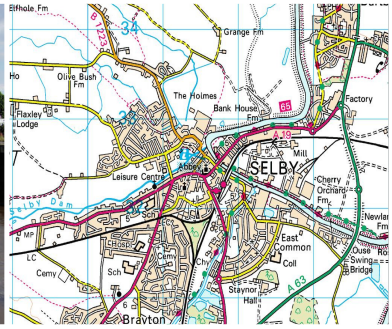
Selby District Council

Level 2 Strategic Flood Risk Assessment

Living Document
February 2010



Prepared for:

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Revision Schedule

Level 2 Strategic Flood Risk Assessment
February 2010

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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Executive Summary

Planning Policy Statement 25: Development and Flood Risk (PPS25, 2006) emphasises the active role that LPAs should have in ensuring that flood risk is considered in strategic land use planning. PPS25 encourages LPAs to undertake a Strategic Flood Risk Assessment (SFRA) to be used as part of the documented evidence base for strategic land use planning decisions as part of the Local Development Framework.

Scott Wilson issued an Updated Level 1 SFRA report for SDC in November 2008. The Level 1 SFRA enabled SDC to apply the Sequential Test (in accordance with PPS25) at a strategic scale in order to inform their spatial planning of land allocations and future development proposed in their emerging LDF (i.e. steering proposed development to areas of lowest flood risk).

The application of the Sequential Test demonstrated that it is not possible for SDC to accommodate all housing and employment land requirements, as specified in the Yorkshire and Humber Regional Spatial Strategy (RSS) (May, 2008), on land at the lowest risk of flooding if wider sustainability and regeneration objectives are to be achieved.

The focus of the Level 2 SFRA is to assess three areas identified by SDC for 'Strategic Growth' to provide detailed flood risk information on the sites that passed the Sequential Test to enable the Exceptions Test to be applied. These include Site A – Cross Hills Lane, and Sites D and G – Olympia Park of the Urban Extension and Strategic Employment Site Options.

The Level 2 SFRA is a Living Document and should be read in conjunction with the Level 1 SFRA study and the SDC Sequential Test.

Site A situated to the north west of Selby town is located partially within the floodplain of the Selby Dam watercourse, which is undefended along the adjacent reach. Depth hazard mapping was undertaken using modelled flood level results in the event of the watercourse overtopping its left bank during a 1 in 100 year and a 1 in 1000 year event, incorporating allowances for pumping station failure.

The maps produced illustrated that the majority of the southern part of the site, and the eastern area to the south of Cross Hills Lane are at risk from flooding during the 1 in 100 year (high risk, Flood Zone 3) and 1 in 1000 year (medium risk Flood Zone 2) flood return periods (1% and 0.1% AEP respectively). The levels of depth hazard experienced during these events would range from an insignificant risk to a 'Danger to All'. The remainder of the site is only at risk from flooding during flood events greater than the 1 in 1000 year (low risk, Flood Zone 1) return period.

The Level 2 SFRA recommends that a phased sequential approach should be adopted for Site A to allocate 'more vulnerable' residential development within lower flood risk areas (Flood Zone 1). Any proposed 'less vulnerable' commercial/industrial development should alternatively be located within the higher flood risk areas (Flood Zones 2 and 3).

In addition, the Level 2 study recommended that a 'blue corridor' is implemented in the southern region of Site A to provide opportunities for flood mitigation, increased biodiversity and recreation, strategic management of surface water runoff and compensatory flood storage.

Sites D and G, at Olympia Park, neighbour one another and are both located to the north east of Selby town. They are located entirely within the defended floodplain of the River Ouse, which is defended up to a 0.5% AEP flood event. Hydraulic modelling undertaken during the Level 2 SFRA confirmed that these defences would not become overtopped during the 0.5% AEP flood event. Similarly, the modelling confirmed that Sites D and G were also defended to the 1% (including and allowance for climate change) flood event.

Depth, velocity and full hazard mapping was created using the SFRA hydraulic model to demonstrate the residual risk of the watercourse breaching flood defences during the 1 in 200 year return period (0.5% AEP). The maps illustrated that residual flood depths across the majority of site D would pose a 'Danger to Most', whilst smaller areas to the east of the site presented depths that would pose a 'Danger to All'. Breach results for Site G illustrated that flood depths across the majority of the site would pose a 'Danger to All', with smaller areas in the west and south posing a 'Danger to Most'. Flood velocities experienced would inevitably be greatest immediately adjacent the location of breach, and flood depths were shown to be greatest in the central and eastern areas of Site G.

However, the risk of a breach within defences along this area is considered to be very low due to their recent construction, quality and maintenance.

This Level 2 SFRA recommends that to accommodate the residual risk of flood defence breach, a phased approach should be adopted to allocate 'more vulnerable' residential development within lower flood risk areas, and 'less vulnerable' commercial/industrial development within the higher flood risk areas. This 'less vulnerable' development should however, firstly be allocated within areas of the residual risk breach floodplain that demonstrate depth and velocity hazards to the fewest people as identified by site specific Flood Risk Assessments (FRAs).

Importantly, the SFRA has recommended that development in Selby should be 'Safe' with regards to flood risk and has identified a number of measures and policies that should be adopted. These include measures such as ensuring that there are safe places of refuge during a flood event and that sleeping accommodation should not be provided on the ground floor in areas of flood risk.

The Level 2 SFRA also assesses the suitability of appropriate SuDS techniques as methods to manage rates of surface water runoff generated from the development at Sites A, D and G.

Abbreviations

Acronym	Definition
AEP	Annual Exceedence Probability
AOD	Above Ordnance Datum
BW	British Waterways
CAMS	Catchment Abstraction Management Strategy
CDA	Critical Drainage Areas
CFMP	Catchment Flood Management Plan
DPD	Development Plan Documents
DTM	Digital Terrain Model
EA	Environment Agency
FRA	Flood Risk Assessment
GIS	Geographical Information Systems
GwV	Groundwater Vulnerability
IDB	Internal Drainage Board
LDDs	Local Development Documents
LDF	Local Development Framework
LiDAR	Light Detection and Ranging
LPA	Local Planning Authority
NFCDD	National Flood and Coastal Defence Database
ODPM	Office of the Deputy Prime Minister
OPSI	Office of Public Sector Information
PCPA	Planning and Compulsory Purchase Act 2004
PPS25	Planning Policy Statement 25: Development and Flood Risk
RSS	Regional Spatial Strategy
SW	Scott Wilson
SA	Sustainability Assessment
SDC	Selby District Council
SFRA	Strategic Flood Risk Assessment
SDC	Selby District Council
SoP	Standard of Protection
SWMP	Surface Water Management Plan
SuDS	Sustainable Drainage Systems
YW	Yorkshire Water

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Climate Change	Both natural and human actions causing long term variations in global temperature and weather patterns.
Culvert	A channel or pipe that carries water below the level of the ground.
Exception Test	Following application of the Sequential Test, if it is not possible or consistent with wider sustainability objectives for the development to be located in zones of lower probability of flooding, the Exception Test can be applied. The Test provides a method of managing flood risk while still allowing necessary development to occur.
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone 1	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or tidal flooding in any year (<0.1%).
Flood Zone 2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of tidal flooding (0.5% – 0.1%) in any year.
Flood Zone 3a	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone 3b	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).
Fluvial Flooding	Flooding by a river or a watercourse.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Internal Drainage Board	Independent bodies with responsibility of ordinary watercourses within a specified district.
Inundation	Flooding
ISIS-Tuflow	A combined 1 dimensional (1-D) hydraulic river model called ISIS (Halcrow) that is dynamically linked to the TUFLOW (WBM) 2-D modelling package, able to effectively model flows overtopping channel banks or defences and continuing across the floodplain.
Local Development Framework	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the

Term	Definition
	development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map.
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Main River	All watercourses shown as such on the statutory main river maps held by the Environment Agency and the Department of Environment, Food and Rural Affairs, and can include any structure or appliance for controlling or regulating flow of water into, in or out of the channel. The Environment Agency has permissive powers to carry out works of maintenance and improvement on these rivers.
Mitigation Measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Pitt Review	Sir Michael Pitt undertook an independent review of the Summer 2007 flood events. The full title of the document is 'The Pitt Review: Lessons learned from the 2007 floods'
Pluvial Flooding	Flooding caused by rainfall of varying intensity and duration where local topography or underlying ground conditions combine to prevent free effective drainage. Pluvial flooding is affected by limited capacity of an existing natural surface water drainage network or network combined with man-made drainage systems to deal with excessive amounts of water and/or sewage discharging to the system.
Risk	The combination of probability and consequence of an event occurring.
Sequential Testing	A risk based approach in to assessing flood risk, which gives priority in ascending order of flood risk, i.e. lowest risk first.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Stakeholder	A person or organisation that has an interest in, or affected by the decisions made within a site.
Strata	Layer of rock or soil with internally consistent characteristics that distinguishes it from contiguous layers. Each layer is generally one of a number of parallel layers that lie one upon another, laid down by natural forces.
Sustainability Appraisal	A process used to identify if policies, strategies or plans promote sustainable development and further used for improving policies. It is a requirement for Regional Spatial Strategies under the Planning and Compulsory Purchase Act 2004.
Sustainable Drainage System (SuDS)	Drainage methods designed to mimic the natural system. Where practicable should be used in preference to traditional piped drainage systems.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
X% Annual Exceedence Probability (AEP) event	Percentage annual exceedence probability (AEP) of occurrence in any one year. For example, a 1 in 200 annual probability event has a 0.5% AEP of occurring in any year.
X% AEP Design Standard	Flood defence that is designed for to protect against a X% AEP event. In events more severe than this the defence would be expected to fail or to allow flooding. For example, defences may be constructed to a standard of protection of 1% AEP.

1 Introduction

1.1 Planning Context

1.1.1 The Planning and Compulsory Purchase Act 2004 (PCPA)[1] requires Local Planning Authorities (LPAs) to produce Local Development Frameworks (LDFs) to replace the system of Local, Structure and Unitary Development Plans. LDFs are a portfolio of Local Development Documents (LDDs) that collectively deliver the spatial planning strategy for the Local Authority area. The PCPA requires LDDs to undergo a Sustainability Appraisal (SA), which assists Local Planning Authorities (LPAs) in ensuring their policies fulfil the principles of sustainability.

1.1.2 Planning Policy Statement 25: Development and Flood Risk (PPS25, 2006) emphasises the active role that LPAs should have in ensuring that flood risk is considered in strategic land use planning. PPS25 encourages LPAs to undertake a Strategic Flood Risk Assessment (SFRA). SFRAs are one of the documents to be used as the evidence base for strategic land use planning decisions as part of the LDF. They are also a component of the SA process and should be used in the review of LDDs or in their production.

1.2 SFRA Overview

1.2.1 The PPS25[2] Practice Guide[3] recommends that SFRAs are completed in two consecutive stages:

- Level 1 SFRA
- Level 2 SFRA

1.2.2 In June 2007 Scott Wilson was commissioned by Selby District Council (SDC) to undertake a Strategic Flood Risk Assessment (SFRA) for the administrative area of Selby District. As part of the commission, Scott Wilson was required to undertake a Level 1 and Level 2 SFRA for SDC.

1.2.3 In February 2008, Scott Wilson issued a Level 1 SFRA to SDC. However, following changes in the emerging Selby Core Strategy and the completion of the Selby Dam and Tributaries Flood Mapping Study (March 2008) for which detailed hydraulic modelling was undertaken (as part of the Environment Agency Strategic Flood Risk Management Framework, Scott Wilson issued an Updated Level 1 SFRA report in November 2008 which made references to this latest available output.

1.2.4 The Level 1 SFRA enabled SDC to apply the Sequential Test (in accordance with PPS25) at a strategic scale in order to inform their spatial planning of land allocations and future development proposed in their emerging LDF (i.e. steering proposed development to areas of lowest flood risk).

1.2.5 The application of the Sequential Test demonstrated that it is not possible for SDC to accommodate all housing and employment land requirements, as specified in the Yorkshire and Humber Regional Spatial Strategy (RSS) (May, 2008), on land at the lowest risk of flooding if wider sustainability and regeneration objectives are to be achieved.

[1] HMSO. *'Planning and Compulsory Purchase Act'*. 1994. OPSI London.
[2] Department for Communities and Local Government. '*Planning Policy Statement 25: 'Development and Flood Risk'*. December 2006. TSO London.
[3] Department for Communities and Local Government. '*Planning Policy Statement 25: 'Development and Flood Risk' Practice Guide'*. December 2009. TSO London.

1.2.6 Where development and infrastructure cannot be allocated in lower flood risk areas in accordance with the Sequential Test, and where there are no other suitable alternative areas for development, it is necessary to increase the scope of the Level 1 SFRA to provide information necessary for application of the Exception Test. In accordance with Paragraph 3.49 of the PPS25 Practice Guide, this increased scope requires the preparation of a Level 2 SFRA.

1.2.7 At this stage, the focus of the Level 2 SFRA is to assess three areas identified by SDC for 'Strategic Growth'. These include Sites A, D and G of their Urban Extension and Strategic Employment Site Options. See Section 3.4 for full details of the Sequential Test and how the scope of this Level 2 SFRA has been defined.

1.2.8 It is recommended that the Level 1 SFRA and SDC Sequential Test is read in conjunction with this Level 2 SFRA report to ensure that an understanding of the general flood risk to the study area is gained.

1.3 PPS25 Requirements for Level 2 SFRAs

1.3.1 It is important to be clear that a Level 2 SFRA is not a replacement for site specific FRAs. Its purpose is strategic in nature to inform planning and policy decisions to the area in question within a district. There is no clear definition of the scale at which a Level 2 assessment should be undertaken in PPS25 or the accompanying Practice Guide. However, in other SFRAs across the country, a Level 2 SFRA has concentrated on individual towns and settlements or large development or regeneration areas within a District.

1.3.2 A Level 2 SFRA uses information gathered during a Level 1 SFRA and additional data where necessary, and concentrates on potential development areas to determine detailed information on the level of flood risk so that sufficient evidence can be provided for the Exception Test to be applied.

1.3.3 This continues the hierarchical approach to flood risk defined in PPS25 and provides Local Planning Authorities (LPA) with more information to ensure that development follows the sequential approach and, if applicable, to apply the Exception Test and determine possible site layouts and/or policies that ensure flood risk to new development is minimised.

1.3.4 To address the particular flood risk issues, as identified within the Level 1 SFRA study, that are specific to the administrative area of SDC, flow charts have been produced (Chart 1-1, Chart 1-2 and Chart 1-3) which highlight what issues a Level 2 SFRA should address and the level of detail and items of work required for the study to comply with the PPS25 requirements.

1.3.5 The charts are based on the four main flood sources within the study area (as defined by the Level 1 SFRA). These include fluvial, sewer and drainage, pluvial and surface water, and artificial sources (including reservoirs).

1.3.6 These charts are not exhaustive as to the scope of a Level 2 SFRA. However, they are considered useful to understand what the general requirements are for a Level 2 SFRA in different circumstances so that, should the need arise, additional Level 2 studies can be specified and undertaken in the future, and updates to the Living Document Level 2 SFRA can be made when necessary.

Chart 1-1: Specifying where a Level 2 SFRA or more detailed studies are required.

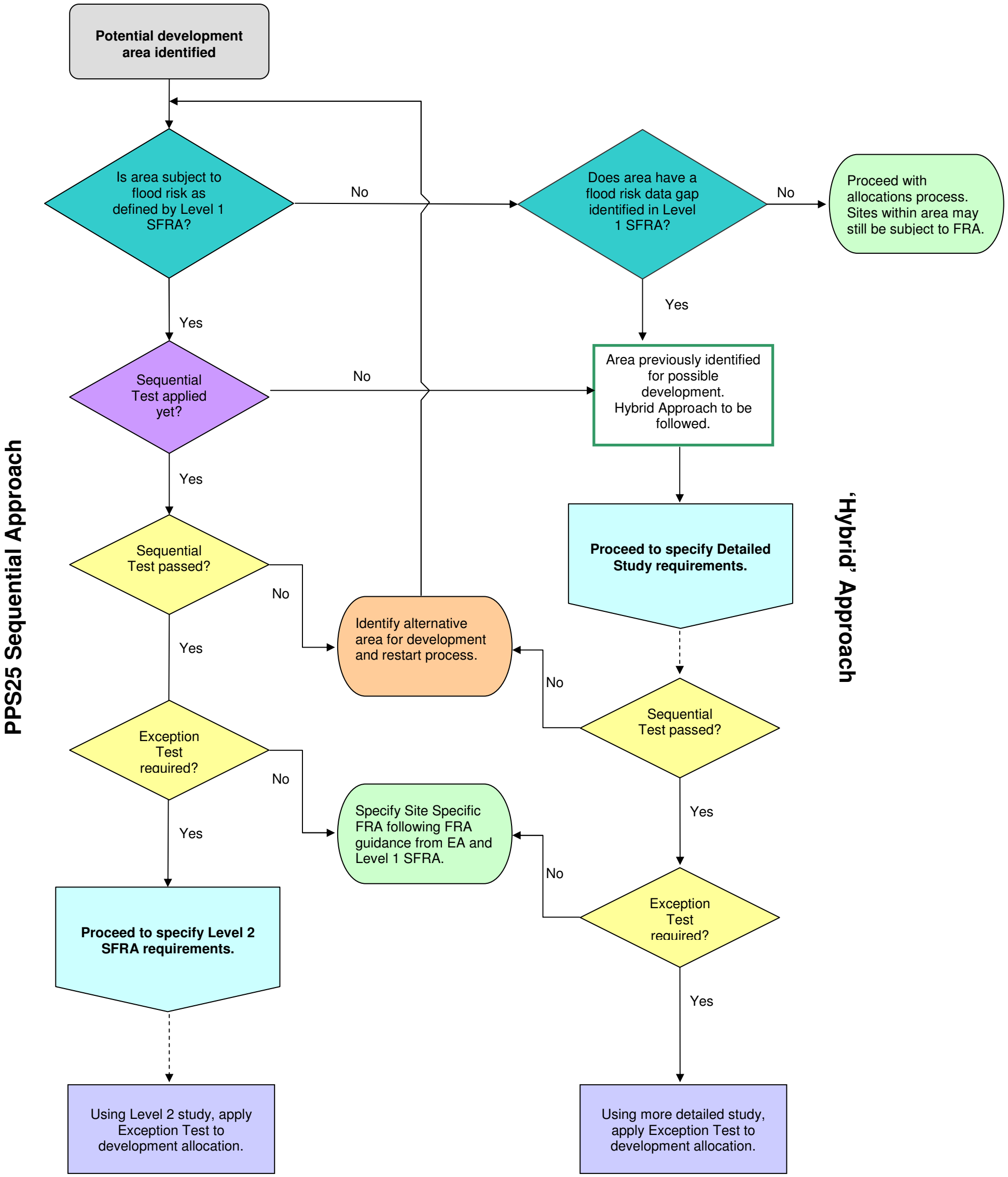


Chart 1-2: Specifying the requirements of a Level 2 SFRA or more detailed study for Fluvial and Pluvial sources of flooding.

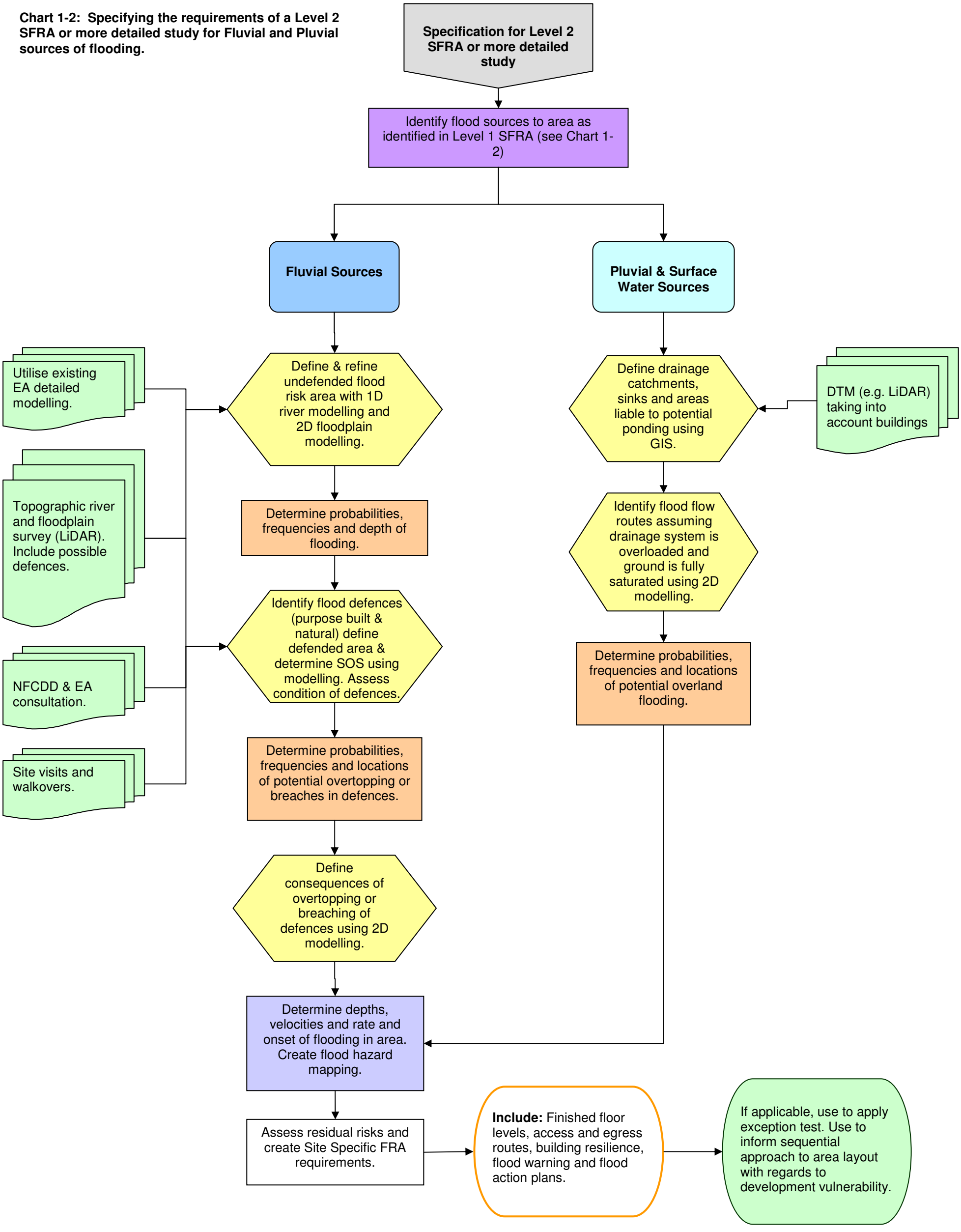
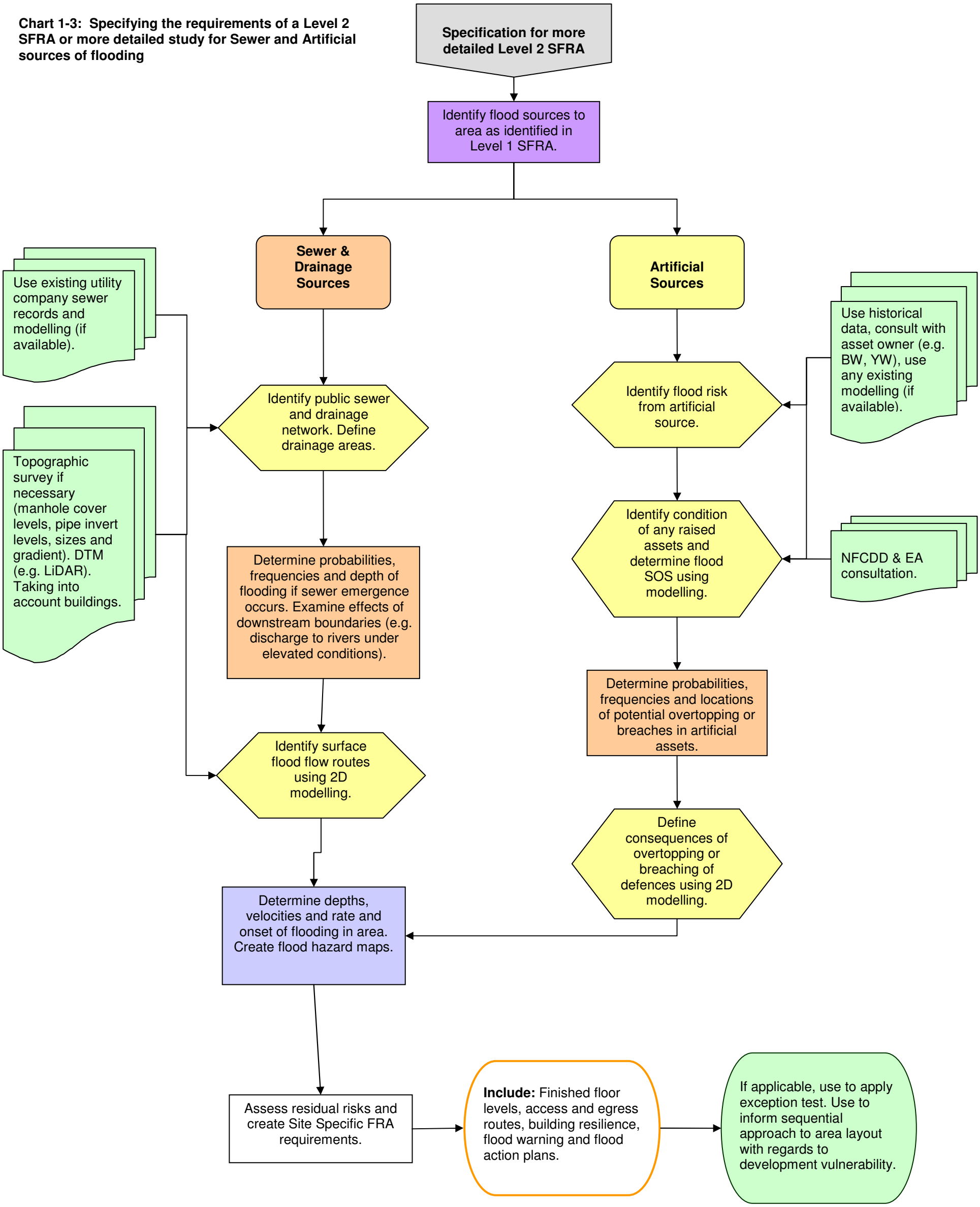


Chart 1-3: Specifying the requirements of a Level 2 SFRA or more detailed study for Sewer and Artificial sources of flooding



1.4 Aims of the Level 2 SFRA

1.4.1 The aim of this Level 2 SFRA is to provide supplementary information to the Level 1 SFRA, to inform on specific flood risk issues and suitability for development of three potential Strategic Growth sites put forward for development in accordance with the guidance set out in PPS25. This should provide sufficient information to enable application of the PPS25 Exception Test to assist in ensuring successful planning applications within the Strategic Growth sites.

1.4.2 A Level 2 SFRA is primarily based upon fluvial and tidal (where applicable) Flood Zones. However the PPS25 Practice Guide requires detailed assessment of all other potential sources of flooding including sewer and drainage, pluvial and surface water, groundwater, overland flow, ponding and artificial sources (including reservoirs/canals).

1.4.3 In order to ensure that the requirements of the Exception Test are incorporated in LDDs, the Level 2 SFRA aims to provide appropriate recommendations regarding future policies, best practice and masterplanning.

1.5 Objectives of the Level 2 SFRA

1.5.1 The SDC Level 2 SFRA will apply the guidance set out in the PPS25 Practice Guide (Paragraph 3.57), and will meet the following objectives:

- appraise the current location, condition, operating standard and level of protection offered by flood defence infrastructure and of the likely future flood management policy with regards to its maintenance and upgrade;
- appraise the probability and consequences of overtopping or failure of flood risk management infrastructure, including estimating the rate and onset of flooding and the velocity and depth of flooding with an appropriate allowance for climate change;
- determine the flood risk within and across Flood Zones at a site or in an area. This will allow policies and guidelines to be developed that place less vulnerable development and water compatible land use (for example, playing fields) in areas of higher risk, whilst development of higher vulnerability is placed in areas of lower flood risk;
- define and map the Functional Floodplain in locations where this is required, including undefended watercourses;
- map the distribution of flood risk across all Flood Zones from all sources of flooding with allowances for climate change;
- identify appropriate policies and practices required for areas which satisfy parts a) and b) of the Exception Test, to ensure development satisfies part c) of the Exception Test at the planning application stage;
- provide guidance on the preparation of Flood Risk Assessments (FRAs) for areas of varying risk across the Flood Zones to enable developers to adhere to flood risk policies. This guidance should include information about the use of Sustainable Drainage Systems (SuDS) techniques suitably applicable to the study area;
- identify the location of Critical Drainage Areas (CDAs) and identification of the need for a Surface Water Management Plan (SWMP) or a series of area specific SWMPs;

- provide meaningful recommendations to inform policy, development management and technical issues;
- assess other residual risks in line with Chapter 7 of PPS25;
- assess risks to other areas upstream and downstream of the areas of interest as a result of development; and
- identify strategic flood alleviation measures for reducing flood risk.

2 Study Area

2.1 District Overview

2.1.1 Selby District is a relatively small rural district, with an estimated mid 2007 population of 80,800. Selby is the largest settlement and provides an administrative, shopping and employment centre for the wider geographical area which is made up of market towns, small villages and agricultural areas.

2.1.2 The District covers an area of approximately 6,190 square kilometres to the south of York and is broadly contained by the A1 trunk road to the west and the River Derwent to the east.

2.1.3 Selby town is the transport hub of the district and features bus and train stations, with direct trains to London, Leeds, Manchester and York. Indeed, the SDC's Strategic Housing Market Assessment suggests that approximately 59% of the working population commute outside the District.

2.2 Spatial Distribution of Development

2.2.1 The spatial distribution of future development in the Selby District is set out in the emerging Selby Core Strategy, and is informed by the Yorkshire and Humber RSS (May, 2008), which seeks to make Principal Towns the main focus for new development. The emerging Selby Core Strategy vision for shaping the future growth of settlements and communities in the District is therefore based upon a settlement hierarchy that will concentrate growth in Selby (the Principal Town), with further growth in the Local Service Centres of Sherburn-in-Elmet and Tadcaster and more sustainable villages to meet local needs.

2.2.2 To achieve the District's housing and employment land targets as set out in the Yorkshire and Humber RSS (May, 2008), the emerging Selby Core Strategy promotes the development of one or more strategic housing sites on the periphery of Selby in the form of sustainable urban extensions, together with a strategic employment site.

2.2.3 The Selby Core Strategy Further Options Report (November 2008) identified the following six urban extension options for housing and two strategic development site options for employment:

Housing Urban Extension Options

- Site A – Cross Hills Lane (42ha)
- Site B – Land West of Wistow Road (25ha)
- Site C – Monk Lane/Bondgate (47ha)
- Site D - Olympia Park (Olympia Mills) (38ha)
- Site E - Baffam Lane (26ha)
- Site F - Brackenhill Lane/Fox Hills Lane (31ha)

Employment Site Options

- Site G – Olympia Park (Land Adjacent to the Bypass) (54ha)
- Site H – Burn Airfield (195ha)

2.2.4 All these sites were considered in the Sequential Test undertaken by SDC (see Section 3.4), which applied a methodology based upon PPS25 and guidance given in the Level 1 SFRA (November 2008).

2.3 Sites Requiring Level 2 Assessment

2.3.1 Following the outcome of the Sequential Test, the study area specific for this Level 2 assessment is defined as Sites A, D and G of SDC's Urban Extension and Strategic Employment Site Options. The locations of the sites are illustrated in Figure 2-1.

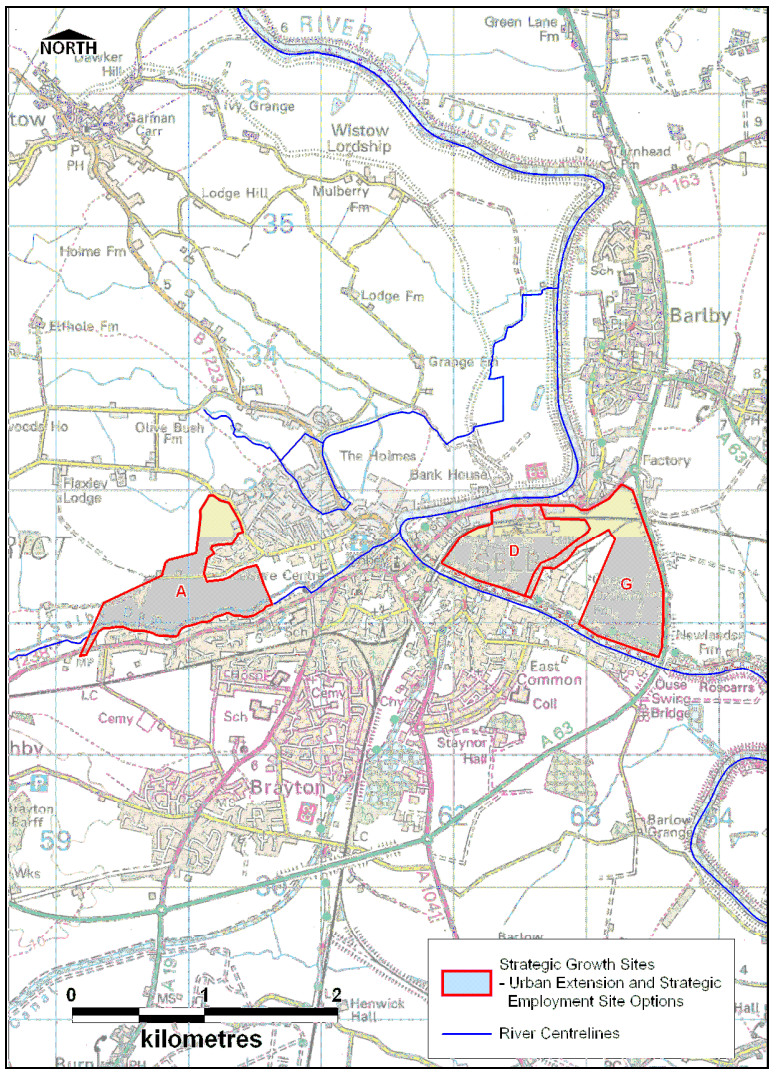


Figure 2-1: Level 2 Study Area Overview

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3 Sequential Approach to Site Allocation

3.1 Development Vulnerability

3.1.1 In order to determine the suitability of land for development in flood risk areas, the vulnerability of the proposed development must first be established. Flood Risk Vulnerability Classifications, as defined in Table D.2 of PPS25, are shown in Table 3-1.

Table 3-1: Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes), which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).

Table 3-1: Flood Risk Vulnerability Classification

Water-Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

3.1.2 Four amendments are proposed for this table in the consultation paper "Proposed Amendments to Planning Policy Statement 25 Development and Flood Risk" [4]. These include the following:

- Water treatment and sewage treatment plants currently shown as 'less vulnerable' would be moved to the 'essential infrastructure' category, plus a clarification to the definition of this category.
- Insertion of additional text providing for police, ambulance and fire stations which are not required to be operational during flooding to be treated as 'less vulnerable'.
- Insertion of additional text in the 'highly vulnerable' category to clarify that where there is a need to locate bulk storage facilities requiring hazardous substances consent with port or other waterside facilities; or installations requiring hazardous substances consent that are associated with energy infrastructure which need to be sited in coastal locations or high flood risk areas, these facilities and installations should be classified as 'essential infrastructure', rather than 'highly vulnerable'.
- Clarification that wind turbines for generating renewable energy should be treated as 'essential infrastructure'.

3.2 Flood Zone Definition

3.2.1 The Flood Zones derived in the Level 1 SFRA Update (November 2008) in the vicinity of Sites A, D and G were based upon data provided by the EA comprising detailed hydraulic modelling outputs. It is important to note that the basic Flood Zones ignore the presence of all formal flood defences in most cases (see Flood Zone definitions below for further information).

Flood Zone 1

3.2.2 Flood Zone 1 comprises land assessed as having a less than 0.1% AEP (1 in 1000 annual probability) of river or tidal flooding in any year (low probability). All uses of land for development are considered appropriate in this zone.

[4] Department for Communities and Local Government. '*Consultation on Proposed Amendments to Planning Policy Statement 25: Development and Flood Risk*'. August 2009. TSO London

3.2.3 A site-specific FRA concentrating on surface water runoff will also be required for any major development within Flood Zone 1 that exceeds 1 ha, illustrating consideration of surface water management options.

Flood Zone 2

3.2.4 Flood Zone 2 identifies the extent of flooding in a 0.1% AEP event, ignoring any formal flood defences OR the extent of the 0.1% AEP event including formal flood defences if greater, OR the largest known historic flood extent if greater.

3.2.5 As defined in Table 3-2, 'Water-Compatible', 'Less Vulnerable', 'More Vulnerable' and 'Essential Infrastructure' land uses are considered appropriate in this Flood Zone. Subject to the application of the Sequential Test, 'Highly Vulnerable' uses are only appropriate in this zone if the Exception Test is also passed. All development proposals in this zone should be accompanied by a detailed site specific FRA.

3.2.6 Policy aims of Flood Zone 2 are such that developers and LPAs should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques (i.e. SuDS).

Flood Zone 3a

3.2.7 Flood Zone 3a identifies the extent of flooding in a 1% AEP (100 year) event, ignoring any formal flood defences, OR the extent of the 1% AEP event including formal flood defences if greater. This Flood Zone also includes the extent of any formal flood storage areas.

3.2.8 As defined in Table 3-2, 'Water-Compatible' and 'Less Vulnerable' land uses are appropriate in this zone. 'Highly Vulnerable' land uses should not be permitted in this zone. 'More Vulnerable' and 'Essential Infrastructure' uses should only be permitted in this zone if the Exception Test is passed. 'Essential Infrastructure' permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood. All development proposals in this zone should be accompanied by a detailed site specific FRA.

3.2.9 Policy aims of Flood Zone 3a are such that developers and LPAs should seek opportunities to:

- relocate existing development to land in zones with a lower probability of flooding;
- reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques; and
- create space for flooding to occur by restoring functional floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

Flood Zone 3b – Functional Floodplain

3.2.10 Flood Zone 3b comprises land where water has to flow or be stored in times of flood with 5% AEP (1 in 20 annual probability) or greater of river flooding in any year or is designed to flood in an extreme flood (0.1% AEP), or at another probability to be agreed between the LPA and the Environment Agency (EA).

3.2.11 As defined in Table 3-2, only the 'Water-Compatible' and 'Essential Infrastructure' land uses should be permitted in this zone. Any permitted development within Flood Zone 3b should be designed and constructed to:

- Remain operational and safe for users in times of flood,
- Result in no net loss of floodplain storage,
- Not impede water flows,
- Not increase flood risk elsewhere.

3.2.12 'Essential Infrastructure' in this zone should also pass the Exception Test. All development proposals in this zone should be accompanied by a detailed site specific FRA.

3.2.13 Policy aims in Flood Zone 3b are such that developers and LPAs should seek opportunities to:

- Reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques (i.e. SuDS),
- Relocate existing development to land with a lower probability of flooding.

3.3 Development Vulnerability & Flood Zone Compatibility

3.3.1 Table 3-2 replicates Table D.3 from Annex D of PPS25, and illustrates a matrix of 'Flood Risk Vulnerability' of a proposed development against 'Flood Zone Compatibility'.

Table 3-2: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification		**Essential Infrastructure**	**Water compatible**	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**
Flood Zone	**1**	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3a	Exception Test required	✓	×	Exception Test required	✓
	3b	Exception Test required	✓	×	×	×

✓ Development is appropriate **× Development should not be permitted**

3.4 The Sequential Test

3.4.1 The Sequential Test is a simple decision making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk. Where new development is necessary in high flood risk areas, it should be directed to sites with the lowest probability of flooding and the flood vulnerability of the intended use should be matched to the flood risk of the site, e.g. higher vulnerability uses located on parts of the site at lowest probability of flooding. The Sequential Test should be applied before moving onto the Exception Test.

3.4.2 Sequential Testing has been undertaken by SDC which applied a methodology based upon PPS25 and guidance given in the Level 1 SFRA (November 2008).

3.4.3 The Sequential Test assesses each of the individual Strategic Development Sites identified in Section 2.2, as well as the broad locations of the local service centres of Sherburn-in-Elmet, Tadcaster and the sustainable villages to determine whether the housing and employment targets set by the RSS (May, 2008) can be accommodated on at the lowest risk of flooding (Flood Zone 1).

3.4.4 The Sequential Test concludes that the housing requirement for Sherburn-in-Elmet and Tadcaster and 'low flood risk' sustainable villages can be satisfied on land at lowest risk of flooding (Flood Zone 1). However, through a detailed analysis of all the Strategic Development Sites identified in section 2.2, the Sequential Test demonstrates that it is not possible to accommodate the remaining housing and employment land requirement on land at the lowest risk of flooding if wider sustainability and regeneration objectives are to be achieved.

Housing

3.4.5 The following provides a summary of the Strategic Development Sites that were not considered to be 'reasonably available' to accommodate future housing:

- Site B was discounted as Wistow Road does not have the capacity to accommodate additional development on any significant scale and there is no realistic highway solution to overcome the problem;
- Site C was discounted for the same reason as Site B, but also because the site is considered to be at significant flood risk, particularly when the dike which drains the site becomes flood-locked by the Wistow Barrier Bank during times of flood; and
- Site E and F were discounted as although they are the least constrained in flood risk terms, significant development on either site would erode the open countryside gap between Selby and Brayton village, potentially leading to coalescence of the two settlements.

3.4.6 This leaves Site A which comprises 50% high flood risk land (FZ3a) and Site D which is virtually all high flood risk land (FZ3a). Part of Site A has the benefit of an existing housing allocation (SEL/1) in the Selby District Local Plan (SDLP) and Site D includes a significant area of previously developed land in close proximity to the existing Selby Urban Area. Given its location on the approach to Selby from the north it could bring significant regeneration benefits to the town. For these reasons Site A and D passed the Sequential Test and are considered under the scope of this Level 2 SFRA for housing.

Employment

3.4.7 Although part of Site H is within an area of low flood risk it was not considered further in the Sequential Test as it is considered to be a less sustainable location than Site G, due to its poorer accessibility and public transport from Selby, and its exposed location.

3.4.8 Site G occupies a strategic location adjacent to the bypass on the northern approach to Selby and is adjacent to existing employment uses. For these reasons Site G passes the Sequential Test and falls within the scope of this Level 2 SFRA for employment activities.

Site G and Site D are considered together in view of their close proximity and opportunitiy to create a comprehensive mixed use scheme.

3.5 The Exception Test

3.5.1 Development is only permissible in areas at risk of flooding where it can be demonstrated that there are no reasonably available sites in areas of lower risk and that the benefits outweigh the risks from flooding. As such, the development must pass the Exception Test (applied by the LPA using evidence supplied by either the Level 2 SFRA or a site specific FRA), which is a method of managing flood risk while still allowing necessary development to occur.

3.5.2 Where there are no reasonably available sites in Flood Zone 1, decision makers should consider reasonably available sites in Flood Zone 2 taking into account the flood risk vulnerability of land uses and applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zone 1 or Flood Zone 2 should decision makers consider sites in Flood Zone 3, taking into account flood risk vulnerability and applying the Exception Test if required.

3.5.3 'More Vulnerable' land uses within Flood Zone 3a and 'highly vulnerable' land uses within Flood Zone 2 should only be permitted if an Exception Test has been passed.

3.5.4 ***Therefore the undertaking of the Exception Test will be required for any proposed residential development within Flood Zone 3a as shown in Table 3-1 and Table 3-2.***

3.5.5 PPS25 states that for the Exception Test to be passed, three main criteria must be satisfied in order for the development to be considered acceptable:

> ***Part A -*** *"It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by an SFRA where one has been prepared. If the DPD has reached the 'submission' stage – the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal",*
>
> ***Part B –*** *"The development should 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",*
>
> ***Part C -*** *A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible will reduce the flood risk overall".*

3.5.6 For successful application it is important that the arguments presented for justification through the Exception Test are in line with policies set out in Local Plans and the LDF, supported by reference to other national planning and sustainability policies, such as development of greenfield sites.

3.5.7 SDC will need to provide evidence that ***Part A*** and ***Part B*** of the Exception Test can be satisfied; the evidence base for which should be partly informed by the Level 1 SFRA Update, LPA Sequential Testing and this Level 2 SFRA. This Level 2 SFRA also aims to provide some information relating to ***Part C*** of the Exception Test for Sites A, D and G.

3.5.8 However, developers will require a site specific FRA to be undertaken for each individual site within these wider strategic development areas to fully satisfy the requirements of ***Part C***.

4 Methodology

4.1.1 This section describes the methodology and scope of the Level 2 SFRA which ensure the objectives stated in Section 1.5 in accordance with PPS25 are achieved.

4.2 Scope of Level 2 SFRA

4.2.1 Following discussions with representatives from SDC and the Environment Agency, and in accordance with PPS25 and the Practice Guide, the following outputs have been agreed to be produced as part of this Level 2 SFRA.

4.2.2 The detailed nature of the flood hazard within each Flood Zone is considered taking account of flood management measures and the presence and likely performance of flood risk management infrastructure, specifically:

- the probability of flooding;
- depth of flooding;
- velocity of flood flows; and
- rate of onset of flooding.

4.2.3 These factors can be significantly affected by the presence of hard or soft flood defences (walls or embankments respectively) or any other infrastructure which may act as a flood defence such as road or railway embankments.

4.3 Hazard Mapping

4.3.1 To provide a greater level of detail on the fluvial flood risks, an appraisal of the probability and consequences of flooding associated with the Selby Dam watercourse and the River Ouse bordering Site A and Sites D and G respectively was undertaken.

4.3.2 Site A has been assessed to determine the risk of overtopping of the left bank as no raised defences currently exist along the adjacent reach of Selby Dam. Sites D and G however have been assessed to determine the residual risk of overtopping and/or breaching of raised defences that exist along the left bank of the adjacent reach of the River Ouse.

4.3.3 It is intended that the hazard maps will provide the LPA with an understanding of the actual and residual flood risks faced in their areas. The hazard maps will inform policies and practices required to ensure development satisfies the requirements of the Exception Test through the detailed consideration of flood hazard.

Data

4.3.4 To produce the hazard maps the following sources of information supplied by the EA have been used:

- LiDAR[5] topographic data (September 2009)
- River Ouse Model Update. One-dimensional (1-D) ISIS Model, draft version September 2009, Halcrow Group Ltd.

[5] Light Detection and Ranging.

- Selby Dam Flood Mapping Study. One-dimensional (1-D) HEC-RAS Model, Final version March 2008, JBA Consulting Ltd.

4.3.5 LiDAR is a method of optical remote sensing which uses light reflections to determine vertical heights. The LiDAR data available for this project was produced with a horizontal resolution of approximately 2m and typically has a vertical accuracy of +/- 0.25m. LiDAR records the vertical heights of an area as the eye would see it from above, and therefore includes all buildings, structures and vegetation; this is known as the Digital Surface Model (DSM). Algorithms which detect the presence of buildings filter the LiDAR data to produce a Digital Terrain Model (DTM) where the majority of buildings, structures, and vegetation are removed. This is processed in a GIS package (MapInfo with Vertical Mapper) prior to being used for the depth hazard mapping.

Site A Approach

4.3.6 The existing hydraulic model of Selby Dam is a 1-D HEC-RAS model comprising channel cross sections and indicative floodplain reservoir units. It does not have an associated detailed velocity output representing flows across the floodplain. As a result, full hazard mapping could not be undertaken. Alternatively, the hazard for Site A resulting from overtopping has been classified as a function of depth assuming zero velocity. Flood levels derived at each of the 1-D cross sections in the model adjacent to the site were extended across the adjacent floodplain using a triangular mesh and the depth was determined in relation to ground levels represented by a LiDAR Digital Terrain Model (DTM). This provided an indication of depths across the floodplain resulting from varying in-channel water levels.

4.3.7 The depth hazard classifications defined by Defra (2005) are shown in Table 4-1.

Table 4-1: Key to Depth Hazard

Depth of Flooding*	At Risk
0.30m - 0.50m	Risk to Some
0.50m - 1.50m	Risk to Most
>1.50m	Risk to All

**Taken from Table 13.1 of the Defra/EA FD2320/TR2 report.*

Sites D & G Approach

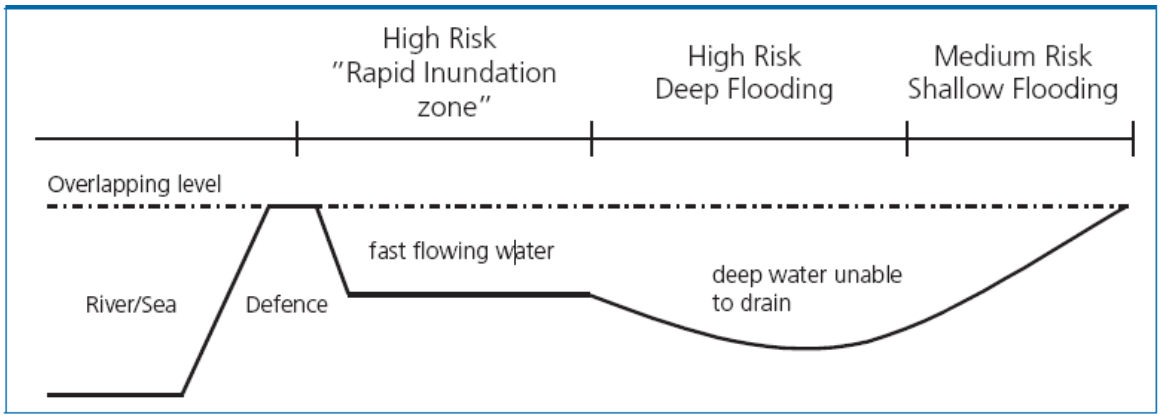
4.3.8 The aim of the Environment Agency's River Ouse modelling project was to develop 'with defences' and 'without defences' models to map flood outlines and areas benefiting from defences for a number of reaches within the River Ouse catchment. The hydraulic model is 1-D, comprising channel cross sections and indicative floodplain reservoir units and does not have an associated detailed velocity output representing flows across the floodplain.

4.3.9 The raised flood defences at Olympia Park present a residual risk of flooding from a breach in defences. PPS25 Practice Guidance identifies the residual flood risk behind a flood defence as dependent upon the following:

- depth of flooding;
- velocity of flood water flow;
- local flow paths;

- speed of onset of the flood;
- distance from the defences (as distance from a defence typically has an effect on velocities and the rate of onset of flooding); and
- duration of the flood and how water will be removed.

4.3.10 Guidance on the level of risk related to distance and flood depth for overtopping and breaching scenarios is provided in Guidance Note S3.2 'Risks to people behind defences' of the Defra/EA FD2320/TR2 report, and illustrated in the following diagram.



Note: This figure is a simplification and accurate mapping of residual risk levels behind flood defences requires consideration of local factors.

Figure 4-1: Risk Zones behind a River or Sea Defence
Extract from Table 7.1 of the PPS25 Practice Guidance summarised from Defra/EA FD2320/TR2 report - Guidance note S3.2.

4.3.11 To quantify the residual risk, the existing ISIS hydraulic model was converted into a hybrid 1D-2D (ISIS-Tuflow) model. The floodplain in the Olympia Park area was represented by linking a 2D Tuflow domain to the ISIS model. The 2D element of the hybrid model calculates the velocity of flood water across the floodplain allowing the full flood hazard to be determined.

4.3.12 The hybrid SFRA hydraulic model was run for the 1% annual probability (100 year) event including an allowance for climate change and the 0.5% annual probability (200 year) event to determine any overtopping of flood defences.

4.3.13 In addition, a breach scenario was undertaken, representing a breach in the left bank flood defences at the north of Olympia Park during the 0.5% annual probability (200 year) event. In line with current best practice and in agreement with the Environment Agency, the following parameters were used to represent the breach scenario:

- The breach start time was simulated to begin one hour before the peak fluvial flood level;
- Since the flood defences are flood walls ('hard' defences), a 20 m wide breach was simulated; and
- The time to closure of the breach was 36 hours.

4.3.14 Guidance set out in the DEFRA/EA Flood Risk Assessment Guidance for New Development FD2320 Technical Report[6] categorises the flood hazard as a function of depth and velocity, and the resultant risk posed to different groups/vulnerabilities of people, as shown in Table 4-2. Using the hazard information, the flood risk within and across Flood Zones at a site can be determined for the desired return period flood events.

Table 4-2: Danger to people for different combinations of Depth and Velocity

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

Key:
- Danger for some
- Danger for most
- Danger for all

Taken from Table 13.1 of the Defra/EA FD2320/TR2 report.

4.3.15 A simplified guide to the groups of people that should be considered as falling into each of the danger classifications are included below:

- Danger for some – includes children, the elderly and the infirm
- Danger for most – includes the general public
- Danger for all – includes emergency services

Assumptions and Limitations

4.3.16 The EA's draft River Ouse hydraulic model that was used for the breach modelling is complex and has evolved over a number of years. The model was assumed to accurately represent the river system and flood defences through Selby. Aside from introducing the breach scenarios, the hydraulic model provided by the EA was not altered.

4.3.17 The results presented in this Level 2 SFRA are suitable for strategic planning purposes to provide an indication of the effects of a breach event at the chosen location.

Rapid Inundation Zones

4.3.18 The PPS25 Practice Guide identifies a rapid inundation zone as an area at risk from rapid flooding should a flood defence structure be breached or overtopped. Unsurprisingly, these areas tend to be located close behind the flood defences. In general, the guidance suggests that new development should be sited away from existing flood defences as there

[6] DEFRA and Environment Agency Flood and Coastal Defence R & D Programme. '*Flood Risk Assessment Guidance for New Development'*. October 2005. R&D Technical Report FD2320/TR2. Defra London.

is a residual risk to all. However, in exceptional circumstances, where a FRA shows how the building and its users will be made safe, then development may be situated closer to flood defences.

4.3.19 There is an inherent risk to properties in the rapid inundation zone from the potential high floodwater velocities following a breach event. Although the local topography and condition of existing River Ouse defences would need to be considered, the definition of this area for a particular site should be identified in a site specific FRA.

4.3.20 Using the above information, the flood risk within and across Flood Zones at a site can be determined. This allows policies and guidelines to be developed that place less vulnerable development and water compatible land use (for example, playing fields) in areas of higher risk, whilst development of higher vulnerability is placed in areas of lower flood risk.

4.4 Policies & Guidance for Developers

4.4.1 A series of policies and guidance for any proposed development at sites A, D and G is provided (see Sections 7 and 8), including site specific FRA guidance and SuDS guidance to enable developers to adhere to flood risk policies. These policy statements are be aimed at reducing the associated flood risk by making recommendations to:

- roll back development away from the watercourse and incorporate green (or "blue") corridors in the layout design, ensuring that no development encroaches within the modelled Flood Zone or is restricted to certain distance away from an un-modelled watercourse;
- consider the risk from all sources of flooding as part of a detailed site specific Flood Risk Assessment (FRA), which may include modelling of a watercourse, should it currently be un-modelled or to an insufficient level of detail;
- determine suitable flood risk mitigation measures and management options (SuDS) where other strategic factors govern the need to develop within a flood risk area; and
- ensure that any proposed development will not have a detrimental effect upon flood risks posed to areas upstream or downstream of the proposed development site.

4.5 Residual Risks

4.5.1 General policy advice has been provided in relation to the consideration of residual risk to proposed development sites, including emergency response (flood warning and emergency plans), access and egress and advice on appropriate finished flood levels (see Section 9).

4.6 Determination of Critical Drainage Areas

4.6.1 It is recommended that CDAs are investigated as part of a SWMP for the regional administrative area of North Yorkshire County Council. The SWMP should determine in detail areas where historical incidents of surface water and sewer flooding (identified in the Level 1 SFRA with any new data) coincide with areas of high flooding probability in the EA's Areas Susceptible to Surface Water Flooding Maps.

5 Level 2 SFRA: Site A - Cross Hills Lane

5.1 Site Introduction

5.1.1 Site A 'Cross Hills Lane' comprises approximately 42 ha and is located on the western edge of Selby Urban Area to the north of the Selby Dam watercourse and the A1238/A63 Leeds Road. Cross Hills Lane follows an east west direction and provides an existing access from Selby town centre via Scott Road, then Flaxley Road to the central area of the site.

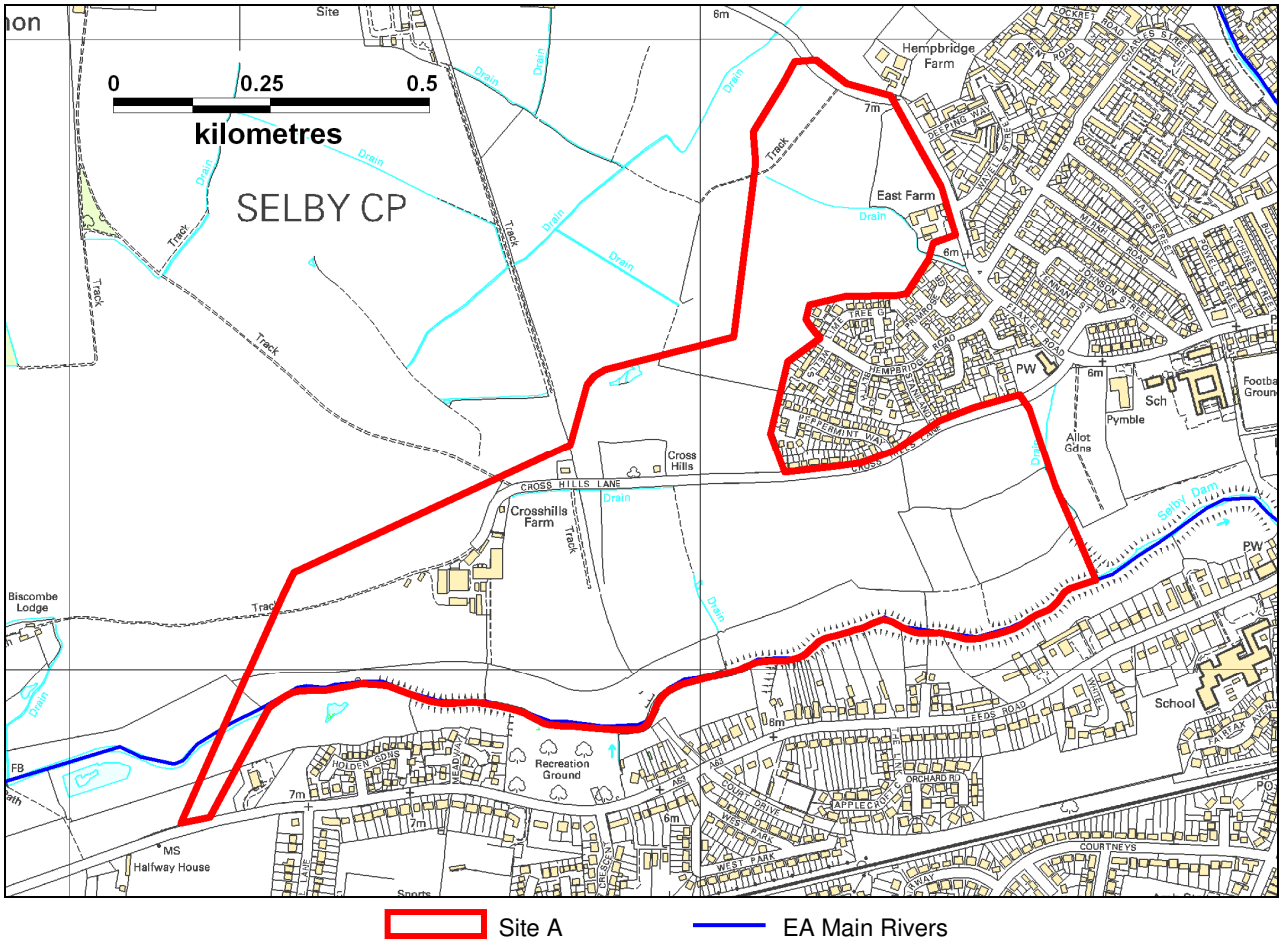


Figure 5-1: Site A - Cross Hills Lane

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5.1.2 Existing land uses at the site include residential and outbuildings associated with Cross Hills Farm located at the western end of Cross Hills Lane, and East Farm located in the north eastern corner off the site which is accessed from the east by Flaxley Road. The remaining majority of the site is comprised of cultivated fields bordered by mature hedgerows and intermittent trees.

5.2 Potential Development Proposals

5.2.1 Part of site A (21.9 ha) has an existing allocation (SEL/1) in the Selby Local Plan for residential development, that was proposed to provide approximately 450 new houses, served from Meadway.

5.2.2 SDC suggest that the increased site boundary of site A, served from Leeds Road via a potential access bridge crossing Selby Dam at the western extent of the site, could accommodate 1000 dwellings. However, the actual residential yield that the site is capable of delivering will be determined by the findings of a detailed site specific flood risk assessment to be carried out by the developer.

5.2.3 Residential development is considered by PPS25 to be 'more vulnerable'.

5.3 Sources of Potential Flooding

Fluvial – Selby Dam

5.3.1 The main channel of Selby Dam watercourse is a designated Main River under the responsibility of the Environment Agency, Ridings Area and Dales Area (Water Resources Act, 1991). The river originates to the east of the settlement of Sherburn-in-Elmet approximately 5.5 km to the west of Selby. The Selby Dam Flood Mapping Study (JBA, 2008) describes the watercourse as draining a catchment area which includes Sherburn-in-Elmet, South Milford, Thorpe Willoughby and the smaller settlements of Monk Fryston (north side), Church Fenton, Little Fenton, Biggin and Hambleton, and encompasses Bishop Wood and the Gascoigne Wood Mine.

5.3.2 This catchment area comprises a drainage network that has been heavily modified from the natural drainage pattern of the area, assisted by a pumping station at Selby and various other structures. Tributaries discharging into Selby Dam are the responsibility of the Selby IDB.

5.3.3 Selby Dam flows in an easterly direction along the southern boundary of the site. From OS 1:10,000 mapping, three minor drain tributaries of Selby Dam have been identified within the site boundary; one flowing southwards along the eastern boundary, a second flowing southwards in the central southern area of the site, and a third running west to east along the southern side of Cross Hills Lane. Approximately 25% of the site was affected by flooding from Selby Dam during the November 2000 event.

5.3.4 The Selby Dam and Tributaries modelling study was completed in March 2008 and the final modelled flood outlines for the Selby Dam and its associated tributaries was provided by the EA for inclusion in the Updated Level 1 SFRA (November 2008). This data represents the most up to date delineation of the Flood Zones associated with Selby Dam and its tributaries and therefore provide the best available representation of flood risk. The study outputs also provide a higher degree of confidence in the definition of flood risk across the floodplain. SDC and the EA agreed as part of the Level 1 update that the Selby Dam and tributary watercourses should be represented by the output of this study.

Fluvial – Agricultural drain tributaries of Cockret Dike

5.3.5 A small number of agricultural land drains facilitate drainage of the northern area of the site. These drains are the responsibility of the Selby Internal Drainage Board (IDB) and comprise tributaries of Cockret Dike to the north, that itself is an EA Main River which forms a part of the larger Holmes Dike catchment area.

Level 1 SFRA Flood Zones

5.3.6 The southern region of the site was illustrated within the Level 1 SFRA Update (November 2008) as being located within fluvial Flood Zone 3a (≤1 in 100 year, 'high probability') and Flood Zone 2 (≤1 in 1,000 year, 'medium probability', also adopted as a proxy for the 1 in 100 year plus climate change flood outline) of Selby Dam.

5.3.7 The northern region of the site was also illustrated as being located within the Flood Zone 3b outline (1 in 20 year Functional Floodplain proxy taken from historical outlines) for the agricultural drain tributaries of Cockret Brook.

5.3.8 The central and far north eastern region of the site was illustrated as being located within Flood Zone 1 (> 1 in 1,000 year 'low probability').

5.4 Existing Flood Mitigation Measures

5.4.1 In accordance with the PPS25 Practice Guide a Level 2 SFRA should consider the location, condition, operating standard and level of protection offered by flood defences and flood risk management structure.

5.4.2 The EA have confirmed that here are no raised flood defences along the left bank of Selby Dam in the vicinity of site A. However, flood risk management infrastructure in the vicinity of site A includes Selby Dam Pumping Station located to the west of Water Hill Lane that pumps flows from Selby Dam into the River Ouse via a 24 inch pump. The EA recently took responsibility for the pumping station and its equipment under new flood management regulations.

5.5 Hazard Mapping – Bank Overtopping Scenario

5.5.1 The Selby Dam Flood Mapping Study hydraulic model simulated a number of different scenarios on Selby Dams and its tributaries. Two main hydrological scenarios were considered in the original study:

1) Fluvial flooding from Selby Dams (fluvial)
2) Flooding where the River Ouse is a dominant factor (tidal)

5.5.2 For each of the above scenarios, four options were modelled as part of the original study:

a) Defended - All pumping stations operating at full capacity
b) Option 1 - Pumping stations not operating
c) Option 2 - Pumping stations operating at 50% capacity
d) Option 3 - Pumping stations not operating and all embankments (upstream of the site) removed

5.5.3 The 'Ouse Dominated' scenario gives higher flood levels than 'fluvial only' scenario. Consequently 'Option 3' also gives the highest or 'worst case' flood levels taking into account potential failure of all pumping stations along the watercourse, including the Selby Dam Pumping Station. As part of the Level 2 assessment for Site A, the following model scenario was used to create depth hazard maps to demonstrate the worst case scenario.

- **2 and d) - Ouse Dominated with Option 3 with pumping stations not operating and all embankments removed.**

5.5.4 At the time of undertaking the depth mapping, the 1 in 100 year (1% AEP) event (Flood Zone 3) and the 1 in 1000 year (0.1% AEP) event (Flood Zone 2) excluding allowances for climate change were the best available information.

Depth Hazard Results

5.5.5 The Depth Hazard map is presented in Figure A-1, Appendix A and illustrates the level of hazard both in-bank and in the floodplain. The map shows that intermittent areas across the southern area of the site adjacent the watercourse are consistent with a 'Danger to All'. Extending further northwards along this corridor, particularly in the eastern half of the site to the south of Cross Hills Lane and south of Cross Hills Farm, the depth has been determined as a 'Danger for Most'. A narrow band alongside this, again to the south of Cross Hills Lane and more pronounced in the eastern area of the site, is classified as 'Danger to Some'. Flood depths within the remaining flood envelope extent and remainder of the site have been determined to pose insignificant risk from Selby Dam.

5.6 Recommendations and Policies

5.6.1 The existing hydraulic model does not take into account a potential increase of 20% in rainfall and resultant flows due to climate change over the expected lifespan for residential development which PPS25 recommends. Site-specific FRAs and future updates to the Level 2 SFRA should therefore take account of the 1% AEP (1 in 100 year) including an allowance for climate change, and the 5% (1 in 20 year) event to determine the extent of the Functional Floodplain (Flood Zone 3b) as defined by PPS25.

5.6.2 General recommendations and policies to be considered for the individual areas in addition to the requirements of PPS25 are included in Section 7. Suitable mitigation measures should be implemented in any proposals to reduce the risk of flooding to the development from all sources, and prevent an increase in flooding resulting from the development to neighbouring land uses upstream and downstream of the strategic site (see Section 9). Specific recommendations to be considered at Site A are detailed below.

- As Selby Dam is undefended along this reach adjacent to the site, phased development within the strategic site should adhere to the sequential approach both across the overall site, and within individual development site proposals as advocated by PPS25, taking consideration of the relative flood risk and development vulnerability of the intended land use. This should include the following:
    - 'More vulnerable' residential development should first be allocated in the western, central western and northern areas of the site, i.e. out of the floodplain extent (Flood Zone 1) where the depth hazard is not considered to pose a significant risk (if any).

- ‘Less vulnerable’ types of development should be allocated in the southern and eastern area of the site to the south of Cross Hills Lane (Flood Zones 2 and 3). Within these Flood Zones, such development should be directed first to the areas illustrated with depths that pose ‘Danger to some’ before depths that pose a ‘Danger to all’.
- Should, where necessity arises, ‘more vulnerable’ buildings be proposed within Flood Zones 2 and 3, they need to incorporate ‘safe places’ of refuge where people can retreat to and reside in relative comfort until they can be rescued by emergency services.
- Residential basement accommodation, single storey accommodation, and multi-storey buildings with ground floor sleeping should not be allocated in these areas. Sleeping accommodation should be restricted to the first floor or above to offer the required ‘safe places’.
- The finished internal floor levels of these ‘safe places’ should be set at a minimum freeboard distance above the peak 1 in 100 year plus an allowance for climate change flood level of the particular area of the site (determined by a site specific FRA). This freeboard should be agreed with the EA as part of the site specific FRA. Internal ground floors below this level could then be occupied by, garages, non-sleeping residential rooms (e.g. kitchen, study, lounge etc) or ‘less vulnerable’ commercial premises (i.e. a sequential approach applied within a building).

- Site specific FRAs should be undertaken by the developer to determine the relative flood risks within the location of the individual site of the larger strategic site.
- For development in the area to the north of Cross Hills Lane, a site specific FRA should include assessment of the likely flood extents for the tributary drains of Cockret Dike (potential modelling) for a range of return periods and relevant mitigation where necessary, agreed with the Selby IDB.
- Surface water management measures should be incorporated into any strategic master-plan across the site, using sustainable drainage systems (SuDS). Section 8.5 describes the geology of the site and provides recommendations for a range of potential SuDS techniques. As part of a site specific FRA for individual development proposals, assessment of detailed geological ground investigation data will be required to determine the suitability of the various techniques.
- To create a more efficient pattern of development there may be potential to raise land within a narrow part of the area along the southern side of Cross Hills Lane above the 1 in 100 year plus climate change flood level (to be determined by a site specific FRA as the Level 1 SFRA currently uses the Flood Zone 2 levels as a proxy for this scenario). This will need to be agreed with the EA and compensatory volume storage will also need to be provided within the south western area of the site to recoup the displaced flood storage volume. Volume compensation should aim to be provided for on a “level for level” basis to mimic floodplain conveyance characteristics prior to the proposed development.
- It is proposed by SDC that a ‘blue’ corridor is to be created alongside the watercourse in the southern area of the site which is largely characterised by the extent of Flood Zone 3. This corridor should be designated for provision of flood mitigation, green infrastructure, providing linkages into existing/creating new public rights of way and as an area with the potential to increase biodiversity (for example creating habitat). Such land uses can be aimed at facilitating public recreation, for example by the creation of boardwalks and bridges to enable visitors to interact better with the river. The corridor

can also provide opportunities to incorporate landscaped compensatory storage areas (intermittent wetlands), and surface water management options (SuDS) by planting of native vegetation including meadow grasslands, trees and marginal aquatic vegetation which assist infiltration reducing runoff rates, and improving water quality.

- Any future proposals for an access bridge crossing Selby Dam from Leeds Road in the far western area of the site will need to ensure no obstruction to flow, and no displacement of flows are created within the 1 in 100 year plus an allowance for climate change flood extent (as determined as part of a site specific FRA).
- The dedicated Floodline Warnings Direct System should be adopted by residential occupants of the site in the event of Selby Dam overtopping its banks. The automated system would ensure warnings are provided during over-night hours when the majority of people are sleeping. Such measures are described further in Section 9.4.

6 Level 2 SFRA: Sites D & G Olympia Park

6.1 Site Introduction

6.1.1 Site D comprises approximately 38 ha and is located adjacent the left bank of the River Ouse to the east of Selby. Existing land uses within the site include mill buildings and former operational land belonging to BOCM (Pauls), allotments, a sport playing field, agricultural land, Ousebank Farm and small parcels of woodland. A railway line to the east of a swing bridge (from where it crosses the Ouse) passes through the site. The site is accessed from the A19 from the north.

6.1.2 Site G comprises approximately 54 ha of land to the west of the A63 bypass immediately adjacent Site D. Existing land uses within the site include predominantly agricultural land, Cherry Orchard Farm along the southern boundary, and an industrial development in the north west corner. The railway line passes through the northern area of the site, where it is adjoined by a second line leading to the Potters Group development to the south, outside the site boundary. The site is currently accessed from the A63 bypass to the east, or along the A19 Barlby Road from the north. There is also a spur road from the bypass roundabout that could provide direct access into the site from the east.

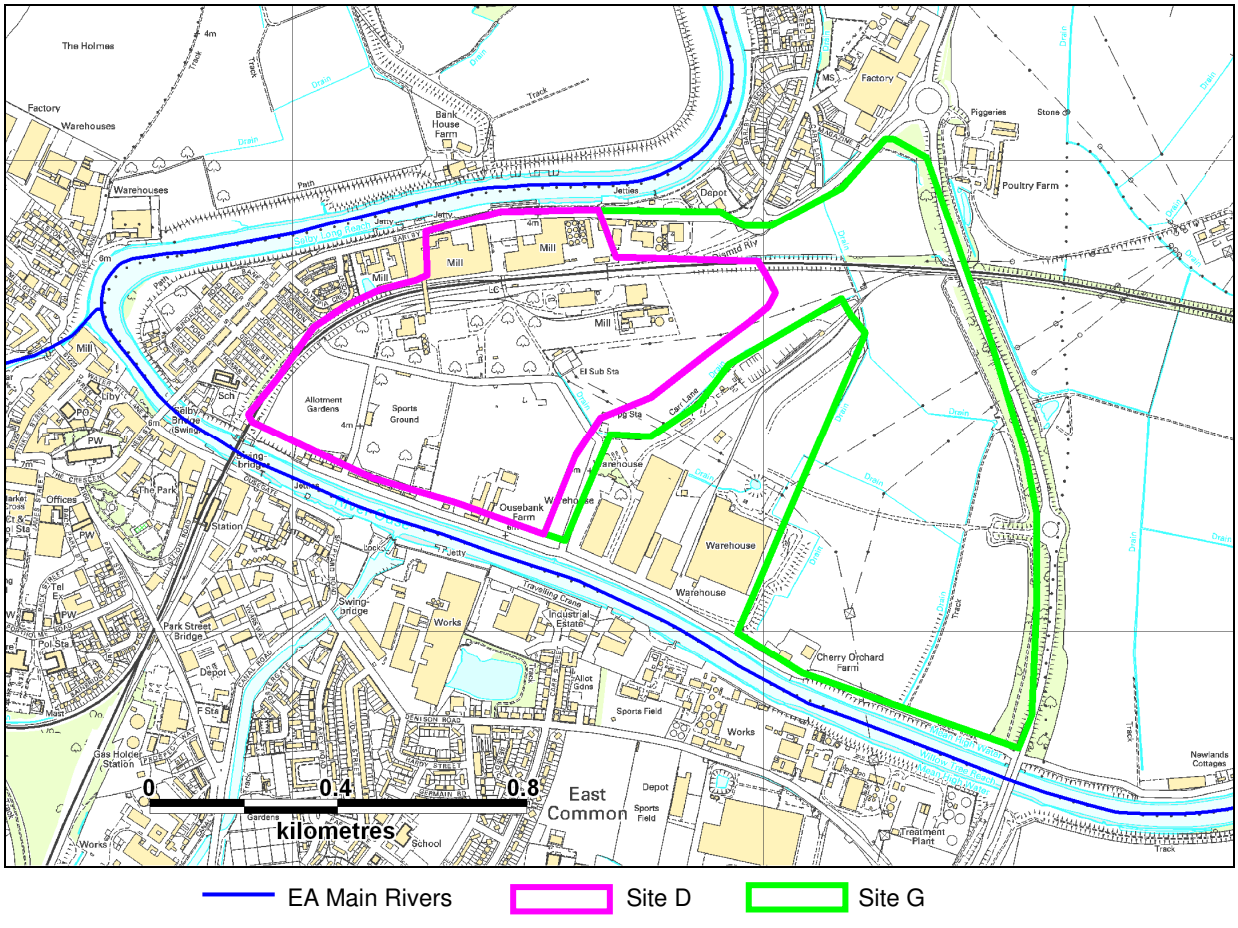

Figure 6-1: Sites D & G – Olympia Park

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6.2 Potential Development Proposals

6.2.1 SDC have proposed that site D could be used to accommodate 800 dwellings. However, the actual residential yield that the site is capable of delivering will be determined by the findings of a detailed site specific FRA to be carried out by the developer. Residential development is considered by PPS25 to be "more vulnerable".

6.2.2 SDC have proposed that site G could be used to accommodate mixed employment activities. The two parcels of land north of the railway already have non implemented planning permissions (a 2 ha parcel in the west for commercial high end B1 uses and an eastern 5ha parcel for B1/B2/B8 uses). A narrow 3.5 ha parcel to the west of the 'Potter Group' development is intended for expansion of freight distribution activities. Such commercial and industrial development is considered by PPS25 to be "less vulnerable".

6.3 Sources of Potential Flooding

Fluvial - The River Ouse & Tributaries

6.3.1 The River Ouse is formed from the River Ure at Cuddy Shore Reach near Linton-On-Ouse, approximately 6 miles downstream of the confluence of the River Swale with the River Ure. Comprising these combined flows originally sourced within the Yorkshire Dales, the River Ouse generally flows in south easterly direction for approximately 100 km, through the city of York and the market towns of Selby and Goole, before joining the River Trent at Trent Falls near the village of Faxfleet forming the Humber Estuary. The River Ouse is a designated Main River under the responsibility of the EA.

6.3.2 The Ouse catchment is a wide, flat plain, with an approximate catchment size of 735 km^2. The Ouse approaches the town of Selby from the north east and at Barlby, begins to meander as a tight bend around the north eastern edge of the town before continuing in a south easterly direction away from Selby towards Hemingbrough.

6.3.3 Heavy rainfall in the river's catchment area can bring severe flooding to nearby settlements. In recent years Selby and surrounding villages, have been very badly affected. There is a well-documented history of flooding from the River Ouse, with records dating back as far as 1263. The principal flood risk to the Selby district is through storm surges that flow upstream from the tidal reach of the Ouse. More recently, the Ouse hit local and national media as a result of widespread flooding in autumn 2000, with Selby town and Barlby worst affected.

Fluvial - Cherry Orchard Drains

6.3.4 A number of agricultural land drains facilitate drainage of the sites. These are known as part of the Cherry Orchard drain network that is the responsibility of the Ouse and Derwent IDB.

Level 1 SFRA Flood Zones

6.3.5 The entire region of the combined site D and site G area was illustrated within the Level 1 SFRA Update (November 2008) as being located within fluvial Flood Zone 3a (≤1 in 100 year, 'high probability') of the River Ouse for the 'undefended' scenario.

6.4 Existing Flood Mitigation Measures

6.4.1 As stated in Section 1.5, in accordance with the PPS25 Practice Guide a Level 2 SFRA should consider the location, condition, operating standard and level of protection offered by flood defences and flood risk management structure.

6.4.2 Formal flood defences are typically engineered structures designed to limit the impact of flooding, but do not eliminate flood risk completely. Flood defences are generally designed and constructed to protect people and property from a given magnitude of flood. This is referred to as the Standard of Protection (SoP) or Design Standard and may vary depending on the age of the structure, the value attributed to the people and property it is designed to serve, and the scale/cost of works necessary to construct the defence. The reduction in flood risk that the defence provides depends on the SoP and the performance and reliability of the defences.

6.4.3 For new defences, such issues and others are balanced through a cost benefit analysis to determine if investment in defence schemes can be justified. Flood defences take several forms including bunds/embankments, canalised channels, culverts and flood storage areas among others.

6.4.4 To protect properties at risk from the River Ouse there are approximately 86 km of defences, the SoP of these defences range from greater than 20% (>1 in 5 year) to less than 0.5% (<=1 in 200 year) in places. Immediately following the November 2000 floods, the EA constructed emergency works at Selby to provide increased temporary protection to the town. A £13.7 million scheme to make these permanent is now complete and will protect approximately 2500 homes. These defences are the responsibility of the EA.

6.4.5 The presence of such flood mitigation measures may however pose a residual risk of flooding to the sites as a result of overtopping or breach during extreme flood events. An assessment of the existing flood defence measures adjacent to Sites D and G is therefore necessary as part of this Level 2 study.

6.4.6 Information on defence structures within the study area has been provided by the EA from their National Flood and Coastal Defence Database (NFCDD). The NFCDD is used as a repository for information relating to flood defences including their location, type, condition and design standard. The NFCDD is still being populated and constantly updated. The River Ouse is defended by raised embankments along its left bank in the vicinity of Sites D and G.

6.4.7 The EA have confirmed that the new Ouse defences constructed at the reach adjacent sites D and G modelled to breach are comprised of LX8 driven sheet piles between 2.5-6 m long, capped by reinforced concrete and are brick faced. The piles are set in a 15 m wide (at the base) earth embankment, at a maximum vertical height above ground level of approximately 3 m. Additionally, on the 'wet' side there is a 10 m long foreshore at a typical height of 4.6 m AOD. A new defence height of 7.46 m AOD is therefore present along this reach providing a design SoP of up to 1 in 200 years.

6.4.8 The embanked defences are well maintained by the Environment Agency, undertaking periodic maintenance such as grass cutting, weed control and vermin control. The river toe is regularly inspected to identify early any potential defects such as bank slips and erosion. Therefore the likelihood of a defence breach scenario adjacent the sites is considered to be very low.

6.5 Risk of Overtopping

6.5.1 Using the methodology outlined in Section 4, the risk of overtopping was assessed using the hybrid SFRA hydraulic model. The hydraulic modelling results show that the flood defences on the left bank of the River Ouse are ***not overtopped*** during either the 1% AEP (1 in 100 year) event including an allowance for climate change or the 0.5% annual probability (1 in 200 year) event. Olympia Park is therefore considered to be an area benefiting from flood defences during these magnitude events.

6.6 Residual Risk of Defence Breach

6.6.1 Using the methodology outlined in Section 4, a breach in flood defences was simulated to determine the residual flood risk during the 0.5% AEP (1 in 200 year) event.

6.6.2 The model simulation identified that Olympia Park becomes inundated during a breach scenario at the given location. The breach location and the Full flood hazard associated with a breach in defences at the given location are presented in Figure B-1, Appendix B. A description of the flood hazard classifications is included in Table 4-1. Figure B-2, Appendix B shows the maximum flood depths across the sites following the breach event. Figure B-3, Appendix B shows the velocity of flood flow following the breach event and Figure B-4, Appendix B shows the inundation time.

6.6.3 In the modelled scenario, the majority of site D is characterised by a flood hazard considered to pose a 'Danger to Most' with a smaller combined area in the east of the site considered to pose a 'Danger to All', site G is characterised mostly by a flood hazard considered to pose a 'Danger to All' with areas in the south considered to pose a 'Danger to Most'. Therefore site G has a greater flood depth hazard than site D.

6.6.4 The topography of the existing site has resulted in maximum flood depth hazards being experienced within the central and eastern areas of site G, being shallower progressing to the west and to the south across both sites. As expected, the velocity hazard of flood flows is greatest immediately adjacent the breach in the defences, becoming less of a hazard with progressing distance away and passing over shallower ground level change gradients.

6.6.5 As stated in Section 6.4, the defences in the vicinity have only very recently been constructed to a high quality and are subjected to regular inspection and maintenance by the EA. The probability of a breach event occurring in these defences is therefore considered to be very low. However, the implications if such an event was to occur without mitigation measures being put in place, have the potential to be severe.

6.7 Recommendations and Policies

6.7.1 General recommendations and policies to be considered for the individual areas in addition to the requirements of PPS25 are included in Section 7. Suitable mitigation measures should be implemented in any proposals to reduce the risk of flooding to the development from all sources, and prevent an increase in flooding resulting from the development to neighbouring land uses upstream and downstream of the strategic site (see Section 9). As it has been demonstrated by the hydraulic modelling that there is no risk of the fences overtopping during events up to and including the 0.5% AEP (1 in 200 year return period),

specific recommendations to be considered at Sites D and G are detailed below as a result of the unlikely event of a defence breach experienced.

- Since the sites fall within the defended floodplain, any proposed development should adhere to the sequential approach within the site advocated by PPS25 and take consideration of the *residual* flood risk and development vulnerability. This should include the following:
    - SDC has indicated that site G will accommodate mixed employment activities ('less vulnerable') and Site D will accommodate residential development ('more vulnerable'). Given the residual risk identified by breach modelling undertaken as part of this SFRA, this spatial distribution of vulnerability classifications would be the most appropriate as the highest risk areas are being considered for 'lower vulnerability' development.
    - The suitability of varying vulnerability land uses will be dependent upon the location of the breach relative to the site, and as such, only general guidance can be given with regards to specific allocation of uses across each of the strategic sites D and G, or across individual development boundaries within these sites.
    - Site specific FRAs should be undertaken by the developer to determine the relative residual risk of flooding from a breach in flood defences at the highest risk location pertaining to the individual development boundary to assess a worst case scenario. Development should then be assigned firstly to areas demonstrating the lowest depth and velocity hazards.
    - As the modelled breach scenario demonstrates a very quick inundation period across the sites, 'safe places' of refuge within both residential and commercial buildings need to be incorporated where people can retreat to and reside/wait respectively in relative comfort until they can be rescued by emergency services.
    - Where there arises a necessity to provide 'more vulnerable' residential accommodation, basement accommodation, single storey accommodation, and multi-storey buildings with ground floor sleeping accommodation should not be allocated in these areas. Sleeping accommodation should be restricted to the first floor or above to offer the required 'safe places'.
    - Internal finished floor levels for proposed residential sleeping accommodation and commercial refuge areas within individually proposed developments within the strategic site should be set relative to the varying flood levels across the site as determined by a site specific FRA. The level should be determined as being a minimum freeboard distance above the peak flood level during a 1 in 200 year breach event (agreed with the EA) as to minimise the potential for inundation. It would need to be made clear the refuge areas have to be permanent and accessible to all - i.e. no temporary/rickety ladders. The agreed freeboard may therefore vary between first floor residential accommodation, and mezzanine commercial accommodation.
    - Internal ground floors below this level could then be occupied by either 'less vulnerable' commercial premises, garages or non-sleeping residential rooms (e.g. kitchen, study, lounge) (i.e. a sequential approach applied within a building).

- A site specific FRA should also include assessment of the likely flood extents for the tributary drains of Cherry Orchard Drain (potential modelling) for a range of return periods, and relevant mitigation where necessary agreed with the Ouse and Derwent IDB.
- The dedicated Floodline Warnings Direct System should be adopted by both residential and commercial occupants of the combined sites in the event of a defence breach. The automated system would ensure warnings are provided during night hours when the majority of people are sleeping. Such warnings within commercial developments should be monitored and disseminated by dedicated site managers, with staff and visitors being inducted into an evacuation plan. All such measures are described further in Section 9.4.
- Signage indicating the most appropriate egress routes away from the floodplain should be implemented. These should be set at levels above the peak 1 in 200 year flood level across the entire area so that they can still be read following a breach flooding event experienced at any location along the adjacent defences. These routes should be determined by site specific FRAs.
- A comprehensive integrated surface water management strategy is required between developers for the whole of sites D and G. A combination of a number of potential storm water management and SuDS solutions could be incorporated into the master-plan, such as green roofs, rainwater harvesting, attenuation ponds and permeable pavements. Section 8.5 describes the geology of the site and provides recommendations for a range of potential SuDS techniques. Detailed ground investigation data will need to be assessed as part of site specific FRAs for the individual site proposals to determine the suitability of these various techniques.

7 Policy and Practice

7.1 Catchment Flood Management Plans

7.1.1 The study area is covered by the River Ouse Catchment Flood Management Plans (CFMP). CFMP documents are produced by the EA to provide an overview for managing the long-term flood risk within a catchment over the next 50 to 100 years. The relevant draft CFMP policies are detailed within the Policy Review of the Level 1 SFRA. It should be noted that the final CFMP document for the Ouse catchment are due for release in Summer 2010.

7.1.2 Once the final version of the River Ouse CFMP is published, this Level 2 SFRA may need to be updated, reflecting the 'Living Document' status of the SFRA.

7.2 The Pitt Report

7.2.1 The Pitt Report (June 2008) was published following the flood events in the summer of 2007. It draws attention to the high proportion of surface water flooding that occurred during that period, and states that the impact of climate change means that the probability of events of a similar nature and scale happening in the future is increasing.

7.2.2 The report calls for improved modelling of all forms of flooding to enable better flood warning and planning and highlights the need for greater use of SuDS. The UK Government has recently endorsed the findings of this report and published the Draft Floods and Water Bill.

7.2.3 There are three key recommendations from Sir Michael Pitt's independent review into the summer 2007 floods related to Local Authorities, as follows.

Recommendation 14: Local Authorities should lead on the management of local flood risk (including surface water flooding) at the local level with the support of relevant organisations (page 85 of the Pitt Review).

Recommendation 16: Local Authorities should collate and map the main flood risk management and drainage assets (over and underground), including a record of their ownership and condition (page 87 of the Pitt Review).

Recommendation 18: Local Surface Water Management Plans, as set out under PPS25 and coordinated by local authorities, should provide the basis for managing all local flood risk (page 90 of the Pitt Review).

7.2.4 Recommendation 18 specifically requires the preparation of local SWMPs. A SWMP can be used to direct development away from areas at risk from surface water flooding as well as identify solutions to communities already at risk.

Surface Water Management Plan

7.2.5 A site-specific FRA is required by PPS25 for all development proposals greater than 1 ha to determine the impacts the development would have upon surface water runoff, regardless of the Flood Zone the development is located within. The use of SuDS should be

encouraged for all development as part of any surface water management strategy. SuDS options could be investigated as part of a SWMP.

7.3 Sequential Approach

7.3.1 As outlined in Section 3, the application of the sequential approach should ensure that development is appropriate in terms of development vulnerability and flood risk (see Table 3-1 and Table 3-2).

- 'More vulnerable' land uses, including residential accommodation should firstly be allocated within Flood Zone 1. 'Less vulnerable' land uses, including commercial and industrial development should be alternatively allocated towards the higher flood risk areas.
- Should 'less vulnerable' commercial buildings and, where necessity arises, 'more vulnerable' residential buildings be proposed within Flood Zones 2 and 3, they need to incorporate 'safe places' of refuge where people can retreat to and reside/wait in relative comfort until they can be rescued by emergency services.
- Residential basement accommodation, single storey accommodation, and multi-storey buildings with ground floor sleeping accommodation should not be allocated in Flood Zones 2 or 3. Sleeping accommodation and refuge areas within commercial/industrial buildings should be restricted to the first floor or above (or as a mezzanine level within commercial/industrial buildings) to offer occupants/staff opportunity to retreat to the 'safe places'.
- Internal finished floor levels of these should be set at a minimum freeboard distance above the peak flood level of the particular area of the site (determined by a site specific FRA). This minimum freeboard should be agreed with the EA as part of the site specific FRA. The ground floors could then be occupied by garages, non-sleeping residential rooms (e.g. kitchen, study, lounge etc) or 'less vulnerable' commercial premises (i.e. a sequential approach applied within a building).
- If development is to be constructed in flood risk areas with 'less vulnerable' uses on ground level, agreements need to be in place to prevent future alteration of these areas to more vulnerable uses without further study into flood risk.

7.4 Assessment of Impacts Upstream and Downstream

7.4.1 Suitable mitigation measures should be implemented in any proposals to prevent an increase in flooding to neighbouring land uses upstream and downstream of the strategic site resulting from the development.

7.4.2 It is imperative that new development should not be constructed in a way that could impede flood water conveyance and thereby cause backing up of water upstream, and should not reduce floodplain storage or increase surface water runoff which would cause increased flooding downstream.

7.4.3 Wherever possible it is desirable that new development actively reduces existing runoff rates and resultant flood risk.

7.5 SFRA Policies

7.5.1 To ensure a holistic approach to flood risk management and make sure that flooding is taken into account at all stages of the planning process, the findings of this report should be incorporated into the emerging LDF for Selby to ensure that:

- development is located in the lowest flood risk areas;
- new development is flood-proofed to a satisfactory degree and does not increase flood risk elsewhere;
- surface water is managed effectively on site; and
- any development in Flood Zone 2 or Flood Zone 3 is safe.

7.5.2 To avoid inappropriate development in flood risk areas, PPS25 Practice Guidance presents practical policies applicable to the planning system that aim to manage flood risks. The key message of PPS25 is to locate development away from flood risk whenever possible, and avoid inappropriate development within flood risk areas where necessity arises for development within them. The approach it adopts to do this can be summarised by the following hierarchy of measures to appraise, manage and reduce flood risk:

- Assess
- Avoid
- Substitute
- Control
- Mitigate

7.5.3 Master-plans are recommended for both strategic development sites (A and D/G) in order to ensure that flood risk considerations and appropriate mitigation measures are embedded in the design schemes. These should then be used to guide site specific FRAs for individual developments within the strategic sites.

7.5.4 Where there arises a necessity to provide 'more vulnerable' residential accommodation within Flood Zones 2 and 3 and apply the Exception Test (Table 3-2), LPAs and developers should seek opportunities to:

- consider relocating existing development to land in Flood Zones with a lower probability of flooding;
- create space for flooding to occur by restoring functional floodplains and flood flow pathways and by identifying, allocating and safeguarding open space for storage;
- consult with the Emergency Services during master-planning of any development in a high flood risk zone;
- provide access and egress that allows safe passage for site users and emergency services;
- reduce the risk of flooding by considering the layout and the form of the development and incorporate appropriate sustainable drainage (SuDS) techniques; and
- ensure developers incorporate flood resilience and resistant measures into the detailed design of the development.

8 Site Specific Flood Risk Assessments

8.1 Overview

8.1.1 In accordance with Paragraph E2 of PPS25: 'Any organisation or person proposing a development must consider whether that development will not add to, and should where practicable reduce, flood risk. The future users of the development must not be placed in danger from flood hazards and should remain safe throughout the lifetime of the plan or proposed development and land use'.

8.1.2 Notwithstanding the Selby SFRA, site-specific Flood Risk Assessments (FRAs) are required for all development in Flood Zone 2 and Flood Zone 3 and for sites greater than 1 ha in Flood Zone 1, in accordance with Table D1 of PPS25. These will be reviewed either by the LPA or the Environment Agency depending upon the scale and nature of the proposed development (see policies and recommendations in Section 7).

8.2 Level 3 – Detailed / Site-Specific Flood Risk Assessment

8.2.1 Where the quality and/or quantity of information for any of the flood sources affecting a site is insufficient to enable a robust assessment of the flood risks, further investigation will be required. For example it is generally considered inappropriate to base an FRA for a residential care home at risk of flooding from fluvial sources on Flood Zone maps alone. In such cases the results of detailed hydraulic modelling are preferable to ensure details of flooding mechanisms and the onset of flooding is fully understood and that the proposed development incorporates appropriate mitigation measures.

8.2.2 Developers should also identify the residual risk as part of a site specific detailed FRA. Such assessment should be appropriate to the scale and nature of the proposed development and flood risk. Should the potential impact be unacceptable, mitigation should be provided. Depth hazard mapping, carried out as part of this SFRA should be reviewed and where necessary be expanded on as part of any site-specific FRA.

8.2.3 At all stages, the LPA, and where necessary the EA, Statutory Water Undertaker and / or Internal Drainage Board (IDB) should be consulted to ensure the site-specific FRA provides the necessary information to fulfil the requirements for planning applications.

8.3 Site Vulnerability and Site Layout

8.3.1 The sequential approach should be applied within the strategic development sites to locate the most vulnerable elements of a development in the lowest risk areas e.g. residential developments should be restricted to areas at lower probability of flooding and parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding.

8.3.2 Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground.

8.4 Building Design

Finished Floor Levels

8.4.1 Where developing in fluvial flood risk areas is unavoidable, the recommended method of mitigating flood risk to people, particularly with 'more vulnerable' (residential) land uses, is to ensure internal floor levels proposed for sleeping accommodation are raised a freeboard distance above the peak 1% AEP (1 in 100 year) plus climate change flood water level for site A, and above the peak 0.5% AEP (1 in 200 year) resultant breach level for sites D and G. These should be derived for the immediate vicinity of the site (i.e. relative to the extent of a site along a watercourse as flood levels are likely to vary with increasing distance downstream) as part of a site specific FRA.

8.4.2 The EA's requirements for a freeboard above the peak flood level for finished internal floor levels within 'less vulnerable' commercial and industrial units vary, depending upon the proposals. For such land uses, finished internal floor levels may not be required to be raised. However, it is strongly recommended that internal access is provided to upper floors (first floor or a mezzanine level) to provide safe refuge in a flood event. Such refuges will have to be permanent and accessible to all - i.e. no temporary/rickety ladders.

8.4.3 In terms of residential accommodation, it is strongly recommended that basement accommodation, single storey accommodation, and multi-storey buildings with ground floor sleeping accommodation should is not allocated in these areas. Sleeping accommodation should be restricted to the first floor or above to offer the required 'safe places'. Internal ground floors below this level could however be occupied by either 'less vulnerable' commercial premises, garages or non-sleeping residential rooms (e.g. kitchen, study, lounge) (i.e. a sequential approach applied within a building).

8.4.4 Further consultation with the EA will therefore be required during the undertaking of any detailed FRA. For both 'less' and 'more vulnerable' developments where internal access to higher floors is provided, the associated plans showing this should be included within any site specific FRA.

8.4.5 Hotels are classed as 'more vulnerable' land uses, however, where it is not be viable to raise finished floor levels, internal access to higher floors must be provided to give safe refuge to all occupants during times of flood.

8.4.6 In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the EA should be approached to discuss options for a reduction in the minimum internal ground floor levels provided flood proofing (resistance) measures (Section 8.4) be implemented up to an agreed level. There are also circumstances where flood proofing (resilience) measures should be considered first.

8.4.7 It is also therefore advised that the adjacent finished external ground levels are also ensured a sufficient distance below any recommended internal ground floor levels to mitigate against any localised external flooding.

8.4.8 Careful consideration should be given to the use of fences/ landscaping walls as to not cause obstruction to flow routes.

8.5 Storm Water Management & SuDS

8.5.1 In designing buildings flood risk management policies require that the developments are 'safe', do not increase flood risk elsewhere and where possible reduce flood risk overall.

8.5.2 In accordance with Annex F of PPS25, Chapter 5 of the PPS25 Practice Guide and EA guidance, it is strongly recommended that suitable surface water mitigation measures are incorporated into any development plans in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should ideally be achieved by incorporating SUDS.

8.5.3 SuDS designs should aim to reduce runoff by integrating storm water controls throughout the site in small, discrete units. Through effective control of runoff at source, the need for large flow attenuation and flow control structures should be minimised.

8.5.4 SuDS can be broadly split into two types: Source control and Site control. Source control methods aim to control runoff at or close to the source e.g. green roofs, rainwater harvesting. Site control is the management of runoff from several areas e.g. the use of ponds.

8.5.5 In order to identify the most suitable drainage solution, both source and site control measures should be assessed as part of any site-specific FRA. SuDS measures that may be suitable for use in SDC are discussed in more detail below.

8.5.6 As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuD to ensure that it remains functional for the lifetime of the development (see Appendix D of the Selby Level 1 SFRA).

8.5.7 Table 8-1 has been reproduced from the SuDS Manual, CIRIA C679 and outlines typical SuDS options and details their typical components.

Table 8-1: Typical SuDS Components

Component Description	Example
Filter Strips	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.
Swales	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow).
Infiltration Basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.
Wet ponds	Wet ponds are basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits.
Extended Detention Basins	Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment.
Constructed Wetlands	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat.

Component Description	Example
Filter Drains and Perforated Pipes	Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect and convey the water.
Infiltration Devices	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground.
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.

8.5.8 Appendix D in the Level 1 SFRA details recommended techniques which may be considered appropriate for site-specific FRAs in the SDC areas relative to the underlying drift and bedrock geology of the sites (see 'Broad-scale Assessment of SuDS Suitability').

8.5.9 BGS DiGMapGB-507 bedrock maps obtained as part of the Level 1 SFRA illustrate that Sites A, D and G are all underlain by Ladinian, late Permian or mid-Triassic period bedrock consisting of Sherwood sandstone. Superficial deposits overlying this within Site A consist of Devensian, glaciolacustrine sand and gravel of the Pleistocene period across the majority of the site, and clay and silt deposits of the same period in the north of the site in vicinity of the Cockret Dike tributaries. Superficial deposits overlying the bedrock beneath Sites D and G, and the southern area of Site A in the vicinity of Selby Dam consist of Quaternary period Alluvium consisting of clay, silt, sand and gravel.

8.5.10 EA soil maps using data from the National Soil Resources Institute (Cranfield University) illustrate that Site A is underlain by 'ground-water gley soils' that are comprised of 'soils with a high groundwater table'.

8.5.11 EA soil maps using data from the National Soil Resources Institute (Cranfield University) illustrate that Sites D and G are underlain by 'brown soils' that are comprised of 'loamy and sandy freely draining soils'.

8.5.12 As part of the Level 1 SFRA EA Groundwater Vulnerability (GWV) Maps were provided for the southern part of the Selby District area (see District Wide Geology Map), and cover only the eastern area of Site G. These maps however are currently being updated and it is therefore recommended that once the new, most up to date data becomes available, the underlying aquifer classifications are investigated as part of site specific FRAs for the sites. Their vulnerability, their relative permeability and the leaching potential of the soil should be assessed to determine the potential for pollutants to be transmitted.

8.5.13 The three sites however do not lie above a Groundwater Source Protection Zone (GWSPZ) as defined by the EA (nearest GWSPZ is approx. 1.5 km to north west, see Figure 8-1) and therefore should not pose a constraint to development. The EA are likely to state that full foundation proposals would have to be approved to ensure the development does not pose an unacceptable risk to groundwater.

[7] British Geological Survey. 2006. Digital Geological Map of Great Britain 1:50,000 scale (DiGMapGB-50) data [CD-Rom]. Version 3.14. Keyworth, Nottingham: British Geological Survey. Tile EW071 Selby V3 Bedrock & Superficial. Release date 05-04-2006.

8.5.14 It is considered however that for site specific FRAs, attenuation techniques may be appropriate for recommendations for Site A, and infiltration or combined infiltration/attenuation systems for Sites D and G.

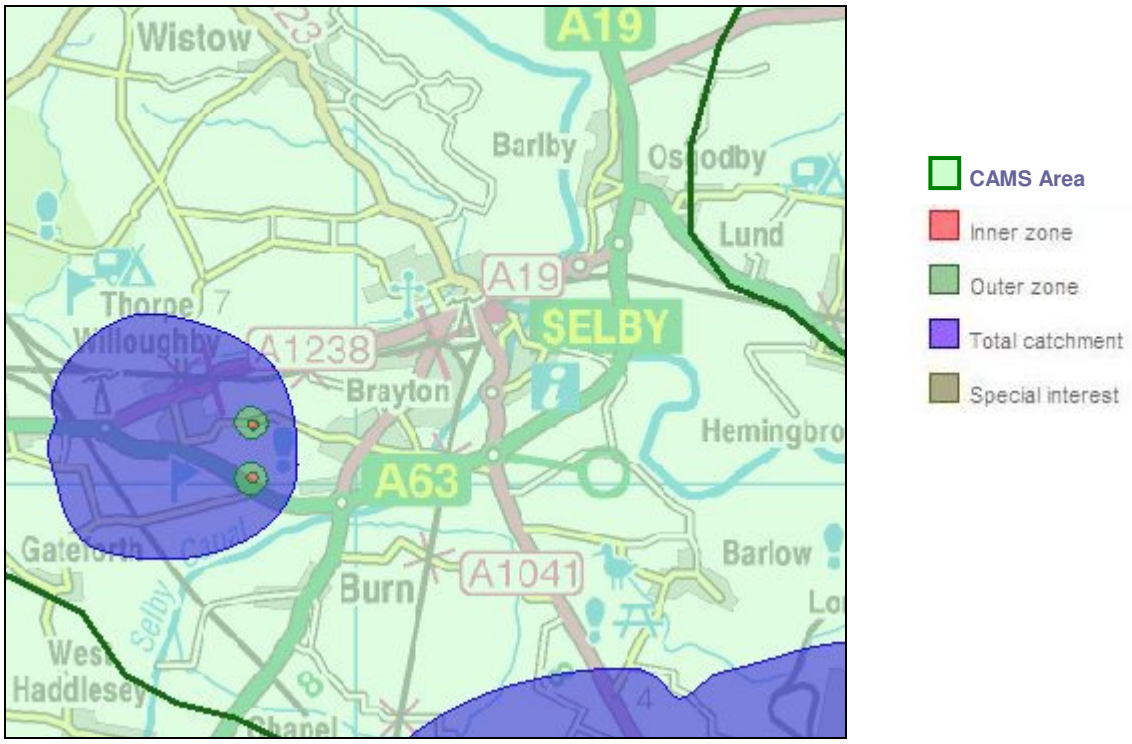


Figure 8-1: EA Groundwater Source Protection Zones

Green Roofs

8.5.15 Green roofs incorporate a layer of vegetation, placed over a drainage layer that is designed to intercept and retain rainfall leading to a reduction in the volume of runoff. The use of green roofs can reduce the size of downstream SuDS and drainage infrastructure that is required.

8.5.16 According to the English Nature research report 'Green Roofs: Their existing status and potential for conserving biodiversity in urban areas', 71% of rain falling on a 100 mm turf layer can be retained within the turf layer, greatly reducing storm water runoff. There are two main types of green roof, extensive and intensive.

8.5.17 An extensive green roof is a covering of the whole roof area with low growing, low maintenance plants. They usually comprise of 25 – 125 mm thick soil layer in which a variety of hardy, drought tolerant, low level plants are grown. Extensive green roofs are designed to be self sustaining and cost effective and can be used in a wide variety of locations often described as an 'ecological protection layer'.

8.5.18 An intensive green roof is a landscaped area which includes planters or trees and is usually publicly accessible. They may include irrigation and storage for rainwater. They often require more maintenance and impose a greater load on the roof structure than extensive green roofs.

8.5.19 The Green Roof Centre[8] website, supported by University of Sheffield, Groundwork Sheffield and Sheffield City Council, "*is an independent research and demonstration hub, which supports and promotes the uptake of green roofs through demonstrating their benefits and potential in a wide range of settings and scales"*.

8.5.20 The website includes a number of examples on of the application of green roofs in South Yorkshire. The Royal Plaza located on West Street in the Devonshire Quarter of Sheffield city centre (see Figure 8-2) comprises a nine storey apartment building ('more vulnerable' residential), and the BTCV head office in Doncaster which incorporates a training centre a visitor reception for a nature reserve ('less vulnerable' commercial) (see Figure 8-3).

Figure 8-2: The Royal Plaza, Sheffield – Example of a Green Roof used within Residential Accommodation.

Figure 8-3: Sedum House, Doncaster – Example of a Sedum Roof used within a Commercial Development.

[8] http://www.thegreenroofcentre.co.uk/ University of Sheffield, Groundwork Sheffield, & Sheffield City Council. February 2010.

8.5.21 The EA's Green Roof toolkit document providing further information and guidance can also be found on their website[9].

Rainwater Harvesting

8.5.22 Rainwater harvesting is also recommended as a potential mitigation method to reduce surface water flood risk. The rainwater harvesting process is essentially the collection of rainwater from roofs into containers, which can be stored either above or below ground. The stored rainwater can then be re-used as and when required for every day non potable uses such as washing machines and toilets. Alternatively, collected rainwater can be released into the sewerage system once the rainfall event has subsided to reduce the risk of flooding and sewerage overflows.

8.5.23 The EA support the use of rainwater harvesting, however note that 'storage in these types of systems will not usually be able to be counted towards the provision of on-site storage for surface water balancing. This is because the storage cannot be guaranteed to be available when required given the sporadic nature of the use of the harvested rainwater'.

Permeable Pavements

8.5.24 Pervious surfaces can be incorporated into soft landscaping and oil interceptors can be added to improve pollutant retention and removal. In urban areas where there is a high percentage of hard cover the use of pervious surfaces for car parks and hard areas is a valuable technique that should be used wherever possible.

8.5.25 While pervious pavements are a good choice of SuDS for use within the study area, consideration of the proximity of basements and foundations must be made. Where pervious pavements are located within 5 m of foundations or basements, an impermeable membrane liner is required to prevent infiltration.

8.5.26 Site geology should also be taken into account when deciding on suitable SuDS measures. Some SuDS systems rely on infiltration which in areas of low permeability may be technically unviable. If SuDS using infiltration are to be used, permeability tests should therefore be carried out to establish infiltration rates.

8.5.27 Any surface water management system should be implemented in accordance with relevant policy and guidance such as PPS25, National SuDS Working Group (2004), BRE365, CIRIA C522 for SuDS, CIRIA 523 (SuDS Best Practice Manual) and CIRIA C697 (the SuDS Manual).

8.6 Climate Change

8.6.1 PPS25 and the accompanying Practice Guide include for an increase in the peak rainfall intensity of up to 30%, as well as increase in peak flows in watercourses of up to 20% within 100 years. This will significantly affect smaller urban catchments, leading to rapid runoff into and subsequent increased flows within watercourses, surface water flooding, surcharging of gullies, drains and sewer flooding.

8.6.2 The draft River Ouse CFMP also considered flood risk for the next 50-100 years and has taken into account the flood risk drivers of climate change, urban development and

[9] http://www.environment-agency.gov.uk/business/sectors/91967.aspx Green Roof Toolkit, Environment Agency, June 2009.

changes in land use. Catchment models and the Modelling and Decision Support Framework software were used in the CFMP to test sensitivity to the flood risk drivers across the catchments in the study area. As stated in Section 7.1, the final CFMP summary documents are expected to be released during summer 2010.

8.6.3 Sewer and surface water flooding are likely to become more frequent and widespread under urbanisation and climate change scenarios as the amount of impermeable surfaces and runoff increase, highlighting the importance of SuDS.

8.6.4 The location of future urban developments and flood defences within a catchment can heavily influence flood risk in the area and has the potential to further increase flood risk at areas downstream of such developments. Impacts include the lowering of the SoP offered by flood defences and the carrying capacity of culverts, drains, sewers and watercourse channels. This potentially leads to areas being at risk of flooding that were previously not at risk and highlights the increasing conflicts and pressures that are emerging between climate change scenarios and future development aspirations.

8.6.5 The PPS 1 Climate Change Supplement sets out important objectives in order to tackle climate change, sea level rise and avoid flood risk. The purpose of design policies should be to ensure that developments are sustainable, durable and adaptable to natural hazards such as flooding. Following this guidance, it should be possible to mitigate against increased flood risk through incorporating 'flood proofing' measures such as raised finished floor levels into the development design, and/or development of compensatory storage and flood storage basins.

8.6.6 The Adaptation Strategies for Climate Change in the Urban Environment project is a study undertaken collaboratively by the University of Manchester, The University of Cardiff, University of Southampton and Oxford Brooks University. The project aimed to further the understanding of the impacts and risks of climate change on towns and cities through three 'exposure units' of human comfort, urban green space and the built environment. One of the aspects examined was surface water runoff during extreme rainfall events. With an increase in development, there comes an increase in the amount of impermeable areas thus leading to increased runoff during storm events. In one of the worst-case modelled scenarios (large urban centre), an increase in rainfall of 56% by 2080, led to an increase in runoff of 82%. This highlights the increasing conflict and pressures that are emerging between climate change scenarios and future development aspirations.

9 Residual Risk Mitigation

9.1.1 Residual risks are those that remain with flood mitigation measures in place. Some of the proposed development areas are located behind defences and therefore are at risk of flooding if these defences fail. This risk has been assessed through breach modelling that was presented in Section 6.

9.2 Flood Resilience and Resistance Measures

> *'Where there is a low probability of limited shallow depth water entry, but not severe inundation to buildings, the use of flood-resilient construction may be considered.' PPS25 Annex E.*

9.2.1 Within the design of buildings in areas where the probability of flooding is low or in areas where flood risk management measures have been put in place, guidance has been outlined in paragraphs 6.29 to 6.35 of the PPS25 Practice Guide and by the Department of Communities and Local Government in 'Improving the Flood Performance of New Buildings'[10].

9.2.2 A number of measures can be used to manage residual risk including:

- use of local topography to guide water away from proposed development and into storm water drainage systems (Section 8.5);
- use of flood proofing (a technique by which buildings are designed to withstand the effects of flooding). There are two main categories of flood proofing; dry proofing and wet proofing. Dry proofing (flood resilience) methods are designed to keep water out of the building, and wet proofing (flood resistance) methods are designed to improve the ability of the property to withstand the effects of flooding once the water has entered the building. Flood resilience and resistance measures include measures such as those below and in Table 9-1 and Figure 9-1:
  - raising floor levels above the flood water inundation level (Section 8.4);
  - replacing chipboard/MDF kitchen/bathroom units with plastic equivalents;
  - installing service meters, boilers and electrical points above flood levels;
  - install one-way valves into drainage pipes to prevent sewage backing up into the house; and
  - replacing timber floors with concrete floors covered with tiles.
- use of SuDS where possible to reduce runoff rates discharging to local drainage systems (Section 8.5); and
- designing and employing flood warning and evacuation plans (Section 9.4).

9.2.3 Further guidance is also provided in the CIRIA Research Project 624 'Development and Flood Risk: Guidance for the Construction Industry' (2004). Table 9-1 summarises recommendations made within Table A3.6 of the report for flood proofing measures which

[10] Communities and Local Government (2007) *'Improving the flood performance of new buildings',* Defra: London.

can be incorporated within the design of buildings (subject to compliance with Building Regulations).

Table 9-1: Flood Proofing Options

Feature	Considerations To Improve Flood Proofing
External Walls	Careful consideration of materials: use low permeability materials to limit water penetration if dry proofing required. Avoid using timber frame and cavity walls. Consider applying a water resistant coating. Provide fittings for flood boards or other temporary barriers across openings in the walls (dry proofing).
Internal Walls	Avoid use of gypsum plaster and plasterboard; use more flood resistant linings (e.g. hydraulic lime, ceramic tiles). Avoid use of stud partition walls.
Floors	Avoid use of chipboard floors. Use concrete floors with integrated and continuous damp proof membrane and damp proof course. Solid concrete floors are preferable; if a suspended floor is to be used, provide facility for drainage of sub-floor void. Use solid insulation materials.
Fitting, Fixtures and Services	If possible, locate all fittings, fixtures and services above design flood level. Avoid chipboard and MDF. Consider use of removable plastic fittings. Use solid doors treated with waterproof coatings. Avoid using double-glazed window units that may fill with flood water. Use solid wood staircases. Avoid fitted carpets. Locate electrical, gas and telephone equipment and systems above design flood level. Fit anti-flooding devices to drainage systems.

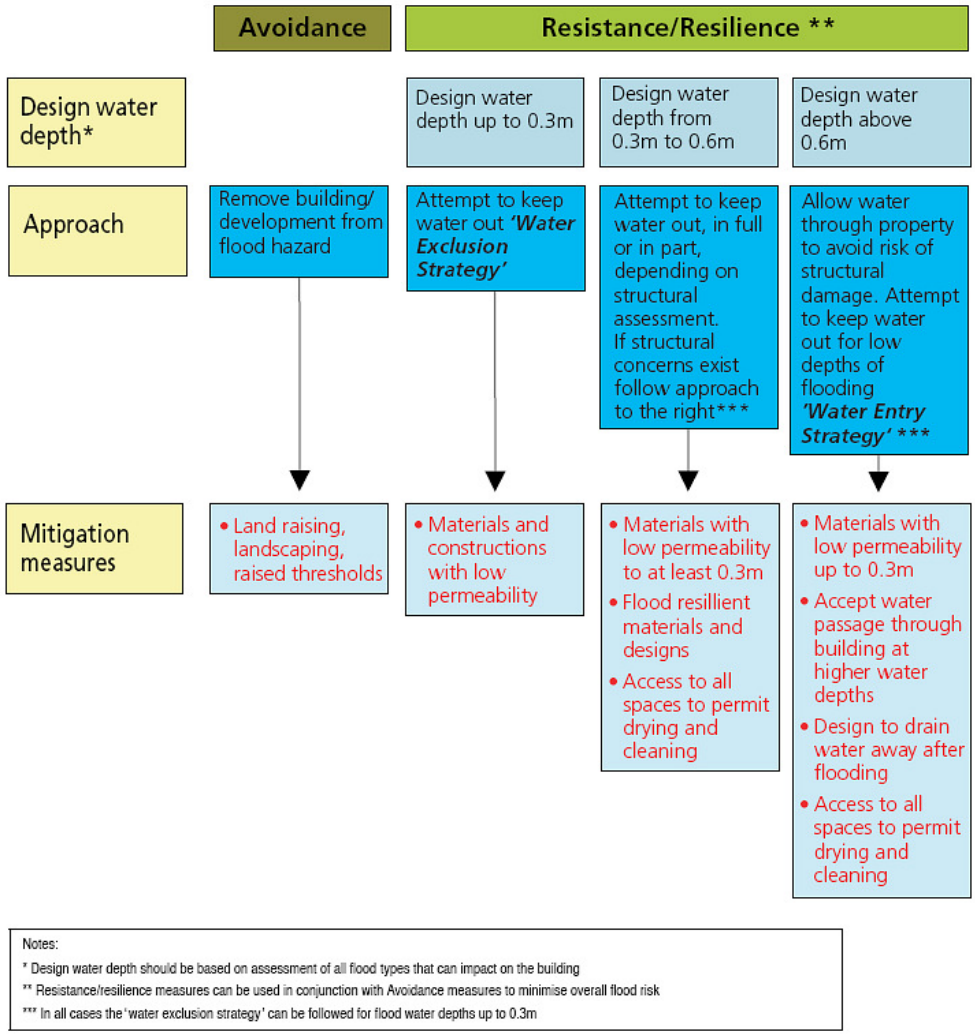


Figure 9-1: Extract from PPS25 Figure 6.2 Rationale for Flood Resilient and/or Resistant Design Strategies

9.3 Emergency Access and Egress

9.3.1 Emergency access and egress is required to enable the evacuation of people from developments and also to provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

9.3.2 An emergency access and egress route is a route that is 'safe' for use by occupiers without the intervention of the emergency services or others. A route can only be completely 'safe' in flood risk terms if it is dry at all times. Signage indicating the most appropriate egress routes away from the floodplain should be implemented. These should be set at levels above the peak flood level across the entire site area so that they can still be read at any location following a flood event experienced. These routes should be determined by site specific FRAs.

9.3.3 For developments located in areas at flood risk the EA consider 'safe' access and egress to be in accordance with EA/Defra FD2320/TR2 report, where the requirements for safe access and egress from new developments are as follows in order of preference.

1) Safe, dry route for people and vehicles.
2) Safe, dry route for people.
3) If a dry route for people is not possible, a route for people where the flood hazard in terms of depth and velocity of flooding) is low and should not cause risk to people.
4) If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

9.3.4 For commercial development ('less vulnerable') it is considered that dry access and egress from the site will be desirable during times of extreme floods. For all new residential development ('more vulnerable'), it is considered that dry access and egress will be essential during times of extreme floods from each residential unit to an area outside of the floodplain. New properties within a 'dry island' of the fluvial floodplain will also require dry access due to the disruption to essential services (gas, water, etc.) that would be experienced during a flood event.

9.3.5 It is necessary to ensure that proposed roads levels are such that emergency access and egress routes are maintained or where possible constructed to a level agreed with the EA. This can significantly reduce the risk of the proposed development becoming inundated by flooding.

9.3.6 Details of how this will be achieved should be clearly described in site-specific FRAs. This should include:

- a review of any detailed river models (where available);
- a review of flood extents from broadscale modelling; and
- comparison of flood extents/levels with local ground levels from topographical survey or digital elevation models.

9.4 Flood Warning and Emergency Procedures

9.4.1 Ensuring people in areas of flood risk are aware of potential flooding is key to ensuring they are prepared, facilitating the protection of property and evacuation where necessary.

Floodline Warnings Direct

9.4.2 A free 'Floodline Warnings Direct' service is operated by the EA for many areas at risk from fluvial and tidal flooding (EA website[11]) as a method of mitigating the risks to people. Until recently, properties could register with this service to receive the flood warnings, however The Pitt Review of the summer 2007 flood events recommended that the EA work with telecommunication companies to provide an alternative 'opt-out' telephone flood warning service rather then 'opting-in'. In response to this recommendation, the EA are now implementing such an 'opt-out' service to properties that are not currently registered for the service.

[11] www.environment-agency.gov.uk

9.4.3 It has been confirmed that starting on 15 February 2010, the EA will be writing to all properties that are applicable to receive the opt-out flood warning service and which have a landline telephone number, explaining that they may receive flood warnings from now on. A supporting booklet providing more information about the EA's flood codes, the free flood warning service, their responses to frequently asked questions and advice on preparing for a flood will also be sent.

9.4.4 People will be able to opt-out of flood warnings by calling Floodline on 0845 988 1188 or by returning a form in a free-post envelope.

9.4.5 The service currently consists of four stages: Flood Watch, Flood Warning, Severe Flood Warning and All Clear. Each code gives an indication of the expected level of danger. Although some members of the public find Flood Watches useful, they are predominantly targeted towards professional partners, alerting them to expected flooding of low lying land and roads. Flood Warnings and Severe Flood Warnings are more useful for the public, alerting them to expected property flooding.

9.4.6 The flood warnings are able to be provided by the service via telephone, mobile telephone, SMS text message, fax or pager. Local radio, TV, loudhailers, sirens and Floodline are also used to deliver flood warning messages. The Floodline number is 0845 988 1188, and it is always kept up to date with the Environment Agency's latest flooding information.

9.4.7 More detailed information on the likely extent and time scale of these warnings can be obtained by request from the EA, by their 'Quick-dial' recorded information service, or via their website.

9.4.8 The Flood Warning areas present relative to the study sites are listed below.

- Properties adjacent to Selby Dam (includes low-lying areas adjacent to the river) (EA Ref: 122FWFDW767) (Floodline Quick-dial number 135903). See Figure 9-2.
- The River Ouse at Barlby from Landing Lane to the A19 Bridge (EA Ref: 122FWFDS760) (Floodline Quick-dial number 135903). See Figure 9-3.

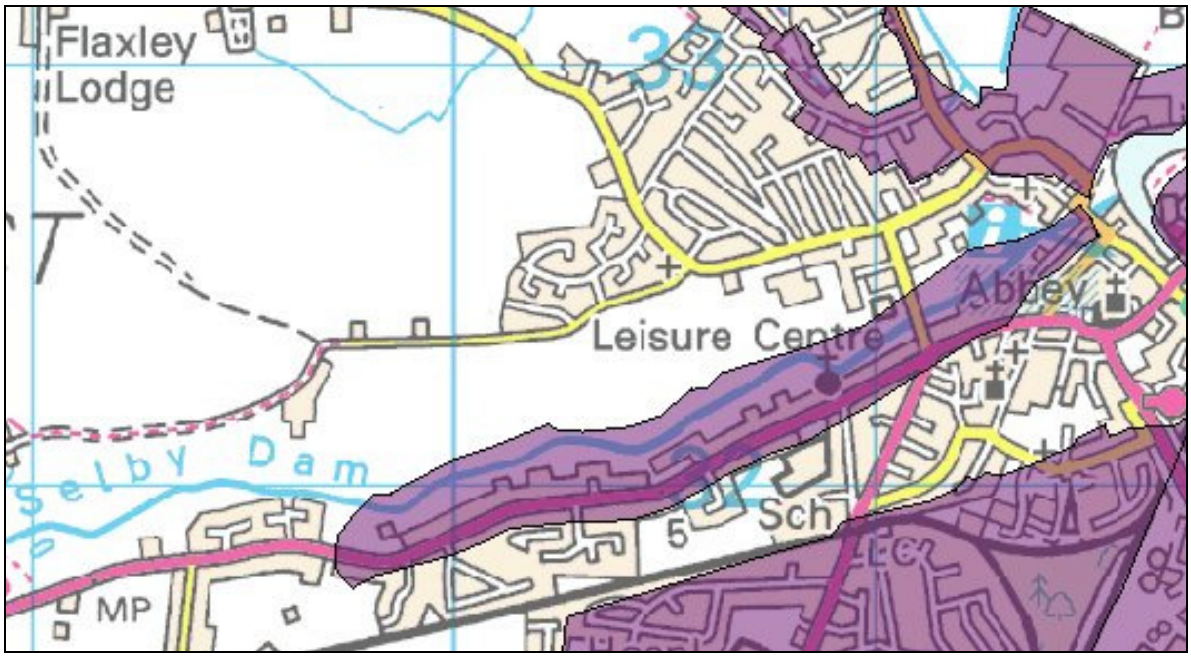


Figure 9-2: EA Flood Warning Area covering Site A [12]

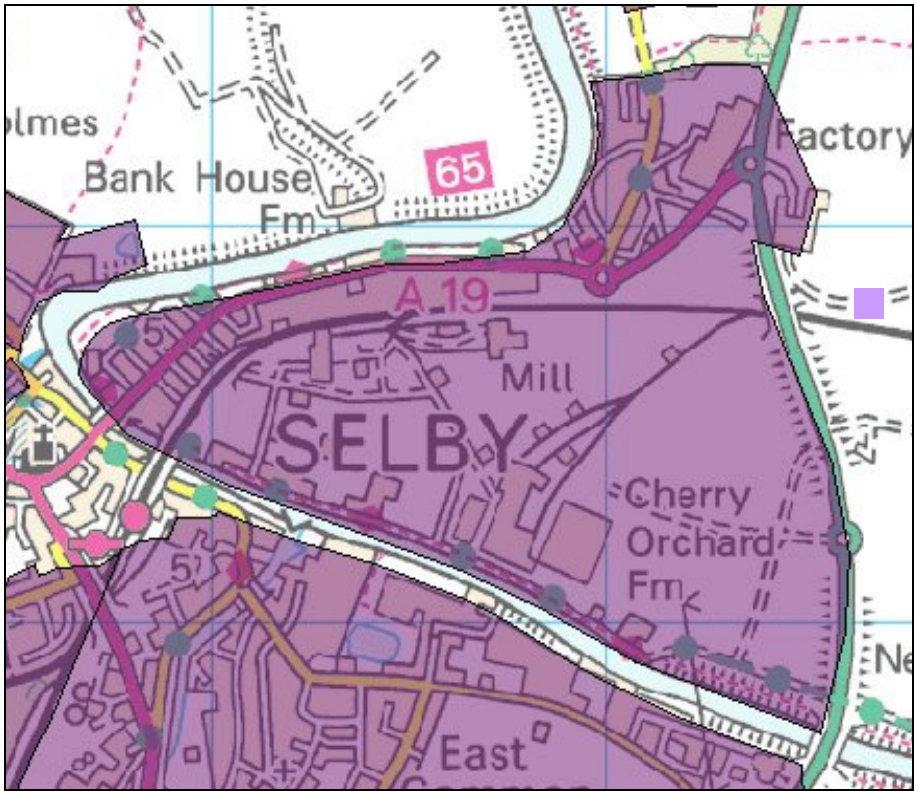


Figure 9-3: EA Flood Warning Area covering Sites D & G [12]

[12] Environment Agency. 2009. *Flood Warning Areas Map*. www.environment-agency.gov.uk Accessed January 2010.

9.4.9 The current flood warning stages/codes are currently under review, a revised service is expected to be launched in late spring/early summer 2010. 'Live' river levels on the internet should be available from March 2010.

Evacuation Plans

9.4.10 For any proposed commercial or industrial developments within a designated floodplain, or those providing a service to vulnerable groups such as elderly care homes or hospitals, a system for monitoring flood warnings should be developed with designated responsible persons able to monitor and disseminate the warnings. This would provide more time to enable emergency access and egress of staff or residential occupants away from local areas that may become flooded during a flood event (including routes for egress) prior to inundation, which is inevitably a preferred method to finding refuge in upper floors.

9.4.11 They should also enable sufficient time to implement protection measures for any commercial goods or personal belongings on site through sealing all external doors to prevent flood inflow into such buildings as a precaution.

9.4.12 The exact nature of these emergency plans and procedures should be determined from the results obtained through the detailed FRAs for the individual sites and may be needed in conjunction with other mitigation measures. The need for, and feasibility of flood warning systems for a development should be discussed with the FRA.

9.4.13 Where there are exceptional circumstances in which development is allowed, which is reliant on evacuation, SDC will need to assess whether the proposals are acceptable to their own emergency planners and the local emergency services. It is not the remit of the EA to make recommendations on this matter.

9.5 Sewer Flooding

9.5.1 Based on the information gathered as part of the Level 1 SFRA, it was determined that the level of risk from sewer flooding within Selby has historically been relatively low.

9.5.2 As recommended in Section 8, suitable mitigation measures should be implemented for sites identified as having a risk of sewer flooding and the risk of flooding should be assessed in greater detail as part of a site-specific FRA.

10 Summary & Conclusions

10.1.1 Following the application of the Sequential Test, strategic sites A, D and G requiring a Level 2 SFRA were assessed according to their local potential flood risk issues.

10.2 Site A – Cross Hills Lane

10.2.1 Site A located to the north west of Selby town is located partially within the floodplain of the Selby Dam watercourse, which is undefended along the adjacent reach. Depth hazard mapping was undertaken using modelled flood level results in the event of the watercourse overtopping its left bank during a 1 in 100 year and a 1 in 1000 year event, incorporating allowances for pumping station failure.

10.2.2 The maps produced illustrated that the majority of the southern region of the site, and the eastern area to the south of Cross Hills Lane are at risk from flooding during the 1 in 100 year (high risk, Flood Zone 3) and 1 in 1000 year (medium risk Flood Zone 2) flood return periods (1% and 0.1% AEP respectively). The levels of depth hazard experienced during these events would range from an insignificant risk to a 'Danger to All'. The remainder of the site is only at risk from flooding during flood events greater than the 1 in 1000 year (low risk, Flood Zone 1) return period.

10.2.3 A phased sequential approach should be adopted by a strategic site master-plan and individual site specific FRAs to allocate 'more vulnerable' residential development within lower flood risk areas (Flood Zone 1). Any proposed 'less vulnerable' commercial/industrial development should alternatively be located within the higher flood risk areas (Flood Zones 2 and 3). Within these higher flood risk areas, any 'less vulnerable' development should firstly be allocated within areas of the floodplain that demonstrate depth hazards to the fewest people.

10.2.4 It has been recommended however that a 'blue corridor' is implemented in the southern region of the site as part of an over master-plan to provide opportunities for flood mitigation, increased biodiversity and recreation, strategic management of surface water runoff and compensatory flood storage should land raising be adopted on land adjacent the southern side of Cross Hills Lane.

10.2.5 Site specific FRAs should address relative flood levels to determine minimum internal finished floor levels and external ground level requirements. The suitability of appropriate SuDS techniques as methods to manage rates of surface water runoff generated from the development should also be assessed following a detailed geological ground investigation. Additionally, the currently un-modelled watercourse tributaries of Cockret Dike should be addressed as part of the review of all other sources of flooding.

10.3 Sites D & G – Olympia Park

10.3.1 Sites D and G neighbour one another and are both located to the north east of Selby town. They are located entirely within the floodplain of the River Ouse, which is defended up to a 1 in 200 year SoP along the adjacent reach, and as such flood water should not overtop these defences during a flood event of this magnitude. This was supported by hydraulic modelling which demonstrated these defences would not become overtopped during such

a 0.5% AEP flood return period, or during a 1% (1 in 100 year) plus an allowance for climate change flood return period.

10.3.2 Depth, velocity and full hazard mapping was undertaken using modelled flood level results in the event of the watercourse breaching its left bank during the 1 in 200 year return period (0.5% AEP). The maps produced illustrated that flood depths during such a breach event across the majority of site D would pose a 'Danger to Most', whilst smaller areas in the eastern region presented depths would pose a 'Danger to All'. Site G illustrated that flood depths across the majority of the site would pose a 'Danger to All', with smaller areas in the west and south posing a 'Danger to Most'. Flood velocities experienced would inevitably be greatest immediately adjacent the location of breach, and flood depths were shown to be greatest in the central and eastern areas of site G.

10.3.3 However, the risk of a breach within defences along this area is considered to be very low due to their age, quality and maintenance regime.

10.3.4 A phased sequential approach should be adopted by a strategic site master-plan and individual site specific FRAs undertaken to allocate 'more vulnerable' residential development within lower flood risk areas, and allocate 'less vulnerable' commercial/industrial development within the higher flood risk areas. This 'less vulnerable' development should however, firstly be allocated within areas of the residual risk breach floodplain that demonstrate depth and velocity hazards to the fewest people.

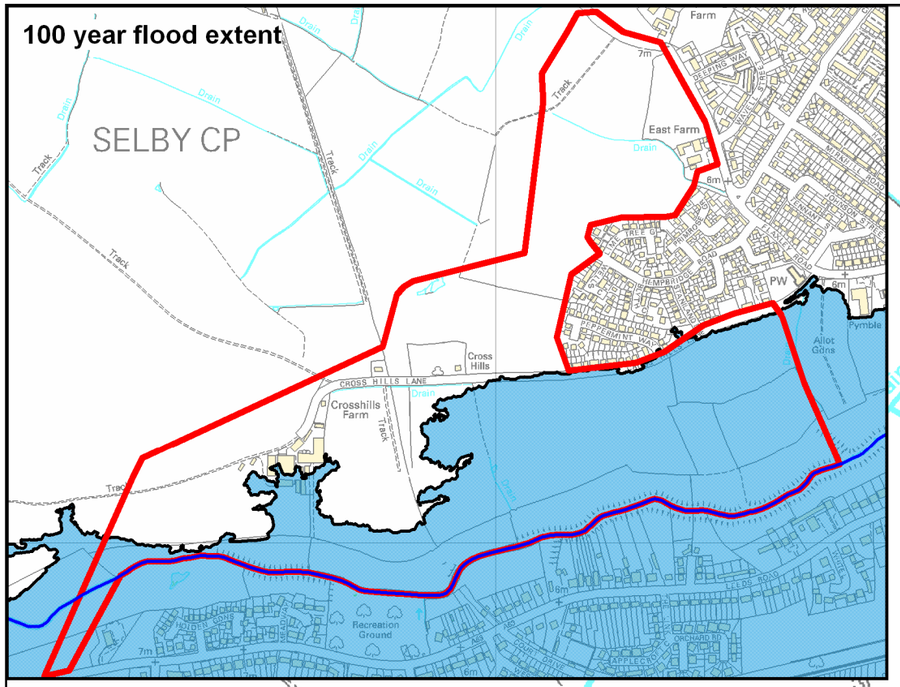
10.3.5 Site specific FRAs should address relative flood levels to determine minimum internal finished floor levels, and external ground level requirements. The suitability of appropriate SuDS techniques as methods to manage rates of surface water runoff generated from the development should also be assessed following a detailed geological ground investigation. Additionally, the currently un-modelled watercourse tributaries of Cherry Orchard Drain should be addressed as part of a review of all sources of flooding.

10.4 Updating the Strategic Flood Risk Assessment

10.4.1 The SFRA is a living document and should be reviewed and updated in the future upon the following potential triggers:

- updates to PPS25 and/or the accompanying Practice Guidance;
- a major flood event;
- updates to the hydraulic modelling of relevant watercourses; and
- publication of revised climate change allowances.

Appendix A



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Notes

Degree of Depth Hazard (Defra FD2321)

- Danger for some
- Danger for most
- Danger for all
- River Centre Line
- Site A Boundary
- 100 year flood extent

Note:
Refer to the figure in the top left hand corner for the flood extent.
On the depth map, the areas that are within the flood extent but are colourless are inundated during the 100 year event, but the depth is lower than the 'Danger for Some' depth hazard threshold of 0.3m.

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Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: SELBY LEVEL 2 SFRA

Drawing Title: Site A Flood Depth Hazard 1% AEP (100 year) event (Ouse Dominated Option 3 Scenario)

Scale at A3			
NTS			
Drawn: FT		Approved: MT	
Stage 1 Check	Stage 2 Check	Originated	Date: 02-2010

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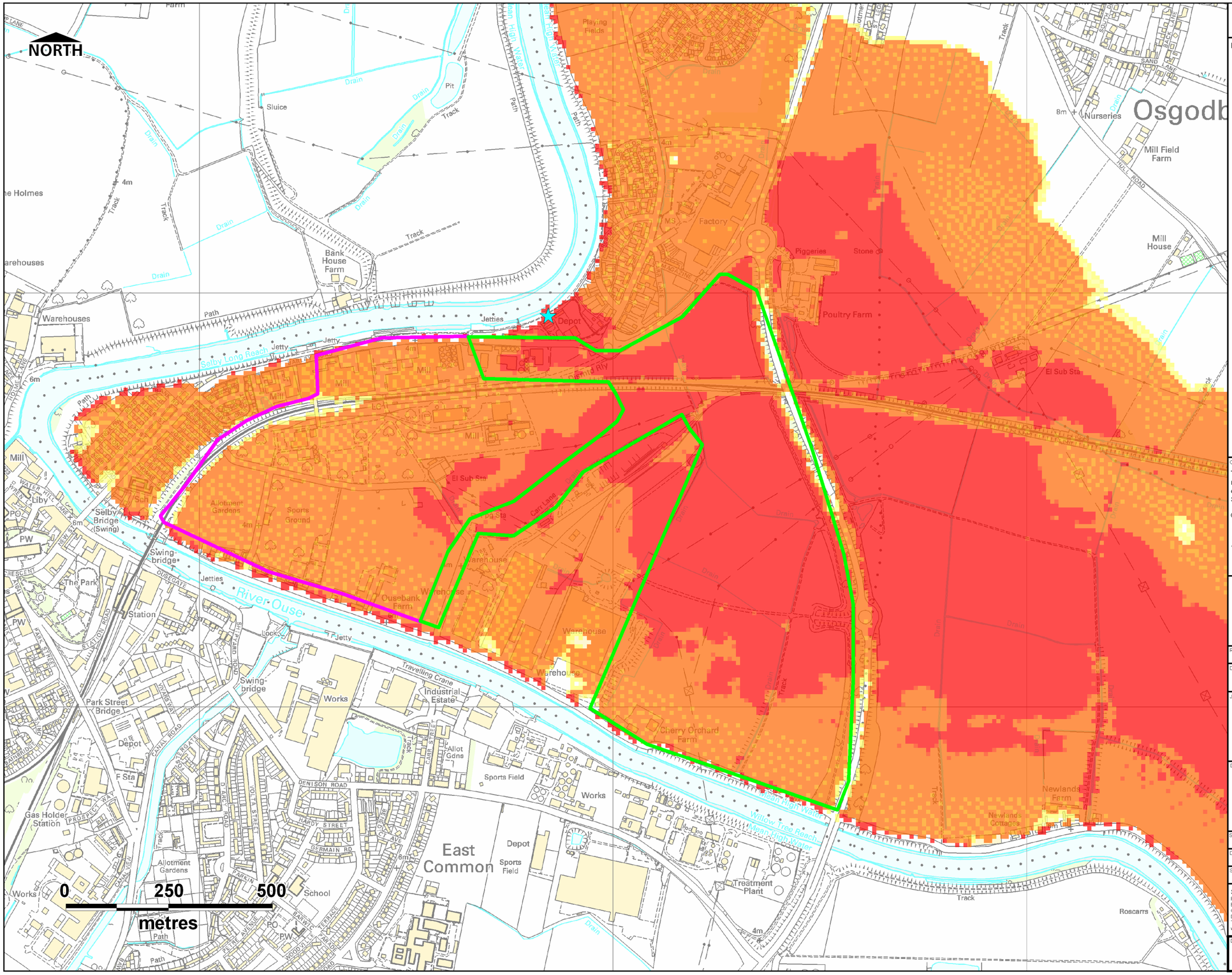
Drawing Number: FIGURE A-1 Rev

Appendix B



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Notes

Degree of Flood Hazard (Defra FD2320)

- Danger for some
- Danger for most
- Danger for all

- Site D boundary
- Site G boundary
- Breach Location

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Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: SELBY LEVEL 2 SFRA

Drawing Title: Defence Breach Flood Hazard Map 0.5% AEP event

Scale at A3	NTS		
Drawn: FT		Approved: MT	
Stage 1 Check	Stage 2 Check	Orginated	Date: 02-2010

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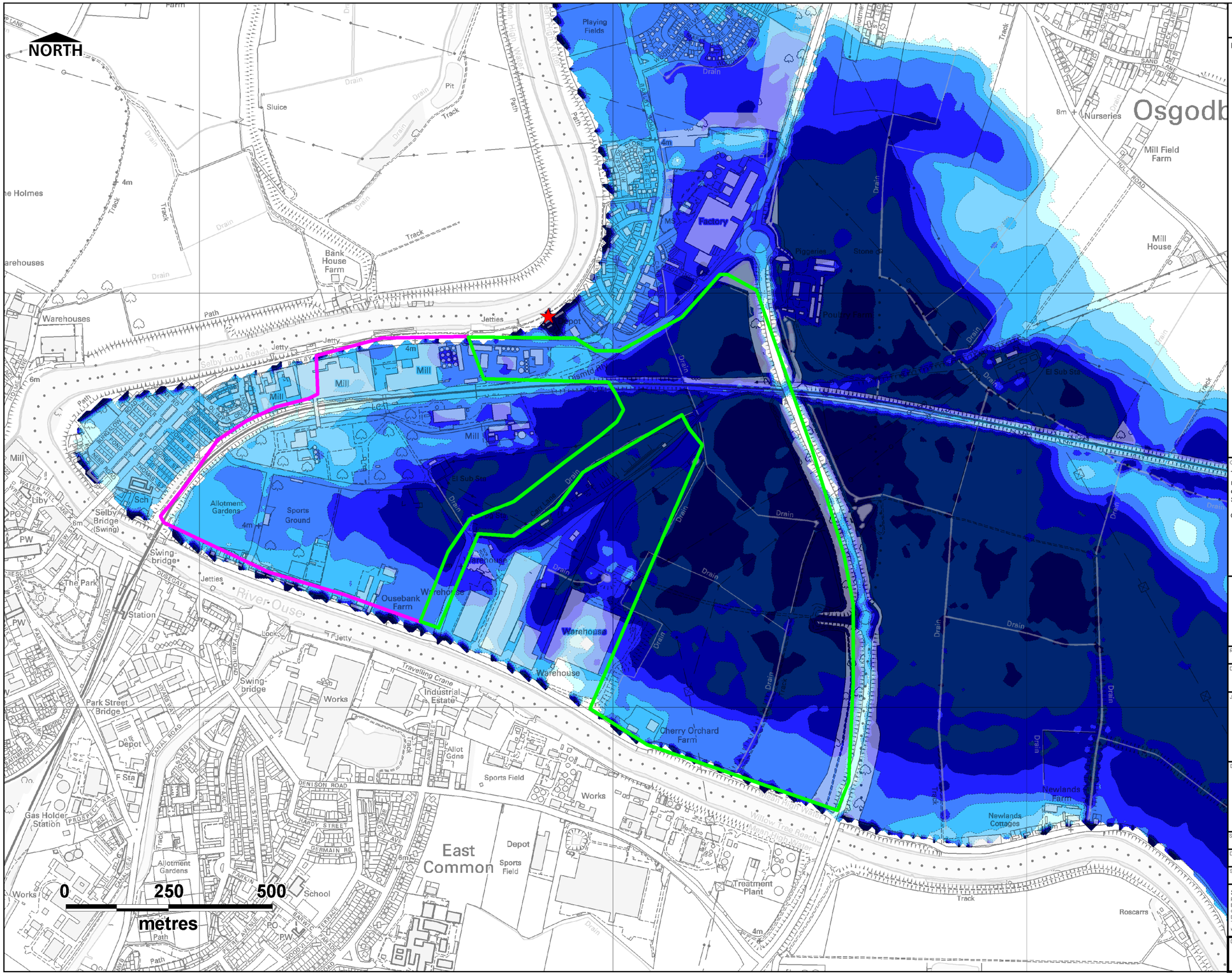
Drawing Number: **FIGURE B-1**

Rev



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Notes

Depth Legend (m)

- 0.0 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 3
- 3 to 3.5
- > 3.5

Site D boundary

Site G boundary

Breach Location

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Drawing Status: FINAL

Job Title: SELBY LEVEL 2 SFRA

Drawing Title: Defence Breach Flood Depth Map 0.5% AEP event

Scale at A3: NTS

Drawn	Approved		
FT	MT		
Stage 1 Check	Stage 2 Check	Orginated	Date
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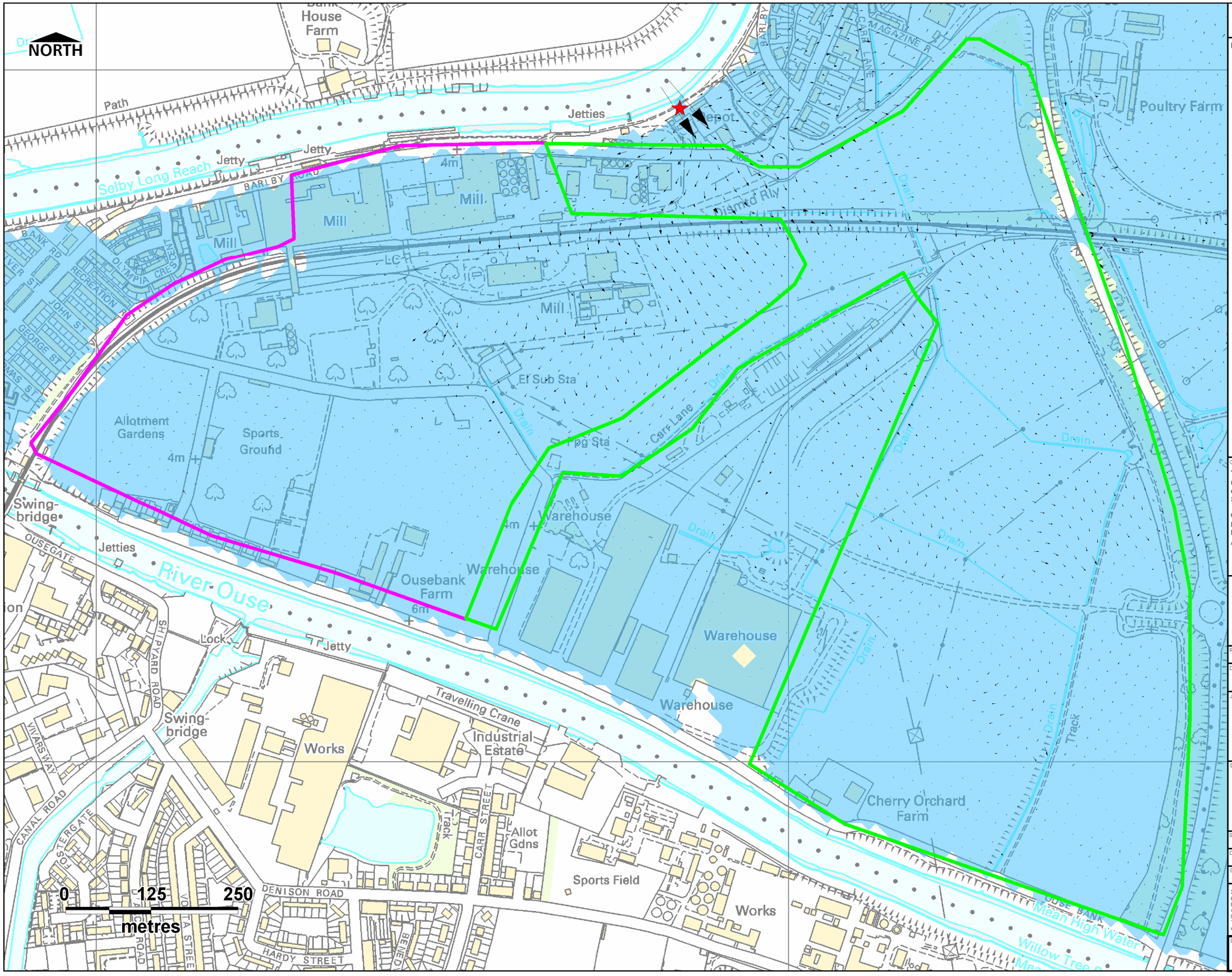
Drawing Number: **FIGURE B-2**

Rev



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Notes

- Site D boundary
- Site G boundary
- Breach location
- Flood extent

Flood velocity (m/s)

- 8.0
- 4.0
- 2.0
- 1.0

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Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: SELBY LEVEL 2 SFRA

Drawing Title: Defence Breach Flood Velocity Map 0.5% AEP event

Scale at A3			
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Drawing Number: **FIGURE B-3**

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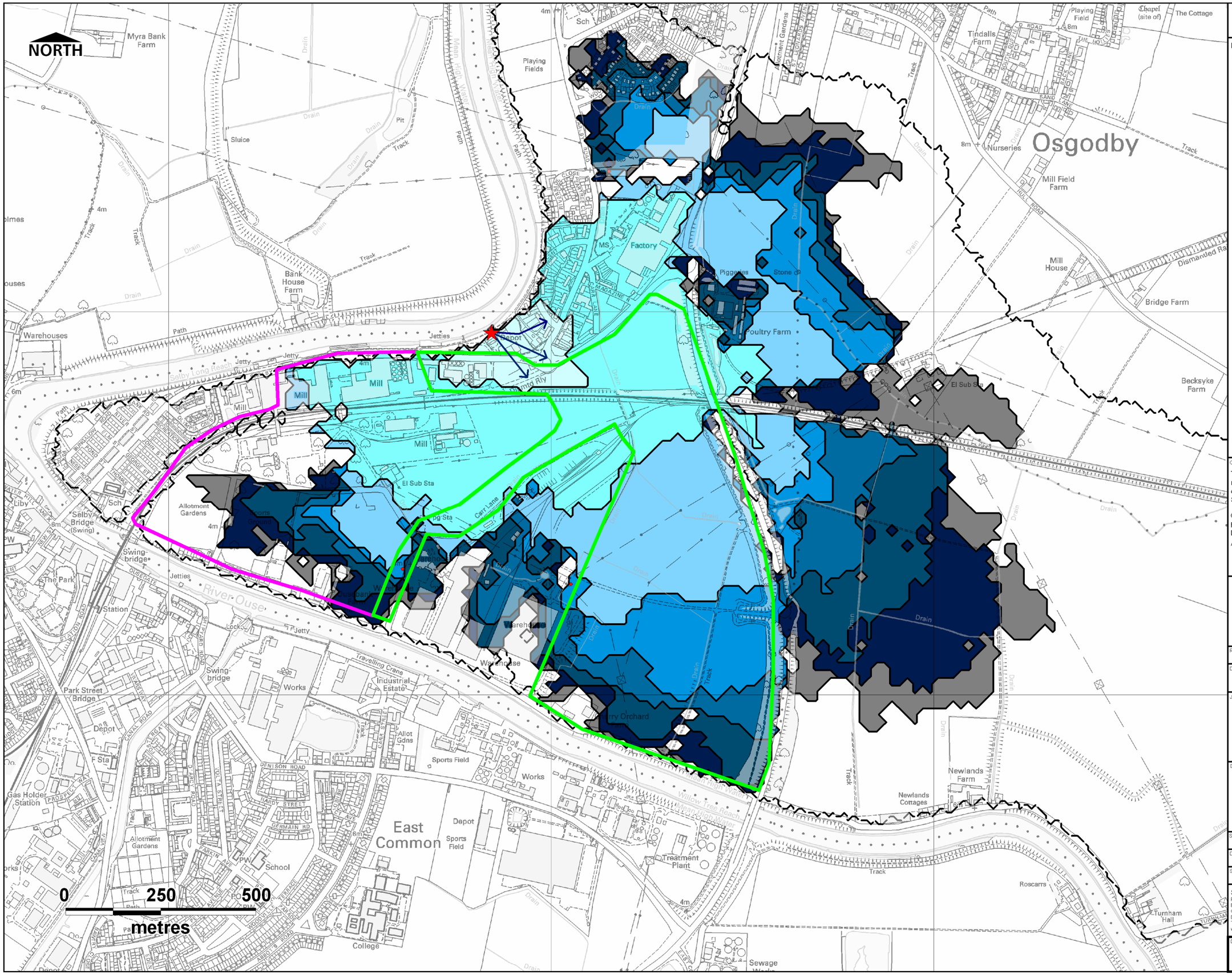

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Notes

Flood Inundation Time after breach (hours)

- 0.25
- 0.50
- 0.75
- 1.00
- 1.50
- 2.00
- 2.50
- 3.00
- Maximum Extent
- Site D boundary
- Site G boundary
- Breach Location

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Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: SELBY LEVEL 2 SFRA

Drawing Title: Defence Breach Flood Inundation 0.5% AEP event

Scale at A3			
NTS			
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Drawing Number: **FIGURE B-4**

Rev