60% of the ward land area extending from the Chesil ridge to the low-lying area of Chesil Cove.

This currently affects industrial buildings and some residential properties to the east of the Flood Zone. A large number of studies have been undertaken for Chesil Beach. The relevant studies should be thoroughly reviewed prior to any additional assessment in this area. Within the ward the lower reaches of watercourse and surface water discharges to the sea will in the future be influenced significantly by rising sea levels. Very low-lying land will also be increasingly subject to tidal inundation.

There are no bounding wards that will be affected by the changes in land use of this ward and since all water discharges to the sea, the effect any development will have downstream will be minimal and therefore only a basic assessment will be required. However appropriate SUDs techniques should be investigated and employed. No specific locations for windfall site development have been identified.

7.14 Tophill East and Tophill West

Located in Portland, these are two of the larger wards within the Weymouth & Portland Borough Council area (374ha and 508.7ha for Tophill East and West respectively). The wards are very steep in parts and sloping to the south; approximately 2% of the wards are low-lying land. The geology of the wards is mostly permeable, comprising Lower Purbeck and Portland stone.

It is anticipated the Tophill East ward will gain 42 properties by 2023 this is an increase of 2.74%, the density in 2023 will be 4.2dph. Tophill West is anticipated to gain 99 properties by 2023 an increase of 4.22%, density 4.8dph. Environment Agency Flood Zones are found to account for very minimal proportions of the two wards (<2% of each) and are located at the coast.

Since there are no bounding wards that will be affected by the changes in land use of this ward and since all water discharges to the sea, instances of localised flooding should be investigated when considering development of windfall sites in this ward. In order to maintain infiltration to the porous Lower Purbeck stone further investigation is required into recommending appropriate SUDS techniques for both wards. There appears to be the potential for development in a variety of locations within both Tophill East and West. Tophill East incorporates one of the Weymouth & Portland Borough Council strategic development sites reviewed in Section 1 of this report.

7.15 Summary

Generally suitable for development	Detailed assessment required before suitability can be determined	Generally unsuitable for development
Upwey and Broadwey	Westham North	Melcombe Regis
Wey Valley	Westham East	Radipole
Littlemoor	Weymouth East	Underhill
Preston		
Weymouth West		
Westham West		
Wyke Regis		
Tophill East		
Tophill West		

A Sequential test will need to be carried out for each windfall site and if appropriate an Exception test. If the site is over 1 hectare in area, a site specific Flood Risk Assessment will be required.

Where wards are considered suitable for development in the list above a thorough investigation of local conditions and flood risk must still be carried out prior to development so that no adverse impact occurs either within the ward or in locations downstream of the development. Where possible development should improve the current situation for both the site and the surrounding area.

8 GLOSSARY OF TERMS

ABD	Areas Benefiting from Defences
AEP	Annual Exceedence Probability. The estimated probability of a flood of given magnitude occurring or being exceeded in any year.
Catchment	The area contributing surface water flow to a point on a drainage or river system (the area drained by that river, including areas away from the watercourse network). Can be divided into sub-catchments.
DEM	Digital Elevation Model
Design Event	A historic or notional flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.
DTM	Digital Terrain Model
EA Flood Zone 1	Low Probability of flooding
EA Flood Zone 2	Medium Probability of flooding. Probability of fluvial flooding is 0.1 – 1% and probability of tidal flooding is 0.1 – 0.5%
EA Flood Zone 3a	High Probability of Flooding. Probability of fluvial flooding is 1% (1 in 100 years) or greater and probability of tidal flooding is 0.5% (1 in 200 years) or greater.
EA Flood Zone 3b	Functional floodplain.
Environment Agency (EA)	Non-departmental public body responsible for the delivery of government policy relating to the environment and flood risk management in England and Wales.
FAS	Flood Alleviation Scheme
FEH	Flood Estimation Handbook. The Environment Agency approved method of estimating flood flows in the UK.
Flood Defence	A structure (or system of structures) for the alleviation of flooding from rivers or the sea to a specified design standard.
Flood Estimation Handbook	The Environment Agency approved method of estimating flood flows in the UK.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Risk Assessment	Considerations of the flood risks inherent in a project, leading to the development of actions to control, mitigate or accept them.
Floodplain	Any area of land over which water flows or is stored during a flood event, or would flow but for the presence of flood defences.
Fluvial	Pertaining to a watercourse (river or stream).
Freeboard	The difference between the design flood level and the lowest point on the flood defence.
GIS	Geographical Information System. A computer-based system for capturing, storing, checking, integrating, manipulating, analysing and displaying data that are spatially referenced.
Greenfield run-off rate	The rate of run-off that would occur from the site in its undeveloped state.

Groundwater	Water occurring below ground in natural formations (typically rocks, gravels and sand).
Hazard	A situation with the potential to result in harm. A hazard does not necessarily lead to harm.
Hydraulic model	A computerised model of a watercourse and floodplain to simulate water flows in rivers to estimate water levels and flood extents.
iSIS	One dimensional hydraulic modelling software.
Main River	Watercourses defined on a 'Main River Map' designated by DEFRA. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
QMED	Mean annual maximum flood
mOD	Metres Ordnance Datum. Elevations use Ordnance Datum Newlyn.
NFCDD	National Flood & Coastal Defence Database. Environment Agency asset management system database.
PPS25	Planning Policy Statement 25; 'Development and Flood Risk'.
Probability	The likelihood of an event occurring.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
SLR	Sea Level Rise.
Standard of protection	The level of flood that a defence is designed to protect against before it is exceeded.
Surface Run-off	Water flowing over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or if rainfall is particularly intense.
Sustainable Drainage Systems (SuDS)	A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.
Time to peak	The time from the centroid of the total rainfall to the peak of the run-off hydrograph, i.e. the length of time it takes to convert rain into river flow.
Topography	The shape and form of the land, in terms of hills, steepness of slopes, or flat land.

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Appendix A

Guidance for site specific FRAs, the use of SuDS techniques and Flood Resilient Construction

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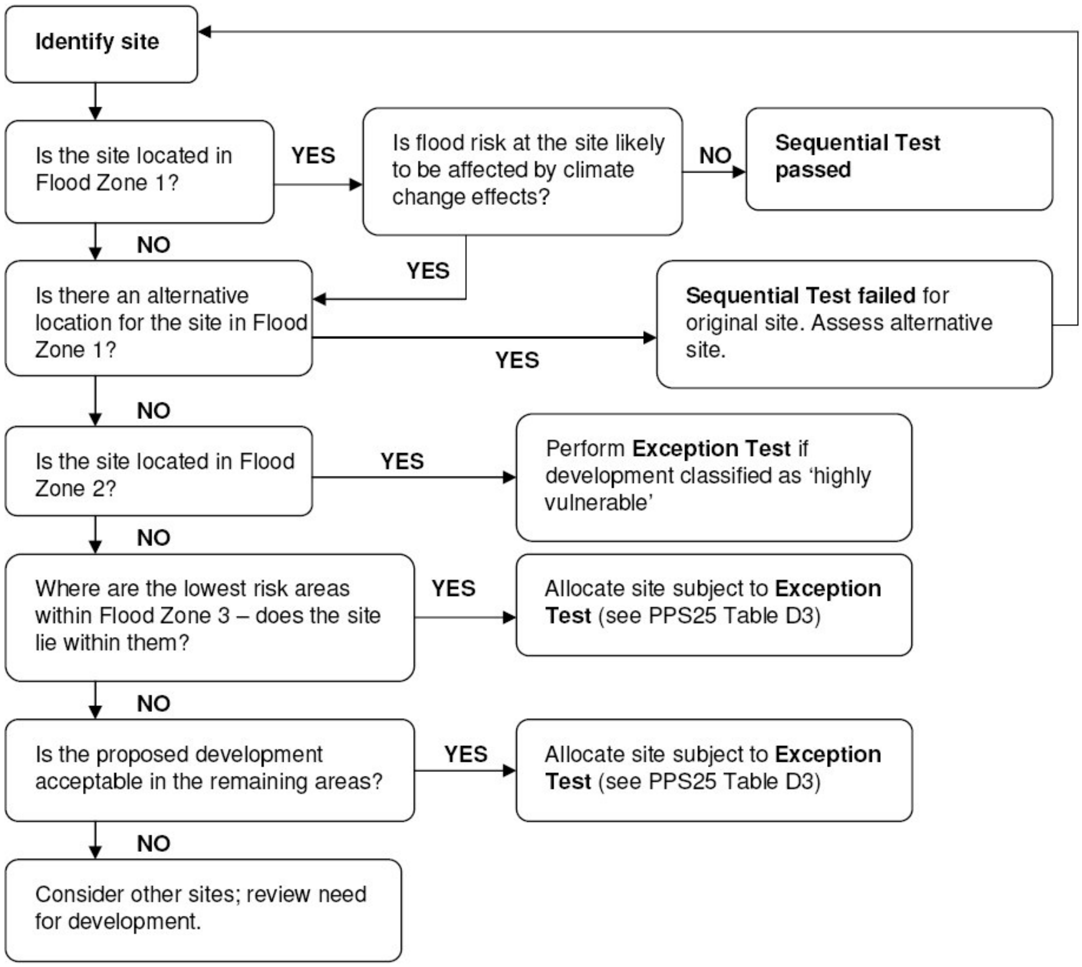
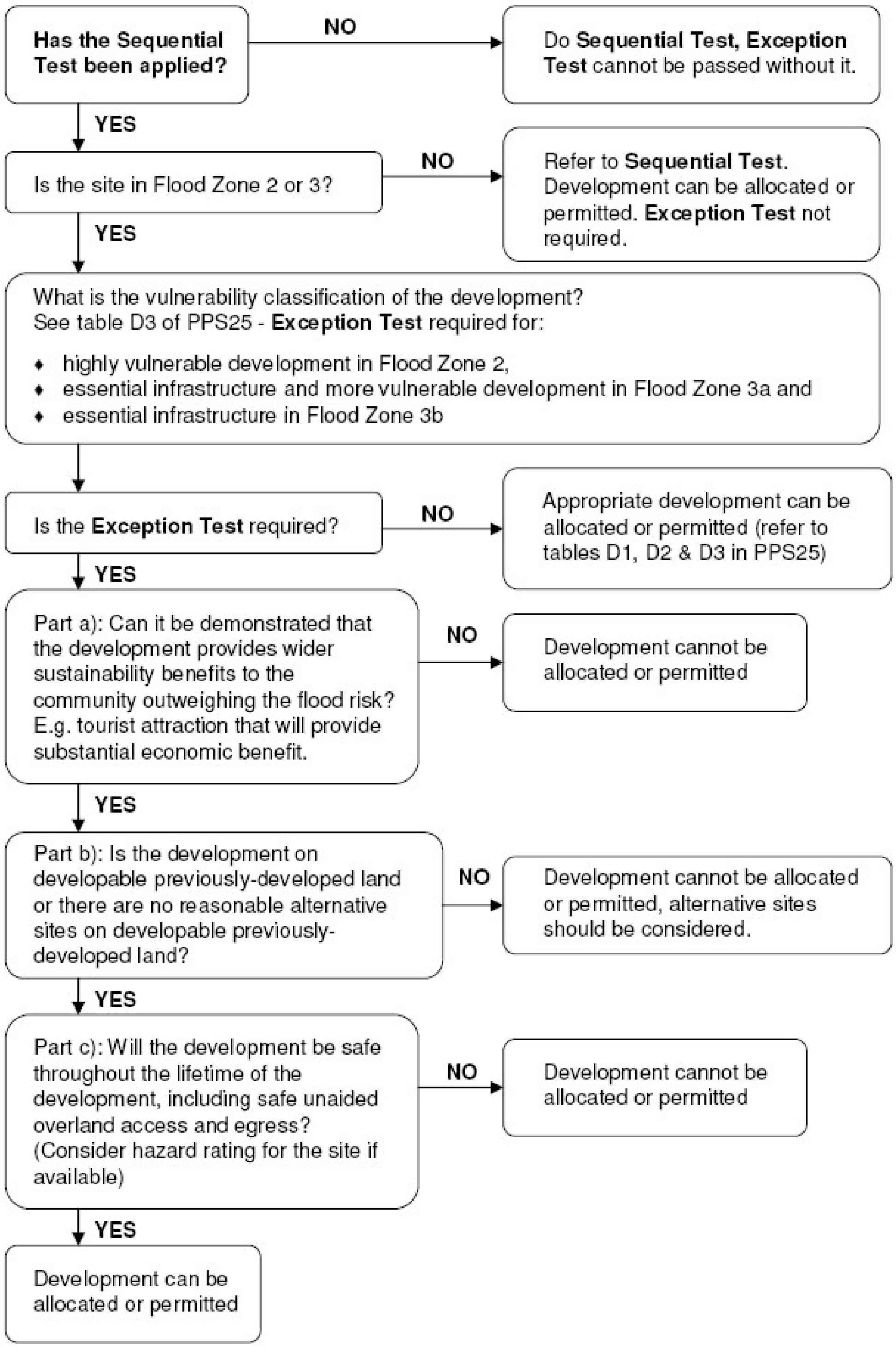
Guidance for application of the Sequential and Exception Tests in accordance with PPS25

Application of the Sequential Test at the Local Level

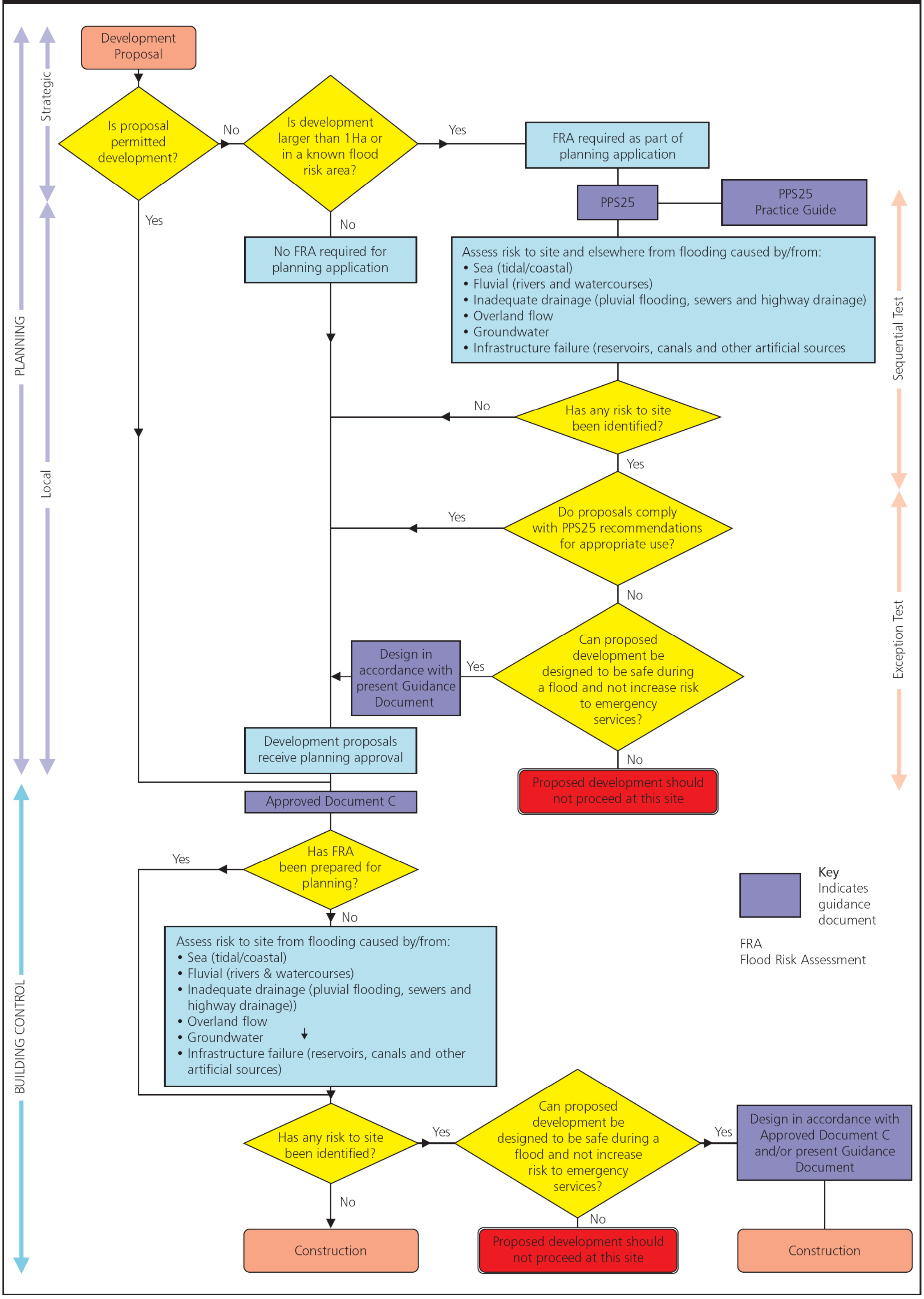


Application of the Exception Test at the Local Level



FRA Decision tree and minimum criteria for assessment

Figure 3.2 **Decision tree for planning process and building control**



Source: Improving the performance of New Buildings: Flood Resilient Construction (Communities and Local Government 2007)

If an FRA is required then the following tick sheet can be used to assess if the minimum criteria have been met…

FRA Criteria	**Included in the FRA?***	**Significant impact?****
Of appropriate detail for the size of the development and risk involved.		
Consider the risk to the development.		
Consider the risk to the surrounding as a result of the development.		
Consider the impacts of climate change.		
Be undertaken by competent people at an early stage in the planning process.		
Consider both the beneficial and adverse effects of any flood risk management infrastructure, along with the consequences of their failure.		
Consider the vulnerability classification of the people who will use the site.		
Put in place safe access to and from the site in times of flood.		
Consider and quantify the existing flood risk from all sources.		
Identify possible measures to reduce the flood risk.		
Consider the effects of a range of flood events on people, property, the natural and historic environment and rivers & coastal processes.		
Include an assessment of the residual risk after flood risk management infrastructure has been put in place and demonstrate that this is acceptable for the development in that particular flood zone.		
Consider how the development may affect how water drains into the ground.		
Consider the effect the proposed development layout may have on the drainage systems.		
Be supported by appropriate data, including historical information on previous events.		

* If any of these are not included in the FRA, return it to the developer for further information.
** If any of these highlight that the impact is significant then further investigation may be required.

If the Exception test is required then more information will need to be collected and analysed.

Surface Water and Sustainable Drainage Systems (SUDS)

Flood risk from surface water flooding is of concern within the study area. A number of flood incidents have occurred within the area caused by surface water alone, or in combination with river flooding. Some of these events are highlighted on the maps as recorded by the EA (FRIS) or historic information. The EA Flood Zone Maps do not show flood risk due to surface water flooding.

Urban developments can have a big effect on the quantity and speed of surface water run-off. By replacing vegetated ground with buildings and paved areas, the amount of water being absorbed into the ground is severely reduced, therefore increasing the amount of surface water present. This additional surface water increases the demand on drainage systems in built up areas. Traditional drainage systems are designed to get rid of the water as quickly as possible to prevent flooding in the built up area. This can cause problems, particularly downstream, by altering the natural flow patterns of the catchment. In addition, water quality can be affected due to pollutants from the built up areas being washed into the watercourse. One technique which can reduce this problem is the use of Sustainable Drainage Systems (SUDS).

Sustainable Drainage Systems (SUDS) are techniques designed to control surface water run-off before it enters the watercourse. They are designed to mimic natural drainage processes, along with treating the water to reduce the amount of pollutants getting into the watercourse. They can be located as close as possible to where the rainwater falls and provide varying degrees of treatment for the surface water, using the natural processes of sedimentation, filtration, adsorption and biological degradation.

CIRIA Guidance (2007) and the SUDS Manual (C687) should be reviewed when the implementation of SUDS is proposed. This will help to ensure that the current guidelines and requirements are met.

SUDS are more sustainable than traditional methods because they can:

- Manage the speed of the run-off
- Protect or enhance the water quality
- Reduce the environmental impact of developments
- Provide a habitat for wildlife
- Encourage natural groundwater recharge.

In addition, they can be used to create more imaginative and attractive developments and are designed so that less damage is done, than conventional systems, if their capacity is exceeded.

Surface water management using SUDS can be implemented at all scales and in most urban settings, ranging from hard-surfaced areas to soft landscaped features, even if there is limited space. Most techniques use infiltration but even if the area has little or no infiltration SUDS can still be used in the form of green roofs, permeable surfaces, swales and ponds.

SUDS are made up of one or more structures built to manage surface water run-off, and used in conjunction with good site management. There are five general methods:

a. Prevention – this can involve minimizing paved areas, replacing tarmac with gravel, rainwater recycling, cleaning and sweeping, careful disposal of pollutants, and general maintenance.

b. Filter strips and swales – these are vegetated surface features that drain water more slowly and evenly off impermeable areas. Swales (figure 4.2) are long shallow channels whilst filter strips (figure 4.3) are gently sloping areas of ground. Both of these mimic natural drainage by allowing rainwater to run in sheets through vegetation, slowing and filtering the flow.

Figure 4.2 - Cross-section of a Swale

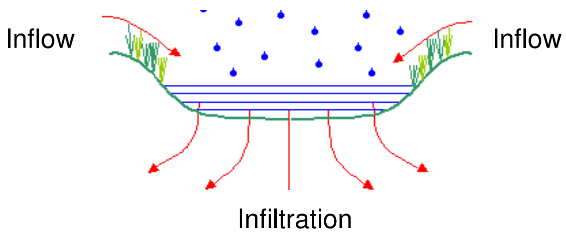
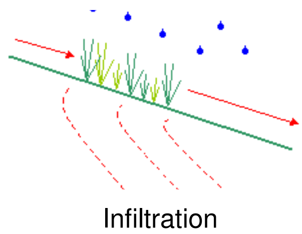


Figure 4.3 - Cross-section of a Filter Strip



c. Permeable surfaces and filter drains – these are devices that have a volume of permeable material below ground to store surface water. Run-off flows to this storage area via a permeable surface.

d. Infiltration devices – these enhance the natural capacity of the ground to store and drain water. They include soakaways, infiltration trenches and infiltration basins. See figure 4.4.

e. Basins and ponds – these are areas for storage of surface run-off e.g. floodplains, wetlands, and flood storage reservoirs. They can be designed to control flows by storing water then releasing it slowly once the risk of flooding has passed. See figure 4.5.

Figure 4.4 - Cross-section through an Infiltration Basin

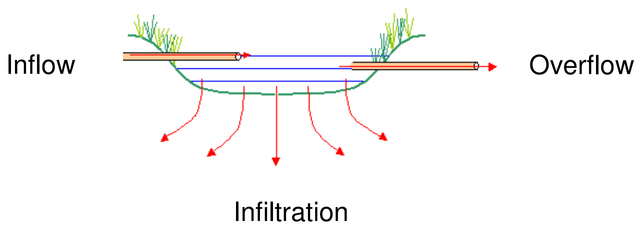
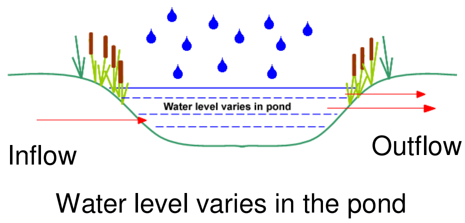


Figure 4.5 - Cross-section of a Pond



SUDS are better suited to areas of new development than in-fill. This is because for new development the drainage system for the whole area can be considered and designed at the same time, ensuring a consistent system across the development area and surroundings. Retro-fitting produces pockets of SUDS which work in isolation and therefore are not as effective as they could be within a SUDS strategy.

It is imperative that when designing SUDS for an area that both the EA and adopting authority are consulted at all stages of the design. This will ensure that the SUDS fit with the existing drainage network.

SUDS need to be regularly maintained to ensure they operate efficiently and effectively. The maintenance regime should be detailed and agreed during the design stage. Different SUDS techniques require different levels of maintenance therefore it is important to make it clear who is responsible for the maintenance at the start of the design and put a programme in place.

Government Guidance has been produced in the new water strategy for England, *Future Water,* which was published in February 2008. This strategy sets out the Government's long-term vision for water management in England. Following this publication, a consultation was carried out regarding policy measures to improve the way that surface water run-off is managed. One of the suggested management tools is the development of Surface Water Management Plans. When completed, these should provide useful guidance for developers and local authorities. More information regarding these strategies and plans can be found on the Defra website, www.defra.gov.uk/Environment/water/strategy/index.htm.

Guidance for developing housing in a flood resistant manner

Setting finished floor levels a minimum of 600m above future design flood levels is considered the minimum mitigation required for new construction. Where the proposal involves a change of use, a reduced freeboard may be acceptable when combined with other flood resistance and resilience measures. Regardless of the flood resistance measures proposed, the development including egress routes must remain safe throughout its design life.

PPS 25 states that development situated in EA Flood Zones 2 or 3 may be required to be built using flood resistant construction.

Exterior Construction

There are several measures to improve flood resistance of a wall using mortar, sealants and fillers. These measures include applying waterproof sealant to the outside face (ideally a breathable sealant), raising the level of the damp proof course, injection of fillers, closing cavities and ensuring there are no cracks or voids in the brickwork.

Excluding water will help reduce damage to the internal fabric of the building and its contents. If water does enter the house, flood resistant building materials will reduce the effects of the water and can reduce the cost of repairs.

Interior Construction

One of the most effective ways of reducing the impact of flooding is to raise the floor level of the property above expected flood levels. If this is not practical, another is to have flooring that can withstand being under water. Chipboard flooring is likely to be damaged by floodwater, so more resistant materials such as treated floorboards, WBP plywood, screed or tiles will be more suitable in flood risk areas. Fixtures that cannot be removed before a flood and might be damaged by exposure to water, such as carpets, parquet and laminate wooden floors should be avoided.

Where internal flooding cannot be avoided, some form of drainage of the water immediately post flood is recommended. In addition to protecting flooring, utility supplies should also be protected so that they can still be used in the event of internal property flooding.

- Electricity

  If there is sufficient space, the meter and fuse box should be positioned at a level which is higher than the expected flood level.

  Modern wiring is not usually affected by flooding, but long immersion may result in the need to replace wiring. Moving the ground floor ring main cables to first floor level could be considered with drop down cables to ground floor sockets. Sockets should also be raised to an appropriate height above flood levels. A further consideration is to have the house wired so that the ground floor main can be switched off, leaving the supply to the upper floors still available.

- Gas supply

  As gas meters can be affected by floodwater it is worth considering raising meters above the expected flood levels. Provision should be made for purging gas supply pipes through the installation of appropriate valves and drain points.

- Central heating systems
  Gas and oil fired boilers and associated pumps and controls should preferably be installed above the maximum expected flood level. Pipe insulation below the expected flood level should preferably be replaced with closed cell insulation. If new heating is being installed, pipework routes should be made easily accessible to allow pipes to be maintained and washed down following flooding.

- Water supply
  Water pipework insulation can be replaced with flood resistant closed cell material below the expected flooding level.

- Telephone and cable services
  Suppliers of the relevant services should be consulted on suitable installation methods in areas liable to flooding. Where possible, incoming telephone lines and internal control boxes should be raised above the expected flood levels.

- Oil storage tanks
  Oil tanks can be damaged during floods and can cause pollution. To avoid this it should be ensured that the tank is anchored down so that it does not float. In addition the oil feed from the tank should incorporate a stop valve at the end nearest the tank so that the tank contents will not be lost if the tank moves and the pipe breaks.

The information above is a summary of the CIRIA Advice Sheets. All the advice sheets, and further guidance for homeowners and developers, can be downloaded from http://www.ciria.org/flooding/advice_sheets.html

In addition, the recently released *Improving the Flood Performance of New Buildings: Flood Resilient Construction,* May 2007, Department for Communities and Local Government provides additional useful information, particularly for properties in low or residual flood risk areas. This can be found at http://www.floodforum.org.uk/improvingfloodresilienceofnewbuildings.pdf

Appendix B

Tidal curves used in town centre model

The graphs displayed below illustrate the tidal curves used in the model used to determine the risk of tidal flooding to the town centre development sites for the Level 2 SFRA.

Figure B.1 – 1 in 200 year tidal curve for Weymouth

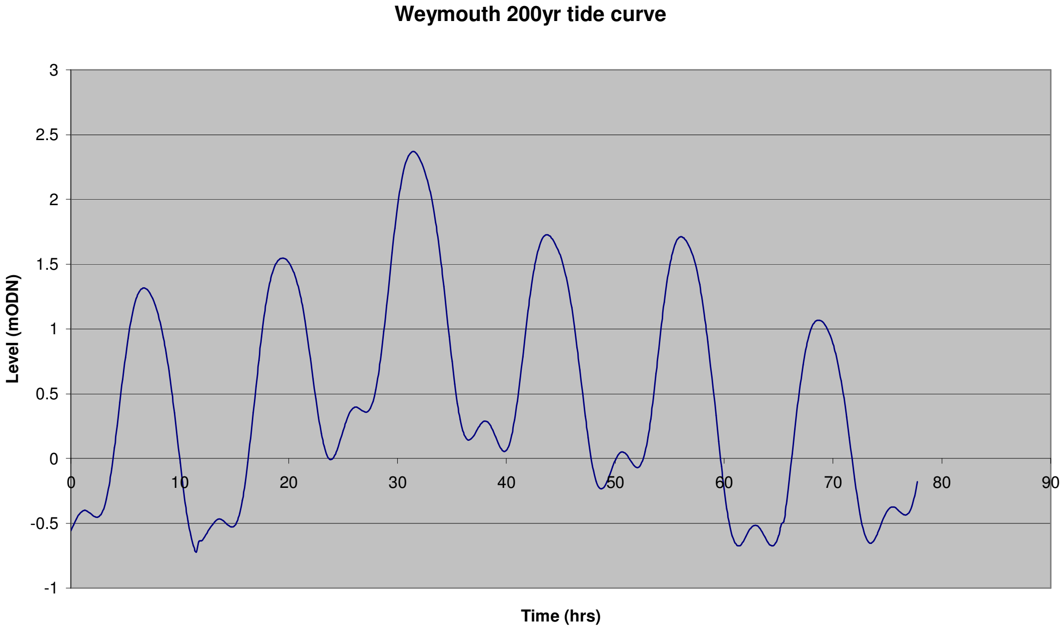


Figure B.2 – 2086 tidal curve for Weymouth

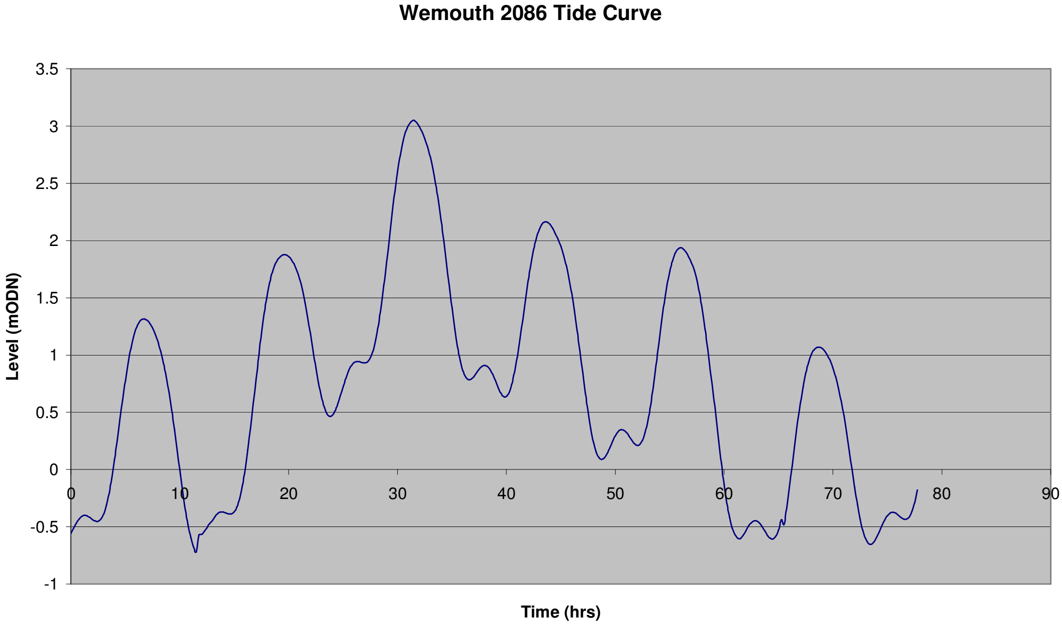
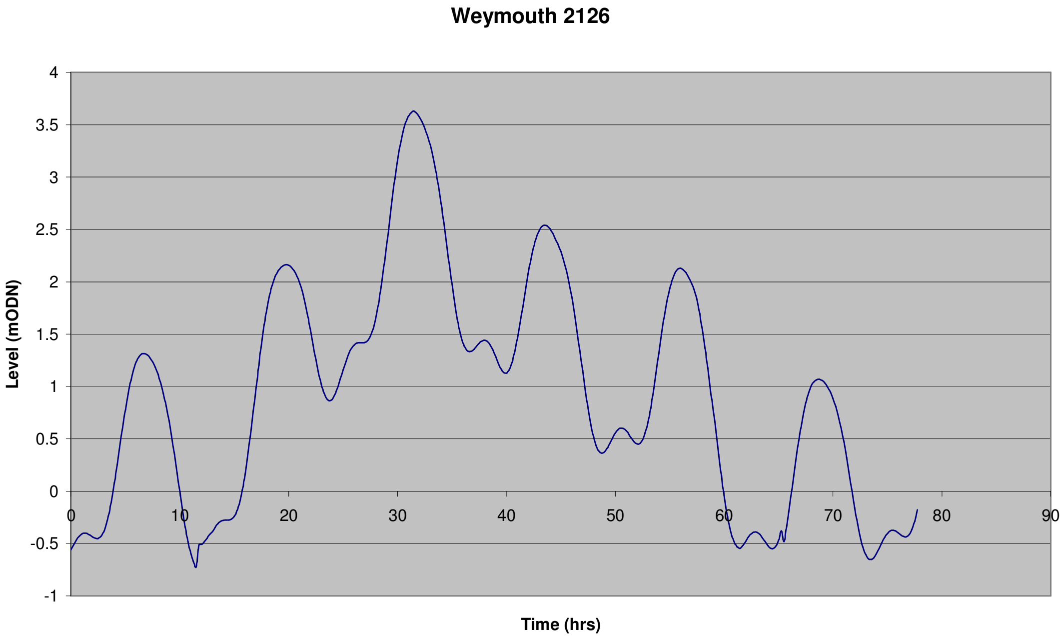


Figure B.3 – 2126 tidal curve for Weymouth



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Appendix C

Town Centre model Site Summary Sheets

Site Summary Sheets

General Information

Specific Site Name:	Weymouth & Preston Beach	Site No:	2
Agency Area:	Wessex (south coast)		
Local Authority:	Weymouth and Portland Borough Council		
Map Tile:	SY67NE, SY68SE		

Site Analysis

Wave Overtopping:	Yes
Wave Transformation:	Yes
Tide Overtopping:	Yes

Data Sources

Defence information - NFCDD; LiDAR Verification survey (April 2007); National Rivers Authority, South Western Region, Engineer's Report on Improvements to the Sea Defences at Preston Beach, Weymouth (June 1994), Ref G4612

Data Audit

Defence information in NFCDD appears to be correct. Survey data has been used due to better resolution.

Defences and Defence Structures

See Defence Information Sheet - Survey spot heights used rather than NFCDD
No formal defence at Weymouth Promenade. Environment Agency requested overtoppping analysis at this site based on historical observations of flooding in 'Park' area. Road level is approximately 3.55m ODN.

Analysis Input

1:200 2035 Extreme Water Level (EWL):		2.53	mODN
1:200 2060 Extreme Water Level (EWL):		2.75	mODN
1:200 2086 Extreme Water Level (EWL):		3.05	mODN
1:200 2126 Extreme Water Level (EWL):		3.63	mODN
Lowest Frontline Defence Crest Level (CL):		2.03	mODN
Difference between CL and EW	1:200 2035	-0.50	m
	1:200 2060	-0.72	
	1:200 2086	-1.02	
	1:200 2126	-1.60	
	1:200 2126	-1.60	

General Site Description

The harbour consists of concrete and masonry walls. Westham Bridge contains 4 flapped culverts which prevent tidal water propogating into Radipole Lake. Harbour defences extend to the breakwater at the mouth of Weymouth Harbour. There is a sea wall fronted by a shingle beach that provides protection to the Lodmoor Nature Reserve, Overcombe and the A353 road. There is also a fllapped outfall from Lodmoor, however the invert level is unknown

Additional Comments

The ABD might be influenced by a fluvial element (River Wey). Wave analysis has been carried out in the SW corner of Weymouth Harbour (where defences are higher than the EWL) and along Preston beach.

Site Summary Sheets

Weymouth Harbour and Preston Beach **Site No:** 2

Defence Information - Summary Table

NFCDD Defence Code	RH ID Number	Description	Defence Type	Crest Level (m AOD)	Source of Data	Date of Data
1112740610001R15	Wey_01	Concrete Wall	Raised Defence	2.29	EA111SVY05167 Survey	April 2007
1112740610001R14	Wey_02	Masonry Wall	Non-Raised Defence	2.40	EA111SVY05167 Survey	April 2007
1112740610001R09	Wey_03	Masonry Wall	Raised Defence	2.16	EA111SVY05167 Survey	April 2007
1112740610001R08	Wey_04	Masonry Wall	Raised Defence	2.06	EA111SVY05167 Survey	April 2007
1112740610001R18	Wey_05	Flood Wall	Yes	2.31	EA111SVY05167 Survey	April 2007
1112740610001R17	Wey_06	Vehicle Ramp	Yes	2.30	EA111SVY05167 Survey	April 2007
1112740610001R06	**Wey_07**	**Masonry Wall**	**Raised Defence**		**EA111SVY05167 Survey**	**April 2007**
1112740610001R03	Wey_08	Concrete Wall	Raised Defence	2.30	EA111SVY05167 Survey	April 2007
1112740610001R02	Wey_09	Masonry Wall	Raised Defence	2.07 to 4.04	EA111SVY05167 Survey	April 2007
1112740610001L03	Wey_18	Concrete Wall	Raised Defence	3.29	EA111SVY05167 Survey	April 2007
	Wey_19	Promenade	Non-Raised Defence	3.70	LiDAR	2006
111EGS2502001C01	Wey_20	Preston beach sea wall	Raised Defence	4.50	NRA (G4612)	01-Jun-1994
	Wey_21	Preston shingle beach	Part of raised defence	3.50	NRA (G4612) and LiDAR	1994 and 2006

Note:
The defences in bold have the lowest survey crest levels of defences in this study site.

Tide Overtopping Summary Sheets

SITE 2

Title:	WEYMOUTH & PORTLAND SFRA LEVEL 2 & LEVEL 1 UPDATE
Alternative Title:	Weymouth/Preston Beach Residual Risk Area (Site 2)
Subject (keyword):	Probability/extent of flooding
Environment Agency Area:	Wessex
Local Authority:	Weymouth and Portland Borough Council
Map Tile(s):	SY67NE, SY68SE

ABSTRACT

			Lineage (Source)
Location Description:	Weymouth including Radipole Lake, Weymouth Harbour, Weymouth Promenade and Preston Beach		
Methodology:	TUFLOW (wey_2035.tcf) TUFLOW (wey_2060.tcf) TUFLOW (wey_2086.tcf) TUFLOW (wey_2126.tcf)		5m grid (filtered LiDAR)
0.5% Annual Probability Tide Levels (mODN): **0.1% Annual Probability Tide Levels (mODN):**	2.37 at Weymouth and Preston Beach (SWX 58) 2.55 at Weymouth and Preston Beach (SWX 58)		South Coast Tidal Flood Mapping – Summary Results Report, South West Region (EA, 2005)
Sea Level Rise (mm)	2035	*160.5*	Defra FCDPAG3_Supplementary_Note 2006
	2060	*378*	
	2086	*680*	
	2126	*1260*	
Astronomic Tide:	Weymouth		SCTFM (EA, 2005)
Tide Duration (hrs):	72		
Date of LiDAR (Resolution) **See LiDAR Information Sheet**	2006 (2m resolution) 2006 (1m resolution)		EA supplied original 2m LiDAR EA supplied original 1m LiDAR
Features in Floodplain: Opening Information Sheet 2	A354 Opening Field Barn Drive Openings Westham Bridge Opening A353 Opening Weymouth Promenade Sea Wall at Preston Beach Frontage		Dorset County Council Data Dorset County Council Data ISIS Model Dorset County Council Data LiDAR NRA, Engineers Report 1994
Wave Overtopping:	Weymouth Promenade, Preston beach		Appendix E2
Roughness	0.1 for hard surfaces 0.03 at land/water boundary		Generic JFLOW value

OUTPUTS

		Further details
Presentation Type:	Map_Digital	Weymouth_2035 Weymouth_2060 Weymouth_2086 Weymouth_2126
Data Type:	MapInfo (tab)	Flood_Extent
Accuracy: **(Quantitative quality flag)**	1. Best of Breed	No better available, unlikely to be improved on in near future
Qualitative Data Quality: **(Quality assurance)**	Model reviewed internally Output reviewed internally	

Tide Overtopping Summary Sheets

Weymouth **Site No:** **2**

Opening Information - Summary Table

Infrastructure	Reference Location	OS Grid Reference	Downstream Invert (m AOD)	Height (m)	Diameter (*)/ width (m)	Comments
Culvert	Lodmoor Outfall Bridge below Preston Road(1504)	SY368973/080988	-0.8	1.5	2.2	Invert inferred from site visit, LiDAR and structure descriptions
Culvert	Field Barn Drive Bridge (957)	SY366858/080274	-0.67	-	1.80*	Invert inferred from site visit, LiDAR and structure descriptions
Culvert	Chafeys Roundabout NE Culvert below A354 (958)	SY366921/080313	-0.9	1.83	10	Invert inferred from site visit, LiDAR and structure descriptions
Culvert	Field Barn Drive (1810)	SY366861/080271	-0.67	1.55	1.55	Invert inferred from site visit, LiDAR and structure descriptions
Culvert	Westham Bridge – 4 centre culverts	SY367695/079240	-1.1	-	1.53* (each)	Values from ISIS modelling for Hydraulic Study; Length inferred from LiDAR.
Culvert	Westham Bridge – 4 outer culverts	SY367695/079240	-0.5	-	1.20* (each)	Values from ISIS modelling for Hydraulic Study; Length inferred from LiDAR.

Tide Overtopping Summary Sheets

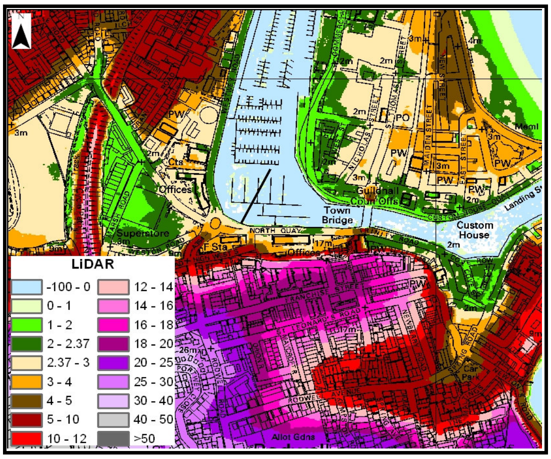
Weymouth **Site No:** **2**

LiDAR Tiles - Summary Table

LiDAR Dataset	LiDAR Tiles
Hires	V0028595 - V0028596
QPM 0204 2005	V0059933 - V0059946
	V0051196
	V0051203 - V0051205
	V0051213 - V0051218
	V0051230 - V0051237
	V0051285 - V0051293
	V0051313 - V0051322
	V0051340 - V0051346
	V0051361 - V0051366

Tide Overtopping Summary Sheets	definition	explanation
	1. Best of Breed	No better available, unlikely to be improved on in near future
	2. Data with known deficiencies	Data should be replaced as soon as improvements are made
	3. Gross assumptions	Not made up but deduced by the project team from experience or related literature/data sources
	4. Heroic assumptions	No data sources available or yet found; data based purely on intelligent guess
	5. Unknown	Accuracy unspecified

Wave Overtopping Summaries



Site 2a

Specific site name	Weymouth Harbour
Agency Area	Wessex Area
Local Authority	Weymouth and Portland Borough Council
Map tile(s)	SY67NE

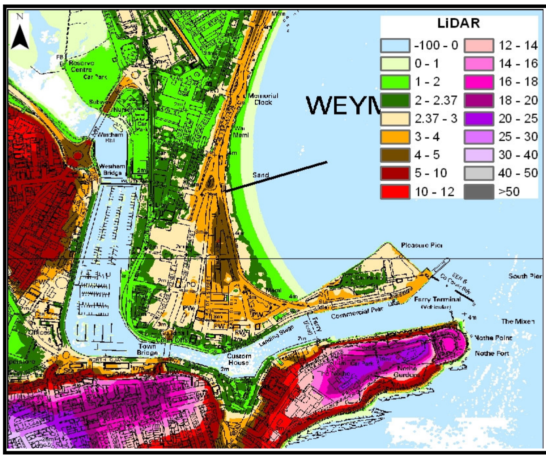
Input data

Input parameters	Chosen values	Comments
Defence level (mODN)	2.8	Taken from survey data issued by Environment Agency
Defence length (m)	185	Harbour wall
Wave overtopping analysis method	EurOtop	Overtopping manual (Aug 2007), chosen instead of AMAZON since defence shape fits 'vertical wall' category. Also angled waves can be assessed.
Starting water depth (m)	5.1	Harbour bathymetry used
Extreme water level (mODN)	2.37	Extreme water level SW update (2003)
Significant wave height (m)	Diffracted wave Hs=0.2	SWAN 2D modelling results (180°N H_s=1.27 and 150°N H_s=1.69)and use of diffraction chart to transfer the wave height into entrance of the harbour giving 0.2m H_s from 150°N and 0.14m H_s from 180°N. Localised wind generated wave being derived by using FBASE and wind data based on BS6399-2:1997 of 13.15m/s, correspond to H_s of 0.27m Used diffracted wave conditions since southerly winds are more likely to occur than northerly with a 0.5% RP water level.
Peak wave period (s)	14.3	Diffracted nearshore wave (see above)
Direction (deg N)	Normal attack	But considered offshore wave direction of 150 deg, nearshore wave with diffraction at harbour entrance gave 0.2m H_s

Outputs

Mean overtopping rate (m³/s/m)	0
Total overtopping volume (m³)	0

Wave Overtopping Summaries



Site 2b

Specific site name	Weymouth Profile 326
Agency Area	Wessex Area
Local Authority	Weymouth and Portland Borough Council
Map tile(s)	SY67NE

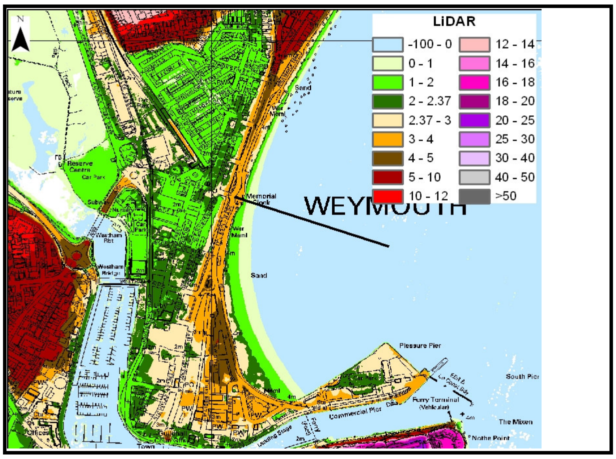
Input data

Input parameters	Chosen values	Comments
Defence level (mODN)	3.55	CCO Survey data was used for beach profile and Lidar was used for the promenade and road (see profile)
Defence length (m)	300	Sandy beach with promenade and road at back (No raised defence)
Wave overtopping analysis method	AMAZON	Defence profile does not match EurOtop standard cross sections
Starting water depth (m)	3.4	CCO Survey data used for bathymetry
Extreme water level (mODN)	1:200 (2035) 2.53m ODN 1:200 (2060) 2.75m ODN 1:200 (2086) 3.05m ODN 1:200 (2126) 3.63m ODN	Extreme water level SW update (EA 2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
Significant wave height (m)	1.39m	SWAN 2D modelling results (offshore input from Oct 2004 Event) Used diffracted wave conditions since southerly winds are more likely to occur than northerly with a 0.5% RP water level. A sensitivity test on the overtopping was carried out using the EurOtop manual (similar to profile 322) Result gave zero Chosen AMAZON result since real profile can be modelled
Peak wave period (s)	14.3s	Wind wave (see above)
Direction (deg N)	Normal attack	AMAZON works in this way. Offshore wind direction is 180N, nearshore wave direction is 112N. Compare to shore normal the difference is 22 deg

Outputs

Mean overtopping rate ($m^3/s/m$)	
1:200 (2035)	0.01
1:200 (2060)	0.02
1:200 (2086)	0.11
1:200 (2126)	0.89
Total overtopping volume (m^3)	
1:200 (2035)	5821
1:200 (2060)	19139
1:200 (2086)	94292
1:200 (2126)	778927

Wave Overtopping Summaries



Site 2c

Specific site name	Weymouth Profile 322
Agency Area	Wessex Area
Local Authority	Weymouth and Portland Borough Council
Map tile(s)	SY67NE, SY68SE

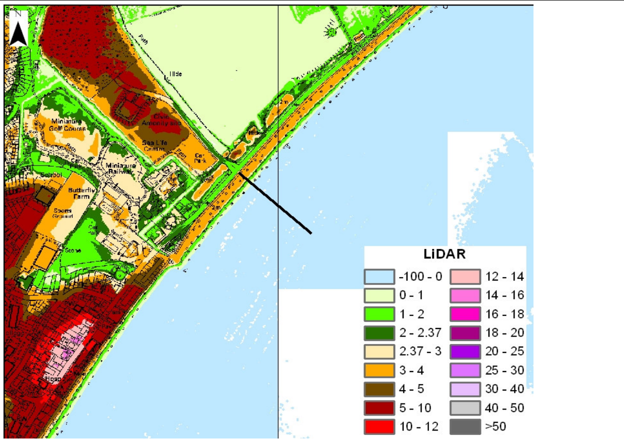
Input data

Input parameters	Chosen values	Comments
Defence level (mODN)	3.77	CCO Survey data was used for beach profile and Lidar was used for promanade and road (see profile)
Defence length (m)	400	Sandy beach with promenade and road at back (no raised defence)
Wave overtopping analysis method	AMAZON	Defence profile does not match EurOtop standard cross sections
Starting water depth (m)	3.4	CCO Survey data used for bathymetry
Extreme water level (mODN)	1:200 (2035) 2.53m ODN 1:200 (2060) 2.75m ODN 1:200 (2086) 3.05m ODN 1:200 (2126) 3.63m ODN	Extreme water level SW update (EA 2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
Significant wave height (m)	1.53m	SWAN 2D modelling results (offshore input from Oct 2004 Event) The 180°N wave case is selected. See explanation from profile 299 (Site Summary 2e) and 305 (Site Summary 2d) at Preston Beach. A sensitivity test on the overtopping was carried out using the EurOtop manual. Result gave zero overtopping. Used diffracted wave conditions since southerly winds are more likely to occur than northerly with a 0.5% RP water level.
Peak wave period (s)	14.3s	Wind wave (see above)
Direction (deg N)	Normal attack	AMAZON works in this way. Offshore wind direction is 180N, nearshore wave direction is 120N. Compared to the shore normal the difference is 18 deg which is not significant.

Outputs

Mean overtopping rate (m³/s/m)	
1:200 (2035)	0.00
1:200 (2060)	0.01
1:200 (2086)	0.49
1:200 (2126)	0.12
Total overtopping volume (m³)	
1:200 (2035)	24451
1:200 2060	49574
1:200 (2086)	133367
1:200 (2126)	798635

Wave Overtopping Summaries



Site 2d

Specific site name	Preston Beach South Profile 305
Agency Area	Wessex Area
Local Authority	Weymouth and Portland Borough Council
Map tile(s)	SY68SE

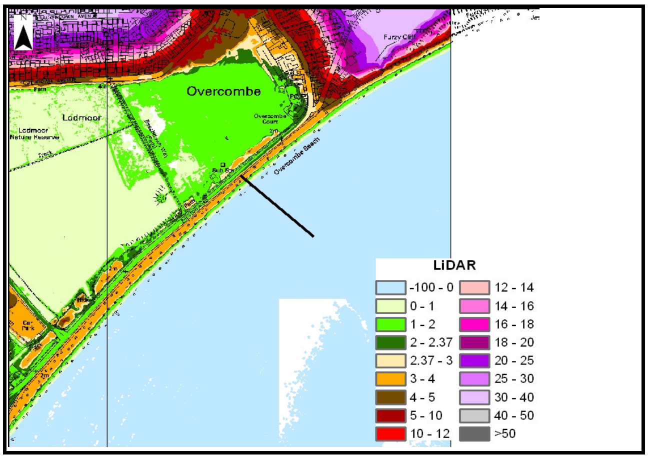
Input data

Input parameters	Chosen values	Comments
Defence level (mODN)	4.5	Sea wall crest taken from Preston Beach Defence drawing (G4612, 1994). Historic winter CCO surveys used to confirm beach width. 10 m beach width chosen to represent the profile.
Defence length (m)	715	Shingle beach front with concrete sea walls
Wave overtopping analysis method	AMAZON	Defence profile does not match EurOtop standard cross-sections.
Starting water depth (m)	5.95	CCO Survey data used for bathymetry
Extreme water level (mODN)	1:200 (2035) 2.53m ODN 1:200 (2060) 2.75m ODN 1:200 (2086) 3.05m ODN 1:200 (2126) 3.63m ODN	Extreme water level SW update (EA 2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
Significant wave height (m)	2.45	SWAN 2D modelling results (offshore input from Oct 2004 Event) Both Direction 150°N and 180°N waves were simulated. 180N with H_s of 2.45m and T_p of 14.3s gave a higher average overtopping rate A sensitivity test on the overtopping was carried out using EurOtop Manual. Results gave zero overtopping. AMAZON results were chosen since real profiles can be modelled.
Peak wave period (s)	14.3	Wind wave (see above)
Direction (deg N)	Normal attack	Used diffracted wave conditions since southerly winds are more likely to occur than northerly with a 0.5% RP water level.

Outputs

Mean overtopping rate (m³/s/m)	
1:200 (2035)	0.02
1:200 (2060)	0.03
1:200 (2086)	0.05
1:200 (2126)	0.12
Total overtopping volume (m³)	
1:200 (2035)	522309
1:200 2060	760983
1:200 (2086)	1278619
1:200 (2126)	3231372

Wave Overtopping Summaries



Site **2e**

Specific site name	Preston Beach North Profile 299
Agency Area	Wessex Area
Local Authority	Weymouth and Portland Borough Council
Map tile(s)	SY68SE

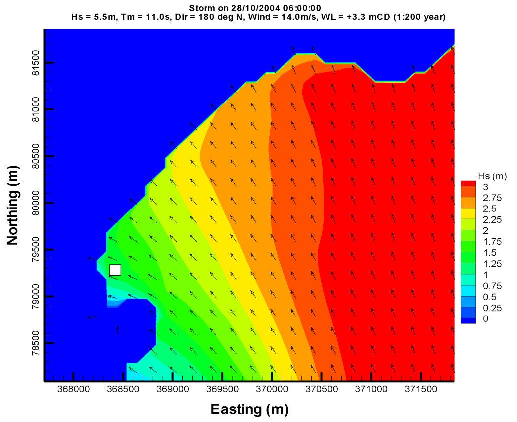
Input data

Input parameters	**Chosen values**	**Comments**
Defence level (mODN)	4.5	Sea wall crest taken from Preston Beach Defence drawing (G4612, 1994). Historic winter CCO surveys used to confirm beach width. 10 m beach width chosen to represent the profile.
Defence length (m)	685	Shingle beach front with concrete sea walls
Wave overtopping analysis method	AMAZON	Defence profile does not match EurOtop standard cross-sections
Starting water depth (m)	5.95	CCO Survey data used for bathymetry
Extreme water level (mODN)	1:200 (2035) 2.53m ODN 1:200 (2060) 2.75m ODN 1:200 (2086) 3.05m ODN 1:200 (2126) 3.63m ODN	Extreme water level SW update (EA 2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
Significant wave height (m)	2.55	SWAN 2D modelling results (offshore input from Oct 2004 Event) Both Direction 150°N and 180°N waves were simulated. 180°N with H_s of 2.55m and T_p of 14.3s gave a higher average overtopping rate The 180°N wave gave more overtopping and hence was selected as the critical wave case. A sensitivity test on the overtopping was carried out using EurOtop manual. Results gave zero overtopping. AMAZON results were chosen since real profiles can be modelled.
Peak wave period (s)	14.3	Wind wave (see above)
Direction (deg N)	Normal attack	AMAZON works in this way. Offshore wave direction is 180°N and nearshore wave direction (from SWAN 2D) is 149°N. Compared against the shore noral the difference is only 9 degrees and so not significant.

Outputs

Mean overtopping rate (m³/s/m)	
1:200 (2035)	0.02
1:200 (2060)	0.02
1:200 (2086)	0.04
1:200 (2126)	0.11
Total overtopping volume (m³)	
1:200 (2035)	392895
1:200 2060	485187
1:200 (2086)	1066563
1:200 (2126)	2822272

Wave Transformation Summaries



SWAN 2D Output

Site 2b

Specific site name	Weymouth Promenade South
Agency area	Wessex Area
Local Authority	Weymouth and Portland District Council
Model Size	105km x 37km
Model Extent	50°24'N to 50°45'N and 1°30'W to 3°00'W

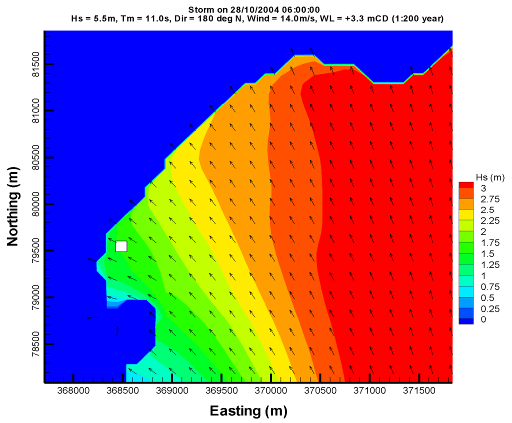
Input data

Input parameters	**Chosen values**		**Comments**
Wave transformation method	SWAN 2D		See ABD report for justification for using model
Bathymetric Data	C-Map Data Survey Data		Hydrographic charts 3315, 2045 and 2615 Channel Coastal Observatory profiles and inferred LiDAR survey
Offshore storm wave directions considered	180°N		Directions taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Figures 3.4 to 3.6 in main report (originally from South Cornwall Coastal Flooding Report, 2005) South west directions not considered due to Portland Bill
Offfshore swell wave directions considered	N/A		Swell waves not applicable due to shelter provided by Portland Bill
Offshore significant wave heights	5.5m : 180°N		Wave heights taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Royal Haskoning (2005), South Cornwall Coastal Flooding Report
Offshore storm mean wave period (Tm)	11.0s : 180°N		Wave periods taken from October 2004 storm in Royal Haskoning (2005), South Cornwall Coastal Flooding Report, where recorded data from Channel Light vessel is summarised
Wind Speed	14.0m/s : 180°N		Admiralty chart used for bathymetry
1:200 year Extreme Water Level (2035)	2.53m ODN	3.46m CD	Extreme water level SW update (2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
1:200 year Extreme Water Level (2060)	2.75m ODN	3.68m CD	
1:200 year Extreme Water Level (2086)	3.05m ODN	3.98m CD	
1:200 year Extreme Water Level (2126)	3.63m ODN	4.56m CD	

Outputs

SWAN Output Location	Easting: 368420 Northing: 79281.9	Output location for input conditions into wave overtopping modelling
Nearshore Wave Heights	180°N : Hs=1.54m (3.46mCD water level) Hs= 1.55m (3.68mCD water level) Hs= 1.39m (3.98mCD water level) Hs=1.39m (4.56mCD water level)	Nearshore wave conditions input for wave overtopping modelling

Wave Transformation Summaries



SWAN 2D Output

Site 2c

Specific site name	Weymouth Promenade North
Agency area	Wessex Area
Local Authority	Weymouth and Portland District Council
Model Size	105km x 37km
Model Extent	50°24'N to 50°45'N and 1°30'W to 3°00'W

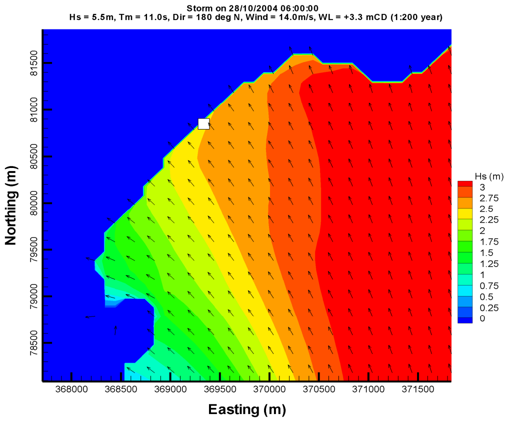
Input data

Input parameters	**Chosen values**		**Comments**
Wave transformation method	SWAN 2D		See ABD eport for justification for using model
Bathymetric Data	C-Map Data Survey Data		Hydrographic charts 3315, 2045 and 2615 Channel Coastal Observatory profiles and inferred LiDAR survey
Offshore storm wave directions considered	150°N 180°N		Directions taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Figures 3.4 to 3.6 in main report (originally from South Cornwall Coastal Flooding Report, 2005) South west directions not considered due to Portland Bill
Offfshore swell wave directions considered	N/A		Swell waves not applicable due to shelter provided by Portland Bill
Offshore significant wave heights	2.5m : 150°N 5.5m : 180°N		Wave heights taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Royal Haskoning (2005), South Cornwall Coastal Flooding Report
Offshore storm mean wave period (Tm)	7.0s : 150°N 11.0s : 180°N		Wave periods taken from October 2004 storm in Royal Haskoning (2005), South Cornwall Coastal Flooding Report, where recorded data from Channel Light vessel is summarised
Wind Speed	19.5m/s : 150°N 14.0m/s : 180°N		Admiralty chart used for bathymetry
1:200 year Extreme Water Level (2035)	2.53m ODN	3.46m CD	Extreme water level SW update (2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
1:200 year Extreme Water Level (2060)	2.75m ODN	3.68m CD	
1:200 year Extreme Water Level (2086)	3.05m ODN	3.98m DC	
1:200 year Extreme Water Level (2126)	3.63m ODN	4.56m CD	

Outputs

SWAN Output Location	Easting: 368485	Output location for input conditions into wave overtopping
Nearshore Wave Heights	180°N : Hs=1.54m (3.46mCD water level) Hs= 1.55m (3.68mCD water level) Hs= 1.55m (3.98mCD water level) Hs= 1.55m (4.56mCD water level)	Nearshore wave conditions input for wave overtopping modelling

Wave Transformation Summaries



SWAN 2D Output

Site 2d

Specific site name	Weymouth Preston Beach South
Agency area	Wessex Area
Local Authority	Weymouth and Portland District Council
Model Size	105km x 37km
Model Extent	50°24'N to 50°45'N and 1°30'W to 3°00'W

Input data

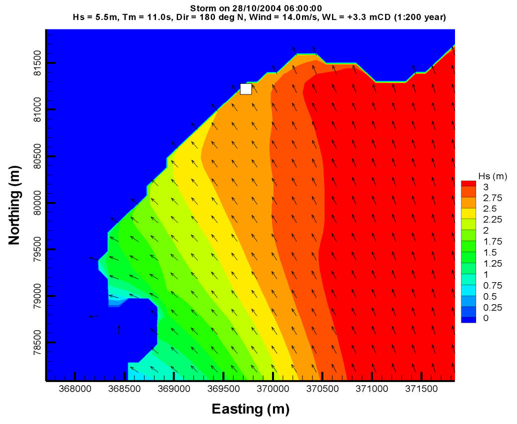
Input parameters	**Chosen values**		**Comments**
Wave transformation method	SWAN 2D		See report for justification for using model
Bathymetric Data	C-Map Data Survey Data		Hydrographic charts 3315, 2045 and 2615 Channel Coastal Observatory profiles and inferred LiDAR survey
Offshore storm wave directions considered	150°N 180°N		Directions taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Figures 3.4 to 3.6 in main report (originally from South Cornwall Coastal Flooding Report, 2005) South west directions not considered due to Portland Bill
Offfshore swell wave directions considered	N/A		Swell waves not applicable due to shelter provided by Portland Bill
Offshore significant wave heights	2.5m : 150°N 5.5m : 180°N		Wave heights taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Royal Haskoning (2005), South Cornwall Coastal Flooding Report
Offshore storm mean wave period (Tm)	7.0s : 150°N 11.0s : 180°N		Wave periods taken from October 2004 storm in Royal Haskoning (2005), South Cornwall Coastal Flooding Report, where recorded data from Channel Light vessel is summarised
Wind Speed	19.5m/s : 150°N 14.0m/s : 180°N		Admiralty chart used for bathymetry
1:200 year Extreme Water Level (2035)	2.53m ODN	3.46m CD	Extreme water level SW update (2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
1:200 year Extreme Water Level (2060)	2.75m ODN	3.68m CD	
1:200 year Extreme Water Level (2086)	3.05m ODN	3.98m DC	
1:200 year Extreme Water Level (2126)	3.63m ODN	4.56m CD	
1:1000 year Extreme Water Level (2126)	3.81m ODN	4.74m CD	

Outputs

SWAN Output Location	Easting:	369345	Output location for input conditions into wave overtopping

Nearshore Wave Heights	180°N : Hs=2.45m (3.46mCD water level) Hs=2.52m (3.68mCD water level) Hs=2.56m (3.98mCD water level) Hs=2.6m (4.56m CD water level) Hs=2.6m (4.74mCD water level)	Nearshore wave conditions input for wave overtopping modelling

Wave Transformation Summaries



SWAN 2D Output

Site	**2e**
Specific site name	Weymouth Preston Beach North
Agency area	Wessex Area
Local Authority	Weymouth and Portland District Council
Model Size	105km x 37km
Model Extent	50°24'N to 50°45'N and 1°30'W to 3°00'W

Input data

Input parameters	**Chosen values**		**Comments**
Wave transformation method	SWAN 2D		See report for justification for using model
Bathymetric Data	C-Map Data Survey Data		Hydrographic charts 3315, 2045 and 2615 Channel Coastal Observatory profiles and inferred LiDAR survey
Offshore storm wave directions considered	150°N 180°N		Directions taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Figures 3.4 to 3.6 in main report (originally from South Cornwall Coastal Flooding Report, 2005) South west directions not considered due to Portland Bill
Offfshore swell wave directions considered	N/A		Swell waves not applicable due to shelter provided by Portland Bill
Offshore significant wave heights	2.5m : 150°N 5.5m : 180°N		Wave heights taken from October 2004 storm. Recorded data from Channel Light Vessel is reproduced in Royal Haskoning (2005), South Cornwall Coastal Flooding Report
Offshore storm mean wave period (Tm)	7.0s : 150°N 11.0s : 180°N		Wave periods taken from October 2004 storm in Royal Haskoning (2005), South Cornwall Coastal Flooding Report, where recorded data from Channel Light vessel is summarised
Wind Speed	19.5m/s : 150°N 14.0m/s : 180°N		Admiralty chart used for bathymetry
1:200 year Extreme Water Level (2035)	2.53m ODN	3.46m CD	Extreme water level SW update (2003) FCDPAG3 Climate Change Impacts - regional net sea level rise allowances (2006)
1:200 year Extreme Water Level (2060)	2.75m ODN	3.68m CD	
1:200 year Extreme Water Level (2086)	3.05m ODN	3.98m DC	
1:200 year Extreme Water Level (2126)	3.63m ODN	4.56m CD	

Outputs

SWAN Output Location	Easting: 369743	Output location for input conditions into wave overtopping
Nearshore Wave Heights	180°N : Hs=2.57m (3.46mCD water level) Hs=2.61m (3.68mCD water level) Hs= 2.65m (3.98m CD water level) Hs= 2.7m (4.56m CD water level)	Nearshore wave conditions input for wave overtopping modelling