

2 Data Sources

2.1 Overview

A key element of the SFRA process is the collation and review of existing data. The SFRA uses best available data at the time of production, and in updating the SFRA, data has been collected from Adur District Council, Worthing Borough Council and the Environment Agency. In conjunction with this, the recently completed West Sussex PFRA was also a source of information as it was assumed all other interested stakeholders would have contributed to the preparation of this document, as such data from this has also been used, where appropriate.

The SFRA should be considered a 'live' document, and should be kept up to date with the latest information; for example Environment Agency Flood Zones, which are continuously being improved by a variety of studies, detailed models, data, and actual flooding information.

Table 2.1 provides a summary of data used to compile and update this SFRA.

Table 2.1: Summary of data used to compile SFRA

Data	Description	Source	Comments
National planning policy statements and guidance	PPS25, PPS 25 Practice Guide, FD2320	CLG, Defra	
Local Plan/LDF	Core Strategy Proposed Submission February 2010	Worthing Borough Council	
Ordnance Survey mapping	1:10,000 and 1:50,000 mapping for Adur and Worthing	Adur District & Worthing Borough Councils	
Existing assessment of flood Risk	Adur & Worthing SFRA (2008) West Sussex PFRA (2011)	Adur District & Worthing Borough Councils West Sussex County Council	
Existing models	Arun to Adur flood modelling April 2011	Environment Agency	
	Shoreham Harbour flood modelling June 2011	Environment Agency	
Geological data	Groundwater vulnerability, groundwater protection, bedrock geology	Environment Agency	
Groundwater flood risk data	Areas Susceptible to Groundwater Flooding (AStGWF)	Environment Agency	Data supplied August 2011
Flood Zones	Environment Agency Flood Zones	Environment Agency	Version 4.4
Flood warning and coastal defence	GIS layers of flood warning areas and defence line from NFCDD	Environment Agency	Note no defence levels are present in tables extracted from NFCDD
Flood risk assessments	Various FRAs submitted to Adur District & Worthing Borough Councils as part of planning applications	Adur District & Worthing Borough Councils	Various dates from 1994 to 2010.
Adur Tidal Walls Project	Letter regarding the West Bank Walls Modelling Study (May 2011)	Environment Agency	Ongoing project looking into improving the SoP of the Adur Tidal Walls
Surface water flood risk data	Flood map for surface water flood risk (FMfSW)	Environment Agency	Data supplied August 2011
	Areas Susceptible to Surface Water flooding layer (AStSWF)	Environment Agency	Data supplied August 2011
	PFRA (2011)	West Sussex County Council	
	Worthing SWMP (2011)	Worthing Borough Council	

2.2 Significant updates to data

2.2.1 Flood Maps

The Flood Map is a multi-layered map which provides information on flooding from rivers and the sea for England and Wales. The Flood Map also has information on flood defences and the areas benefiting from those flood defences.

The Environment Agency's Flood Map is updated quarterly to provide the best and latest information to the public on flood risk. The updates include taking account of information received from the event of actual flooding and more detailed models when developed. The Flood Maps used in this update are version 4.4.

A study to investigate flood risk between and including the River Arun at Littlehampton and the River Adur in Shoreham was completed in April 2011, as was a more detailed study looking at risk in the Shoreham Harbour area. These projects are summarised in Section 2.2.4. Such information will be used to improve the Environment Agency Flood Map, but at the time of writing the flood map had not been updated with this data. As a result of having more detailed studies, the flood zones 2, 3a and 3b have been updated accordingly when assessing flood risks for Adur and Worthing Councils' Local Plan and Core Strategy sites respectively.

2.2.2 Surface water

The SFRA (2008) used available topographical, geological and soil type information to identify areas more likely to flood. It also provided a summary of historical surface water flooding within Adur and Worthing and a series of maps providing an indication of those areas which suffered from this type of flooding.

Since the Adur and Worthing SFRA was completed in January 2008, the UK Government accepted the recommendations of the Pitt review of the 2007 summer floods in December 2008. As a result of Recommendation 2, the Environment Agency took on a national overview of all flood risk, including surface water and groundwater flood risk, with immediate effect. The Environment Agency released two key datasets to provide more information about surface water flood risk. These are summarised below:

Areas Susceptible to Surface Water Flooding (AStSWF)

- The AStSWF forms the first generation of surface water mapping and identifies the susceptibility to flooding in three bandings: More Susceptible, Intermediate Likelihood and Less Susceptible. The AStSWF assesses the pluvial flood risk based on a rainfall event with a return period of 1 in 200 years occurring in any given year with a 6.5 hour storm duration, assuming the drainage capacity of any available surface water network is at capacity.

Flood Map for Surface Water (FMfSW)

- The FMfSW forms the second generation of surface water mapping, and is the latest dataset. The EA has produced the FMfSW to assess the flood risk with a return period of 1 in 30 years in order to demonstrate the onset of flooding. *"The 1 in 30 rainfall was used as it is the largest common design standard for urban drainage. Therefore it seeks to capture the 'onset' of flooding in many urban locations"*⁴.
- The maps display the flood hazard in two depth bandings: greater than 0.1m (surface water flooding) and greater than 0.3m (deeper surface water flooding). The FMfSW has two datasets based on a rainfall event with a return period of 1 in 30 years and 1 in 200 years occurring in any given year with 1.1 hour storm duration.
- The most notable difference from the AStSWF is that the FMfSW takes into consideration infiltration using percentage runoff values of 39% in rural areas and 70% in urban areas. In addition, the FMfSW takes account of the sewer network capacity by a reduction of 12mm/hr in urban areas.

Both surface water flood risk datasets were reviewed to update the SFRA (2008) and details of the surface water flood risk within Adur and Worthing area are given in Section 4.4 and shown in Maps 12 to 14 (Appendix A).

⁴ EA (2010) *What is the Flood Map for Surface Water*
2011s5199 Adur and Worthing Councils SFRA Update Final Report (v1 Jan 12)

Worthing SWMP (2011)

The risk assessment section from the Worthing SWMP was provided for this SFRA update. The risk assessment stage is a vital part of the SWMP process which aims to identify broad locations which are considered to be more vulnerable to surface water flooding with the aim of implementing a risk based approach to the assessment of risk and options for implementation.

Information from this section is used to update the surface water flooding and sewer flooding sections.

West Sussex PFRA (2011)

The Flood Risk Regulations 2009 (FRR) Part 2 (Section 10) place a duty upon West Sussex County Council as a Lead Local Flood Authority (LLFA) to prepare a Preliminary Flood Risk Assessment (PFRA) by June 2011, and where necessary a Surface Water Management Plan.

The Preliminary Flood Risk Assessment aims to provide a high level screening exercise to facilitate flood risk management. The PFRA report was used in this SFRA update for Adur District and Worthing Borough Councils. Information relating to the surface water flood risk and sewer flood risk, as well as the historic flood events experienced throughout the study area will be used in this update where appropriate.

2.2.3 Groundwater

An initial assessment of comparing groundwater borehole data from the 2000/1 event; historic data documented in CFMPs; and point historic flood event data was carried out by the SFRA (2008). An analysis of physical, hydrological and environmental spatial data sets within a Geographical Information System (GIS) platform using the EA groundwater vulnerability, geology and bedrock layers was then carried out for the previous Adur and Worthing SFRA.

Information on the drivers of groundwater flooding, recorded historic flood events and areas likely to experience groundwater flooding were collated during the production of the SFRA (2008). The results of the analyses were summarised and shown in a series of maps within the SFRA (2008) report.

The Areas Susceptible to Groundwater Flooding (AStGWF) data was requested from the Environment Agency for the SFRA update.

Areas Susceptible to Groundwater Flooding is a strategic scale map showing groundwater flood areas on a 1km square grid. The data is annotated to show what percentage of the 1km area is susceptible to groundwater flood emergence. This provides an indication as to the degree of risk from groundwater flood risk within an area.

The details of groundwater flooding are in Section 4.5, and Map 15 (Appendix A) indicates the risk of groundwater flooding within the Adur and Worthing study area.

2.2.4 Studies

More detailed modelling studies and site-specific flood risk assessments were reviewed as part of the SFRA update and used where applicable.

The details of each study that was used to update the SFRA are summarised below:

Arun to Adur Flood Modelling (June 2011)

A project was commissioned by the Environment Agency's Southern Region (now South East Region), in cooperation with the Shoreham Harbour Regeneration Partnership⁵, to investigate flood risk between and including the River Arun at Littlehampton and the River Adur in Shoreham. The study used comprehensive extreme sea level and wave information, good quality topographic data and advanced floodplain inundation modelling techniques to produce revised tidal Flood Zones 2 and 3, to identify Areas Benefiting from Defences, and to examine the potential impacts of climate change on flood risk.

⁵ The Shoreham Harbour Partnership consists of Adur District Council, Brighton and Hove City Council, West Sussex County Council, Shoreham Port Authority and the Homes and Communities Agency (HCA). The partnership are working together to deliver the long term strategic objective "to regenerate the Harbour area so that it provides the homes, jobs, facilities and services that are needed by all communities in the area, and to reduce deprivation and inequalities".

The modelled flood outlines are used to improve the accuracy of the Flood Zone 3a, 3b and 2 at the Shoreham Harbour area. The model results from climate change and overtopping scenarios are used to update the understanding of the impact of climate change and residual risk.

Shoreham Harbour Regeneration: Design and Flood Risk Study (June 2011)

This study was commissioned by the Environment Agency in cooperation with the Shoreham Harbour Regeneration Partnership to develop an evidence base for the Shoreham Harbour Regeneration Scheme in terms of flood and erosion risk exposure and associated management options. The approach for the study involved the following 4 key steps:

- Step 1: Work with the Shoreham Harbour Regeneration Partnership to identify several flood risk management design concepts or "Design Scenarios" for the coastal frontage that could be evaluated in terms of design, flood risk and outline development costs.
- Step 2: Use Multi-Criteria Assessment and numerical modelling approaches to refine the initial Design Scenarios for the coastal frontage.
- Step 3: Produce outline development costs and drawings for each coastal frontage Design Scenario.
- Step 4: Use numerical modelling approaches to investigate flood risk in the tidal river and canal area and to investigate potential solutions to mitigate against this risk.

Three potential Flood and Coastal Risk Management (FCRM) Design Scenarios were developed for the coastal frontage as part of this study. These three scenarios, which are listed below, represent increasing levels of development ambition:

- Design Scenario 1: "Un-planned" evolution of the port (i.e. none or limited level of development).
- Design Scenario 2: Port Master Planning and Eco-town Development (medium level of development).
- Design Scenario 3: Major regeneration of the port and housing development to meet regional Growth Point requirements (highest level of development).

For each of these potential Design Scenarios a preferred option was derived in terms of the defence elements required and their associated Standards of Protection. The preferred options and their associated components and costs were summarised.

Engineering designs and costs were not produced for the canal area and tidal river in the same way as the coastal frontage. However, three basic tidal river/canal area flood defence options were developed in order to evaluate their merits and impacts in terms of flood risk in the Shoreham Harbour Regeneration Area. There was a desire to focus on this Design Scenario in terms of flood risk assessment and modelling. This evaluation of flood risk was undertaken using a 1D/2D TUFLOW/ISIS model.

The results of the modelling indicated that the Shoreham Harbour Regeneration Area was indeed susceptible to flood risk. The results also indicate that the proposed River/Canal Flood Defence Options are likely to provide the desired level of flood protection for the development areas and are not expected to increase sea-levels significantly, illustrating that defending these areas is unlikely to increase flood risk elsewhere. None of the analysis carried out for this study has included the presence of the proposed River Adur Tidal Walls (West Bank) Scheme. The effect of these defences on the town of Shoreham was being investigated in a separate study, and it was recommended that additional modelling was carried out in order to evaluate its effects in combination with the Shoreham Harbour Regeneration proposals following the implementation of the West Bank Scheme. Furthermore, the flood risk modelling undertaken for the study did not account for the risk of coastal flooding from outside the study area (i.e. Hove). It would be necessary to account for the risk of flooding from this area as part of any further design work.

The study results are incorporated when assessing the Shoreham Harbour Core Strategy area.

Shoreham Adur Tidal Walls Project

This project is ongoing, for the SFRA update we were provided with a briefing note summarizing the Shoreham Adur Tidal Walls Project Board Meeting July 2011 and a letter detailing the West Bank Walls Modelling Study dated May 2011.

The Rivers Arun to Adur Flood and Erosion Management Strategy recommends the standard of protection (SoP) for the River Adur west bank (from the A27 to the river mouth) be improved or sustained to 0.33% AEP. For the River Adur east bank, it has been recommended to improve the SoP to 0.5% AEP for the north section (from the A27 to footbridge) and sustain the current SoP for the central section (footbridge to Kingston Beach lighthouse) and undertake no active intervention for the east section (Kingston Beach lighthouse to the lock gates). The Flood and Erosion Management Strategy identified that the west bank be completed by 2012 and the east bank the following year.

The Adur tidal walls are proposed to cover a long stretch of the west bank of the River Adur from the A27 road bridge in the north through to Shoreham Fort. It is suggested that these walls will be continuous apart from a short section close to the Adur Recreation Ground, where the Brighton Road embankment is high enough to form part of the defence line. It is proposed that the Adur Tidal Walls will be constructed to a height of 4.84m AOD in the model for present day scenarios and an elevation of 5.53mAOD for scenarios beyond 50 years in the future⁶. It is assumed this provides the SOP of 0.33% AEP as recommended by the Arun to Adur Flood Risk an Erosion Management Strategy.

Modelling undertaken as part of the study to test the effect of building the west bank Adur Tidal Walls showed that if the walls were built along the west bank the depth of flooding, and hence risk, increases on the east bank. This has meant that the project has now been expanded to look into local improvements to the east bank defences to mitigate the risk.

The study also undertook model scenarios, which incorporated the other proposed defence improvements along the River Adur:

- The "Redevelopment walls", intended to protect the development areas under consideration as part of the Shoreham Harbour Regeneration Scheme, were modelled as tied into high ground and set to a level which would protect the areas from flooding during a 200-year return period extreme sea-level event based in the year 2115.
- The "Ropetackle defences", proposed to provide flood protection for the Ropetackle North development site in Shoreham, were modelled as a wall assigned with an elevation of 5.6m AOD, in accordance with the planned design.

At the time of writing the scheme had yet to be ratified and the funding secured.

Lancing Brooks Flood Investigation (2010)

In 2010, Royal Haskoning undertook investigations on the Lancing Brooks surface water drainage system. The study area was defined as being south of the A27, west of Shoreham Airport and east of Teville Stream. The study concluded that:

- The study area is subject to surface water flooding approximately once every 10 years, which can take weeks to drain away in some cases.
- Agricultural land within the study area was the worst affected but there is also disruption to the Shoreham Airport, highways and nearby gardens particularly within the Paddocks area.
- Flooding problems are likely to get worse and increase in occurrence with climate change.

The study results are incorporated when assessing the surface water flood risk in Section 4.4.

Restoring the Teville Stream Catchment for the Community Scoping Report (2009)

Royal Haskoning undertook an initial high-level study in 2009 to identify opportunities for enhancement and potential constraints in view of the current condition of Teville Stream, associated drainage network and surrounding floodplain.

The project study area was the stretch of Teville Stream that was bounded by Clarendon Road at the upstream end and the culvert leading into Brooklands Lake at the downstream

⁶ Letter to Malcolm Ward Dated 6 May 2011, Ref: MRL\2010s4031-S-L019-1.doc
2011s5199 Adur and Worthing Councils SFRA Update Final Report (v1 Jan 12)

end. A desk based study and a site visit was carried out but no detailed modelling was undertaken for this project.

Shoreham Airport FRA (2007)

Shoreham Airport is located between Shoreham-by-Sea and Lancing. It is bounded by the A27 and the Ricardo Technical Centre to the north, River Adur and Shoreham-by-Sea to the east, the Portsmouth to Brighton railway line to the south, and an area of undeveloped land separating the airport from the built up area of Lancing to the west.

WSP Development and Transportation were commissioned by Erinaceous Group Plc in 2007 to carry out a Flood Risk Assessment (FRA) for development proposals at Shoreham Airport. The proposed development involved the restoration of the Grade II* Listed terminal building and new commercial and hangar floorspace adjacent. Residential dwellings were proposed on the top floors of the two new buildings, Aviation Square East and West.

Detailed hydraulic modelling undertaken of the tidal River Adur by the Environment Agency indicates that the site would not be flooded during the current 1 in 200 year, however the entire site would be inundated during the 1 in 200 year plus climate event. The Environment Agency agreed that the main risk of flooding would be from the overtopping or breach of the local defences (earth embankment on the west bank of the River Adur) during an extreme tidal event. The Environment Agency along with Adur District Council are investigating options for a phased improvement of the flood defences on the west bank of the River Adur Estuary including the reach adjacent to the site (See section above on Shoreham Adur Tidal Walls Project).

The study also concluded that once the River Adur Estuary Flood Alleviation Scheme was complete; the proposed development would have an acceptable level of risk over the lifetime of the development.

Shoreham Airport 1 in 20 Year Flood Modelling (2010)

In 2010 February, WSP Development and Transportation reviewed and reran the ISIS-TUFLOW model developed for the Adur and Worthing SFRA (2008).

The SFRA model was considered suitable for a broad scale assessment of risk, particularly for high flood events. However, it was deemed not fit for purpose for assessing the risk from lower return period flood events. The 2D domain had a resolution of 20m, which was decided did not accurately represent the topography of the area, notably the flood defence levels.

The SFRA model was rerun with a separate GIS layer to explicitly represent the defence levels. The result from the model rerun showed that part of the airport did fall within 1 in 20 year flood extent. However, WSP concluded that the airport should not be treated as a "functional floodplain" (Flood Zone 3b) for planning purposes. The reasoning to support this is summarised below:

- The site only experienced short duration shallow flooding. The defence overtopping in the 1 in 20 year event occurred for a length of time of 0.5hours, with the peak level above the defence being 0.04m. From this, it was suggested that the airport site was not acting functionally. It was also highlighted that as a result the model is sensitive to the accuracy of the specified Environment Agency flood defence level.
- A 20m grid resolution applied for the model means that a larger area (20mx20m) would be shown as wet even with a small volume of flood water.
- A long drainage grip appeared to be present immediately behind the flood defence, which was not reflected in the SFRA model. This drainage grip could potentially collect and divert floodwater which spills over the defences.
- There is an agreed principle to raise the tidal walls at the airport to a minimum standard of protection of 1 in 100 years meaning that the site would not be affected in a 1 in 20-year flood event (See section above on Shoreham Adur Tidal Walls Project).

The model result and conclusion from this modelling study are compared in Section 4.3.3 to the result of the Shoreham Harbour Regeneration: Flood Risk and Design Study. Both study results are used to inform the discussion on functional floodplains (Section 4.3.3) and the level 2 site specific assessment for Shoreham Airport.

Other studies

A number of other detailed studies were reviewed, but did not provide any additional information for use in this update. These were:

- MONSON Engineering Ltd report on survey and hydraulic analysis of Lancing drainage ditches (1994).
- Land Drainage Ditches and Watercourse Clearing Progress (2009).
- Teville Stream Flood Risk Mapping Study is an ongoing joint Worthing Borough Council and Environment Agency study which includes detailed modelling of the Teville Stream. At the time of writing the outputs from this study were not finalised, so were not available for use in this SFRA update.