

**Reigate & Banstead Borough
Council**

**Redhill Town Area Action Plan
(TQ280505)**

Flood Risk Assessment

September 2011




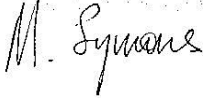
Document control sheet

Client: Reigate & Banstead BC
 Project: Redhill Town AAP FRA

Job No: B0534400

Title: Flood Risk Assessment

	Originator	Checked by	Reviewed by	Approved by
REVISION	NAME	NAME	NAME	NAME
A05 to RBBC	Ivan Sreckovic	Richard Horlor	Alastair Elder	
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
30/8/11				
Document Status				

FINAL	NAME	NAME	NAME	NAME
	I Sreckovic	R Horlor	A Elder	M Symons
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
5/9/11				
Document Status				

This report, and information or advice which it contains, is provided by Jacobs UK Limited solely for internal use and reliance by its Client in performance of Jacobs UK Limited's duties and liabilities under its contract with the Client. Any advice, opinions, or recommendations within this report should be read and relied upon only in the context of the report as a whole. The advice and opinions in this report are based upon the information made available to Jacobs UK Limited at the date of this report and on current UK standards, codes, technology and construction practices as at the date of this report. Following final delivery of this report to the Client, Jacobs UK Limited will have no further obligations or duty to advise the Client on any matters, including development affecting the information or advice provided in this report. This report has been prepared by Jacobs UK Limited in their professional capacity as Consulting Engineers. The contents of the report do not, in any way, purport to include any manner of legal advice or opinion. This report is prepared in accordance with the terms and conditions of Jacobs UK Limited's contract with the Client. Regard should be had to those terms and conditions when considering and/or placing any reliance on this report. Should the Client wish to release this report to a Third Party for that party's reliance, Jacobs UK Limited may, at its discretion, agree to such release provided that:

- (a) Jacobs UK Limited's written agreement is obtained prior to such release, and
- (b) By release of the report to the Third Party, that Third Party does not acquire any rights, contractual or otherwise, whatsoever against Jacobs UK Limited, and Jacobs UK Limited accordingly assume no duties, liabilities or obligations to that Third Party, and
- (c) Jacobs UK Limited accepts no responsibility for any loss or damage incurred by the Client or for any conflict of Jacobs UK Limited's interests arising out of the Client's release of this report to the Third Party.

Contents

1	Background	1-1
1.1	Introduction	1-1
1.2	Legislative Background	1-1
1.3	Relevant Flood Studies	1-2
1.4	Objectives	1-4
2	Site Description	2-1
2.1	Redhill Environs	2-1
2.2	Watercourses, Surface Water and Topography	2-3
3	Assessment of Flood Risk to the Site	3-1
3.1	Basis of the Assessment	3-1
3.2	Historical Flooding	3-1
3.3	Flood Risk Mapping	3-1
3.4	Fluvial	3-2
3.5	Fluvial Flood Mechanisms	3-4
3.6	Analysis of other topographical data and site inspection	3-5
3.7	Surface Water	3-5
3.8	Groundwater Flood Risk	3-6
3.9	Artificial Sources e.g. Canals, Reservoirs	3-7
3.10	Assessment of Risk due to Informal Defence Failure	3-7
3.11	Flood Hazard	3-7
3.12	Summary of Risk to and from the Site	3-8
3	Assessment of Flood Risk from the Development Sites	3-9
4.1	PPS25 Requirement	3-9
4.2	Impermeable Areas	3-9
4.3	SuDs Measures	3-9
4.4	Risk from the Site	3-9
5	Planning – PPS25 and the Sequential Test	3-11

5.1	Flood Zone Maps and Flood Risk Vulnerability	3-11
5.2	Use and Vulnerability	3-13
5.3	Keeping People from Danger	3-16
6	Planning – Planning and Pollution Control – PPS23	3-18
6.1	Site Information	3-18
6.2	Planning Considerations	3-18
6.3	Pollution Control Measures	3-18
7	Conclusions and Recommendations	3-19
7.1	Flood Risk Assessment	3-19
7.2	The need to change use or the potential to change flood risk	3-19
7.3	Flood Hazard	3-20
7.4	Recommendations	3-20
	Reigate & Banstead SFRA Area 2	1

Appendices

Appendix A – Proposed Development Masterplan

Appendix B – Flood maps

Appendix C – Flood Hazard map

Appendix D – Options to Reduce Flood risk

Appendix E – SFRA Extracts

1 Background

1.1 Introduction

Jacobs was commissioned by Reigate and Banstead BC in October 2008 to carry out a detailed Flood Risk Assessment (FRA) to inform the preparation of the Redhill Area Action Plan (RAAP). The Council have successfully completed the Issues and Options and Preferred Options Stage of the RAAP but require a FRA and Sequential Testing for sites proposed to be developed within the flood plain.

The initial FRA identified that the existing flood mapping was inadequate for the assessment of flood risk. It was therefore agreed with the Environment Agency (EA) that a new mathematical model should be prepared that integrated both surface water and fluvial modelling into one. The resultant model was accepted by the EA on 20 August 2010 and new flood zone maps were prepared which have been used for this FRA.

Eight sites within the Redhill town centre regeneration area including the Railway Station, Memorial Park and a car park are being considered for re-development. The eight sites are typically for mixed use with dwellings. This FRA has been conducted to meet the requirements of PPS25 and is a level 1 FRA: Scoping Study¹ including:

- An appraisal of the availability and adequacy of existing information;
- A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere;
- An application of the Sequential Test.

Redhill is a town in the Borough of Reigate and Banstead, Surrey and lies within the London commuter belt. Redhill and the adjacent town of Reigate form a single urban area. Redhill/Reigate is a transport hub and Redhill aspires to be a retail centre. A Masterplan of the proposals for the site is shown as Figure 1 - Redhill Town Centre and again in Appendix A.

Redhill bus station is adjacent to Redhill railway station and lies at the junction of the A23 and A25 roads. There are therefore important rail and road connections to London, Brighton, Reading and Gatwick.

1.2 Legislative Background

1.2.1 Planning Policy Statement (PPS) 25

In order to strengthen and clarify the key role of the planning system in managing flood risk and contributing to adapting to the impacts of climate change, Planning Policy Statement 25 (PPS25) was published in December 2006 (replacing the previous PPG25 issued in 2001), and sets out policies for planning authorities to:

- Ensure flood risk is properly taken into account at all stages in the planning process;
- Prevent inappropriate development in areas at high risk of flooding;
- Direct development away from areas at highest risk.

¹ PPS25 Development and Flood Risk, Levels of Flood Risk Assessment Table 2.3 p57

PPS25 states that the Flood Risk Assessment “should identify and assess the risks of all forms of flooding to and from the development and demonstrate how these flood risks will be managed, taking climate change into account.”

1.2.2 Planning Policy Statement (PPS) 23 and Water Quality

PPS23 requires Local Planning Authorities (LPA) to consider the potential for contamination in relation to existing and proposed use and the possibility of encountering contamination during development. The statement advises that the consideration of the quality of land, air or water and potential impacts arising from development is capable of being a material planning consideration. The EU Water Framework Directive (2000/60/EC) provides the main machinery for protecting and enhancing water quality. The central objective of the Directive is to achieve ‘good’ status for all ground and surface water bodies, including estuarial and coastal waters. The Environment Agency (EA) is responsible for protecting and enhancing the quality of surface (inland and coastal) waters and groundwater. The Town and Country Planning (General Development Procedure) Order 1995 (SI 1995/41) (GDPO) (as amended) requires Local Planning Authorities (LPA) to consult the relevant pollution control authority in considering certain types of planning application. The Environment Agency is the relevant pollution control authority in this case.

1.3 Relevant Flood Studies

1.3.1 Catchment Flood Management Plan (CFMP) Thames Region

One of the EA’s main goals is to reduce flood risk from rivers and the sea to people, property and the natural environment by supporting and implementing government policies.

Flooding is a natural process – we can never stop it happening altogether. So tackling flooding is more than just defending against floods. It means understanding the complex causes of flooding and taking coordinated action on every front in partnership with others to reduce flood risk by:

- Understanding current and future flood risk;
- Planning for the likely impacts of climate change;
- Preventing inappropriate development in flood risk areas;
- Delivering more sustainable measures to reduce flood risk;
- Exploring the wider opportunities to reduce the sources of flood risk, including changes in land use and land management practices and the use of sustainable drainage systems.

Catchment Flood Management Plans (CFMP) are a planning tool through which the EA aims to work in partnership with other key decision-makers within a river catchment to explore and define long term sustainable policies for flood risk management. CFMP are a learning process to support an integrated approach to land use planning and management, and also River Basin Management Plans under the Water Framework Directive.²

A CFMP has been developed for the River Thames catchment. The River Mole is a major tributary of the River Thames.

Four over-arching key messages have been highlighted by the Thames CFMP:

Flood defences cannot be built to protect everything;

² Catchment Flood Management Plans – Volume 1 (Guidance), Version 1.0, July 2004

- Climate change will be the major cause of increased flood risk in the future;
- The floodplain is our biggest asset in managing flood risk;
- The ongoing cycle of development and urban regeneration is a crucial opportunity to manage flood risk.

The consultation draft also includes a specific message for the urban area situated within the upper reaches of the River Mole catchment. Defining it as “major urban expansion in or close to flood plains”, the draft CFMP states that:

- The location, layout and design of developments - in that order - are the most vital factors in managing flood risk. Development should only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding;
- Effective ways of managing the risk must be incorporated into planning and design to prevent the need for future intervention. This is dependent on the location and layout of development;
- Development should avoid flood risk to people and property where possible. It should manage any residual risk, taking into account the impacts of climate change;
- Flood risk, water resources and water quality need to be balanced through out management of waste water, surface water and sewers.

These succinctly reinforce the over-arching objectives of PPS25, i.e. it is important that Local Authorities seek to restrict development within flood affected areas, protecting the natural floodplain wherever possible.

1.3.2 Regional Flood Risk Appraisal

The draft Regional FRA June 2007 deals primarily with risk to London and the London Rivers and does not specifically mention the River Mole catchment.

1.3.3 Strategic Flood Risk Assessment (SFRA)

The Reigate & Banstead SFRA was completed in July 2007 and was in the process of being reviewed in July 2011. This Redhill Town Flood Risk Assessment should be read in conjunction with the SFRA, once published. Extracts from the document referring to the Sequential Test and development guidance are attached at Appendix A. The key message is:

- “Redhill Brook flows through the centre of Redhill, largely in culvert. The capacity of the culvert is relatively limited, and the system is prone to blockage. Consequently, there is a risk of fluvial flooding to properties within Redhill and Earlswood.

Of particular importance from a planning perspective is Redhill town centre, a key regeneration area. The train and bus station precinct and the commercial area adjoining the A23 (Brighton Road) immediately to the south of the railway are the most at risk of flooding. Opportunities to minimise this risk through rigorous culvert and gully maintenance, and possibly on site flood storage (introduced as part of the site regeneration) should be sought.”

1.3.4 Flood Risk Assessment - desktop study

The desktop study (2010) carried out for this FRA is based on available data which includes the site development proposal Masterplan, EA Flood Zone extents as revised by the accepted integrated model prepared by Jacobs in 2009, National Groundwater Mapping, Ordnance Survey mapping contours and Digital Terrain Mapping (DTM). A Flood Risk Assessment was carried out for the Redhill Bus Station Redevelopment within the town centre in August 2007.

The EA kindly reviewed and accepted the integrated mathematical model from which the Flood Zone mapping shape-files were prepared and also supplied, survey data and Digital Terrain Mapping (DTM).

Drainage plans have been sought from Thames Water who have given consent to the use of plans held already by Reigate & Banstead BC. The ownership of some converted sections of the Lynwood Ditch (now classified as main-river) changes between the EA and Thames Water to become public sewer downstream of Frenches Pond and then reverts back to main-river at the Redhill Brook. A section upstream of the pond is not classified.

The CFMP and SFRA identified that “The ongoing cycle of development and urban regeneration is a crucial opportunity to manage flood risk” 1.3.1.

1.4 Objectives

The purpose of this FRA is to demonstrate that the proposed developments identified within the Area Action Plan meet the requirements of PPS25, as referred to in Section 1.2.1, and that the location of the various developments is appropriate (in terms of flood risk) for the intended use and that the development will not increase the risk of flooding elsewhere.

2 Site Description

2.1 Redhill Environs

Redhill is a town in the Borough of Reigate and Banstead, Surrey, England with a population of over 25,000. It is situated in the North Downs on the junction of the A23 road running north to south (London to Brighton) and the A25 road running east to west (Dorking to Sevenoaks). Being only 19 miles from Westminster it is part of the London commuter belt.

Redhill and the adjacent town of Reigate form a single urban area. A major factor in the development of Redhill town was the arrival of the railway. With good road and rail links, Redhill is an important transport hub. It is also close to Gatwick International Airport and Redhill airport, a local air hub. The bus station and railway stations are strategically placed on the A23/A25 junction at the centre of town. Figure 1 shows the development sites included within the Redhill Town Centre Area Action Plan.

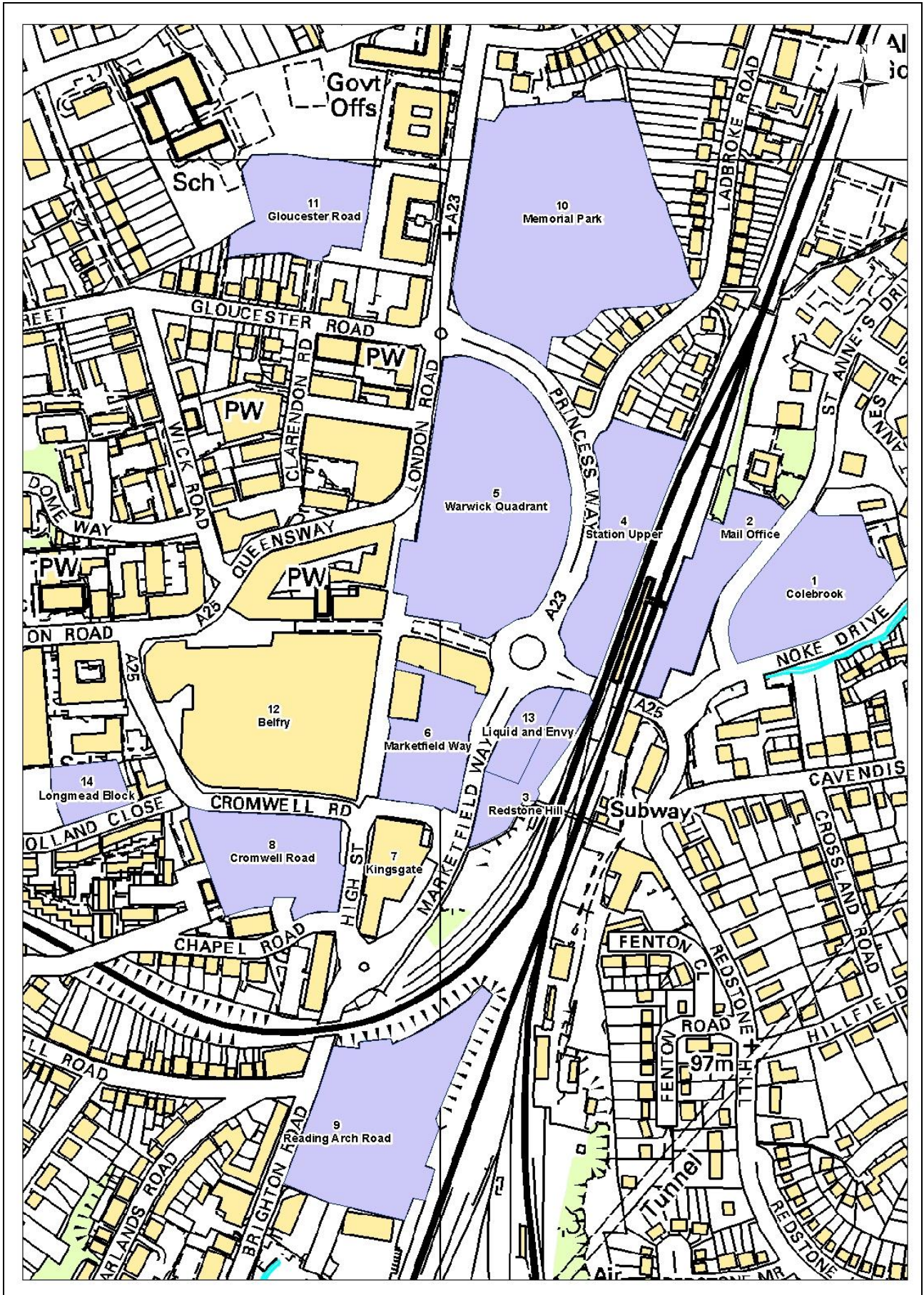


Figure 1 - Redhill Town Centre AAP and Numbered Sites

2.2 Watercourses, Surface Water and Topography

The principal watercourse that flows through the town is the Redhill Brook which rises less than 3km away near South Merstham. The Brook, formerly known as Deans Brook, drains both the northern and southern ridges from Merstham and Nutfield respectively across a water-meadow known as Nutfield Marsh. It is an open watercourse until it meets Redstone Hill (A25 east) at Noke Drive where it is culverted under the A25 to Sevenoaks, under the London to Brighton main railway line, and continues under the A23 South (Marketfield Way) until it crosses under the Reigate (westbound) railway Line. At this point the channel is open for inspection by the EA immediately before it enters a brick culvert under the railway line. From here it passes through a series of culverts and open sections.

Runoff from Gatton Park, a large open area to the north of Redhill, which is bounded to the north by the M25, is collected in a lake, it flows from this point in culvert to the east via Battlebridge Brook into Redhill Brook, away from the natural drainage path which would otherwise pass through the town. South of the A242, which runs around the southern boundary of Gatton Park, the Coles Park area is urbanised and run-off is collected via a public sewer into Frenches Pond (main-river) and then into a public sewer running approximately South underneath Sutton and East Surrey Water property, Memorial Park and Princess Way to the confluence with the Redhill Brook at the Station Road roundabout (A23/A25 junction). Another sewer drains the Gloucester Road area into the public sewer in Memorial Park. The remaining Northwest quadrant of the town extending as far as Doynings Leisure Centre is drained via sewers under Kingsgate/Brabazon House buildings to the Redhill Brook.

The town centre lies within the shallow natural valley lying North/South and is dissected by the A23/High Street and the railway line which also runs generally North/South. The natural valley is disguised and disrupted primarily by the Warwick Quadrant complex which includes the Theatre, Sainsburys supermarket and offices at 3 Princess Way. The valley continues into Marketfield Way but **the valley is closed by the Redhill to Reigate railway line thus forming a depression or low area which is drained only by the Redhill Brook culvert under the railway line.** It should be noted that virtually all the land North of the A25 (Redstone Hill along the Nutfield Ridge east to the M23) and Redhill Reigate railway line (west from Kingsgate to Doynings) **has to drain through this culvert.** Once the culvert capacity is exceeded, no surface water can drain out of Redhill down the A23 until an area extending from Kingsgate to the bus station is flooded.

From Marketfield Way, the Redhill Brook flows south through Reading Arch Road in a part-open, part-closed culverted channel until it reaches open space to the south of Earlswood. The Brook continues from here as a natural channel to confluence with the Salfords Stream which, in turn, joins the River Mole which flows through the Mole escarpment near Dorking and, ultimately, to the River Thames, at Esher.

3 Assessment of Flood Risk to the Site

3.1 Basis of the Assessment

The flood risk assessment commences with a review of the site within the context of all sources of flooding based on the updated (2010) EA Flood Maps which use the integrated fluvial and surface water model prepared by Jacobs. This review focuses on the Sequential Test and the Exception Test to establish if this is an appropriate site for this type of development.

The forms of flooding considered are fluvial, surface water, surface water drainage and groundwater flooding. The relation to the River Mole and regional issues and the impacts of climate change complete the assessment.

3.2 Historical Flooding

Redhill suffered flooding in 1968, and 1993, 2000, 2001, 2002 and 2003. The most extensive was in 1968. The cause of most recent flooding can broadly be described as from highways (40%), from sewers (29%) and land drainage (24%) with the remainder uncertain.

Places that repeatedly flood are Marketfield Way and the Brighton Road which can be attributed to fluvial flooding from Redhill Brook. Surface water flooding occurs in Noke Road near to the development site when the Redhill Brook is in spate. However, the A25 under the London to Brighton Railway line adjacent to the Redhill Railway Station passes through a depression which is prone to surface water ponding during heavy rainfall.

Other sites which suffer from local highway and sewer flooding include Frenches Road, Budgen Drive, Ringwood Avenue and London Road. All these sites are to the north of the study area near Frenches Ponds and are good indications that the surface drainage capacity can be exceeded. Recently, the major rainfall of 20th July 2007 resulted in flooding of shops in the High Street and at Marketfield Way via overland flow.

3.3 Flood Risk Mapping

3.3.1 EA Flood Zone Mapping

The EA flood map (updated 2010) is a fluvial flood map derived from an integrated model comprising three InfoWorks models as follows: an upstream CS (sewer/surface water) model of Merstham connects to an RS (fluvial) model incorporating the Redhill Brook catchment in Nutfield Marsh which then connects into a second CS (sewer/surface water) model of Redhill town extending to the south of Earlswood. The model utilises LiDAR Digital Terrain Mapping (DTM) dated 2008. The model is not fully integrated in that it does not feed back iterative changes in level from the downstream model to the upstream model to enable constant corrections but does produce a hydrograph output from the upstream model which is used by the downstream model to achieve a valid approximation.

As the model includes both the surface water and fluvial regimes, there are two critical storm durations. The critical storm for fluvial is 375 minutes but for surface water is 60 minutes, therefore two sets of flood extents are produced for Flood Zones 2, 3a and 3b and a two maps are required for each probability. Although the maps are the result of an integrated model the principle sources of flood risk and mechanism are treated individually.

Twelve development sites are identified within the Redhill Town Centre Area Action Plan, of these; all are impacted to some degree by flooding. Table 1 provides a summary of risk based on the source. Several are situated within Flood Zone 3b (Functional Floodplain), Flood Zone 3a (High probability) or Zone 2 (Medium Probability as depicted by the Environment Agency Flood Zone Maps, 2010). The flood zones are shown in Appendix B Flood Maps in relation to the development areas.

It was decided to use two sets of maps displaying two different minimum depths as well as the two critical storm durations for more objective assessment because the integrated mapping would display large areas of shallow surface water flooding not critical when planning to exclude development. Note the maps represent the 'Base-case' and do not include for Climate Change. Design for new development has to make an allowance for Climate Change.

Maps 1 and 2 display a flood depth of 50mm or greater for the 375 minute and 60 minute critical storm durations respectively. Maps 3 and 4 display a flood depth of 10mm or greater for the same events respectively. The 50mm maps are intended to be used for the Flood Risk Assessment and planning within the Town Area but the 10mm for comparison with EA fluvial flood zones mapped for the entire catchment and to which the public can access via the EA website ("What's in your Backyard?").

3.3.2 Groundwater Mapping

The National Groundwater Emergence map identified three sites at risk in the adjacent town of Reigate but they do not affect the development sites in Redhill and therefore are not shown on the maps.

3.4 Fluvial

Redhill Brook, the primary watercourse through the town, is a tributary of the River Mole. The Redhill Brook and Lynwood Ditch confluence in the Town Centre close to the Railway Station at the 'Liquid and Envy Club' formerly the Odeon Cinema. Both watercourses flow almost entirely in closed culverts within the town centre area but the ground route above are none-the-less prone to flooding.

The fluvial flood risk is determined by examination of the model outputs and resultant flood mapping (Appendix B – Flood Maps) and an assessment of local watercourses and topography.

The integrated model which includes the new Park 25 and Watercolour residential developments incorporates surface water sewers of 300mm diameter and above from Merstham which is then connected to the fluvial model in Redhill Brook so that it provides representative flows for all tributaries and the brook as it flows into the town.

3.4.1 The Fluvial Environment Upstream of Redhill

The Redhill Brook rises at the foot of the North Downs just to the South of the M25 and East of the M23. It flows to the South of Merstham and through Nutfield Marshes where it confluences with Nutfield marsh ditch before entering Redhill at Warwick School. The Nutfield Marsh Ditch formally rises near Canal Cottage to the southeast of Mercers Park Lake but in practice the ditch is usually dry and its principle inflow comes from the Biffa Landfill site just north of Nutfield. Two other watercourses enter the Redhill Brook upstream of Redhill: South Merstham Ditch (West) and Battlebridge Brook. The South Merstham Ditch (West) conveys M25 motorway runoff to a purpose-built motorway surface water attenuation area adjacent to Merstham Sewage Treatment Works. Very little other drainage enters the ditch so it is primarily dedicated to the drainage of the motorway; the outfall is via a trash screen into the Battlebridge Brook. Battlebridge Brook drains much of Gatton Park after being attenuated in "The Lake" it then flows under the running track into a flood storage area built at the same time as the new railway underpass to Holmethorpe industrial estate. The ditch flows through the caravan park and into the new Watercolour housing estate where it is channelled into two lakes which were formally sand settling ponds, and which are separated by a low weir, and then to the Battlebridge Brook via a small outlet pipe and ditch.

Two other seasonal ponds have been created on Nutfield Marsh providing environmental habitat which attract birds in the winter are not connected to the brook. Much of the flood plain on the marsh is taken up by flood zone 2 but there is one significant area of dry ground called The Moors to the south of Watercolour and upstream of the high-speed railway culvert which is not within this zone.

Where the Redhill Brook enters Redhill at Warwick School there are two ponds, one is purely for habitat the other to attenuate surface water runoff from the school. This area is known as the school environmental area but both ponds would be inundated in Flood Zone 2.

Brook Road, Bletchingley Close and Weldon Way in South Merstham were reported in the SFRA to be potentially at risk of flooding however, the majority of the area of flood plain is open space with some remaining potential for flood storage.

3.4.2 The Flood Risk Environment within the Redhill AAP

Downstream of Warwick School most of the developed areas adjacent to the Brook are at risk of flooding. The sites, their status within the AAP and flood risk based on current mapping to the southernmost site on Brighton Road are shown in Table 1 below. The Lynwood Ditch enters Redhill Brook by the Liquid and Envy Club on Marketfield Way. Much of the western side of Redhill drains into the Redhill Brook culvert in Marketfield Way upstream of the Reigate railway culvert.

Redhill Brook - Noke Drive to Reading Arch Road			375 minute duration (50mm display)		
No	Site	Within AAP	FZ3b	FZ3a	FZ2
1	Colebrook	Yes	Yes	Yes	Yes
2	Mail Office	Yes	Yes	Yes	Yes
3	Redstone Hill	Yes	No	No	No
4	Station Upper	Yes	Yes	Yes	Yes
5	Warwick Quadrant	Yes	No	Yes	Yes
6	Marketfield Way	Yes	Yes	Yes	Yes
7	Kingsgate	No	Yes	Yes	Yes
8	Cromwell Road	Yes	No	No	Yes

Redhill Brook - Noke Drive to Reading Arch Road			375 minute duration (50mm display)		
9	Reading Arch Road	Yes	Yes	Yes	Yes
10	Memorial Park Cafe	Yes	Yes	Yes	Yes
11	Gloucester Road	Yes	Yes	Yes	Yes
12	Belfry	No	No	Yes	Yes
13	Liquid and Envy	Yes	Yes	Yes	Yes
14	Longmead Block	Yes	Yes	Yes	Yes

Table 1- Flood Risk (375 minute duration storm) - Redhill Brook - Noke Drive to Reading Arch Road

The Lynwood ditch rises from a small sub-catchment within Gattons Park and then is culverted in a combination of main-river and public sewer culverts to Frenches Pond where it is an open lake classified as main-river. The pond outfall is via a penstock into a public sewer which runs under Memorial Park and Princess Way to confluence with Redhill Brook. Main-rivers are managed by the EA and Public Sewers by Thames Water. Two large sewer pipes enter the main public sewer upstream of Frenches Pond from Coles Meads. A 900 diameter sewer pipe enters at Memorial Park from Gloucester Road area. Drainage from the Bus Station and Warwick Quadrant enter the sewer in Princess Way.

There is no flood risk from tidal rivers or the sea.

There are no formal flood defences in the area but some sites are protected by existing buildings and topography which act as informal defences.

3.5 Fluvial Flood Mechanisms

The fluvial flood risk is as modelled for the 375 minute event. Only surface water deeper than 50mm is shown on the maps. The likely fluvial flood mechanism is as follows (see Figure 1 for the locations described):

The Redhill Brook would surcharge at the Noke Drive culvert (Colebrook site) and flood out of bank along Noke drive in a 5% Annual Exceedance Probability (AEP) event (Flood Zone 3b). However, in an event greater than 1% AEP (Flood Zone 3a), it could flow over the road at the junction with the A25 on Redstone Hill and flood under the A25 Railway Bridge by Redhill Railway Station (see Flood Zone Map 1 at Appendix B). Much of the Colebrook site and part of the Mail office site begin to flood at the 0.1% AEP event.

The Brook largely remains in culvert until immediately upstream of the A23 (Horley Road) Railway Bridge to the south end of Marketfield Way but is likely to flood out via surcharging surface water outfalls back into Marketfield Way. It then passes in a double brick-arched culvert under the railway line to emerge in open channel at the Reading Arch Road site behind the Ford Garage (commercial) forecourt. The Brook could flood out both upstream and downstream of the railway culvert but as the upstream ground levels are high, at approximately 77m AOD, flooding from the culvert in Marketfield Way is expected to take place earlier. The Brook continues in a series of culverts and open channels to south of Earlswood at the sports ground.

The flood zone maps indicate that in a 1% AEP event the flood will extend through much of the built up area between Marketfield Way, the High Street and Princess Way tailing back to the south-eastern extent of the Bus Station which is at a ground level (GL) of approximately 76.2m AOD. The 0.1% AEP (Flood Zone 2) event floods the bus station area, much of the High Street, Belfry and Station site too.

At the Bus Station roundabout (Junction of A23/A25) is the confluence of a Public Sewer connecting Frenches Ponds to the Redhill Brook and drains much of Coles Meads, Holmethorpe Industrial Estate and Gloucester Road area. The Public Sewer runs south from Frenches Pond, under the Memorial Park and Princess Way roughly consistent with the natural valley but modified at Princess Way when the Warwick Quadrant complex was built. This Public Sewer which confluent with a 900 diameter sewer from Gloucester Road would surcharge and flood Memorial Park, London Road, Gloucester Road school and car park and Lynwood Road. All surface water intended to drain this area is likely to back-up from these surcharged culverts. (See 3.7)

3.6 Analysis of other topographical data and site inspection

The flood mapping extents were corroborated by topographical survey levels obtained from a building site at Kingsgate, Marketfield Way, Gloucester Road and Memorial Park which add confidence to the DTM used in the model.

3.7 Surface Water

3.7.1 Surface Water Drainage, Pluvial and Overland Flow

The primary surface water flood risk is modelled in the 60 minute event map which models the faster response time typical of surface water from urban runoff. (See Flood Zone Map 2 at Appendix B) Only surface water deeper than 50mm is shown on the maps.

The interaction between surface water and fluvial flooding are particularly important in Redhill. The integrated model which includes the new Park 25 and Watercolour developments, incorporates surface water sewers of 300mm diameter and above, models surface water and overland flows in roads and streets but is limited by the scale of the model to treating properties as blocks of development rather than individual houses. The threshold of flood water entry to property and kerb heights is assumed to be 150mm above local ground level.

By examination of the model results and by ground observation, it is clear that surface water would flow along the natural valley of the Lynwood Ditch from the north and via the Gloucester Road site from the northwest. The two streams would tend to confluence at Memorial Park, and flow south through a low-lying area in front of No 3 Princess Way to where it will be obstructed by the building complex. The preferential route due to high ground to the East (Princess Way/Ladbroke Road junction) is down the High Street toward the Belfry Centre and Station Road. It would tend to pond in the area between Station Road, Marketfield Way and the High Street due to the high ground beneath the railway bridge over the A23 at the end of the High Street. Both the bus station and railway station are liable to flood.

Any flow down Ladbroke Road will tend to fall to the west into the park or Princess Way. Any flow continuing down Princess Way will meet exceedance flow from Redhill Brook and Redstone Hill at the A23/A25 roundabout by the Bus and Rail stations on the A23/Marketfield Way.

Some flood risk to the town centre is reduced by the presence of the Warwick Quadrant/No3 Princess Way complex holding water in Princess Way and Memorial Park, however, flood water will eventually be diverted to the High Street.

The surface water mapping (Flood Zone Map 2 at Appendix B) indicates that the surface water drainage system capacity would be generally exceeded in less than a 5% AEP event (FZ3b). The exceedance flow will tend to flow down natural valleys overland which is defined by the flood map (Flood Zone Map 2 at Appendix B).

There are two principle drainage runs into the Redhill Brook at the town centre. The Lynwood ditch which, as discussed under fluvial above, comprises both main-river and public sewer culverts from the North and Holland Close which drains much of the western side of the town via the Cromwell Road site. Apart from the Lynwood Ditch, two large sewer pipes enter the main public sewer upstream of Frenches Pond from Coles Meads and a 900 diameter sewer pipe enters at Memorial Park from Gloucester Road area. Drainage from the Bus Station and Warwick Quadrant enters the sewer in Princess Way. The Holland Close sewers which drain from the watershed near Doynings culminate in an 1135x1100 culvert joined by a 900 diameter sewer from Cromwell Road before entering the Redhill Brook near Kingsgate.

The implication is that these sewers may back up from Redhill Brook already surcharging due to the Redhill /Reigate railway line culvert restriction and are also likely to have their design capacity exceeded resulting in significant pluvial (surface water drainage exceedance) flooding exacerbating fluvial flood flow in Marketfield Way.

Redhill Brook - Noke Drive to Reading Arch Road			60 minute duration (50mm display)		
No	Site	Within AAP	FZ3b	FZ3a	FZ2
1	Colebrook	Yes	Yes	Yes	Yes
2	Mail Office	Yes	Yes	Yes	Yes
3	Redstone Hill	Yes	Yes	Yes	Yes
4	Station Upper	Yes	Yes	Yes	Yes
5	Warwick Quadrant	Yes	No	No	Yes
6	Marketfield Way	Yes	Yes	Yes	Yes
7	Kingsgate	No	Yes	Yes	Yes
8	Cromwell Road	Yes	No	No	Yes
9	Reading Arch Road	Yes	Yes	Yes	Yes
10	Memorial Park Cafe	Yes	Yes	Yes	Yes
11	Gloucester Road	Yes	Yes	Yes	Yes
12	Belfry	No	Yes	Yes	Yes
13	Liquid and Envy	Yes	Yes	Yes	Yes
14	Longmead Block	Yes	Yes	Yes	Yes

Table 2- Flood Risk (60 minute duration storm) - Redhill Brook - Noke Drive to Reading Arch Road

3.8 Groundwater Flood Risk

Historically, Redhill was marshland and there is evidence of this from the Nutfield Marsh just 1km upstream. During seasonal periods of frequent and prolonged rainfall, the local water table may rise and increase flows to the drainage system. The town lies beneath the North Downs which is a chalk aquifer. Flooding is typically likely to occur at the spring-line where the groundwater can emerge. The National Groundwater Emergence map was used to assess groundwater flood risk. However, this map is prepared at a relatively small scale (National) as compared to the larger scale of the detailed flood mapping and thus the boundaries are not well defined and interpretation is required. There are three reported groundwater flood incidents in Reigate; in the vicinity of Holmesdale Road (near the station), Raglan Road and Blackborough Road (near Reigate Grammar School). These occurrences are from winter 2000/1 and 2002/3.

These incidents are evidence of isolated flood risk that will be intermittent in this area as superficial geological deposits cover the chalk.

3.9 Artificial Sources e.g. Canals, Reservoirs

“The Lake” in Gatton Park has a raised embankment and spillway. It is monitored under the Reservoirs Act and any risk of failure or overtopping is very low.

An assessment of the topography suggests that flood water from the dam would flow southeast over the A23 toward the Battlebridge sports ground and northern extent of Holmethorpe, including the College buildings. Flooding from dam failure can be sudden, dangerous to people and damaging to property. However, the volume of impounded water is relatively small and is unlikely to significantly flood beyond the Holmethorpe area. The railway embankment may tend to deflect flow southwards toward Redhill along Frenches Road. A dam-break analysis would confirm the extent and severity of flood risk.

None of the other lakes in the area, within Nutfield Marsh, including Mercers Park, the Sand Pits and the Moors Lakes at Watercolour/Park 25, has a raised embankment which can fail.

3.10 Assessment of Risk due to Informal Defence Failure

The only structure to be considered to act as an informal defence is the office complex at the northern end of Warwick Quadrant (No 3 Princess Way) as it obstructs the natural valley from the Memorial Park and redirect flow into the London Road/ High Street and around the site. The town centre could be at greater risk whenever this building is redeveloped and if the overland flow-path is altered.

3.11 Flood Hazard

Flood Hazard describes an assessment of risk to pedestrians and cars from fast flowing and /or deep surface water. Flood Hazard has been estimated using the velocity and depth derived from the 2D model and mapped as at Appendix C - The mapping indicates by the use of the length and density arrows areas where velocities are relatively high.

Hazard is the product of depth and velocity where a depth of 0.6m at a velocity of 1m/s can move a car and a depth of 0.15m at 1 m/s can destabilise a pedestrian’s footing.

However, the velocity of the water in Redhill shown on the mapping is 0.1m/s which in terms of hazard is very low. There are very few areas where velocity is as high as 1m/s but the depth is shallow. The depths shown in the legend are in meters for example red is at least 0.5m of depth.

Depth of water is indicated in red and dark blue where water accumulates in low-lying terrain or behind a structure. The areas where depth and velocity are most significant are:

- Between the office buildings and behind the wall opposite Memorial Park.
- In the low-lying area at the South end of Memorial Park and On Princess Way;
- Sainsbury car park ramp;
- Marketfield Way adjacent to Kingsgate;
- Kingsgate underground parking;
- Belfry Goods ramp;
- Railway cutting passing under Linkfield Street;

- Noke Drive and the A25 under the railway line;
- The visible fluvial flood map is the Redhill Brook on Noke Drive.

Flood Hazard is not considered a significant risk due to the shallow depths of water.

3.12 Summary of Risk to and from the Site

3.12.1 Risk to the Site

In summary, the key risks to the Town Centre Area Action Plan development sites from the various sources are shown in Table 3 – Flood Risk to the Site Summary by Source.

Redhill Brook - Noke Drive to Reading Arch Road			375 minute duration (50mm display)			60 minute duration (50mm display)			GW ³	Dams etc.
No	Site	Within AAP	FZ3b	FZ3a	FZ2	FZ3b	FZ3a	FZ2		
1	Colebrook	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
2	Mail Office	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
3	Redstone Hill	Yes	No	No	Yes	No	No	Yes	No	No
4	Station Upper	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
5	Warwick Quadrant	Yes	No	Yes	Yes	No	No	Yes	No	No
6	Marketfield Way	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
7	Kingsgate	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
8	Cromwell Road	Yes	No	No	Yes	No	No	Yes	No	No
9	Reading Arch Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
10	Memorial Park Cafe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
11	Gloucester Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
12	Belfry	No	No	Yes	Yes	Yes	Yes	Yes	No	No
13	Liquid and Envy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
14	Longmead Block	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No

Table 3 – Flood Risk to the Site Summary by Source

³ Groundwater

3 Assessment of Flood Risk from the Development Sites

4.1 PPS25 Requirement

In addition to the flood risk to the site, in accordance with PPS25 an assessment has been made of the impact the proposed development may have to other parties off-site.

4.2 Impermeable Areas

All of the proposed development areas would be described as being constructed of impermeable surfaces with the current information available. Therefore attenuation in runoff to the equivalent Greenfield standard would need to be provided. The rate needs to be calculated and agreed with the EA.

4.3 SuDS Measures

There is a significant opportunity and need to provide SuDS measures. It is assumed that without mitigation measures all new development would generate 100% runoff being from impermeable surfaces. The opportunities to attenuate runoff could arise from:

- Permeable paving and storm cell type voids beneath for storage;
- Grass roofed buildings which can reduce runoff by 20%;
- Attenuation tanks in the basements of new developments to attenuate water before it is discharged to the surface water sewers.
- Creation of dual-use open-space for temporary water storage e.g. parking or seating area.

4.4 Risk from the Site

In summary, the key risks from the site are due to an increase in flood risk to properties downstream due to displacement of floodwaters within the flood plain, see Table 4.

The precise impact would need to be calculated if these developments are to proceed. SuDS measures for each development should be designed to attenuate the additional runoff to equal to, or less than the existing run-off at the site plus an allowance for climate change as a minimum requirement, however, it is good practice to seek to achieve run-off from the site at a runoff rate equivalent to Greenfield for the local site geology. This measure will, in time, restore the catchment to more natural run-off regimes.

Redhill Brook - Noke Drive to Reading Arch Road			375 minute duration (50mm display)			60 minute duration (50mm display)		
No	Site	Within AAP	FZ3b	FZ3a	FZ2	FZ3b	FZ3a	FZ2
1	Colebrook	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Mail Office	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Redstone Hill	Yes	No	No	Yes	No	No	Yes
4	Station Upper	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	Warwick Quadrant	Yes	No	Yes	Yes	No	No	Yes
6	Marketfield Way	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Kingsgate	No	Yes	Yes	Yes	Yes	Yes	Yes
8	Cromwell Road	Yes	No	No	Yes	No	No	Yes
9	Reading Arch Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	Memorial Park Cafe	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11	Gloucester Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12	Belfry	No	No	Yes	Yes	Yes	Yes	Yes
13	Liquid and Envy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	Longmead Block	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4- Flood Risk from the Site Summary

5 Planning – PPS25 and the Sequential Test

5.1 Flood Zone Maps and Flood Risk Vulnerability

5.1.1 The Sequential Test

PPS25 Annex D is clear that the risk-based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas of the lowest probability of flooding (Zone 1)⁴. Flood Zones used for the assessment are those as shown in Appendix B, maps 1 and 2 showing the 60 minute and 375 minute duration storm event and displaying 50mm minimum flood depth.

The tables below indicate which sites are located in a particular Flood Zone sufficiently to **significantly** impact on development, its vulnerability classification for the proposed use as described in Table D2 of PPS25, and thus if an Exception Test is required or not. Where a Flood Zone only encroaches the edge of the development site it is anticipated that the design can leave sufficient flood storage without detriment and so is described as not within the site as a general classification. However, individual development sites will take account of the flood zones at design stage.

5.1.2 Sites in Flood Zone 1

None of the development sites are only within Flood Zone 1.

5.1.3 Sites in Flood Zone 2

Table 5 shows proposed developments that are **only** within the Flood Zone 2 Medium Probability i.e. **not significantly** within the Fluvial Flood Zones 3a or 3b. The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure are appropriate in this zone. An Exception Test is not required for 'More vulnerable' developments within FZ2 but would be required if were significantly within FZ3a.

No	Site	375 min duration			60 min duration			Vulnerability	Proposed Use	Exception Test Required?
		FZ3b	FZ3a	FZ2	FZ3b	FZ3a	FZ2			
3	Redstone Hill	No	No	Yes	No	No	Yes	More Vulnerable	Mixed-use Dwellings	No
8	Cromwell Road	No	No	Yes	No	No	Yes	More Vulnerable	Mixed-use Dwellings	No

Table 5 - Sites in Flood Zone 2

⁴ Planning Policy Statement 25 Annex D, D1

5.1.4 Sites in Flood Zone 3a

Table 6 shows proposed developments that are **only** within the Fluvial Flood Zones 3a High Probability i.e. **not significantly** within the Fluvial Flood Zone 3b. The water-compatible, less vulnerable uses of land are appropriate in this zone. More Vulnerable and Essential Infrastructure require and Exception Test to be passed. The Warwick Quadrant and Bus Station is a combined site comprising shops and offices for professional services which are classified as 'Less Vulnerable', the Theatre and Library being classified as 'More Vulnerable' and the Bus Station site which is classified as 'Essential Infrastructure'. The parts of the site which encroach the flood plain are the offices on Princess Way to the north and the Bus Station. The office buildings actually protect the 'More Vulnerable' Theatre area from flooding by keeping water in Princess Way. The Theatre and Library are in any case on the first floor with safe access and egress to the London Road. Any redevelopment would need to be aware of this. The Bus Station site is classified as 'Essential Infrastructure (Figure 2 – PPS25 Table D.2 Flood Risk Vulnerability Classification), is within FZ3a 375 minute storm duration (Table 6) and as thus requires an Exception Test to be passed as stated in section 'Appropriate uses' in PPS25 Table D1 'Zone 3a High Probability'. Transport essential infrastructure permitted in this zone should be designed and constructed to remain operational.

No	Site	375 min duration			60 min duration			Vulnerability	Proposed Use	Exception Test Required?
		FZ3b	FZ3a	FZ2	FZ3b	FZ3a	FZ2			
5	Warwick Quadrant & Bus Station	No	Yes	Yes	No	No	Yes	More Vulnerable	Mixed-use Dwellings	Yes

Table 6 - Sites in Fluvial Flood Zone 3a

Warwick Quadrant encroaches both FZ2 and 3a at the periphery, with most impact at the Bus Station area therefore whilst the majority of the site can be developed freely, these areas must be designed with regard to PPS25 according to use. For example, 'Mixed-use Dwellings' require an exception test and 'Essential Infrastructure' has to be able to remain safe in operation.

5.1.5 Sites in Flood Zone 3b

Table 7 shows proposed developments that are **only** within the Surface water Flood Zones 3b. The **Surface Water** Flood Zone 3b is not presently classified by PPS25 as Functional Flood Plain but the risk is considered equally for planning purposes except that for this assessment a 50mm minimum flood depth is used within the urban environment. Only water-compatible and essential infrastructure that has to be there should be permitted in this zone. All of the sites listed in Table 7 are classified as 'More Vulnerable or Less Vulnerable' and within FZ3b and therefore development within the FZ3b not permitted at all. However, if the flood zone 3b, were to be removed by other measures such as upstream flood attenuation or the buildings moved out of the zone by design but remain in FZ3a, the sites would still need to pass an Exception Test.

No	Site	375 min duration (50mm display)			60 min duration (50mm display)			Vulnerability	Proposed Use	Development Permitted or only with an Exception Test?
		FZ3 b	FZ3 a	FZ2	FZ3 b	FZ3 a	FZ2			
1	Colebrook	Yes	Yes	Yes	Yes	Yes	Yes	More Vulnerable	Mixed-use Dwellings	Development not permitted in FZ 3b
2	Mail Office	Yes	Yes	Yes	Yes	Yes	Yes	Less Vulnerable	Storage & Distribution	Development not permitted in FZ 3b
4	Station Upper	Yes	Yes	Yes	Yes	Yes	Yes	More Vulnerable	Mixed-use Dwellings	Development not permitted in FZ 3b
6	Marketfield Way	Yes	Yes	Yes	Yes	Yes	Yes	More Vulnerable	Mixed-use Dwellings	Development not permitted in FZ 3b
9	Reading Arch Road	Yes	Yes	Yes	Yes	Yes	Yes	More Vulnerable	Mixed-use Dwellings	Development not permitted in FZ 3b
10	Memorial Park Cafe	Yes	Yes	Yes	Yes	Yes	Yes	Less Vulnerable	Café	Development not permitted in FZ 3b
11	Gloucester Road	Yes	Yes	Yes	Yes	Yes	Yes	Less Vulnerable	Storage & Distribution	Development not permitted in FZ 3b
13	Liquid and Envy	Yes	Yes	Yes	Yes	Yes	Yes	More Vulnerable	Mixed-use Dwellings	Development not permitted in FZ 3b
14	Longmead Block	Yes	Yes	Yes	Yes	Yes	Yes	More Vulnerable	Mixed-use Dwellings	Development not permitted in FZ 3b

Table 7- Sites in Surface Water Flood Zone 3b

The sites in Table 7 encroach upon Flood Zones 2, 3a and 3b. The vulnerability for the proposed use means that development is not permitted in FZ3b. The pragmatic way forward is to design the development to avoid FZ3b completely and FZ3a where possible or carry out the Exception Test. Therefore, whilst the much of each site can be developed freely, these areas within flood zones must be designed with regard to PPS25 according to use. For example, 'Mixed-use Dwellings' in FZ3a require an exception test to be carried out.

5.2 Use and Vulnerability

The Reigate & Banstead SFRA was completed in July 2007 and was in the process of being reviewed in July 2011. This Redhill Town Flood Risk Assessment should be read in conjunction with the SFRA 2011 once published.

In order to determine the appropriate development use reference is made to PPS25 Annex D, Table D.3 below which sets out the appropriate Flood Zones for the various development uses and vulnerabilities.

Table D.2: Flood Risk Vulnerability Classification

Essential Infrastructure	<ul style="list-style-type: none"> • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	<ul style="list-style-type: none"> • Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.¹⁹
More Vulnerable	<ul style="list-style-type: none"> • Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste.²⁰ • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	<ul style="list-style-type: none"> • Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).

Figure 2 – PPS25 Table D.2 Flood Risk Vulnerability Classification

Table D.3²²: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	X	Exception Test required	✓
	Zone 3b 'Functional Floodplain'	Exception Test required	✓	X	X	X

Key:

✓ Development is appropriate

X Development should not be permitted

Figure 3 – PPS25 Table D.3 Compatibility between Flood Risk Vulnerability and Flood Zone

(a) Sites within Flood Zone 1

Flood Zone 1 comprises all areas other than Flood Zones, 2, 3a and 3b (which have planning constraints) and thus there is no restriction on use in FZ1.

(b) Sites within Flood Zone 2

Appropriate for essential infrastructure, water compatible, more vulnerable and less vulnerable uses (See Figure 2 for type of development); therefore all developments listed in Table 5 are appropriate (See Figure 3) subject to the development control advice given in the SFRA:

- Positive reduction of risk e.g. reduce building footprint. *Note. This effectively increases flood plain storage.*
- Simple FRA. *Note. The FRA should be at a level of detail to explain the risk and mitigation clearly and concisely.*
- Finished floor levels 0.3m above 1% AEP plus climate change allowance level. *Note, raising threshold levels should reduce the onset of flooding into buildings except at extreme events provided air bricks and cellars are able to be sealed prior to a flood event.*
- SuDS to achieve Greenfield runoff rates. *Note. The EA requirement is to match the runoff from the site prior to development, however, on brownfield sites, it is good practice to seek a return to Greenfield runoff rates to reduce flood risk overall.*
- Safe access and egress routes. *Note. PPS25 requires developments which can have the environs flooded to provide dry and safe access and egress.*

(c) Sites within Flood Zone 3a

Appropriate for water compatible and less vulnerable uses (i.e. not more vulnerable uses, See Figure 2 for type of development) therefore site 5 (Warwick Quadrant) listed in Table 6 is not appropriate for this zone without an exception test being carried out (See Figure 3). If the development was changed to less vulnerable use then the following conditions would apply:

- Positive reduction of risk e.g. reduce building footprint. *Note. This effectively increases flood plain storage.*
- Detailed FRA. *Note. The FRA should be at a level of detail to explain the risk and mitigation clearly and concisely. Hydraulic Modelling and calculations should be provided where necessary.*
- Finished floor levels 0.3m above 1% AEP plus climate change allowance level. *Note, raising threshold levels should reduce the onset of flooding into buildings except at extreme events provided air bricks and cellars are able to be sealed prior to a flood event.*
- Basements not for habitation. *Note. The EA policy is to discourage basements where people could be trapped within FZ3a.*
- SuDS to achieve Greenfield runoff rates. *Note. The EA requirement is to match the runoff from the site prior to development, however, on brownfield sites, it is*

good practice to seek a return to Greenfield runoff rates to reduce flood risk overall.

- Safe access and egress routes. *Note. PPS25 requires developments which can have the environs flooded to provide dry and safe access and egress.*
- No increase in flood levels. *Note. The EA policy is to ensure that new developments do not cause an increase in flood levels and, if the development were to be permitted, would usually require compensation storage on a volume for volume and level for level basis so that there is no increase in flood risk.*
- Provide at minimum an 8m buffer zone to any watercourse. *Note. The EA have statutory powers to maintain an 8m zone from the top of bank of a watercourse for access so that any development restricting access should be avoided. This usually applies to watercourses classified as main rivers for which they have responsibility but could be applied more widely to ordinary watercourses if critical to flood risk.*

(d) Sites within Flood Zone 3b

Only water compatible and essential infrastructure (See Figure 2 for type of development are permitted with the following conditions (See Figure 3).

- Remain operational and safe for users in time of flood. *Note. Users should have safe access and egress to and from the site in time of flood.*
- Result in no net loss of floodplain storage. *Note. The EA policy is to ensure that new developments do not cause an increase in flood levels and, if the development were to be permitted, would usually require compensation storage on a volume for volume and level for level basis so that there is no increase in flood risk.*
- Not impede water flows. *Note as above.*
- Not increase flood risk elsewhere. *Note as above.*
- Essential infrastructure should pass the exception test (See Figure 3).
- Water Compatible does not require an exception test (See Figure 3).

The Colebrook, Mail Office, Station Upper, Marketfield Way, Memorial Park Café and Gloucester Road sites all have some flooding in the 5% AEP event, classified as functional flood plain. The local topography suggests that development proposals for these sites could be designed to accommodate the area of the site within the flood plain.

5.3 Keeping People from Danger

If developments are allowed within flood zones, safe access and egress is essential and some assessment of flood hazard is required. This is determined using maps of water depth and velocity produced by the 2D (two-dimensional) hydraulic model.

Flood hazard maps are included at Appendix C. Velocities that are greater than 0.1m/s and depths of at least 0.5m are shown. Surface water presents the more significant risk over a wider area. Flood hazard in Redstone Hill, Gloucester Road, Linkfield Lane and Holland Close could impact on the access and egress from the development sites. The Colebrook site hazard is mainly within the channel or within the road of Noke Drive.

An examination of the flood maps shows that neither the development at Marketfield Way nor Reading Arch Road have access and egress that is not affected by the flood zones.

6 Planning – Planning and Pollution Control – PPS23

6.1 Site Information

All of the developments sites except the Memorial Park Café are either currently used or proposed to be used by cars or are within the urban/street environment where the risk of surface water contamination is high.

6.2 Planning Considerations

The proposed development should endeavour to improve the quality of surface water prior to entering the watercourse.

6.3 Pollution Control Measures

Surface water runoff from roofs could be harvested for reuse by the development. Surface water from hard-standing and car parks should pass through a bypass interceptor which will filter out hydrocarbons from the run-off and reduce pollution entering the watercourse. Surface water and water exceeding the drainage network (Pluvial) should be controlled and treated through either proprietary systems or vegetation swales.

Groundwater pollution risk should be assessed for each development.

7 Conclusions and Recommendations

7.1 Flood Risk Assessment

The flood risk assessment has been carried out with using latest available information however, the model has been developed at sub-catchment scale and therefore there remains some uncertainty as to the accuracy of the flood extents for individual developments for the following reasons:

- The model uses a stripped (bare ground) Digital Terrain Model (DTM) with meshing suitable for the scale. Smaller meshes may be appropriate at larger scale;
- The properties are modelled in groups and given boundary conditions appropriate to the scale for the town assessment rather than for individual properties. It is likely that for individual development Flood Risk Assessments that more detailed modelling of individual buildings may be required as appropriate for the larger scale.

7.2 The need to change use or the potential to change flood risk

It was important to decide if the short-duration 'surface water influence' flood zones should be accepted as appropriate to be used as a planning constraint in the same manner as the long-duration 'fluvial influence' flood zones are. It was agreed with the EA at a meeting to discuss Marketfield Way development (26 January 2011)⁵ that it was for the Council to decide whether to adopt the flood zones. It was agreed, and consistent with PPS25, that it is appropriate for planners to consider all-sources of flooding. However, because surface water zones can be extensive but shallow, the Council intends to use both short and long-duration flood zones as integrated mapping but displaying 50mm minimum depth of water to represent risk. Both the 60minute and 375minute duration maps are required to represent the full risk.

Most of the development sites, Colebrook, Mail Office, Station Upper, Marketfield Way, Memorial Park Café and Gloucester Road would not be appropriate for the planned development being within Flood Zone 3b, the 'functional flood plain'. The railway station (included with Station Upper) would be included in this group but is classified as essential infrastructure.

Where a development is considered not to be appropriate for a site the options are either to:

- Not develop the site,
- Develop with an appropriate use e.g. water compatible within flood zone 3b,
- Modify the flood zones by attenuation or diversion,
- Develop only part of the site to avoid the flood plain.

Taking the last point, the sites could be made developable if parts of the site were designated for building and the remainder allowed to flood so that for example:

⁵ 110126 Redhill_Marketfield Way_FRM Mtg

- Only the part of the site that is appropriate is developed for dwelling with the buildings being either shaped around the flood area or the ground reshaped to accommodate the flood volume and to make space for the building,
- Other parts are utilised as amenity open space for flood attenuation and storage to reduce flood risk downstream in Earlswood.

There is scope in Marketfield Way for the above approach where the existing car park is in a relatively low area created when the road was raised above the Redhill Brook culvert. Ideally, the space would be opened up (deculverting) by realigning the road (A23) through Marketfield Way. The resultant space could be dual-space, suitable for both amenity and flood plain storage. The new development could be shaped around the amenity space to increase its value. However, this option is considered too costly to implement and therefore was not taken forward as a viable option.

Another approach is to consider changing the risk areas by mitigation measures that are acceptable to the EA. Preliminary options have been modelled to explore the feasibility of this approach (See Appendix D) for example:

- Provide attenuation upstream of the town in Memorial Park and, or Gloucester Road car park both of which are development sites. The designed measures need to allow for climate change flows but indications are that the depth of water in Marketfield Way for example can be reduced from 0.8m to 0.4m which, would be more manageable and along with other sustainable drainage measures may change the flood extent sufficiently to enable development to take place.
- Provide attenuation in Nutfield Marsh to reduce fluvial flow in the Redhill Brook. Nutfield Marsh is a large, wide water-meadow through which flows the Redhill Brook from its upper catchment near the M25/M23 Junction 7/8. Large areas of the meadow have been quarried for aggregates and are now used for amenity or nature reserves as lakes and ponds. There is potential to divert some flood flow from Redhill Brook into one or more of these lakes and ponds to reduce flooding in the town area, particularly at Marketfield Way and Colebrook. The feasibility and benefits of this measure would need to be tested by hydraulic modelling.

7.3 Flood Hazard

Flood Hazard is not considered a significant risk due to the shallow depths of water.

7.4 Recommendations

The Council should establish if alternative sites can be found for any or all of the development sites proposed as part of sequential testing and if not, undertake the required Exception Tests. Should the necessary tests be passed, the development sites may be made viable provided that satisfactory FRAs and designs are submitted which do not increase flood risk.

Site specific FRAs with modelling at an appropriate scale are necessary for individual developments as required by the EA.

THIS PAGE LEFT BLANK INTENTIONALLY FOR DOUBLE-SIDED PRINTING