

Southend-on-Sea Borough Council
and Rochford District Council

London Southend Airport and Environs
Flood Risk Constraints Report

December 2009

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Glossary

Term	Meaning / Definition
AOD	Above Ordnance Datum
BGS	British Geological Survey
BREEAM	BRE Environmental Assessment Method
CEEQUAL	Civil Engineering Environmental Quality Assessment and Award Scheme
CIRIA	Construction Industry Research and Information Association
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
JAAP	Joint Area Action Plan
LSACL	London Southend Airport Company Limited
MRO	Maintenance, Repair and Overhaul
PPS25	Planning Policy Statement 25: Development and Flood Risk
RESA	Runway End Safety Area
SFRA	Strategic Flood Risk Assessment
SPZ	Groundwater Source Protection Zone
SUDS	Sustainable Drainage Systems

Executive Summary

Atkins has been commissioned by Southend-on-Sea Borough Council and Rochford District Council to complete a report detailing the flood risk constraints affecting the proposed Joint Area Action Plan (JAAP) development at and around London Southend Airport. The assessment can be used to inform the master-planning process, as well as providing key input to the production of individual Flood Risk Assessments (FRA) to support future applications for planning permission.

The current preferred option includes proposals to redevelop approximately 165 hectares of the JAAP area, with a mixture of airport facilities, new employment provision and improved public open space. Two key flood risks have been identified as constraining development, with the potential to result in objection to the JAAP unless a range of alterations and considerations are incorporated into the proposals.

Areas adjacent to the Rayleigh Brook and the Eastwood Brook are at risk of fluvial flooding, with approximately 20% of the proposed development located in either Flood Zones 2 or 3, as defined by the Environment Agency. Flood risk data including flood extents, levels and flows has been obtained from the Environment Agency for the Eastwood and Rayleigh Brooks. It is recommended that subsequent studies purchase topographic data and use it alongside this flood risk information to enable a more detailed analysis of risk and hazard in the areas proposed for development.

The size and complexity of the JAAP area mean that there are a range of suitable mitigation measures which can be incorporated into the development proposals. Most importantly, the development layout should be planned and designed sequentially, in line with PPS25, to take into account both the risk of flooding and the relative vulnerability of the specific components of development. The preferred option is currently laid out contrary to the sequential approach, with commercial development located immediately adjacent to the watercourses in areas of fluvial flood risk, while water-compatible open space has been allocated to lower risk sites. In areas where it is not possible to entirely avoid the flood risk (for example, because of the need to locate the MRO facilities close to the airport), any development in the floodplain will require alternative management solutions to ensure that it remains safe during a flood event. There will also be a requirement to provide compensatory floodplain storage.

New developments additionally need to carefully consider the likely impact on surface water flows and how these can be managed sustainably to ensure no increase in surface water flood risk to the development and from the development to neighbouring areas. The existing Greenfield nature of much of the JAAP area means that the requirement to mitigate surface water runoff to existing rates are likely to have significant implications on land take. A variety of Sustainable Drainage Systems (SUDS) are available for use on the site, although infiltration is unlikely to be a viable option given the impermeable nature of the clay geology. As the site layout evolves in the future, it is important that allowances are made for the land take for associated surface water drainage features, which will need to be located between the development and the watercourses.

It is recommended that the JAAP proposals (and in particular the layout of the developments) are re-visited in light of the findings of this flood risk constraints report, the requirements set out in PPS25 and correspondence with the Environment Agency. Wherever possible, attempts should be made to re-allocate some of the proposed open space, which is currently located outside of the floodplain, and substitute it for the airport-related and employment development. This would act to create a green corridor alongside the Eastwood and Rayleigh Brooks, safeguarding developments from fluvial flooding, providing space to sustainably manage surface water and promoting other environmental benefits.

1. Introduction

1.1 Background

Rochford District Council and Southend-on-Sea Borough Council are producing a Joint Area Action Plan (JAAP) planning policy document to guide future development at and around London Southend Airport.

The development area occupies a location which is at risk of fluvial flooding from a number of tributaries of the River Rother. In addition, large parts of the JAAP area on which development is proposed are currently Greenfield land. This means that, without appropriate mitigation, the development could result in an increase in the rate and volume of surface water run-off, increasing flood risk for the site itself and neighbouring or downstream sites. As such, the consideration of flood risk in the development area and the management of this risk through appropriate planning and design will form a crucial part of the emerging plans for this large and significant development area.

This document presents the findings of a flood risk scoping assessment for the development area and includes information gathered from the Environment Agency, who is a statutory consultee in the assessment of development sites at risk of flooding. The assessment is intended to provide a baseline assessment of flood risk constraints which can be used to inform the master-planning process and later provide key input to the production of individual Flood Risk Assessments (FRA) to support applications for planning permission, in line with Government 'Planning Policy Statement 25: Development and Flood Risk' (PPS25) (Ref. 1).

1.2 Terminology

Throughout this document, flood events are defined by their likelihood (probability) of occurrence. The rarity of flood events is described using 'annual probability', whereby a flood event is defined by the annual chance of its occurrence. For example, if there is a 1 in 100 chance of that flood occurring in any one year, that flood has an annual probability of 1%.

Occasionally, when referring to documented correspondence or guidance, the term 'return period' may be used, and a flood with an annual chance of 1 in 100 can be termed a '1 in 100 year flood event'. The use of return periods is generally discouraged to prevent non-specialist users assuming a regular occurrence of a flood event, rather than an average occurrence of a particular flood.

2. The JAAP Area

2.1 The Development Area

2.1.1 Description

The total JAAP area covers 390 hectares (3.9km²) and is focused on London Southend Airport and the surrounding land. The JAAP area is located in Essex, on the border between Rochford District Council and Southend-on-Sea Borough Council. It is partly within the Thames Gateway South Essex Growth Area, as defined by the South of England Plan. It is bounded by the A127 / Prince Avenue to the south, Cherry Orchard Way to the west, Hall Road in the north and Southend Road to the east. Figure 2.1 shows the location and extent of the JAAP area.

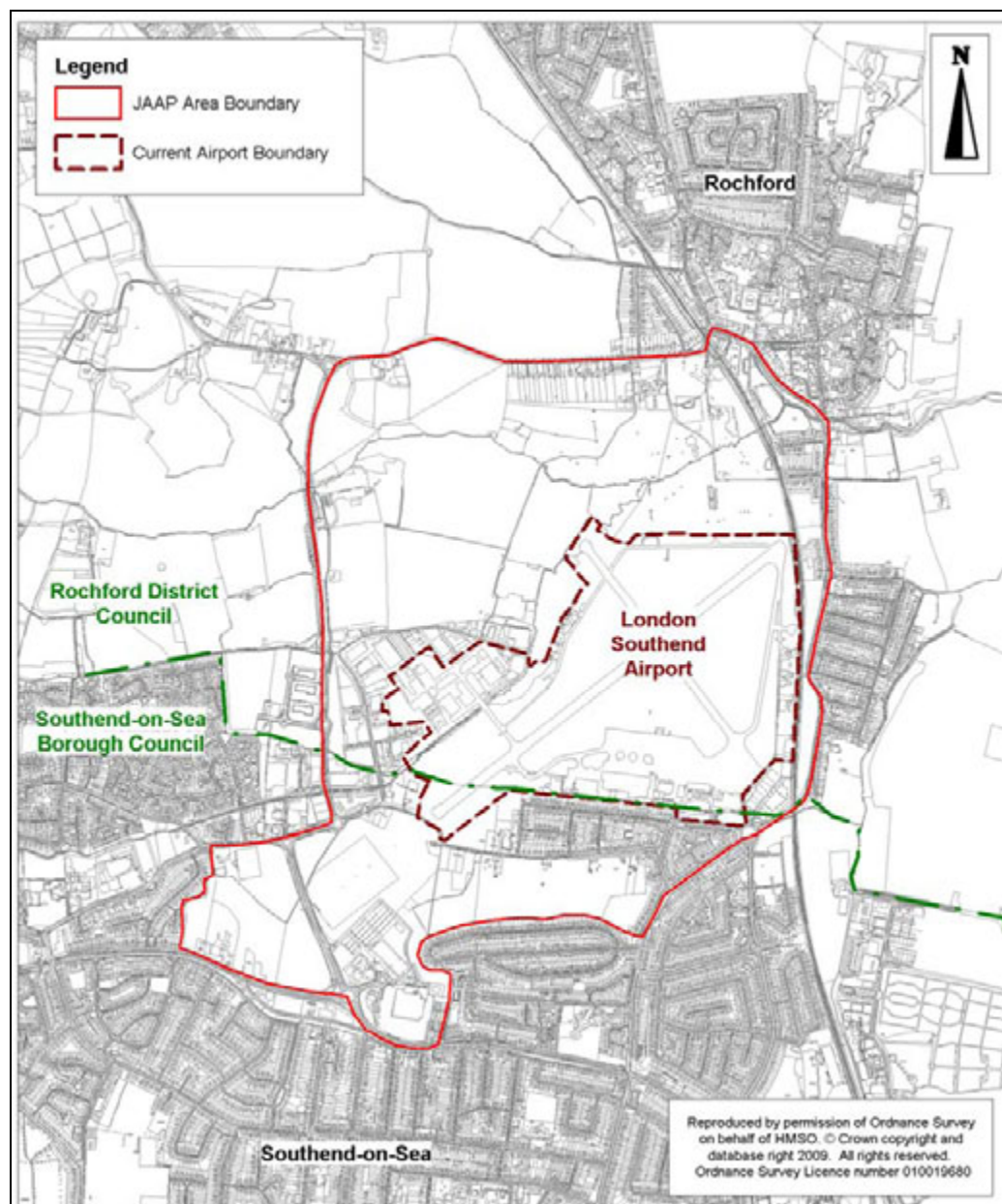


Figure 2.1 – Plan Area Location

2.1.2 Land Use

Figure 2.2 shows the current land use in the JAAP area. The majority of the JAAP area (70%) is presently greenfield land with a mixture of open countryside, recreational (sports fields and allotments) and agricultural areas. Just under half of the site is designated as Metropolitan Greenbelt Land. The presence of large undeveloped areas within the JAAP area means that the findings of the PPS25 Sequential Test (Ref. 1) will form an important part of the Environment Agency response to any development proposals. More information about planning policy and flood risk is found in Chapter 3.

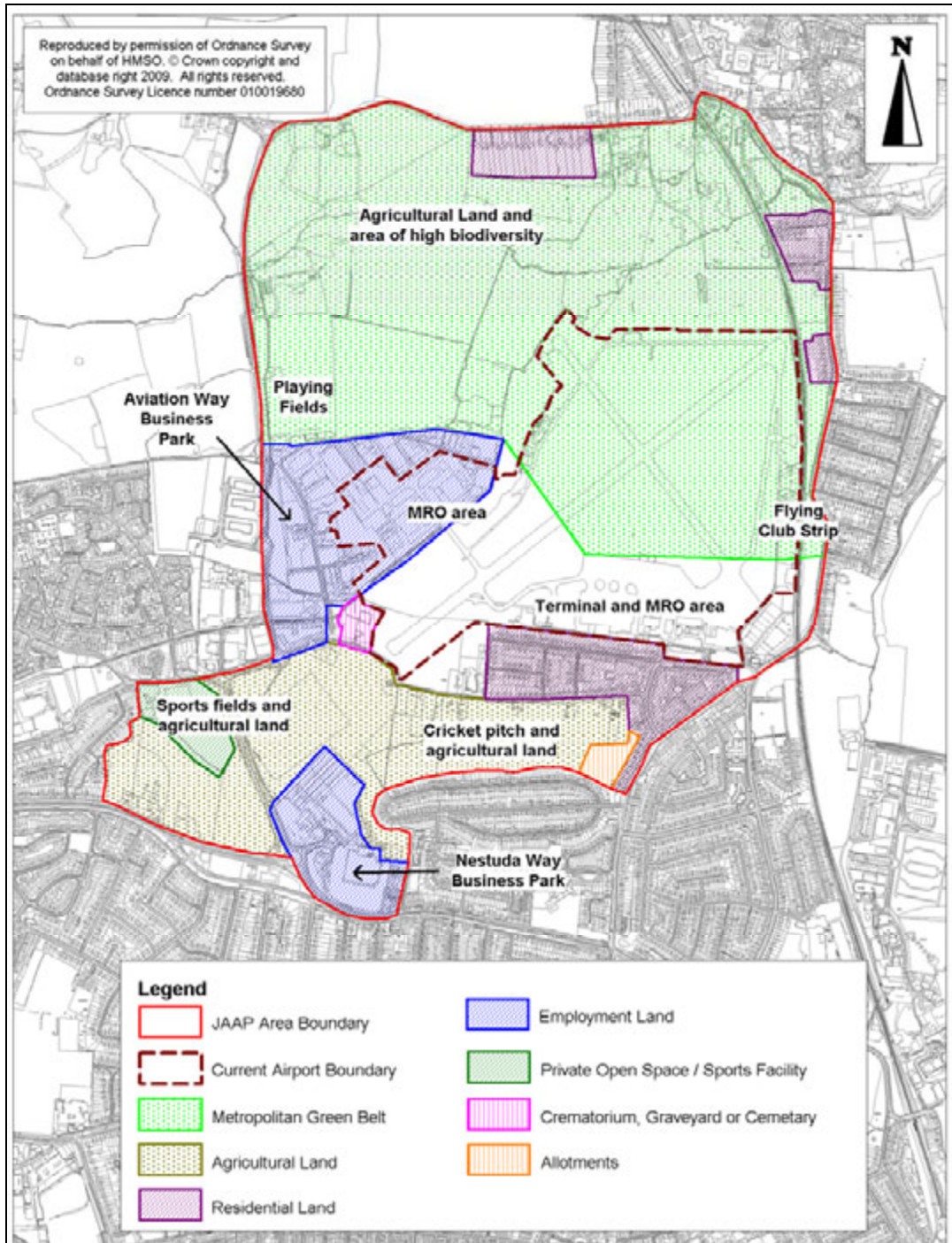


Figure 2.2 – Current Land Use in the JAAP Area

London Southend Airport is situated in the central eastern part of the JAAP area and occupies approximately 125ha. The airport is comprised of a runway, flying club strip, Runway End Safety Area (RESA) and buildings associated with the terminal and Maintenance Repair and Overhaul (MRO) facilities.. The airport served approximately 44,000 passengers in 2008¹, with 92.5% of all air traffic being commercial in nature¹.

There are also residential areas to the south and north of the JAAP area, and industrial estates / business parks in the west and south (Aviation Way and Laurence Estate).

2.1.3 Physical Site Characteristics

Topography

The majority of the JAAP area is relatively flat, but elevations do range from 18m AOD in the southwest, to 5m AOD in the northeast. Further topographic information can be provided in the form of Light Detection and Ranging (LiDAR) data, which is discussed later in this report.

Waterbodies

Figure 2.3 highlights the watercourses that are present within or near the JAAP area. There are three brooks which flow within the site itself and one immediately to the east. The Eastwood Brook has a mainly urban catchment. It enters the development area to the south of Aviation Way Business Park and flows northeast along the western boundary of the airport to the confluence with the Rayleigh Brook in the grounds of the Rochford Hundred Golf Club. The Rayleigh Brook has a more rural upstream catchment. It enters the site immediately north of the old brickworks and flows east to join the Eastwood Brook north of the airport. At their confluence, the two tributaries join to become known as the Hawkwell Brook, which then flows through a fishing lake in the north east corner and out of the development area, around the south of Rochford town centre. This then flows into the River Roach approximately 400m to the east of the site boundary.

There is a fourth tributary of the River Rother. The Prittle Brook flows in a northerly direction along the eastern boundary of the development area. The southeast part of the airport drains to Prittle Brook as it flows immediately east of the site.

Parts of the development area are within the fluvial floodplains of these watercourses and are therefore at risk of fluvial flooding. All the watercourses are located upstream of the tidal boundary of the River Rother in Rochford.

In addition, many of the agricultural fields within the development area contain drainage ditches along their margins. Water levels within these ditches are quite low, with highly fluctuating flows.

Licensed water abstractions within the development area include Rochford Hundred Golf Club and Tabor Farm Ltd, both for spray irrigation. There are several surface water discharge licenses relating to the airport and industrial site, and to both the Eastwood Brook and the Prittle Brook (Ref. 5).

Geology

A high-level geological assessment using the British Geological Survey (BGS) of England and Wales map sheets 258 / 259 Southend and Foulness was undertaken. The bedrock geology is comprised of the Thames Group (previously known as London Clay) of clays, silts, sands and gravels. This is overlain by loam (River Brickearth) and buried channel

¹ UK Airport Statistics, CAA, 2009
<http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&pageid=3&sqlid=3>

deposits. Superficial sand and gravel river terrace deposits associated with the existing alignment of the River Roach are found in the north and west of the development area.

This map-based assessment was complimented by borehole data obtained from the National Geological Records Centre of the BGS. A number of boreholes in and around the development area have been analysed in the last 50 years, from which a selection of 5 were obtained from the BGS for this report. Figure 2.3 shows the location of these 5 boreholes, while Figure 2.4 illustrates the results. Full borehole results are provided for information in Appendix A.

London Clay has a low permeability and is classified as a Non Aquifer by the Environment Agency. The superficial sand and gravel deposits in the areas close to the watercourses are of higher permeability and are classified as Minor Aquifers. The development area is not located in a groundwater Source Protection Zone (SPZ), as defined by the Environment Agency. The implications of the geology of the development area are considered later in this document.

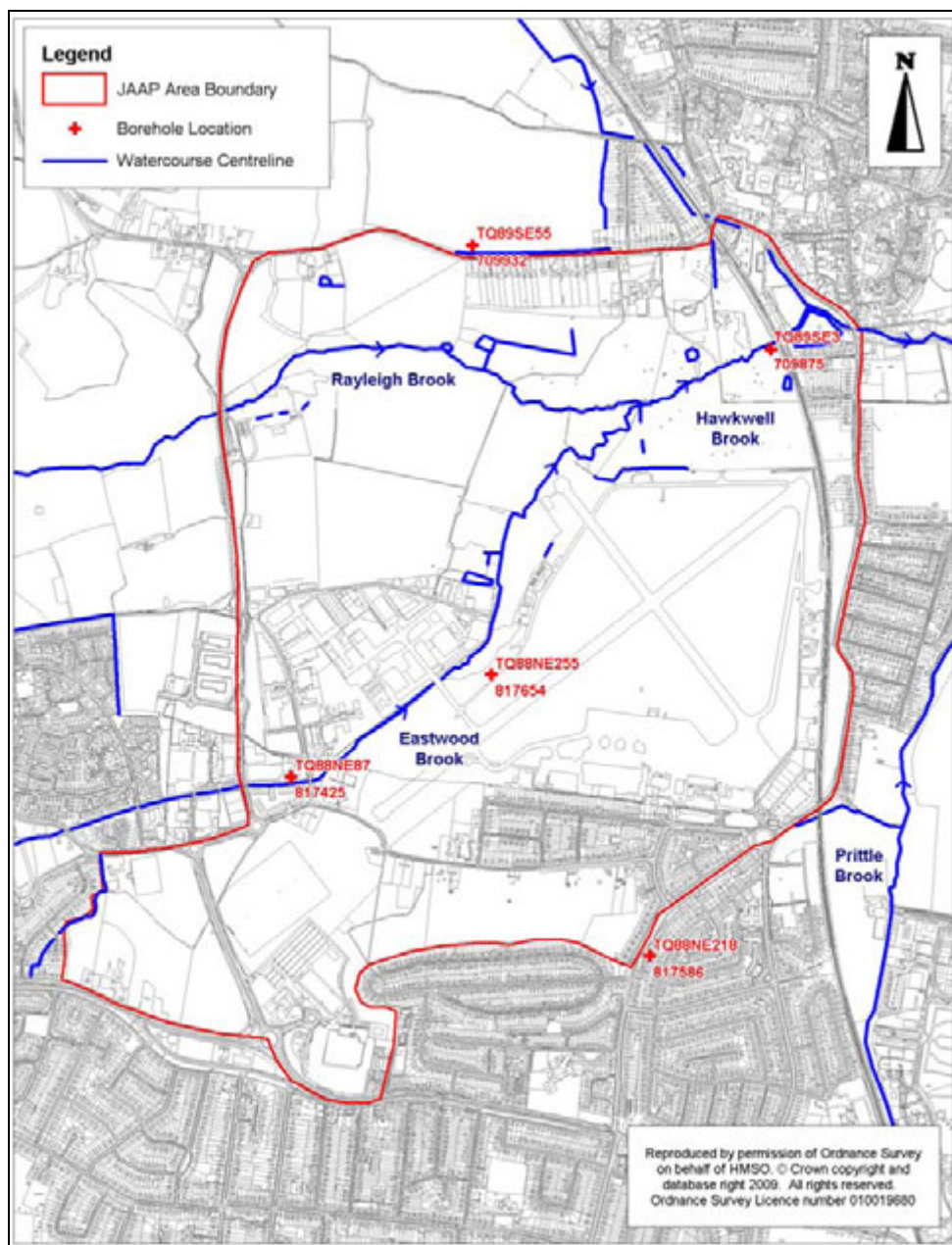


Figure 2.3 – Location of Waterbodies and Selected Boreholes

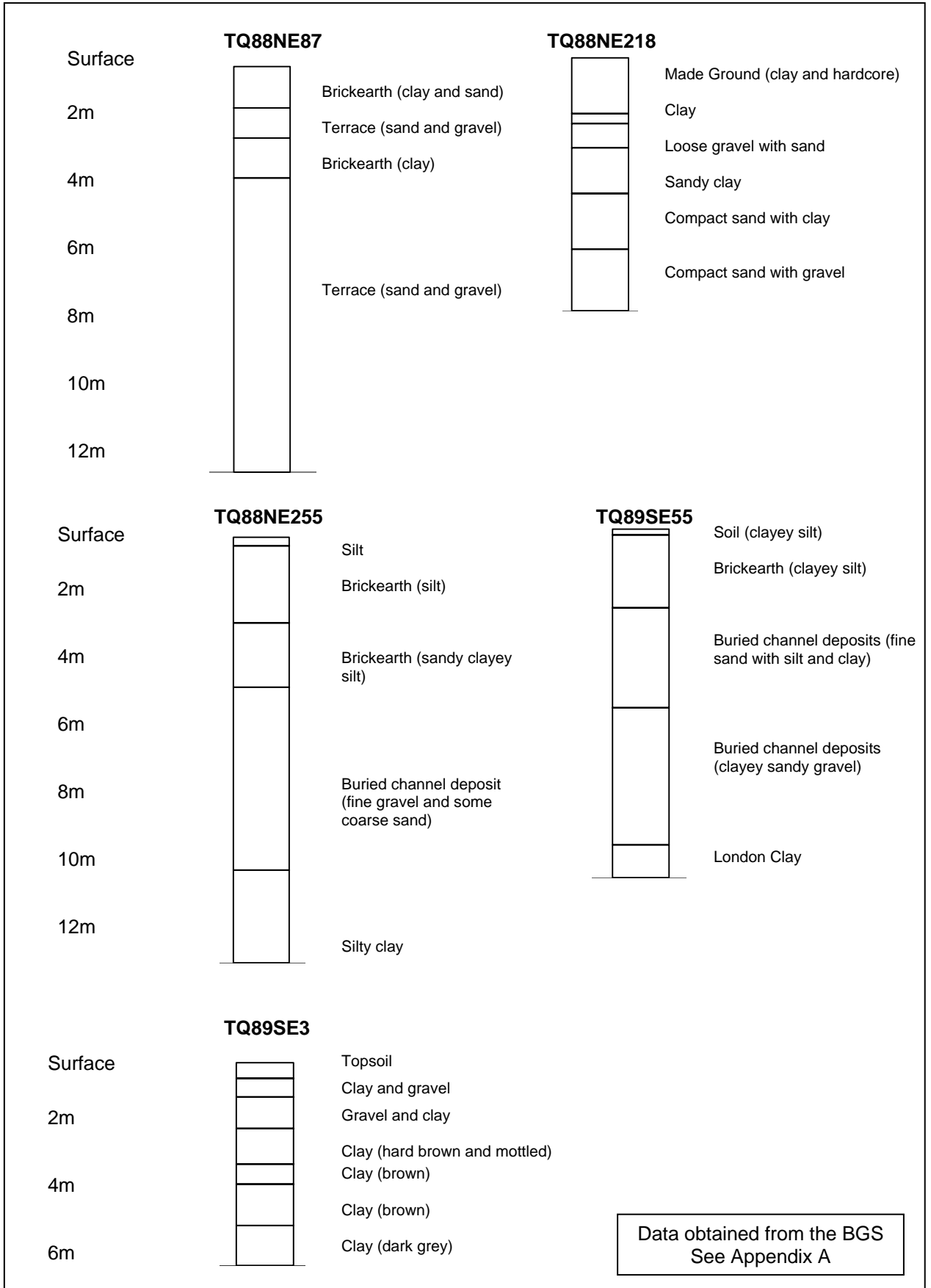


Figure 2.4 – Illustrative Summary of Selected Borehole Records

2.2 Development Proposals

A Joint Area Action Plan (JAAP) has been prepared by Rochford District Council and Southend-on-Sea Borough Council for the area including and surrounding London Southend Airport. Area Action Plans are a type of planning document that target areas with the potential for significant change and conservation. They aim to integrate land use, transport and regeneration proposals with clear mechanisms for delivery. The London Southend Airport & Environs JAAP will establish planning policies and provide the basis for coordinating the actions of a range of partners with an interest in this area until 2021.

The preparation of the JAAP document is in accordance with the Planning and Compulsory Purchase Act 2004, which allows for the preparation of a Development Plan Document (DPD) by two or more local authorities. In this case, council collaboration was required as the council boundary runs through the centre of the development area.

There have been a number of different stages in the JAAP preparation process. These are schematically represented in Figure 2.5.

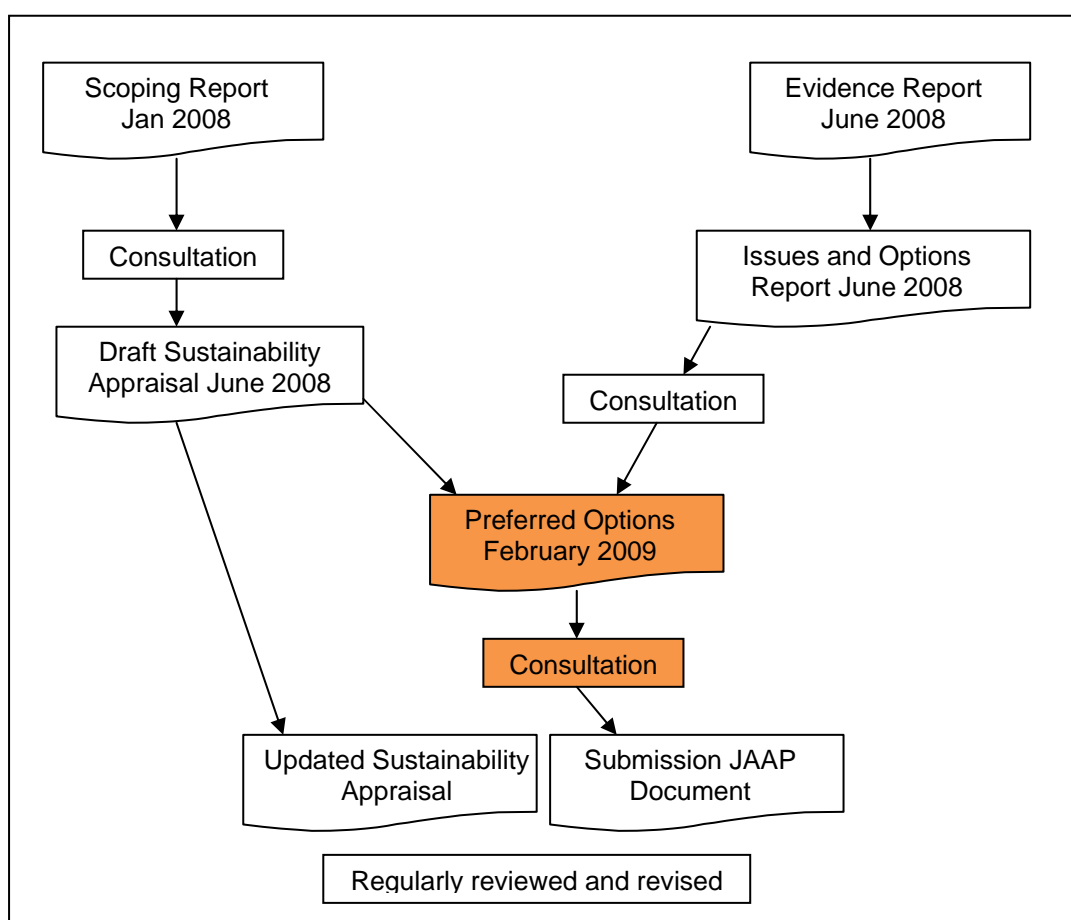


Figure 2.5 – Schematic Representation of the JAAP preparation process

A scoping report was completed in January 2008. This identified programme and sustainability issues and objectives, collected baseline information and developed a framework for assessing the suitability of the plan. In June 2008, an Evidence Report and an Issues and Options report were published. These provided further information about the site, stated the vision and objectives for the area and identified the key issues and likely development constraints. The Issues and Options report lists the key issues as being:

- Southend Airport – opportunity to provide new facilities and expand the runway.
- Employment – growth possible through the intensification of current employment land and the allocation of new land for employment purposes.
- Environmental Enhancement – potential to revise Greenbelt boundaries, enhance open spaces and mitigate undesirable environmental impacts of development.
- Transport and Movement – appropriate transport strategy required.
- Area for Change – opportunities for (re)development exist on vacant and under-utilised sites, re-designated Greenbelt land and reorganised airport areas.

The report identifies fourteen ‘areas of change’ (shown on Figure 2.6) and describes four potential development scenarios, as follows:

- Scenario 1: Low growth – limited investment in the airport and employment growth contained within existing areas. Few transport improvements and no environmental enhancements.
- Scenario 2: Medium employment-focused growth – limited airport investment, intensification of existing employment areas and provision of a new business park. Limited residential infill on the old brickworks site and some environmental enhancements.
- Scenario 3: Medium airport-focused growth – existing runway maintained but new airport facilities added and aviation-related employment growth. New transport infrastructure, residential infill and local recreation and amenity improvements.
- Scenario 3: High growth – extended runway and new / improved airport facilities. Business park extension / creation, mixed use development, environmental improvements and a wider transport strategy.

The various issues and options were assessed in the accompanying Sustainability Appraisal. Strategic fit was found to increase with the increase in proposed development. This means that scenario 3 with the dual focus on airport and general employment growth is assessed as having the strongest strategic fit.

The Issues and Options report outlined above was issued for consultation and the feedback received used to prepare the Preferred Options report for future development in the area. The high growth scenario (3) was chosen as the preferred option for the area as a whole. The preferred option for development in each ‘area of change’ is illustrated on Figure 2.6. While the JAAP covers a total area of 390 hectares, only 165 hectares (42%) is proposed for development. Table 2.1 breaks the proposal down into approximate areas allocated for each development type.

Development Type	Area (hectares)
Airport MRO	28
Airport facilities (including terminal)	3
Runway extension and RESA	16
Employment	71
Open Space	48

Table 2.1 – Approximate areas proposed for each development type

The Environment Agency responded to the existing JAAP proposals. Their response is included in Appendix B and discussed later in this document. Following consultation on the Preferred Options report, the final stage in the plan preparation process will be a submission document. Once adopted, this will be regularly reviewed and revised as necessary.

Later in this document, flood risk constraints are highlighted as being important factors for consideration at all further stages of the progression of the proposed development. This flood constraints report therefore aims to provide information and advice with respect to flood risk in the development area. Its findings should be used to inform future stages of the development planning process. The study can also provide valuable background information for use in the production of detailed Flood Risk Assessments (FRA) that will be required to support specific planning permission applications in the future.

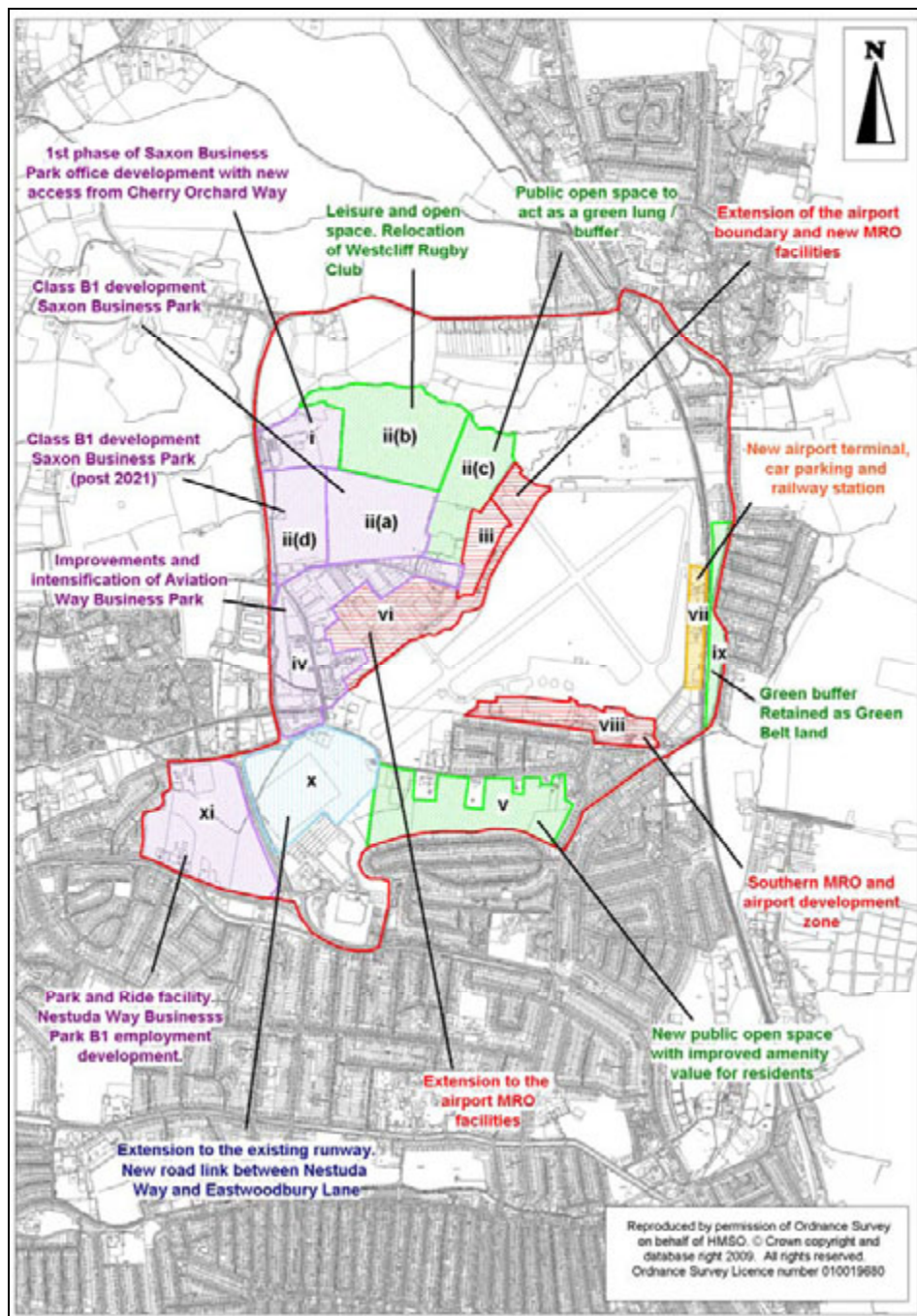


Figure 2.6 – JAAP Preferred Options – Areas of Change

3. Planning Policy and Flood Risk

3.1 Planning Policy Statement 25

Planning Policy Statement 25 (PPS25; Ref. 1) was published in December 2006 and sets out Government policy on development and flood risk. The aim of the policy is to ensure that flood risk is taken into account at all stages of the planning process, to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. PPS25 also aims to ensure that development does not increase flood risk elsewhere and where possible, acts to reduce overall flood risk. Early adoption of the principles set out in PPS25 during the development of local development documents can ensure that detailed designs at later stages take due account of the importance of flood risk and include appropriate mitigation of risks.

3.1.1 Sequential Test

PPS25 details a Sequential Test which classifies proposed development into one of four flood risk zones. These zones are summarised in Table 3.1.

Flood Zone	Annual Probability of Flooding (%)	Equivalent Return Period (years)
1. Low Probability	Fluvial and Tidal <0.1%	> 1000
2. Medium Probability	Fluvial 0.1-1.0% Tidal 0.1-0.5%	1000-100 1000-200
3a. High Probability	Fluvial > 1.0% Tidal >0.5%	<100 <200
3b. The Functional Floodplain	Fluvial and Tidal >5.0% Or, areas which are designed to flood during an extreme (0.5%) flood, or another probability agreed between the LPA and the EA. ²	< 20

Table 3.1 – Summary of PPS25 Sequential Test

PPS25 specifies that the suitability of all new development in relation to flood risk should be assessed by applying the ‘Sequential Test’. The application of the ‘Sequential Test’ should demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or the land use proposed.

The ‘Sequential Test’ gives preference to locating new developments wherever possible in Flood Zone 1 (Low Probability). If there are no reasonably available sites in Flood Zone 1, the flood vulnerability of the proposed development should be taken into account when locating development in Flood Zones 2 and then Flood Zone 3. Flood Zone 3 can be further sub-divided into Flood Zones 3a and Flood Zone 3b, where Flood Zone 3b represents the portion of Flood Zone 3 where water regularly has to flow or is stored during flood events. The Environment Agency does not provide data to subdivide Flood Zone 3 in this way. The functional floodplain is instead defined using available detailed flood risk information often produced through a Strategic Flood Risk Assessment (SFRA).

² The definition of the functional floodplain is currently out to consultation (Ref. 14). The proposed revision includes advice to use the 1 in 20 year outline as a starting point, but make allowances for local circumstances based on knowledge of flooding mechanisms. The revision aims to provide clarification while also increasing flexibility.

PPS25 provides guidance on assessing the vulnerability of land uses in relation to flood risk and classifies new developments into one of five categories:

- Essential Infrastructure
- Water Compatible
- Less Vulnerable
- More Vulnerable
- Highly Vulnerable

PPS25 provides guidance on the compatibility of each land use classification in relation to each of the Flood Zones as summarised in Table 3.2.

	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test required	✓	✓
Zone 3a	Exception Test required	✓	✗	Exception Test required	✓
Zone 3b	Exception Test required	✓	✗	✗	✗

Table 3.2 – Flood Risk Vulnerability Classification (Source: PPS25)

Key:

- ✓ Development is appropriate
- ✗ Development should not be permitted.

3.1.2 Exception Test

Following application of the Sequential Test, if a development that is consistent with wider sustainability objectives cannot be located in a low probability flood zone, the Exception Test can be applied. There are three conditions which must be fulfilled before the Exception Test can be passed. These conditions are as follows:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment (SFRA) where one has been prepared. If the Local Development Document (LDD) has reached the 'submission' stage the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal (SA);
- The development must be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and
- A site-specific Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

3.1.3 Implications for the JAAP Area

Southend-on-Sea Borough Council and Rochford District Council have worked in collaboration to produce a JAAP to reflect the scale and impact of the proposed redevelopment. As part of this process, a separate application of the Sequential Test (Ref. 13) has been undertaken and is summarised here.

To pass the Sequential Test, there is a need to demonstrate that there are no reasonably available alternative sites, with a lower probability of flooding, that would be capable of meeting

the employment requirements of the JAAP area. Potential sites identified in the Employment Land Reviews for Rochford and Southend were assessed using the following criteria:

- Flood risk.
- Access to the strategic transport network.
- Attractiveness to high-tech end users and location with respect to the airport.
- Location in a predominantly non-residential area, where the scale and character of the proposal would not conflict with the living conditions of existing residents or the character of the surrounding built environment.
- Sufficient size to accommodate the proposed development.
- Realistic site availability.

Application of the Sequential Test demonstrated that none of the alternative sites located in Flood Zones 1 or 2 met all the planning, land and operational criteria for the development proposed for the JAAP area. The principle reasons for this included:

- Inappropriate location for airport related uses.
- Poor access to primary route networks and rail services.
- Uncertainty about site assembly.
- Low value, secondary locations not suited to high-tech business use.

The assessment of sites in Flood Zone 3 identified two locations with the potential to meet the JAAP objectives. However, both are located in an area identified in the SFRA as being at risk of tidal flooding following a breach in defences, with hazard classified as ‘high’, and consequently have been discounted.

The application of the Sequential Test has therefore demonstrated that there are no reasonably available sites elsewhere in Rochford or Southend that are at a lower risk of flooding and meet the planning and operational requirements of the JAAP area.

The summary of assessment findings detailed above refers to the application of the Sequential Test for the development area as a whole. There is however, also a need to sequentially test within the JAAP area. While a majority of the area falls within Flood Zone 1, there are some sites that are at a higher risk of flooding. To pass the Sequential Test, site layout should be planned according to the risk of flooding and the relative vulnerability of the specific components of the development.

Table 3.3 classifies the proposed new development into one of the five available categories and summaries flood zone compatibility as stated in Table 3.2.

Vulnerability Classification	Development Type	Flood Zone Compatibility
More Vulnerable	Residential Hotel	Development appropriate in Flood Zones 1 and 2 but not 3b. Exception Test required for 3a.
Less Vulnerable	Employment land / offices Airport MRO and terminal Railway station Car parking / Park and Ride	Development appropriate in Flood Zones 1, 2 and 3a but not 3b.
Water Compatible	Leisure and open space Runway End Safety Area (RESA)	Development appropriate in all Flood Zones.

Table 3.3 – Development flood risk vulnerability and flood zone ‘compatibility’

At the planning stage, all attempts to restrict vulnerable development to Flood Zone 1 should be sought, possibly by substituting areas of development currently located in areas at risk of flooding with water-compatible open space currently designated elsewhere in the JAAP area. This would lead to the creation of river corridors that make space for water and provide additional biodiversity and amenity benefits.

Other constraints however, such as the need to reduce the impact on the existing greenbelt or Metropolitan Open land and the need for peripheral development of airport activities, may mean that flood risk avoidance is not entirely possible whilst meeting the aims of the wider development. The majority of the proposed development is classified as 'less vulnerable' and according to PPS25, this is appropriate in Flood Zones 2 and 3a, without the need to satisfy the Exception Test. The Exception Test would be required if the residential or hotel developments were located in Flood Zone 3a, but the preferred option currently locates these development in areas of low flood risk.

4. Assessment of Flood Risk

4.1 Sources of Flooding

4.1.1 Overview

Annex C of PPS25 outlines the different forms of flooding which should be considered as part of development proposals for all sites. The significance of each of the sources depends on the geography of the site. Table 4.1 describes these sources and indicates whether the risk is a relevant constraint within the JAAP area. Importantly, those sources of flood risk that are not highlighted as a constraint for further discussion in this document should still be addressed in individual Flood Risk Assessments (FRA) submitted alongside planning applications for individual development sites. At this level of study however, they are not considered to be significant constraints on the emerging development proposals.

Source of Flood Risk	Description	Site Constraint	Details
Flooding from Rivers (Fluvial)	Flood water directly conveyed by a nearby watercourse when the volume of water exceeds the capacity of the river channel.	✓	In those areas adjacent to watercourse, fluvial flood risk is likely to pose a significant constraint. Further details provided below.
Flooding from the Sea (Tidal)	Flooding caused by high tides, storm surges and wave action (often in combination)	✗	The site is located upstream of the River Rother tidal boundary and is approximately 4km from the Thames Estuary. The risk of tidal flooding is therefore not considered to constrain development.
Flooding from Land (surface water)	Intense rainfall which exceeds the available infiltration / drainage capacity, resulting in surface water runoff.	✓	Management of surface water likely to be a significant constraint. Further details provided below.
Flooding from Groundwater	Raised groundwater on the land surface following prolonged rainfall.	✗	No evidence to suggest it could constrain development. Given the proximity of local watercourses, it could be expected that groundwater table is shallow. Groundwater flooding should be considered in any future site-specific FRAs.
Flooding from Sewers	Exceedence of sewer capacity or flooding caused by blockages in the sewer network.	✗	Since the majority of the development area is either existing open land or associated with the airport, new development will require investment in new foul and surface water drainage systems, designed according to best practice, to avoid increasing flow rates into existing sewers/watercourses. Surface water flooding is considered separately in this document.
Flooding from Infrastructure Failure	Flooding caused by the failure of man-made structures which store or convey water, such as reservoirs and canals.	✗	There are no man-made structures in the vicinity of the development area that could breach and / or fail and cause flooding. This is not considered to be a constraint, but should be reviewed in site-specific FRAs.

Table 4.1 – Sources of Flooding

4.1.2 Fluvial Flooding

The Environment Agency publishes a national flood risk dataset for England and Wales on their website. This dataset is known as the ‘Flood Map’ and includes the Flood Zones designated in PPS25.

Figure 4.1 is an extract from the Environment Agency map and shows the location of the proposed development site in relation to the Flood Zones. The map indicates that large areas in the vicinity of the Eastwood and Rayleigh Brooks are considered to be at risk of flooding. Approximately 9% of the whole site is within Flood Zone 3 and is therefore classed by PPS25 as having a high probability of flooding (>1% annual probability). A further 10% of the site is within Flood Zone 2 and has a medium probability of flooding (0.1-1% annual probability). When considering only the areas of change proposed for development (165ha), 21ha (13%) lies in Flood Zone 3 and a further 13ha (8%) in Flood Zone 2.

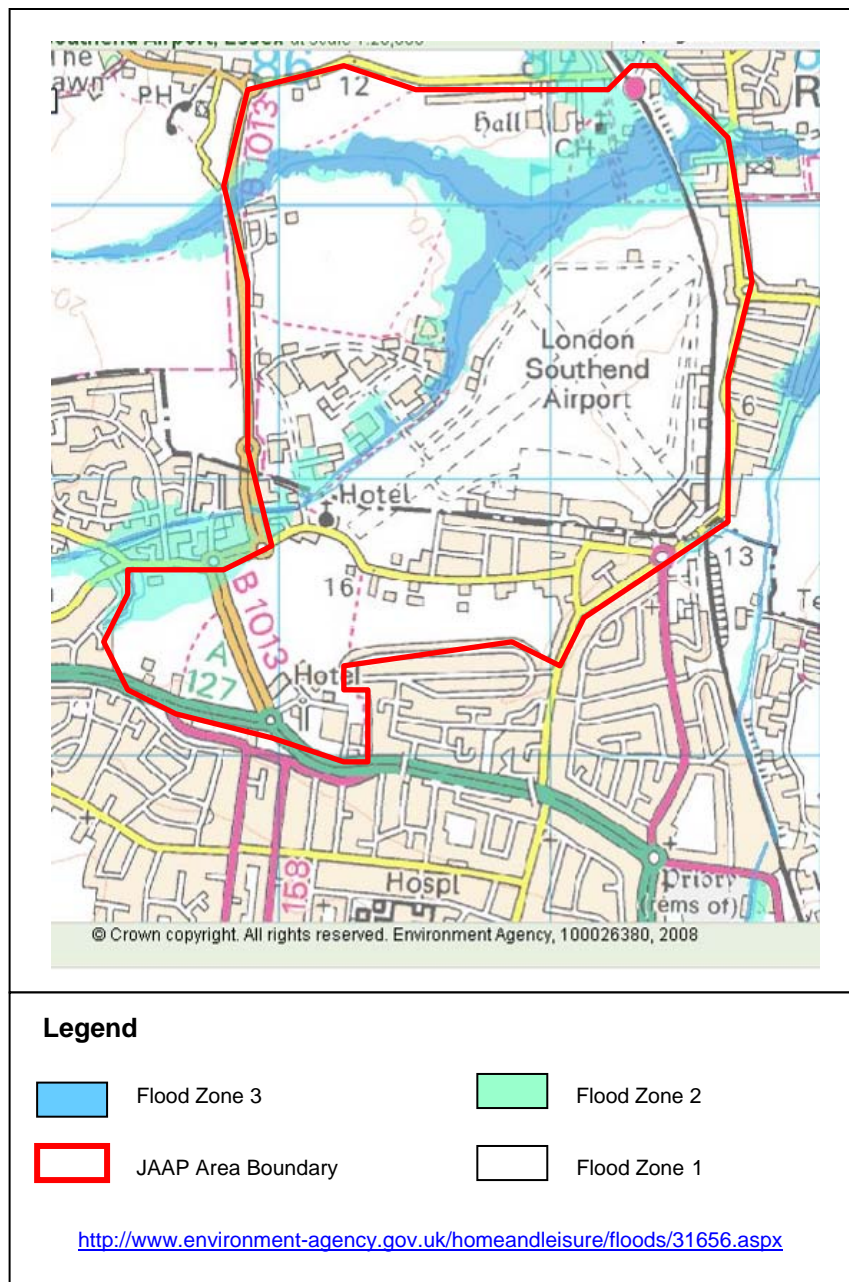


Figure 4.1 – Extract from the Environment Agency Flood Map

The risk of fluvial flooding originating from both the Eastwood and Rayleigh Brooks has the potential to constrain development on the site. All individual developments whose boundaries fall partially or wholly within Flood Zones 2 and 3 (3a/3b) will require a detailed FRA to accompany an application for planning permission. This document presents detailed information on flood risk, obtained from the Environment Agency, and makes recommendations as to how fluvial flood risk can be avoided or, where necessary, mitigated.

4.1.3 Surface Water Flooding

Surface water flooding occurs when intense rainfall exceeds the available infiltration capacity and/or the urban drainage capacity of an area, resulting in surface water runoff.

Impermeable urban areas act to increase both the rate and volume of surface water runoff into drainage ditches and river systems. There is also the risk that intense rainfall exceeds the capacity of urban drainage systems, leading to overland flow and surface water flooding. This risk is exacerbated when blockages prevent water from entering the drainage system. Any changes in the size and type of the development area have the potential to impact on this source of flooding. Therefore, any development proposals will have to carefully consider the likely impact on surface water flows and how these can be managed sustainably to ensure no increase in flood risk both to the development and from the development to neighbouring areas.

All individual developments greater than 1 ha are required to have a Flood Risk Assessment that accompanies applications for planning permission and details how surface water will be managed for the proposed development. Given the size of the JAAP area and the magnitude of the likely development proposals, it is recommended that a drainage strategy is developed for the JAAP area. This strategic study should identify how individual developments within the development area can be drained in collaboration with nearby sites, to ensure a holistic and sustainable drainage system is provided for this large future development area, in line with the requirements of PPS25.

PPS25 states that opportunities to reduce rates and volumes should always be sought wherever possible. Sustainable Urban Drainage Systems (SUDS) comprise of a range of techniques that offer a way to manage surface water flows. In the case of the proposed development area, significant SUDS features are likely to be required in order to meet the Environment Agency requirement that the development proposals cannot increase the rates and volumes of surface water runoff generated by the development area. This will be considered in more detail in subsequent sections of this report.

4.1.4 Groundwater Flooding

At present, no information is available to assess the likelihood of groundwater flooding affecting the development area, nor has any evidence been presented to suggest that existing buildings in the area have been affected by groundwater flooding. As such, groundwater is not assessed as a constraint on development layout in this document. Nevertheless, given the proximity of local watercourses, it could be expected that groundwater tables in the area are shallow. Groundwater flooding should therefore not be ruled out and should be considered in any full FRA carried out within the development area.

4.1.5 Flooding History

The Environment Agency confirmed that their records show that parts of the development area flooded in 1968 and that the “Eastwood Brook catchment is particularly prone to flash flooding” (EA consultation – see Appendix C). However, no further details were obtained, with the records only showing flooding to the land and not necessarily internal property flooding. Little more is known about the flooding history of the JAAP area, with no details included in the Strategic Flood Risk Assessment (SFRA) (Ref. 3). More details on the SFRA are provided later in this section.

4.2 Available Data

As part of this flood constraints study, further flood risk data was obtained from the Environment Agency to increase the understanding of flood risk to the JAAP area. The Environment Agency

response is provided in Appendix C and the flood risk information in Appendix D. The data provided included:

4.2.1 Flood Extents

The Flood Map shown in Figure 4.2 indicates the likely risk of flooding in the JAAP area. Under Section 105 of the Water Resources Act (1991), the Environment Agency was given responsibility to provide general supervision for all matters relating to flood defence in England and Wales. As part of this role, the Environment Agency undertook a programme of flood risk mapping for all main rivers. This programme involved the development of catchment hydraulic models to derive flood extents that defined the Flood Zones, but also took into account the level of protection provided by flood defences.

The Environment Agency has provided a flood extent map (Figure 4.2) for the development site relating to fluvial flooding from the Eastwood, Rayleigh and Hawkwell Brooks. This map is provided in Appendix D. Whilst in some cases, the Environment Agency are able to provide more detailed revised flood extents for individual sites, in this instance, there is no apparent difference between the Flood Zone extents on the detailed map provided as part of the data request and the standard Flood Map shown on the EA website (Figure 4.1). Figure 4.2 does however provide clearer outlines of the Flood Zones in relation to the individual JAAP areas of change. There are no areas benefiting from defences within the development area.

This flood map was derived from hydraulic modelling of the Rayleigh Brook (referred to on the map as the Noblesgreen Ditch), the Eastwood Brook and the River Roach. The node locations for this modelling are shown in Figure 4.3 and Figure 4.4.

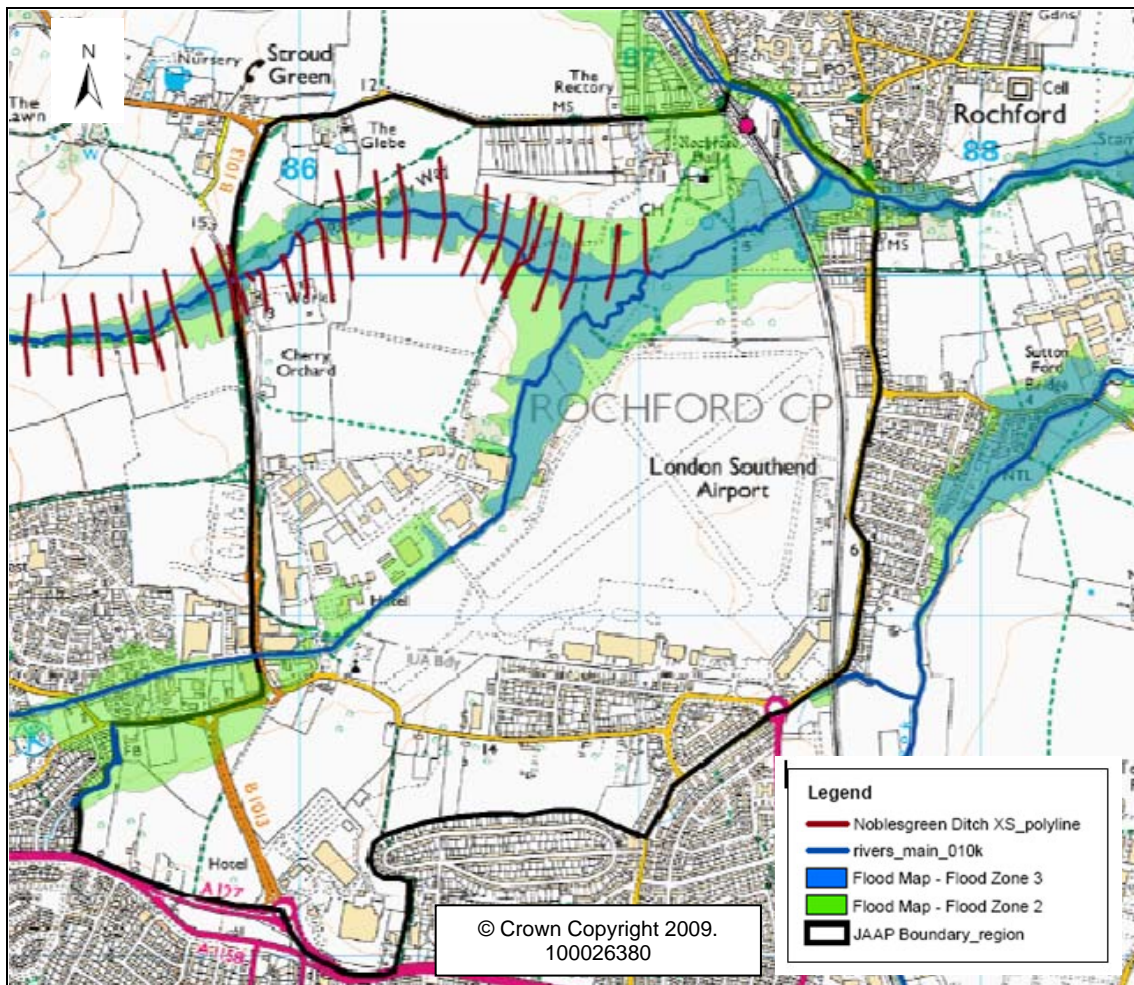


Figure 4.2 - Extract from the Environment Agency Detailed Flood Map

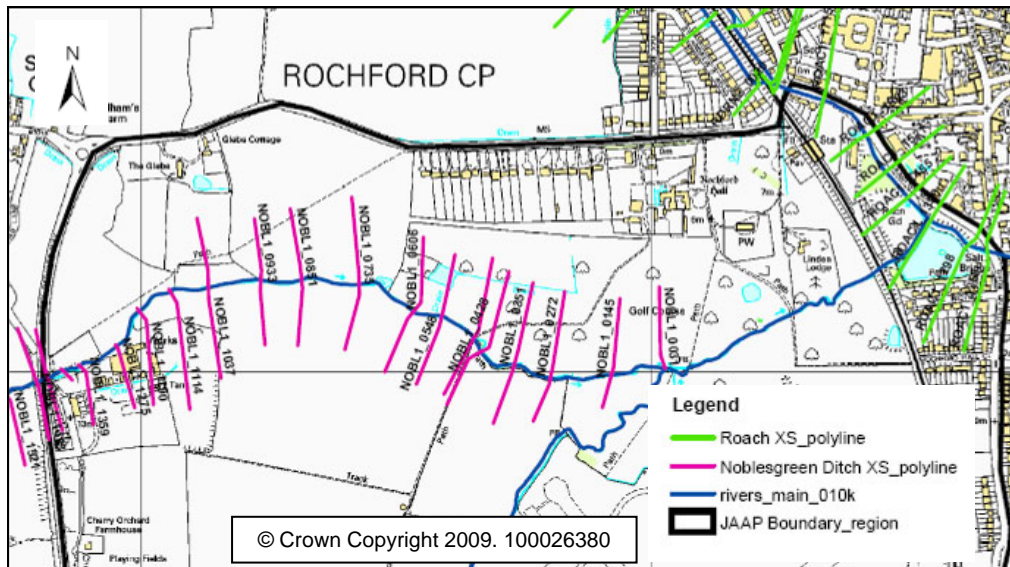


Figure 4.3 - Environment Agency Node Location Map – Rayleigh Brook

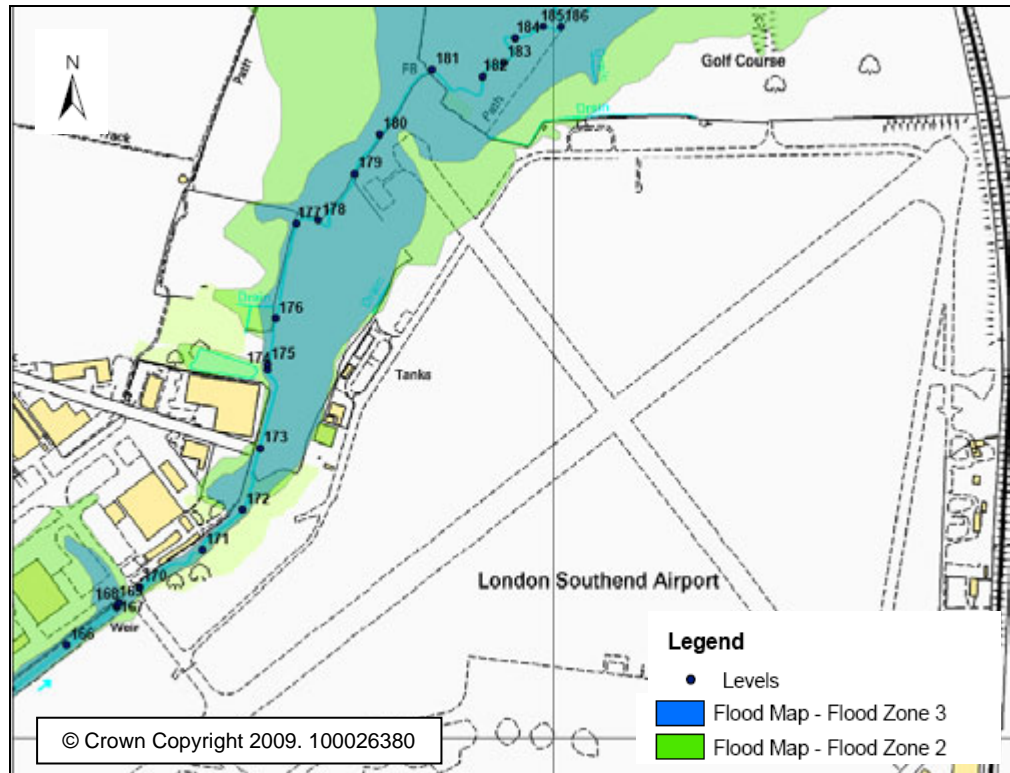


Figure 4.4 - Environment Agency Node Location Map – Eastwood Brook

This flood constraints study has only established that hydraulic modelling for the two Brooks exists. Subsequent studies may need to review and modify the models to refine the Flood Zones in the JAAP area. Any such development of a hydraulic model should be carried out following consultation with the Environment Agency so that the modelling approach can be approved and the results utilised in site-specific FRAs.

4.2.2 Flood Levels

The Environment Agency has provided a range of flood levels derived from hydraulic modelling of the Rayleigh Brook and Eastwood Brook. Table 4.2 details the Rayleigh Brook flood levels at nodes close to which vulnerable development (the business park in area i) is proposed. It is not specified whether the levels provided include an allowance for climate change. It should therefore be assumed that an additional increase in these flood levels is to be expected over the lifetime of the development. This may require additional modelling for site-specific FRAs.

Model Node	1 in 10	1 in 20	1 in 50	1 in 100	1 in 1,000
NOBL1_1359	11.376	11.399	11.431	11.457	11.557
NOBL1_1275	10.560	10.594	10.653	10.715	10.879
NOBL1_1190	10.019	10.105	10.250	10.392	10.587
NOBL1_1114	9.831	9.956	10.225	10.300	10.431
NOBL1_1037	9.489	9.596	9.835	9.895	10.173

Table 4.2 – Fluvial flood levels (in mAOD) for the Rayleigh Brook

Table 4.3 details the Eastwood Brook flood levels at nodes close to which vulnerable development is proposed (business park improvements in 'area iv' and the airport MRO in 'area iii' and 'area vi'). These include an allowance for climate change on top of the 1 in 100 year flood level.

Model Node	1 in 20 (5%)	1 in 75 (1.33%)	1 in 100 (1%)	1 in 100 + Climate Change	1 in 1000 (0.1%)
166	10.34	10.68	10.74	10.88	11.14
167	10.25	10.61	10.69	10.83	11.10
171	9.17	9.25	9.26	9.36	9.58
172	8.99	9.05	9.06	9.13	9.39
173	8.69	8.74	8.75	8.81	9.03
174	8.31	8.34	8.35	8.39	8.57
176	8.08	8.11	8.11	8.15	8.31
177	7.68	7.71	7.72	7.76	8.22
179	7.40	7.46	7.48	7.50	8.22
180	7.15	7.17	7.17	7.33	8.22

Table 4.3 – Fluvial Flood Levels (in mAOD) for the Eastwood Brook

In the absence of topographic data (see Section 4.2.4), no assessment of flood depth and hazard is possible as part of this study. Future FRAs will need to obtain this information to enable a more complete assessment of flood risk on individual sites. The modelled flood levels should also be used when setting ground floor levels, to ensure development safety (see Environment Agency planning advice in Section 4.3.2).

4.2.3 Flood Flows

The Environment Agency additionally provided flood flows derived from the hydraulic modelling of the Eastwood Brook. An extract of this data can be found in Table 4.4 and the full data set in Appendix D.

Model Node	1 in 20 (5%)	1 in 75 (1.33%)	1 in 100 (1%)	1 in 100 + Climate Change	1 in 1000 (0.1%)
166	7.91	9.27	9.60	11.50	23.90
167	7.93	9.30	9.62	11.54	23.93
171	7.94	9.32	9.63	11.56	23.94
172	7.97	9.34	9.66	11.59	23.97
173	7.99	9.37	9.68	11.62	24.00
174	8.01	9.39	9.69	11.64	24.02
176	8.03	9.40	9.69	11.65	24.03
177	8.04	9.39	9.71	11.64	24.04
179	8.02	9.38	9.66	11.66	24.03
180	8.02	9.37	9.66	11.66	24.01

Table 4.4 – Fluvial Flood Flows (m³/s) for the Eastwood Brook

4.2.4 Topographic Data

LiDAR Coverage and Use in this Study

Light Detection and Ranging (LiDAR) topographic data can be purchased from the Environment Agency, who manage a library of data for most areas at risk of flooding in England and Wales. LiDAR data is an airborne survey method using a laser to measure ground elevation, resulting in a good coverage of large areas on the ground, with accuracy within approximately +/- 200mm.

There is complete LiDAR coverage for the development area, with 2m resolution data originating from March 1999. In addition, approximately 10% of the north east part of the site is covered by 25cm resolution data originating from July 2008. This includes the confluence between the Rayleigh and Eastwood Brooks, the Hawkwell Brook, the golf course, small parts of the residential areas and the north east corner of Aviation Way Business Park.

For complete coverage with the 2m resolution data, 10 separate LiDAR tiles are required, with many tiles only covering a small part of the development area. A minimum of 4 tiles for example, would be needed for use in relation to the modelled flood levels obtained for the Rayleigh Brook. This is a large requirement given the limited amount of vulnerable development currently proposed for this location. In light of these observations and given the scope of this study, it was decided not to obtain LiDAR data at this stage. Appendix E includes maps provided by the Environment Agency illustrating the extent of LiDAR information available for the JAAP area at both 2m and 0.25m resolution. This coverage is dated November 2009 and was provided as part of a quotation by the Environment Agency Geomatics Group (01225 487637 / ARCHIVED-LIDARDATA@environment-agency.gov.uk).

Advice for Future FRAs

The use of the 2m and / or the 25cm resolution LiDAR data should, however, be considered as necessary when preparing more detailed site-specific FRAs. The elevation of the development sites should be compared to the 1 in 100 and 1 in 100 climate change flood levels. This would enable a calculation of flood depth at various locations and highlight those areas most at risk of fluvial flooding. Knowledge of flood depths and velocities should then be used to calculate the Flood Hazard Rating and the corresponding Hazard to People Classification (Ref. 8). This is necessary to show that the safety requirements of PPS25, detailed by the Environment Agency in correspondence, can be met at each development site.

4.2.5 Strategic Flood Risk Assessment

The Thames Gateway South Essex Strategic Flood Risk Assessment (SFRA) (Ref. 3) provides publicly-available information on flood risk in the development area and its surroundings. The predominant concern of the assessment is tidal flooding from the River Thames and the North Sea, but the location of the airport site means that this is not a risk in the development location. The SFRA contains limited information on other sources of flooding, with no information about surface water or groundwater flood events in the area. The SFRA states that these risks should instead be addressed at a local scale, and this will be done using information obtained from the Environment Agency.

The SFRA has area-specific appendices which provide more detail on fluvial flood risk. Appendix D (Rochford) describes the tributaries of the River Roach, including the Eastwood Brook and the Rayleigh Brook. Both are noted to pose a fluvial flood risk to the surrounding area, with a documented flood event in 1968. Appendix E (Southend) describes the flood defence scheme that took place in the 1960s, designing to a 1 in 100 standard of protection. A reassessment in the year 2000 however, suggested that standards of protection are now lower than this.

Chapter ten of the SFRA discusses Sustainable Urban Drainage Systems (SUDS) as the preferred method for managing surface water run-off generated by development sites. These systems act to reduce flood risk while helping to reduce pollution and provide landscape and wildlife benefits. The document outlines different options and the factors that should be considered when planning drainage systems. There are however no recommendations for post-development run-off rates or constraints.

4.3 Consultation with the Environment Agency

4.3.1 Responses to the JAAP Documents

The Environment Agency was consulted following the publication of both the 'JAAP Issues and Options' and the 'JAAP Preferred Options'. A copy of their full response is included in Appendix B. Comments and objections to the two documents relevant to development and the water environment can be summarised as follows:

- The objective of ensuring a high quality environment should be expanded with a broader definition of the environment, including flood risk reductions, improved water quality and enhanced green space and biodiversity.
- The documents omit a discussion of water use, quality, disposal and surface water runoff. Development plans will require a detailed drainage strategy that deals with these issues. Greater emphasis should be put on managing demand for water as well as more efficient use of water, for example through rainwater harvesting and water re-use schemes.
- Where possible, the discharged water quality should be improved compared with the current baseline standard. Water quality considerations are important given the opportunity for contamination from the airport and old brickworks site.
- In keeping with the principles of PPS25, any future growth in the JAAP area should be directed away from the flood risk areas, as identified on the EA Flood Zone maps. The EA show concern that proposed development areas on the site fall within Flood Zone 2 (medium risk) and 3 (high risk). The Environment Agency state that the Sequential Test is unlikely to demonstrate that development must be located in these zones when there are other available areas within the site that are in Flood Zone 1 (low risk). If development is deemed to be appropriate, a detailed Flood Risk Assessment (FRA) must demonstrate that the flood risk can be managed and the development is safe, with flood risk mitigation measures incorporated into designs.
- The Environment Agency are disappointed that flood risk in general is given very little consideration, despite the presence of high risk areas. It is also noted that where flood risk has been classified as an environmental issue, this classification has been incorrectly described as medium, instead of high risk.

- Areas that already serve as flood attenuation and storage locations should be safeguarded for this purpose and the opportunities for their use maximised.
- Sustainable Drainage Systems (SUDS) should be included in all developments to manage surface water; reducing flood risk, improving water quality and providing biodiversity benefits.
- Every opportunity should be taken to protect and enhance existing habitats, including water courses / features. The provision and enhancement of river corridors is part of the Thames Gateway South Essex green grid strategy and re-development provides opportunities to reduce flood risk, enhance biodiversity and improve natural processes along the Eastwood and Rayleigh Brooks.

The main development constraint arising from these Environment Agency comments is the requirement for the Sequential Test to be applied to the JAAP area as a whole and on specific sites within the JAAP area. If the Sequential Test is not passed, the Environment Agency is likely to object to the JAAP proposals on the grounds of inappropriate development in an area of flood risk. A separate application of the Sequential Test has been undertaken (Ref. 13) and was summarised in Section 3. While it demonstrated that there are no reasonably available alternative sites in Rochford or Southend, the current preferred option does not always allocate vulnerable development to areas of lowest flood risk within the JAAP area. In light of this, a key recommendation of this study is that the layout of the development proposals be re-visited to ensure that a Sequential Approach is applied within the JAAP area.

4.3.2 Planning Advice

The EA response to the data request also included planning advice with respect to flood risk on the development site. The full response can be found in Appendix C, with a summary of the information below.

Safety Requirements for an FRA

“The FRA must satisfy that the development will be safe in a 1 in 100 year fluvial flood event at the end of the lifetime of the development making allowance for climate change. Lifetime of the development is considered to be 75 years for commercial.”

There are three aspects of safety which should be considered in relation to flood risk, as follows:

- The source and nature of the flood (including frequency, depth, velocity and speed of onset).
- The safety of the people using the development.
- The safety of the buildings.

Buildings should remain safe for all events up to the 1 in 100 year return period. This includes the need for ***“unaided safe access and egress... [for all] occupants and visitors, including those with restricted mobility.”***

To ensure that the inside of buildings remain dry, the Environment Agency state that a 300mm freeboard is to be added to the 1 in 100 year modelled flood level when setting ground floor levels. ***“For single storey dwellings or ground floor flats where there is no safe refuge on an upper floor, then floor levels should be set 300mm above the 1 in 1000 year level.”***

The Environment Agency advises that the following information should be provided in a FRA:

- Flood Hazard (depth and velocity of flood waters).
- Duration of flooding and removal of water.
- Rate of flooding onset and rate of floodwater rise.
- Local flow paths.
- The presence or absence of debris.
- The availability of a safe refuge and provision of key services.
- Availability of effective flood warning capability and an evacuation plan.

In addition, ***“the FRA should provide extent and magnitude of potential flooding (depth and velocity) between the development and local facilities including shops, schools, doctors’ surgeries and buildings etc. likely to be used as places of assembly during flooding.”*** These routes must be shown to have only a very low hazard rating and it is preferable that they remain flood free.

The FRA should include details of up to a 1 in 1,000 year return period flood for the purposes of emergency evacuation and rescue planning.

Compensatory Floodplain Storage

“If any development is proposed within Flood Zone 3 then compensation will be required for any loss of storage within the floodplain.” The Environment Agency provides the following requirements in relation to compensatory storage:

- The required compensation area should be based on calculations of existing floodplain storage volume and loss of available storage due to development.
- New storage should be provided by re-contouring the land.
- Storage must be provided on a direct / level-for-level basis within the outline limits for the return period of interest. This means that the new storage is filled at the same point in the flood event as the lost storage would have done.

Functional Floodplain

PPS25 does not permit development on the functional floodplain unless it is classified as being water compatible. ***“Commercial development is considered to be a less vulnerable development type and according to PPS25 is not appropriate in the functional floodplain.”*** The EA would therefore object to any proposal to locate new development in the ***“area of functional floodplain associated with Eastwood Brook”***.

Surface Water Discharge

The management of surface water at source, utilising SUDS and in particular soakaways, is required, to prevent an increase in flood risk. Development on greenfield areas should discharge surface water at the 1 in 1 greenfield runoff rate. For brownfield areas, the discharge should be no greater than the existing rate, with a return to greenfield rates where possible. Runoff rates should be calculated and provided to the Environment Agency within a site-specific FRA. Storage calculations would then be required to design a storage area to attenuate up to the 1 in 100 year storm event.

The Environment Agency accepts that given the nature of the airport development, other legislation / protocol may have to be worked with in conjunction with PPS25, potentially constraining the SUDS options available on the site.

Culverting of Watercourses

All of the watercourses on site are designated as main rivers. This means that under the terms of the Water Resources Act 1991 and the Anglian Region Bylaws, ***“prior written consent [from the Environment Agency] is required for any proposed works or structures, in, over or within 9 metres of the top of the bank[s].”***

The Environment Agency is generally opposed to the culverting of watercourses because of the disruption to flow (and associated increase in flood risk) and ecological loss that can result. ***“Eastwood Brook catchment is particularly prone to flash flooding and [the Environment Agency] would be unlikely to grant permission to culvert it.”*** The Environment Agency recommends that a bridge is considered instead of a culvert if a crossing of the Eastwood Brook is required as part of the development.

This planning advice needs to be considered at all stages of the development, from informing the preferred options to providing input to the site-specific FRAs and detailed design phases.

4.4 Summary of Flood Risk

This section of the flood constraints study has presented the existing information on sources of flood risk in the area around Southend Airport. The following risks have been identified as key constraints for the proposed development:

- **Fluvial flooding** occurs when the volume of water in a river exceeds the channel capacity and floodwater is conveyed directly from the watercourse to surrounding land. This is a significant development constraint in those areas adjacent to the Rayleigh Brook and the Eastwood Brook, two watercourses that cross the development area. Approximately 9% of the whole site is within Flood Zone 3 and is therefore classified by PPS25 as having a high probability of flooding (greater than 1% annual probability). A further 10% of the whole site is within Flood Zone 2 and has a medium probability of flooding (between 0.1 and 1% annual probability). When considering only the 165ha development area, 8% is in Flood Zone 3 and a further 13% is in Flood Zone 2. In accordance with the sequential approach advocated by the government through PPS25 and the Environment Agency, sites at risk of flooding should be avoided where possible for any development that is not 'water compatible'.
- **Surface water flooding** originates from intense rainfall which exceeds the available infiltration / drainage capacity, leading to high runoff rates and volumes. The addition of new impermeable urban areas during development acts to increase both the rate and volume of surface water runoff into drainage ditches and river systems. Any changes in the size and type of the development area have the potential to impact on this source of flooding. Therefore, any development proposals will have to carefully consider the likely impact on surface water flows and how these can be managed sustainably to ensure no increase in flood risk both to the development and from the development to neighbouring areas. A common way of doing this is through the implementation of Sustainable Drainage Systems (SuDS).

These sources of flooding have the potential to result in objection to the proposed JAAP from the Environment Agency, unless a range of alterations and considerations are incorporated into the emerging development proposals. Options for management of both the fluvial and surface water flood risk are considered in the next two sections.

5. Management of Fluvial Flood Risk

This section outlines potential development solutions for the management and mitigation of fluvial flood risk in the JAAP area and discusses the fluvial flood constraints with reference to the preferred option. Management of the risk posed by surface water is considered separately, in Section 6.

5.1 Mitigation Options

The PPS25 Practice Guide (Ref. 2) advocates the Flood Risk Management Hierarchy as a strategic approach to flood risk management. This is comprised of five stages of management, numbered in the order in which they should take place. The hierarchy is illustrated in Figure 5.1 and outlined in further detail in Table 5.1. Following this hierarchy when planning new development ensures that:

- Flood risks are minimised
- Development is appropriate
- Reliance on traditional engineering methods of risk management are reduced
- Mitigation is a last resort

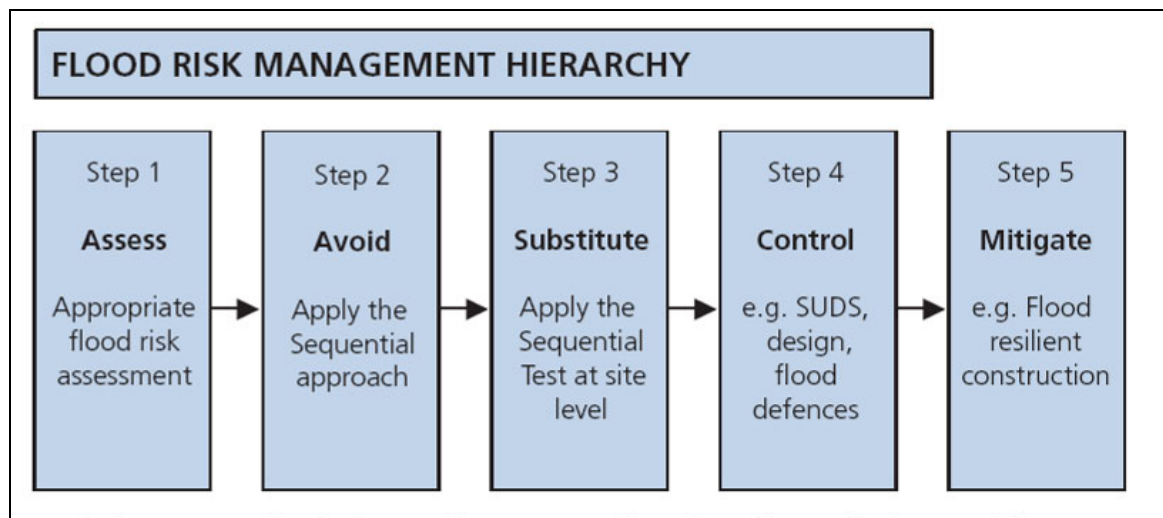


Figure 5.1 – Flood Risk Management Hierarchy Stages (PPS25 Practice Guide, Ref. 2, p.2)

Management Stage	Description of Stage
1. Assess	Undertake studies to collect data at the appropriate scale and level of detail to understand what the flood risk is.
2. Avoid	Allocate developments to areas of least flood risk and apportion development types vulnerable to the impact of flooding to areas of least risk.
3. Substitute	Substitute less vulnerable development types for those incompatible with the degree of flood risk.
4. Control	Implement flood risk management measures to reduce the impact of new development on flood frequency and use appropriate design.
5. Mitigate	Implement measures to mitigate residual risks.

Table 5.1 – Stages of Flood Risk Management

This document represents the first stage in the Flood Risk Management Hierarchy for the JAAP area. There are a number of different development solutions which may be appropriate for consideration in the future development of the JAAP options. In relation to fluvial flooding, these include site layout, building design, modification of ground levels, provision of flood walls and embankments, safe access and evacuation plans and flood resilience measures. These are described in more detail below, in an order that is consistent with the Flood Risk Management Hierarchy.

5.1.1 Development Area Layout

The principle of risk avoidance is the second stage in the Flood Risk Management Hierarchy and must be applied before other management options are considered. Risk avoidance is the underlying principal of the PPS25 Sequential Test as discussed in Section 3.1.1 of this document. Within a large scale development area such as this, it can be realised through consideration of the layout and placement of individual developments and land uses. In an ideal situation, the development should be laid out sequentially, in line with PPS25, to take into account both the risk of flooding and the relative vulnerability of the specific components of development. In fact, proving that risk has been avoided, wherever possible, using an appropriate development layout, is likely to be the most constraining requirement of PPS25 and the Environment Agency with respect to the proposed development at Southend airport.

A total of 19% of the whole JAAP area (390ha) lies within either Flood Zone 2 or 3. However, only 165ha (42%) is being considered for redevelopment. Therefore, taken on first principles, it is clear that there is sufficient land available within the development area to accommodate all the required development without encroaching on areas of high fluvial flood risk.

Due to the location of the development area, the risk of fluvial flooding is greatest along the edges of the Eastwood, Rayleigh and Hawkwell Brooks. The simplest and preferred approach to avoid placing new development at unnecessary risk of flooding is thus to zone land uses within the development area based on their vulnerability to flooding identified above. This would involve locating those developments which are considered most vulnerable furthest from the water courses and towards the south and west boundaries of the development area. Section 3 outlined the guidance provided by PPS25 on assessing the vulnerability of land uses in relation to flood risk and this was applied to the proposed JAAP developments in Table 3.3. This concept of determining layout by considering risk and vulnerability is illustrated in Figure 5.2. The development plans may need adjustment, with proposed developments 'substituted' to appropriately match vulnerability with risk, following the third stage in the Flood Risk Management Hierarchy.

Other constraints, however, such as the need to reduce the impact on existing greenbelt or Metropolitan Open Land and the need for peripheral development of the airport activities and associated supporting businesses may mean that avoidance may not be possible whilst meeting the aims of the wider development. Although the Eastwood Brook is located partially within and alongside the existing airport boundary, any new MRO development needs to be adjacent to the existing airport and hence potentially close to this watercourse. As such, the sequential approach should also be applied within the Flood Zones, such that hazard, and therefore risk, is minimised if it cannot be avoided. At all stages, evidence must be shown as to how the Sequential Test is satisfied for individual developments. In this instance, it may be necessary to show that no alternative sites for some parts of the proposed development (e.g. additional MRO areas) exist adjacent to the airport.

If vulnerable land uses have to be located in flood risk areas, various mitigation measures may need to be included to reduce the flood risk to these sites. Any building or flood mitigation measures which affect the existing nature of flooding in the development area must not increase flood risk elsewhere. As such, adequate compensatory flood storage may be required to offset the effects of any land raising or building within the fluvial floodplain.

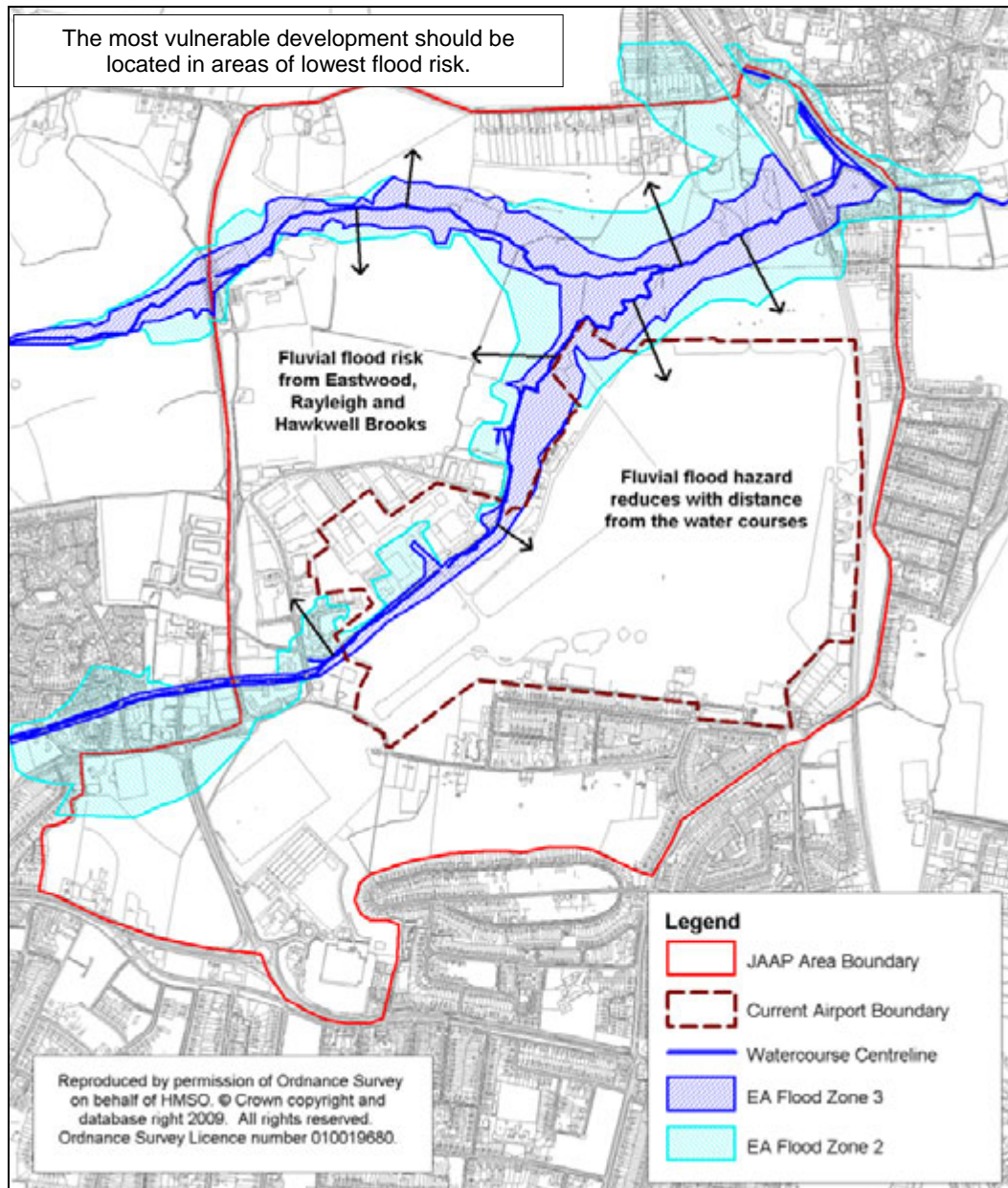


Figure 5.2 –Land Use Zoning with respect to Fluvial Flood Risk and Development Vulnerability

5.1.2 Building Design

Subject to the prior acceptance by the Environment Agency that the Sequential Test is satisfied, a number of potential building design measures can be undertaken to reduce the risk of flooding to new developments. This is an example of a control measure – the fourth stage in the Flood Risk Management Hierarchy.

Buildings can be raised above ground levels to prevent flood waters of a given depth entering the buildings. Adequate compensation for the loss of floodplain storage would be required if this option was chosen, to prevent the increase in flood levels elsewhere. Topographic data such as LiDAR can be used to inform such land-raising at the earliest possible stage in the development process.

In mixed-use developments, consideration can be given to placing less vulnerable uses such as retail or offices on ground levels, with more sensitive uses such as residential dwellings located on the floors above. However, safe access to and from these developments will still be required.

5.1.3 Modification of Ground Levels

In large development areas, it may be possible to change the makeup of the floodplain by raising land in some locations and lowering it in others. Appropriate conveyance of flood flows to the designated low areas can be facilitated by use of storage areas and ponds. Altering the fluvial floodplain in this way can reduce some of the restrictions to development in current flood risk areas. Opportunities for selective landscaping in the JAAP area are limited, although works to widen or naturalise the brooks through the development has the potential to provide amenity benefit, while reducing the fluvial flood risk.

LiDAR data can be used to inform assessments of potential landscaping changes in the development area and ensure that appropriate floodplain compensation is provided. It should be noted that any works which result in a change in the likely flooded area (floodplain) will require full testing, using a hydraulic model in consultation with the Environment Agency, in a site-specific FRA.

5.1.4 Flood Walls and Embankments

Where all other mitigation measures are impossible, new flood defences can be engineered to prevent flooding to new developments. PPS25 (Ref.1) and its accompanying Practice Guide (Ref. 2), however, make it clear that such measures should be avoided so that unnecessary residual risks (due to failure or overtopping) are not created. Any construction of flood walls or embankments would require appropriate floodplain compensation as discussed in previous sections. It is not considered that engineered flood defences represent a suitable mitigation measure for the proposed development, but nevertheless small-scale features (e.g. flood bunds) could be implemented as part of a wider approach to avoiding flood risk.

5.1.5 The Need for Safe Access

In order for a development to be considered 'safe', occupants must be able to evacuate safely and quickly before a flood event occurs. As detailed in the correspondence in Appendix C, the Environment Agency considers safe access to be a dry evacuation route suitable for use by emergency vehicles, and all occupants and visitors, including those with restricted mobility.

Further assessment of safe access is outside the scope of this study. Individual FRAs should, however, utilise flood depth and velocity information to calculate hazard ratings (Ref. 8) to show that Environment Agency access requirements are met. It should be noted that the more development encroaches on the floodplain, the more difficult and costly safe access is to provide. In accordance with the Flood Risk Management Hierarchy, avoiding the risk in the first instance may well be the most beneficial option from a number of perspectives.

5.1.6 Flood Resilience

Buildings in development areas at risk of flooding can be built to be flood resilient, such that a degree of flooding is accepted, but damage incurred from flooding is reduced. Such measures include maintaining electrical fittings and other services above the design flood level, installation of flood resistant flooring such as tiles, and the use of water-resistant coatings on doors, walls and other fixtures. These measures allow the building to return to use quickly after flood conditions have ceased. The availability of adequate insurance however, can still be limited for flood resilient buildings. This is the fifth stage in the Flood Risk Management Hierarchy and should be used not as a primary form of mitigation, but to mitigate residual flood risks.

5.2 Constraints on the Preferred Development

5.2.1 Overview

A proposed development should be laid out sequentially in line with PPS25 and the Flood Risk Management Hierarchy. Approximately 80% of the total JAAP area is classified as Flood Zone 1, with a low probability of flooding. However, the preferred option includes large areas of development that fall within Flood Zones 2 (21ha, 13% of development area) and 3 (13ha, 8% of development area), including land proposed for commercial purposes (employment) and the airport MRO zone. Ideally, in order to show that the Sequential Test had been appropriately

passed within the development area, the layout should be adjusted so that only ‘water compatible’ development is planned for the areas at risk alongside the Brooks, with the other ‘less vulnerable’ developments set back from these locations. Whilst demonstrating a sequential approach with respect to flood risk, this could potentially allow for additional benefits in terms of biodiversity, recreation space and aesthetics by creating a ‘green corridor’ alongside the brooks and adjacent to the proposed development. This could help towards the delivery of the Thames Gateway South Essex Green Grid Strategy.

The preferred option implies that many of the new development areas will be in close proximity to watercourses. This may have a number of disadvantages, including:

- Increased risk of fluvial flooding. Areas closest to the brooks are in Flood Zone 2 or 3, with a medium or high risk of fluvial flooding. The sequential approach (as detailed above) necessitates locating development away from the river edge if alternative sites are available.
- Loss of floodplain storage when buildings are located on the floodplain can result in an increase in overall flood levels if adequate compensation is not provided. The requirement to provide compensatory floodplain storage was outlined in the Environment Agency planning advice (Appendix C). It must be provided on a direct level-for-level basis. The volume of the new storage should equal that of the storage area lost, and be provided by land re-contouring.
- Loss of habitat. Important aquatic and terrestrial habitats may be present along the river corridor. Encroachment on these areas by new development may reduce the quantity and quality of this habitat.
- Prior written consent from the EA is required for any work within 9m of the main rivers in the development area. This includes both the Eastwood and Rayleigh Brooks. Development close to the Eastwood Brook may require culverting of the watercourse. The Environment Agency is opposed to this because of the resulting increase in flood risk and habitat disruption and hence is unlikely to grant the necessary permission for such works.

For the remainder of this fluvial flood assessment, the development area has been divided into 3 sections. These are as follows:

- North West sites that incorporate Rayleigh Brook, including ‘area i’, ‘area ii(b)’ and ‘area ii(c)’.
- The Eastwood Brook corridor including ‘area ii(c)’, ‘area iii’, ‘area iv’ and ‘area vi’.
- South West sites at risk of flooding from Eastwood Brook to the north, including ‘area x’ and ‘area xi’.

The locations of these sections relative to the Environment Agency Flood Zone outlines are shown on Figures 5.3, 5.4 and 5.5.

Fluvial flood risk in the other areas of change is low and hence is not expected to constrain the proposed development. This includes the airport terminal, car parking and railway station sited in the south and east of the JAAP area. These sites are therefore not discussed in this section.

5.2.2 Rayleigh Brook NW Areas

The Rayleigh Brook runs along the northern boundary of ‘area i’, ‘area ii(b)’ and ‘area ii(c)’. The preferred option is to use ‘area i’ for the first phase of the new Saxon Business Park office development. This is classified as ‘less vulnerable’ commercial development that should, where possible, be located in an area of low flood risk. ‘Area ii(b)’ and ‘area ii(c)’ are proposed for use as leisure facilities and public open space. These are water compatible and are appropriate in areas of flood risk.

All three areas lie partially within the Flood Zones 2 and 3 (see Figure 5.3), specifically the northern and western edge of ‘area i’, the north of ‘area ii(b)’ and a majority of ‘area ii(c)’. Across these three areas, there is sufficient land to lay out the development sequentially so that the Business Park development is not situated in an area of flood risk. The sequential approach would advocate a revision to the development proposal so that the northern and western parts of ‘area i’

are allocated to ‘water compatible’ open space, with a compensatory employment area in the south of ‘area ii(b)’. This would provide a complete green corridor along the Rayleigh Brook.

It is unlikely that it could be demonstrated that the Sequential Test had been satisfied in this instance were the development proposals left unaltered. If, however, other planning constraints can justify why the development cannot be relocated, ‘less vulnerable’ development would still be acceptable, providing floodplain compensation was provided and suitable design measures put in place to ensure the safety of buildings and users during a flood event. This would however, incur additional design, testing and construction costs.

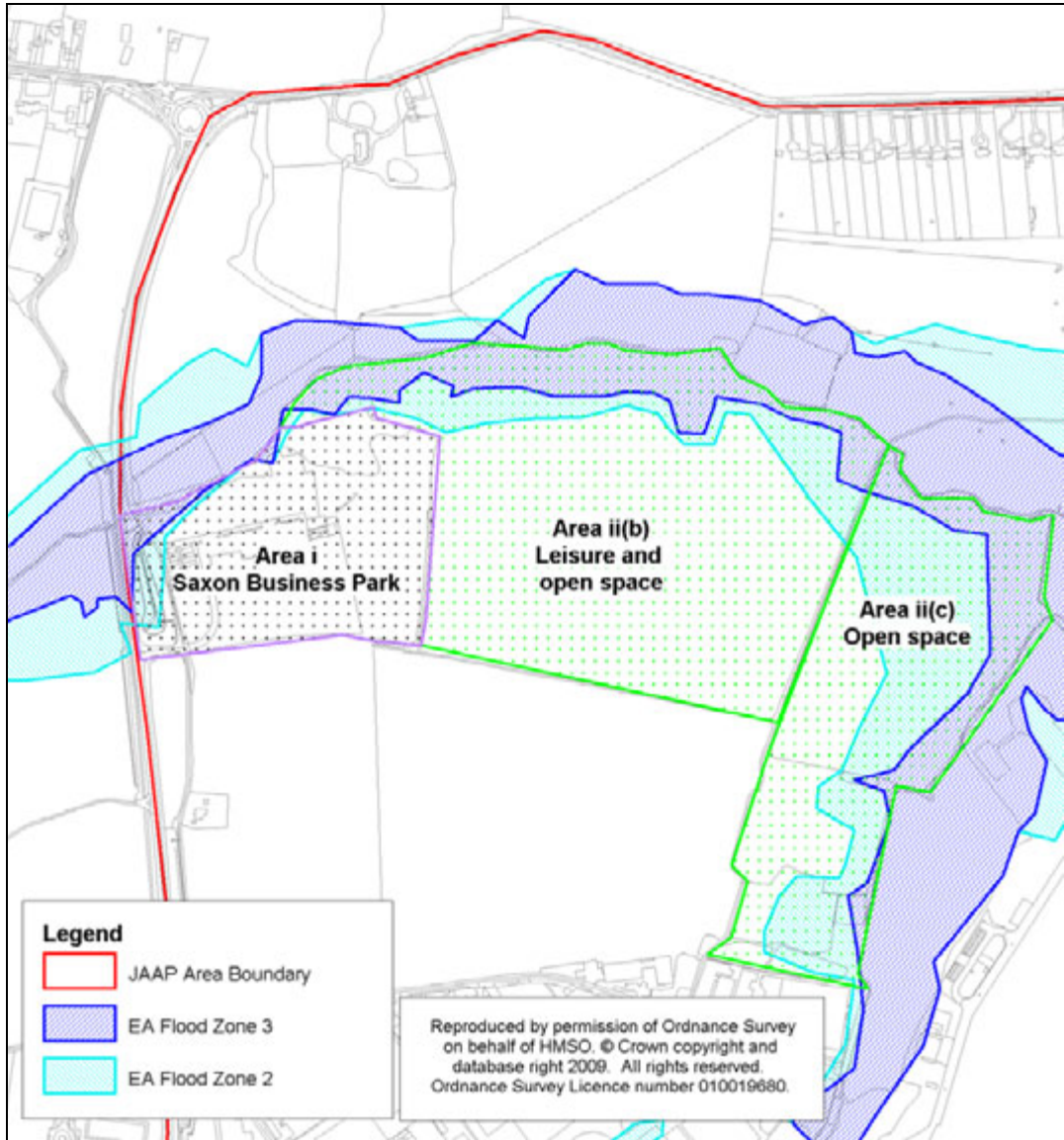


Figure 5.3 – Proposed Development and Flood Zones – Rayleigh Brook NW Area

5.2.3 Eastwood Brook Central Corridor

Eastwood Brook runs through / alongside ‘area ii(c)’, ‘area iii’, ‘area iv’ and ‘area vi’. All but ‘area ii(c)’ are proposed to be used for built-up development, with ‘area iii’ and ‘area vi’ part of the airport MRO zone and improvements to Aviation Way Business Park made in ‘area iv’. The open space in ‘area ii(c)’ is water compatible, but the urban developments in the other areas are classified as ‘less vulnerable’ and should be located away from areas of flood risk.

All four areas lie partially within the Flood Zone 2 and 3 outlines (see Figure 5.4), specifically a majority of ‘area ii(c)’, the whole of ‘area iii’, the north and south east of ‘area vi’ and the south of ‘area iv’. The proposal for locating the airport MRO in ‘area iii’ and ‘area vi’ should be reconsidered, given the high risk of fluvial flooding from the Eastwood Brook and the need to

adequately demonstrate the application of a sequential approach. If, however, other planning constraints can justify why the development cannot be relocated, ‘less vulnerable’ development would still be acceptable, providing floodplain compensation was provided and suitable design measures put in place to ensure the safety of buildings and users during a flood event. This would however, incur additional design, testing and construction costs.

It is recommended that development in these areas is set back from the edge of Eastwood Brook to reduce flood risk and loss of floodplain storage. Such a revision to the development proposals in this area would provide an opportunity for creation of a green corridor along the Eastwood Brook and allow for future improvements to the conveyance of flood flows. As well as reducing flood risk, providing an undeveloped corridor along the brook would improve the environmental habitat gains provided within the development area.

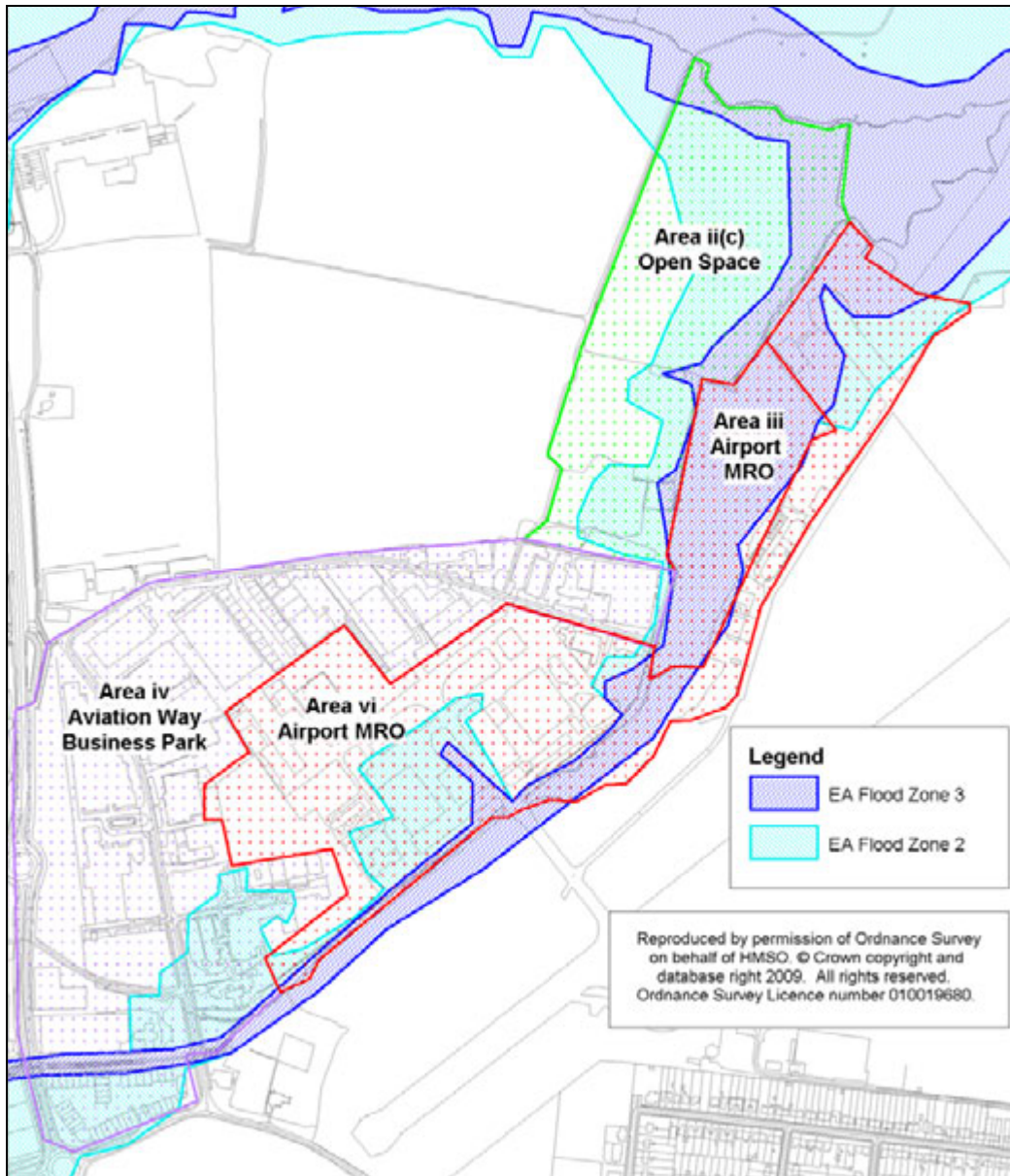


Figure 5.4 - Proposed Development and Flood Zones – Eastwood Brook Central Corridor

5.2.4 South West Eastwood Brook Areas

The Eastwood Brook enters the development area in the southern part of ‘area iv’. The Flood Zone 2 outline, however, extends south and includes the northern parts of ‘area x’ and ‘area xi’. In addition, a tributary of the Eastwood Brook flows north along the western boundary of ‘area xi’.

It is proposed to extend the Southend Airport runway and associated Runway End Safety Area into 'area x' and provide a new road link between Nestuda Way and Eastwoodbury Lane. The Flood Zone 2 extent is only small (see Figure 5.5), and as proposed, the developments lie in Flood Zone 1, with a low risk of fluvial flooding. Development in Flood Zone 2 is limited to the Runway End Safety Area, which is classified as a 'water compatible' land use and is appropriate in this Flood Zone.

The preferred option is to use 'area xi' for a new Park and Ride facility and extend the Nestuda Way Business Park with new commercial developments in the southern part of the area. The latter satisfies the sequential approach, as the southern area is furthest from the watercourse and has a low probability of fluvial flooding. When planning the exact location of the Park and Ride facility, the extent of Flood Zone 2 should be taken into account and avoided where possible. Whilst it may not be inappropriate to site parking areas within Flood Zone 2 in principal, this is often discouraged since vehicles can potentially be lifted during extreme flood events, increasing the hazard to nearby people and buildings.

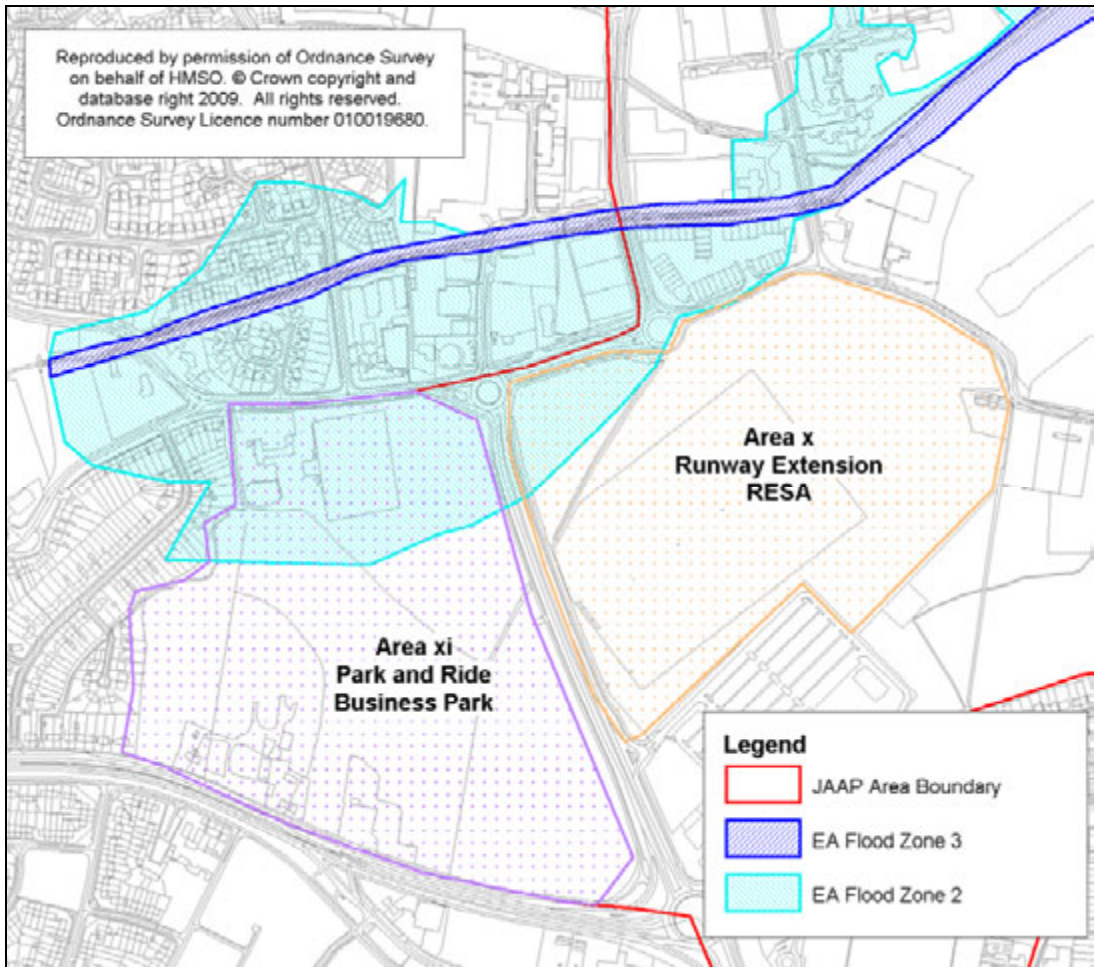


Figure 5.5 - Proposed Development and Flood Zones – SW Eastwood Brook Area

6. Management of Surface Water

6.1 Mitigation Options

In addition to the risk of flooding from fluvial sources considered so far in this document, PPS25 (Ref. 1) specifies that developers should also consider the impact of the development on surface water flooding derived from rainfall falling on the site itself. Generally, developers must ensure that the post-development rate and volume of runoff, following extreme rainfall, is equal to or less than the pre-development rate and volume. In this instance, where the existing site is composed largely of permeable surfaces, it is likely to be difficult to meet this requirement without providing significant surface water management mitigation. The size of the development area and the nature of the changes proposed to the existing land use mean that consideration of surface water runoff and its sustainable management will be very important. Opportunities to reduce rates and volumes should always be sought wherever possible. This is mostly likely to be achieved by using Sustainable Drainage Systems (SUDS).

6.1.1 Site Layout

Vulnerability to surface water flooding is likely to be greatest in areas of low elevation. Site layout can thus be informed by topographical trends over the development area. Topographic (LiDAR) data has not been obtained for this high-level study but it should be utilised to inform the layout of individual sites within the development area.

6.1.2 Sustainable Drainage Systems

In accordance with PPS25 and the forthcoming Floods and Water Management Bill, surface water arising from the development area should be managed using SUDS. The design of these systems should be based upon the principles given in the CIRIA SUDS Manual (Ref. 4) and CIRIA 'Design for Exceedance' practice guide (Ref 9).

Development can result in a number of negative impacts related to drainage, as follows:

- Changes in flow characteristics of runoff. Runoff from hard surfacing and building roofs is faster than from natural surfaces and this can cause flooding downstream.
- Changes in the quality of runoff. Runoff from developed sites is likely to be more polluted than runoff from natural surfaces as pollutants from activities on the sites (e.g. oil from car parks) can be washed into the drainage system. Conventional drainage systems are not designed to remove pollution.
- Biodiversity and amenity losses.

The purpose of a SUDS system is to minimise these impacts, by aiming to mimic natural drainage processes, remove pollutants and attenuate peak flows from urban runoff at source. SUDS comprise a wide range of techniques, including green roofs, permeable paving, rainwater harvesting, swales, detention basins, ponds and wetlands.

The CIRIA SUDS Manual (Ref. 4) describes the concept of a 'SUDS Management Train' as being fundamental in designing a successful SUDS scheme that mimics natural catchment processes as closely as possible. It is comprised of a hierarchy of drainage techniques that act incrementally to reduce pollution and runoff flow rates and volumes. These are as follows:

1. Prevention – the use of good site design and site housekeeping to prevent runoff and pollution, for example rainwater harvesting / re-use and sweeping to remove surface dust and detritus from car parks.
2. Source Control – control of runoff at or very near its source, for example soakaways and other infiltration methods, green roofs and permeable paving.

3. Site Control – management of water in a local area or site, for example routing of water from building roofs and car parks to a large soakaway, infiltration or detention basin.
4. Regional Control – management of runoff from a site or several sites, typically in a balancing pond or wetland.

The management train with this hierarchy of techniques is summarised in Figure 6.1.

The techniques that are higher in the hierarchy are preferred to those further down, so that prevention and control of water at source should always be considered before site or regional controls. The drainage statement produced for the prospective plot developers should include a recommendation for usage of green roofs, rainwater harvesting and greywater recycling opportunities, as well as recommendations for water efficiency, which will minimise use of potable water consumption and reduce foul drainage flows and volumes at source. Wherever possible, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments. Water should only be conveyed elsewhere if it cannot be dealt with on site. Priority should also be given to the use of infiltration drainage techniques that return surface water to the ground, as opposed to surface water discharge. Where infiltration techniques are not viable, discharging site runoff to watercourses is preferable to the use of sewers.

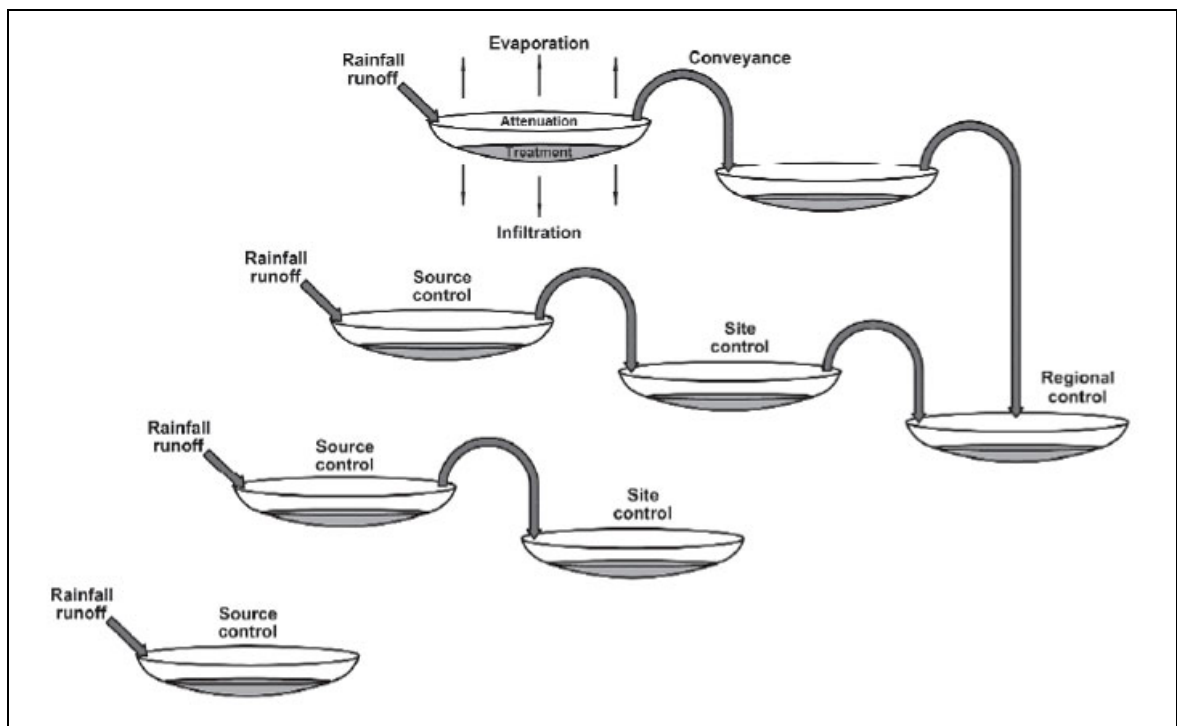


Figure 6.1 – The SUDS Management Train (The SUDS Manual, CIRIA, 2007, p1-12)

Natural conveyance systems (for example swales and filter trenches) are the favoured method for transferring water between individual parts of the management train, although pipes and sub-surface proprietary products may be required, especially where space is limited. Overland flow routes are also required for safe controlled conveyance of floodwater during extreme events, and pre-treatment (removal of silt / sediment) and maintenance is vital to ensure the long term effectiveness of all SUDS techniques.

Many different SUDS techniques are available. Table 6.1 describes the most common schemes and their associated benefits. In general, the greater the number of techniques used in series, the better the likely performance and the lower the risk of overall system failure. The number required partly depends on the expected level of pollution from different sources. Discharges from roofs would require one level of treatment (one SUDS element from Table 6.1. to be applied); while others would require a number of SUDS elements in series in order to mitigate the anticipated pollution. These requirements need to be proposed in accordance with PPG3 (Pollution Prevention Guide) and agreed with the Environment Agency.

Position on management train	SUDS Technique	Description	Benefits
Prevention	Good housekeeping	Separation of contaminated areas	Reduce risk of wider contamination and treat at source.
	Rainwater harvesting	Collection of rainwater for its re-use.	Attenuated runoff, reduced water demand.
	Water butts	Collection of water from roofs and surface storage.	
Source Control	Green roofs	Systems that cover a buildings roof with vegetation to mimic natural surface drainage	Attenuated run-off, improved aesthetics, climate change adaptation.
	Permeable paving	Paving that allows inflow of rainwater into underlying construction / soil.	Promotes attenuation and groundwater recharge, treatment by detention and filtration.
Site Control	Infiltration basins	Depressions that store water and dispose of via infiltration.	Potentially compatible with dual-use (for example sports fields) and can be any shape, designed for visual amenity. Treatment by detention and filtration.
	Detention basins	Dry depressions designed to store water for a specified retention time.	Can be designed as an amenity or provide a wildlife habitat. Treatment by detention.
	Soakaways	Sub-surface structures that store and dispose of water via infiltration.	Run-off attenuation and treatment by filtration.
	Bioretention areas	Vegetated areas for collecting and treating water before it is discharged downstream, or to the ground via infiltration.	Run-off attenuation by detention and infiltration. Improvements in water quality, enhanced visual amenity and provision of new habitat.
Regional Control	Retention ponds	Depressions used for storing and treating water. They have a permanent pool and bank-side emergent and aquatic vegetation.	Enhance visual amenity, wildlife habitat, opportunities for fishing, boating and other water sports. Can abstract water for re-use. Treatment by detention.
	Wetlands	As ponds, but shallower and the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow.	Provide a range of habitats for plants and wildlife. Linear wetlands can provide green corridors. Biological treatment.
Conveyance System	Filter drain	Linear drain / trench filled with permeable material, often with a perforated pipe in the base of the trench. An infiltration trench additionally allows infiltration through the trench sides.	Attenuated runoff, treatment by filtration.
	Filter Strips	Vegetated strips of gently sloping land that drain water from impermeable areas, while filtering out silt and other particulates.	Run-off attenuation, provision of green links / corridors through development, treatment by filtration.
	Swales	Shallow vegetated channels that conduct and / or retain water and filter particulates.	Provide green links / corridors, improved visual amenity, conveyance of storm water and can permit infiltration when unlined.

Table 6.1 –Description and Benefits of SUDS Techniques

6.1.3 Site Constraints

Not all techniques are suitable for every development, and the JAAP area has a number of site constraints that affect the potential for SUDS implementation. There are as follows:

- **Soil Type / Geology** – The borehole data (Figure 2.4) confirmed that large parts of the JAAP area are underlain by impermeable London Clay. This limits the potential for SUDS techniques based on infiltration. There may be the potential for infiltration into the sand and gravel deposits along the Eastwood and Rayleigh Brooks. However, the close proximity of these more permeable deposits to the watercourses suggests that the potential for infiltration will instead be limited by shallow groundwater levels. Instead, the potential for rainwater harvesting should be maximised along with utilisation of green roofs and grassed drainage elements to maximise evapotranspiration in the development area. Surface storage techniques may then need to be used to further attenuate flows, with discharge to one of the 3 watercourses that pass through the site.
- **Contaminants** – There is a risk that the former brickworks site in the northwest of the development area is contaminated. In addition, runoff from the airport is likely to be contaminated with aircraft fuel. The drainage system chosen will need to treat surface water before it is discharged to the watercourses, to ensure that no deterioration of water quality occurs as a result of the development.
- **Space Availability** – The proximity of the proposed development areas to the watercourse edges means that there is limited space for SUDS storage (providing runoff attenuation and treatment) prior to discharge into the brooks. The land-take of SUDS features is therefore likely to be an important contributing factor in the layout of the proposed development.

The following parameters should also be addressed to accommodate the requirement that the infrastructure and buildings are built to the highest CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme) and BREEAM (BRE Environmental Assessment Method) standards:

- Both flow and volumes reduction to the pre-development rates should be applied. This should be achieved by applying source/site/regional control SUDS techniques on site (Table 6.1).
- SUDS elements with minimal carbon footprint should be proposed.

6.1.4 Surface Water Runoff Rates

Under the guidance in PPS25, an FRA needs to establish the extent and discharge rates of the existing and proposed drainage systems, and use this to determine the capacity of any necessary storage or other SUDS devices.

The design of all surface water drainage systems on the development area should take into account the effects of climate change in accordance with latest government guidelines. The Environment Agency has indicated that the PPS25 recommendation relevant to climate change should be taken into account when undertaking drainage design calculations. Specifically, the rainfall intensity value should be increased by 30% for a design life for commercial developments of 75-100 years. Additionally, peak discharge rates at the end of the design life should be no greater than present day discharge rates.

The Interim Code of Practice for Sustainable Drainage Systems (Ref. 10) suggests that the peak Greenfield runoff rates for areas smaller than 50 ha should be calculated using the Institute of Hydrology Report 124; Flood Estimation for Small Catchments (Ref. 11). It has been assumed that the development area plots will be separately developed and submitted for planning applications and hence will be less than 50ha in area each. Table 6.2 summarises the estimated Greenfield runoff from the development area (a 125ha 'built up' area of change has been used), calculated for different return periods using the IOH124 methodology.

Storm Event	Greenfield Runoff (l/s/ha)	Runoff from whole site (l/s)
1 in 1	1.2	150
1 in 30	2.7	338
1 in 100	4.0	500

Table 6.2 – Estimated Greenfield Runoff Rates

These rates need to be communicated and agreed with the Environment Agency during the development of subsequent FRAs. Both the Environment Agency and the BREEAM requirements will call for maintaining Greenfield runoff rates from the site. For development taking place on Greenfield areas the Environment Agency would expect surface water to be discharged from the site at the 1 in 1 Greenfield runoff rate. For brownfield areas, surface water should be discharged at a rate no greater than existing with attempts to return to Greenfield rate being made where possible to provide overall betterment. Even for the highest return period, the Greenfield rates for the proposed site are highly restrictive and allow no to more than 150 l/s to be discharged off-site, based on the estimations in Table 6.2.

Restriction to these flows means that plot developers need to provide additional storage for runoff above that limit to mitigate the impact which site development has on surface water flood risk.

6.1.5 Required Storage Volumes

Assuming that no infiltration is possible on-site and that off-site discharge is required (no greater than the Greenfield runoff rates), indicative storage requirements have been calculated (Table 6.3) using the quick storage module of WinDES. These provide an example of the typical amounts of surface water storage that may be required to meet surface water runoff requirements. In these calculations, the total proposed 'built up' areas of change has been taken to be 125ha. The maximum required storage has been calculated for a 1 in 100 storm, with a 30% increase in intensity allowing for climate change.

The volume requirements would vary based on the amount of impervious areas to be built on site. At this stage, this is unknown and so the indicative required storage has been calculated for a varying percentage of new impervious area. It is expected that these volumes need to be contained within the development area.

Storm Event	Percentage of Impervious Areas (%)	Impervious Area (ha)	Storage requirements (m ³) for a restricted discharge of 1.2l/s/ha
1 in 30	25	31.25	12,500
	50	62.5	29,000
	75	93.75	48,000
1 in 100	25	31.25	17,000
	50	62.5	39,000
	75	93.75	63,000
1 in 100 + 30%*	25	31.25	23,000
	50	62.5	53,000
	75	93.75	86,500

Table 6.3 – Storage Requirements for the Site (m³)

*allowance for climate change

The stated volumes are indicative as they do not take into account any infiltration into the soil or any ponding allowance on site. The stated volumes could be significantly reduced based on infiltration, although borehole information has indicated that opportunities for infiltration are limited by impermeable clay geology and likely shallow groundwater levels close to the watercourses.

It is common practice that underground storage is provided for storms of up to a 1 in 30 annual chance and that additional volumes up to 1 in 100 (plus allowance for climate change) is provided in ground ‘depressions’, within kerbs in car parks or in open spaces. This could vary, however, and depends on the developer’s aspiration for the site and on the layout of individual sites within the development area. Safe overland flow routes need to be provided for less frequent but more extreme storm events, than 1 in 100, within each development site.

The provision of the large attenuation volumes must be considered at the earliest stage of site layout planning, as a large land take is anticipated. For an area that is 75% impervious for example, attenuation to the 1 in 1 Greenfield runoff rate in a storage facility that is 1m deep, would require land take in the region of 8.6ha. This equates to over 5% of the proposed development area. Development layout needs to not only take the volume / area of storage into account but also the requirement to route surface water via the attenuation provision before it reaches the watercourses. This is likely to be particularly difficult where development has been proposed adjacent to Rayleigh and Eastwood Brooks.

6.2 Constraints on the Preferred Development

6.2.1 Overview

This section has already considered the extent to which the management of surface water is likely to constrain future development within the JAAP area. Key issues that require addressing were identified as follows:

- The need to reduce post-development runoff rates and volumes, exacerbated by the large increase in impervious area that would result from the proposed development.
- The need to address potential contamination, arising from existing land uses on the site (for example, the old brickworks) and the proposed development of airport-related facilities.
- The lack of space between watercourses and existing and proposed development.
- The geology of the JAAP area, which may act to limit the appropriateness of some SUDS techniques.

6.2.2 Proposed SUDS Solution

General Constraints

The proposed SUDS solutions for the JAAP area will require significant space provision to mitigate the increase in flows from the new impervious areas and to provide pollution control. The new urban areas associated with the proposed development can be broadly grouped into three categories, as follows:

- Roof runoff, which is relatively unpolluted.
- Park and Ride area, car parks and access roads, which have a risk of surface water pollution from diffuse pollution sources and accidental spillages.
- Airport extension and MRO facilities, with high point source and diffuse pollution.

While all three types of discharges need to meet water quantity and water quality criteria, there are different criteria for surface water collection, storage and disposal from each source. These are outlined in more detail below.

Roof Surfaces

- Quantity control: The proposed attenuation of roof runoff should be provided either in the form of: green roofs; swales and detention ponds; filter drains and underground reservoirs (if the rainwater will be harvested and re-used) or underground reservoirs below car parks.
- Quality control: Separate attenuation of roof runoff from other areas ensures that the relatively unpolluted roof runoff passes through the drainage system and does not dilute the potentially contaminated car park and road runoff thus preventing its effective treatment. In order to meet further BREEAM requirements, rainwater harvesting either in water butts or in underground tanks and utilisation of green roofs should be considered. If space is limited, however, and no separation of storage for roof and hardstanding runoff is feasible, underground reservoirs below car parks combining these two storages should be considered.

Car Park and Road Surfaces

- Quantity control: The proposed attenuation of the runoff should be provided in the form of: green street planters, porous pavements, grass strips and swales or filter drains before its potential discharge into the site and regional control devices in the form of ponds (as presented in Table 5.3).
- Quality control: As runoff from these areas is at the risk of being polluted, utilisation of oil separators or SUDS elements to treat surface water runoff will be required. A majority of the techniques proposed in Table 6.1 could be used on the development site and each element should be treated as one level of treatment in the management train. For these surfaces, at least two or three levels of treatment are required at the plot level to mitigate pollution.

Runway and MRO Surfaces

- Quantity control: large impervious areas of the runway and the MOR surface indicate large requirements for flow attenuation (as per Section 5.2) and the site layout needs to accommodate these provisions prior to discharge into watercourses.
- Quality control: As the runoff from these surfaces is likely to be highly polluted, options for pollution control need to be investigated which may include: flow attenuation and further connection to the existing treatment works in the area, consideration of providing a new treatment system on site, combination of oil separators and SUDS techniques as part of the proposed solution.

These requirements need to be proposed in accordance with the PPG (Pollution Prevention Guidance; Ref 12) and communicated and agreed with the Environment Agency. In addition, a separate study should be undertaken to further investigate drainage options and pollution control methods for the airport runway and MRO surfaces. As these elements require large space provision, it is essential that their layout is considered at an early stage of planning and incorporated into the proposed development layout. As with fluvial flood risk constraints, encroachment on the watercourses within the JAAP area, as currently proposed, will reduce the likelihood that there is adequate space for SUDS techniques to manage the surface water arising from the proposed development. It is recommended that further consideration is given to the layout of the proposed development to include allowances for the land take of SUDS features as well as meet the requirements of the Environment Agency in demonstrating a sequential approach to development planning.

7. Summary and Recommendations

7.1 Summary of Findings

This document has assessed the flood risk constraints that are likely to impact on the redevelopment of an area around Southend Airport in Essex. The document has considered the requirements of government planning policy on flood risk and new development (PPS25) and has presented existing information on all relevant sources of flood risk. Whilst there are a number of flood risks that should be considered at a more detailed level by site specific Flood Risk Assessments (FRAs), the following key risks have been identified, at this stage. These risks have the potential to result in significant objection to the proposed JAAP unless a range of alterations and considerations are incorporated into the emerging development proposals:

- **Fluvial flooding** occurs when the volume of water in a river exceeds the channel capacity and floodwater is conveyed directly from the watercourse to surrounding land. This is a significant development constraint in those areas adjacent to the Rayleigh Brook and the Eastwood Brook, two watercourses that cross the development area. Approximately 9% of the site is within Flood Zone 3 and is therefore classified by PPS25 as having a high probability of flooding (greater than 1% annual probability). A further 10% of the site is within Flood Zone 2 and has a medium probability of flooding (between 0.1 and 1% annual probability). In accordance with the sequential approach advocated by government through PPS25 and the Environment Agency, sites at risk of flooding should be avoided where possible for any development that is not 'water compatible'.
- **Surface water flooding** originates from intense rainfall which exceeds the available infiltration / drainage capacity, leading to high runoff rates and volumes. The addition of new impermeable urban areas during development acts to increase both the rate and volume of surface water runoff into drainage ditches and river systems. Any changes in the size and type of the development area have the potential to impact on this source of flooding. Therefore, any development proposals will have to carefully consider the likely impact on surface water flows and how these can be managed sustainably to ensure no increase in flood risk both to the development and from the development to neighbouring areas. A common way of doing this is through the implementation of Sustainable Urban Drainage Systems (SUDS).

The size of the JAAP area and the complexity of the proposals mean that there are a range of suitable mitigation measures which can be incorporated into the development proposals, ranging from strategic options such as selectively locating various land uses with respect to flood risk to the provision of formal flood defence and surface water management measures. These can be summarised as follows:

- **Development layout should be planned / designed sequentially**, in line with PPS25, to take into account both the risk of flooding and the relative vulnerability of the specific components of development. This means that only water compatible developments are located in areas of flood risk, with those developments which are most vulnerable, located furthest from the watercourses in areas of low flood risk. It is likely that the Environment Agency would object to any development proposals where any of the other mitigation measures detailed below were proposed to reduce flood risks without evidence that a sequential approach had been applied and that alternative locations for development within the JAAP area had been exhausted.
- The **building design** of developments in areas at risk of flooding can help ensure the safety of occupants. Options include improving the flood resistance of buildings by raising them above flood levels and improving the flood resilience of buildings by employing features such as raised electrical fittings and flood-proof coatings on doors and walls.

- **The modification of ground levels** can alter the locations of and sometimes reduce flood risk. Works to widen and/or naturalise the Eastwood Brook, for example, have the potential to decrease flood risk as well as creating new habitat. Landscaping may also be required to provide suitable floodplain compensation should proposed buildings reduce the volume of storage on the floodplain.
- **Flood walls and embankments** can be constructed to prevent flooding to new developments. Engineered flood defences are not, however, considered to be a suitable flood mitigation solution for the proposed development, although small-scale features could be implemented alongside some of the other measures summarised here.
- If development is located in an area at risk of flooding, provision must be made for **safe access and egress** in the case of a 1 in 100 year flood event.
- Surface water flows on and off the development need to be managed to ensure no increase in the runoff rate or volume and hence no increase in surface water flood risk both to and from the development area. A number of **surface water management** measures have been proposed, in the form of **Sustainable Drainage Systems (SUDS)** techniques that attempt to mimic natural drainage systems and serve to both control provide additional environmental benefit. The topography and geology of the JAAP area may limit the applicability of some SUDS techniques, whilst the undeveloped nature of much of the floodplain means that the requirements for the attenuation and/or storage of surface water are likely to be high.

Through the process of conducting a Joint Area Action Plan (JAAP), Southend-on-Sea Borough Council and Rochford District Council have identified a 'preferred option' for the redevelopment, which has been appraised in this document and the following commentary provided in relation to the principles and requirements of PPS25:

- The preferred option is laid out contrary to the sequential approach advocated by PPS25 (Ref. 1) and required by the Environment Agency (Appendix C). Airport-related and mixed-use developments are proposed to be located adjacent to the watercourses that cross the development area, inside the floodplain. In order for these developments to be located in this manner within the site, it must be shown that there are no alternative sites available with a lower probability of flooding. Given the current level of information, this is not possible, and the proposed JAAP would not pass the Sequential Test as set out in PPS25 and reviewed by the Environment Agency.
- If it is possible to show that no alternative sites exist, development in the floodplain will require mitigation in the form of floodplain compensation storage, to ensure new buildings do not reduce the volume of storage for floodwaters on the floodplain. Floodplain storage will be required at a level-for-level basis, and must be agreed in consultation with the Environment Agency. The less encroachment on floodplain areas, the less floodplain compensation will be required and the easier it is to achieve the required level of mitigation.
- Encroachment into the river corridor by new development, if unmitigated, could also result in negative impacts on the environment, including loss of habitat. Whilst there are areas of open space proposed within the JAAP area, these are not always adjacent to the watercourses.
- Any works within 9m of the watercourses crossing the JAAP area would require prior written consent from the Environment Agency. Furthermore, the Environment Agency is likely to object to any proposals to construct new culverts within the JAAP area, especially along the Eastwood Brook, which has been shown in the past to have a flashy response to storm events.
- The existing Greenfield nature of much of the JAAP area means that the requirement to mitigate surface water runoff to existing rates is likely to need a large amount of attenuation and/or storage features, with significant implications on land take. SUDS techniques offer an attractive method of controlling runoff in this manner, but it is noted that the current proposal to provide airport-related and mixed-use development alongside the watercourses leaves

little room for SUDS and may mean that required runoff rates are unachievable given the current layout.

- The amount of proposed open space within the development proposals should allow for adequate avoidance and mitigation of fluvial and surface water flood risks respectively.

7.2 Recommendations

Given the flood risk constraints identified in this study and the examination of the preferred option, the following recommendations are made with respect to flood risk. Adherence to these recommendations as details for the proposed development emerge will maximise the likelihood that the JAAP will meet the requirements of PPS25 and take due account of flood risks.

- **It is recommended that the JAAP proposals (and in particular the layout of the developments) are re-visited in light of the findings of this flood risk constraints report and the requirements set out in PPS25 (Ref. 1) and correspondence with the Environment Agency (Appendix C).**
- Wherever possible, attempts should be made to re-allocate some of the proposed open space, which is currently proposed outside the floodplain, and substitute it for the airport-related and employment development shown currently within the floodplain adjacent to the Eastwood and Rayleigh Brooks.
- Consideration should be given to incorporating a green corridor alongside the Eastwood and Rayleigh Brooks, within which areas could be safeguarded for (i) fluvial flooding, or (ii) the management of surface water runoff from the proposed development.
- It is recommended that a drainage strategy be developed for the proposed development so that the surface water management constraints identified in this document can be incorporated into the emerging development proposals at the earliest possible opportunity and a sustainable surface water management solution be developed.
- SUDS techniques should be utilised wherever possible in the management of surface water within the development area. Appropriate control of the quantity and quality of runoff from the various elements of the proposed development should be provided, in accordance with best practice and up-to-date guidance on development and flood risk (PPS25; Ref. 1 and Ref. 2) and pollution prevention and control (PPG3; Ref. 12). Surface water runoff rates will need to be discussed and agreed with the Environment Agency.
- It is a requirement of PPS25 (Ref. 1) that FRAs are produced to accompany each individual planning application for developments in Flood Zones 2 and 3, and all developments that are greater than 1ha in Flood Zone 1. The information in this document is an important resource in the production of such Flood Risk Assessments. It is recommended that the information provided in this constraints report is reviewed in light of specific development proposals and additional data purchased or made available, where required (see below).

7.2.1 Recommendations for Data Purchase

It is recommended that the following data is purchased as part of subsequent FRAs:

- **Climate Change Data**

At this level of assessment, the Environment Agency has not provided flood extents and levels that include provision for climate change along the Rayleigh Brook. This data will also be required for subsequent studies.

- **Topographic data**

Purchase of LiDAR data was considered to be outside the scope of this study, but details have been given regarding what is available (see Section 4.2.4 & Appendix E). Alternatively, topographic data can be derived from a detailed site survey. This data needs to be used in conjunction with flood level data to determine flood depths and hazard. It is also required when designing SUDS attenuation storage facilities and floodplain compensation schemes.

8. References

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