North and North East Lincolnshire

Strategic Flood Risk Assessment

NORTH LINCOLNSHIRE COUNCIL

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1 Terms of Reference

Background Information

1.1 In November 2006, North East and North Lincolnshire Councils (NE/NLC) published their Strategic Flood Risk Assessment (SFRA), prepared in accordance with Planning Policy Guidance 25 (PPG25) – Development and Flood Risk. This document provided the planning authorities with the information they needed to make objective judgements about flooding, both when making decisions on land allocations for development plans and when deciding planning applications for development in their areas.

1.2 Since the SFRA was published Planning Policy Statement 25 (PPS25) has replaced PPG25, providing revised guidance on how to assess flood risk. In addition more detailed information has been produced allowing the earlier assessment to be improved.

1.3 The two councils need the SFRA to be updated so they can prepare Core Strategy and other documents required for their Local Development Frameworks (LDFs). Accordingly the councils have asked RYE Consultancy to review the SFRA taking into account the policy changes introduced in PPS25 and the other information currently to hand, as discussed later in this section.

The Study Area

1.4 The study area, shown in Map 1, stretches from Cleethorpes in the east to Crowle and from Kirton in Lindsey in the south to the Humber Estuary. The total area of land covered by the two councils is 1080 km^2 containing some 318,600 people. Although most people live in urban areas including Cleethorpes, Grimsby, Immingham, Brigg, Barton upon Humber and Scunthorpe, nevertheless a significant number live in smaller towns and villages scattered throughout the remaining rural areas.

1.5 As well as people and the houses they live in, the study area contains industrial and commercial property including steel mills, power stations, chemical plants and storage areas for a range of goods. It also contains important infrastructure links including port facilities, roads, railway lines, an airport, power transmission lines and gas pipelines. A significant number of the businesses are chemical industries that have working practices and restrictions under the Health and Safety legislation.

1.6 Much of the industry is located in the South Humber Bank Industrial Area, which is allocated for estuary-related commercial and industrial development. Other important development proposals include the port area at Grimsby and the planned Lincolnshire Lakes development by the Trent near Scunthorpe.

1.7 The main sources of flood risk within the study area are the Humber Estuary and the rivers draining to it, particularly the Ancholme and the Trent but also a number of smaller ones including Waithe Beck, Freshney, East Halton Beck, Bottesford Beck and the various canals and drains east of the Trent by the Isle of Axholme. Flooding can also arise from smaller drains and from blockages in culverts, while groundwater levels can rise following heavy rain leading to ponding if the water cannot get away, as occurred in July 2007.

1.8 The area has been divided into three parts for the assessment:-

- **Eastern Coastal Area;** covering the southern shoreline of the Humber Estuary from Humberston Fitties to South Ferriby Cliff and extending inland to the eastern boundary of the River Ancholme catchment.

- **Ancholme Valley Area;** covering the catchment of the River Ancholme, including Brigg, and the Humber Estuary shoreline between South Ferriby Cliff and Whitton.

- **Trent Valley Area;** covering the remaining land including most of Scunthorpe, the River Trent and the Isle of Axholme.

This document covers all three areas.

Scope (and limitations) of the Review

Changes introduced by PPS25

1.9 A SFRA is a tool used by a planning authority to assess all types of flood risk for spatial planning and making planning decisions. The requirement to produce one was set out in PPG25, which introduced the Sequential Test as a means of demonstrating there are no reasonably available sites with a lower risk of flooding suitable for the type of development proposed. This approach was extended in PPS25, which also introduced the Exception Test for use where the Sequential Test alone cannot deliver acceptable sites but where continued development is necessary for wider reasons.

1.10 PPS25 recommends a staged approach to drawing up a SFRA as this allows flexibility in the level of assessment (and detail) required. The first stage is a Level 1 assessment, defined as providing the information needed to undertake the Sequential Test. A Level 2 assessment is a more detailed review of the flood hazard taking into account any management measures (such as flood defences) present, and provides the extra information needed to undertake the Exception Test.

1.11 PPS25 includes new climate change guidance, including greater rates of sea level rise, and suggests that the impacts of climate change should be considered over 100 years. As a result the extreme water levels to be covered in the review are higher than those taken into account in the original study, which took a horizon of 50 years.

1.12 Following a consultation in 2009, a revised version of PPS25 was published in March 2010. The amendments are confined to Tables D.1 and D.2 of Annex D of PPS25 and are concerned with the application of the policy to essential (critical) infrastructure; emergency services facilities, certain installations requiring hazardous substances consent; and wind turbines, and with the identification of functional floodplain.

1.13 Guidance on implementing PPS25 is contained in the PPS25 Practice Guide, which was updated and re-issued in December 2009. The updated version notes that future amendments to PPS25 will be reflected in further iterations of the Practice Guide.

Other information now available or in preparation

1.14 The Environment Agency (EA) now has lidar data covering the whole of the tidal and fluvial floodplain within the study area and has provided a copy of this information for the Review. This has allowed the topography of the area to be mapped more accurately, improving the quality of the assessment and allowing the tidal flood zones to be defined in more detail.

1.15 Following the extensive flooding due to very heavy rainfall in June and July 2007, both councils collected a considerable amount of data about the areas that flooded, the drainage network and the drainage problems that caused the flooding to occur. This information and the experience gained while collecting it have been used to provide a more detailed assessment of the risk of flooding following heavy rainfall.

1.16 The EA has completed studies relating to the Lower Trent and the River Torne, but these have raised major questions about the future management of flood risk in the low-lying land around the Isle of Axholme and further studies are now in hand. In due course these further studies should lead to a comprehensive strategy for managing the risks in this area being agreed but this is likely to take several years.

1.17 The EA has also completed flood map improvement studies for several rivers and smaller watercourses in the study area together with breach studies for the River Ancholme and River Freshney and a comprehensive study of overtopping and breach hazard from the estuary defences seaward of Whitton.

1.18 North Lincolnshire Council (NLC) is undertaking a detailed flood risk assessment, including a Sequential Test and Scunthorpe Western Extension Exception Test Strategy, to provide evidence for the Lincolnshire Lakes Area Action Plan that is being drawn up for the area between Flixborough and East Butterwick on the east bank of the Trent. The associated flood and breach modelling studies have already been completed.

Topics covered by the Review

1.19 "The Review has been drawn up in accordance with the PPS25 recommendations. It includes a Level 1 Assessment covering the whole of the study area and provisional Level 2 Assessments for places where both councils are promoting future development growth which could require the Exception Test to be applied."

1.20 The Review also gives guidance on applying the Sequential and Exception Tests, preparing Flood Risk Assessments and the use of sustainable drainage systems.

2 Planning Policy Context

Introduction

2.1 The main purpose of a SFRA is to provide the information needed for a planning authority to take flood risk into account when making land use allocations and determining planning applications. It will also help a planning authority to:-

- prepare policies for managing flood risk;
- take flood risk into account when preparing strategic land use policies;
- identify the level of detail required for site-specific Flood Risk Assessments (FRAs);
- ascertain the implications of flood risk on emergency plans.

2.2 These decisions need to be taken in the context of national, regional and local planning policy as well as the Environment Agency's intended approach to managing flood risk, including any flood defences, in the area. The key documents in the spatial planning process and their links with other key strategies for managing flood risk are illustrated in Appendix A.

National Policy

2.3 The principal tools PPS25 sets out for assessing the impact of flood risk on development proposals are the Sequential Test and the Exception Test. In its most basic form the Sequential Test is a process in which the most vulnerable land uses (e.g. residential development) are directed away from areas with the highest probability of flooding towards those with the lowest. Conversely, the least vulnerable uses (e.g. outdoor recreation) are acceptable in areas with the highest probability so are not directed away from them.

2.4 In practice, where floodable areas are extensive and land use patterns have been established over centuries many types of interdependent land uses will co-exist irrespective of the flood risk. In view of this, the Practice Guide to PPS25 recognises there are circumstances where a straightforward application of the Sequential Test is not possible. This might be because the proposed, more vulnerable land use supports a community, such as the development of a school where the catchment area is already established, or because the development itself will bring about the wider socio-economic benefits needed to help regenerate an area.

2.5 The socio-economic needs of a community are important considerations in looking at the case for regeneration. PPS25 recognises that in seeking to minimise flood risk care should be taken to avoid circumstances that could lead to blight; this is particularly important where a site's dereliction may be detrimental in the short or long term.

2.6 The application of the Sequential Test needs to take into account other established policies when considering any alternative sites; that they are in areas where the probability of flooding is low is not a guarantee that they are suitable. Areas of Outstanding Natural Beauty, for example, have policies protecting their character that result in development restrictions being applied. Some areas where the

probability is low may nevertheless be unsuitable because they do not have the facilities or infrastructure to make them sustainable for development.

2.7 The planning system is a plan lead process and the Sequential Test is first applied in statutory plans such as Core Strategy Development Plan Documents (DPD). This DPD set out the long term spatial planning framework for development by providing strategic policies and guidance to deliver the vision for the area including the scale and distribution of development, the provision of infrastructure to support it and the protection of our natural and built environment. North Lincolnshire Council has an adopted Core Strategy DPD while North East Lincolnshire Council is progressing its Core Strategy DPD towards submission and examination. Both councils also have a supporting Sequential Test which demonstrates the spatial distribution of their housing and employment requirements.

2.8 The Exception Test is also part of the overall planning process. It is required when a potential development site passes the Sequential Test despite having flood risk issues because no suitable site in a lower flood probability area can be found. In effect the Exception Test considers whether the wider community benefits provide sufficient justification for the development to take place and confirms, on the basis of a site-specific Flood Risk Assessment, that acceptable flood risk mitigation measures can and will be taken to make the development safe.

2.9 The Government is currently reviewing all Planning Policy Statements and Planning Policy Guidance, and is consulting (until October 2011) on a National Planning Policy Framework (NPPF) that will consolidate all existing planning guidance into a single document. The NPPF indicates that local plans should continue to apply a sequential, risk-based approach to the location of development to avoid flood risk to people and property where possible, taking into account the impacts of climate change, and to manage any residual risk by applying the Sequential and Exception Tests.

Regional Policy

2.10 Regional policy is set out in the Regional Spatial Strategy (RSS), approved as the Yorkshire and Humber Plan in May 2008. PPS25 had not been published at the time of the Plan's formal examination, although it had become national policy by the time the Secretary of State approved the Plan. The RSS was due to be reviewed but a general election was held in May 2010 and the new Government stopped any further work on the review process.

2.11 Since the election the Secretary of State for Communities and Local Government has indicated his intention to abolish Regional Strategies including the Yorkshire and Humber Plan. This revocation was successfully challenged in the High Court, meaning that Regional Strategies continue to form part of the Development Plan for the time being. Nevertheless their abolition remains a central policy objective of the Government.

2.12 The RSS for Yorkshire and Humber recognises both the vulnerability of the South Humber area to flood risk and the major economic potential offered by its coastal location, potential that is of regional and national importance. It identifies the main urban areas of Scunthorpe and Grimsby/Cleethorpes as the most sustainable locations for most types of development and indicates that the majority of new residential development should take place either within or as extensions to these urban areas. It also identifies the South Humber Bank as a strategic employment site.

Local Policy

2.13 The Core Strategies of the two councils will demonstrate how the national policies and regional policies set out in the RSS were taken forward into the Local Development Framework. North Lincolnshire Council adopted it Core Strategy DPD in June 2011 following a public examination in January 2011. North East Lincolnshire Council is now finalising its Core Strategy DPD before submitting it to the Planning Inspectorate.

2.14 Each council is currently preparing other DPD (such as Housing and Employment Land Allocations and Area Action Plans) and Supplementary Planning Documents (SPD) that will follow the principals set out in their respective Core Strategy which is supported by a robust evidence base and has been subject to a Sustainability Appraisal and Sequential Test. North East Lincolnshire Council has also prepared an additional Sustainability Test which is being used to score future land allocations and planning applications in high flood probability areas.

2.15 North Lincolnshire Council's Core Strategy includes Policy CS19 on Flood Risk and provides a direct link to this SFRA. It supports the risk based sequential approach to determine the suitability of land for development that uses the principles of locating development reflecting PPS25's requirement for Sequential Test, Exception Test, site specific Flood Risk Assessments and the use of Sustainable Drainage Systems where necessary and appropriate. Policy CS19 also makes reference to the Western Scunthorpe Urban Extension Exception Test Strategy agreed with the Environment Agency (EA) and indicates that any further changes to this Strategy which may be produced in the future will have to also be agreed with the EA.

2.16 Both councils have to carry out Sustainability Appraisals as part of the development planning process. These address social, environmental and sustainability objectives and include Strategic Environmental Appraisals and Habitats Regulations Assessments as appropriate. Flood risk is one of the environmental objectives.

2.17 A key output of each council's development planning will be the Housing and Employment Land Allocations DPD. This will review possible development sites, assess their suitability taking all material policy issues into account (including the results of the Sustainability Appraisal and the Sequential Test), and on this basis make appropriate land allocations. These documents will be important considerations when undertaking Sequential and Exception Tests intended to support site-specific planning applications.

2.18 A SFRA also has to take into account any policies produced by other organisations, in particular the Environment Agency, which may affect the flood risk in the area in the future. The Environment Agency's long-term plans for managing flood risk are generally set out in Shoreline Management Plans (SMPs) for the coast and Catchment Flood Management Plans (CFMPs) for river catchments, supplemented by any more detailed Strategies or other studies that may have been completed.

2.19 Two SMPs for the coast between Flamborough Head and Gibraltar Point were produced in 1998 (Flamborough Head to Donna Nook) and 1996 (Donna Nook to Gibraltar Point). These are currently being reviewed and a joint document (the HECAG SMP) covering the whole of this coastline including the south bank of the Humber seaward of Immingham, will be produced in due course. Tidal flood risk from the Humber Estuary is covered by the Humber Flood Risk Management Strategy (HFRM), published in 2008, which covers the study area seaward of Keadby Bridge.

2.20 The River Trent CFMP is currently being finalised but is not yet available, although more detailed studies covering selected rivers and watercourses have been produced. A Strategy for the low-lying land surrounding the Isle of Axholme, west of the Trent, is currently being prepared but has not yet been completed. The Grimsby and Ancholme CFMP was published in November 2009. The policies adopted in these documents do not affect the flood risk assessments described in this SFRA.

3 Assessing Flood Risk

Factors affecting Flood Risk

3.1 Flooding is a natural process that plays an important role in shaping the natural environment. However, it also threatens life and causes substantial damage to property.

3.2 Flood risk involves both the statistical probability of a flood occurring and the scale of the potential consequences. The main causes of flooding are generally categorised as:-

- **Tidal flooding** – flooding beside the sea or an estuary caused by high sea levels, sometimes influenced by high waves
- **Fluvial flooding** – flooding from a river or large watercourse caused by high river flows
- **Surface water flooding** – flooding from small watercourses, ditches, sewers and overland flow caused by heavy rainfall and
- **Groundwater flooding** – flooding that occurs when groundwater levels rise above ground levels, often following prolonged heavy rainfall.

The mechanism of flooding is different in each case and this can have an impact on how floods develop, how often they are likely to occur and how they can be managed. Further information is given in Appendix B.

Flood Zones and Flood Maps

3.3 A key element in the assessment of flood risk is the concept of flood zones. These are areas where the probability of flooding varies between the limits set out in Table 3.1 (on the next page), taken from PPS25. Plotting the flood zone boundaries allows the preparation of flood maps, which give a visual understanding of how the probability of flooding varies across an area. Existing flood defences are not taken into account in the assessment as they may not be maintained in the future. Further information about flood zones is given in Appendix C.

3.4 The Environment Agency publishes flood zone maps covering England and Wales, which are updated at regular intervals. These maps show PPS25 Flood Zones 1, 2 and 3 but do not subdivide Flood Zone 3 in to 3a and 3b so do not show the functional floodplain. A typical example is shown on page 11. An important point is that they are based on the conditions that occur at present and so do not include any allowance for climate change. To avoid confusion the flood zones resulting from the assessments in this SFRA (and shown on the flood zone and breach hazard maps discussed in Sections 5 and 6), which do take climate change into account, are referred to as 'SFRA Flood Zones'.

3.5 The Environment Agency also produces maps showing the location and extent of historic fluvial and tidal flooding and has recently produced maps showing areas where there is a potential risk of surface water flooding. The surface water maps are based on a high-level assessment, however, that does not take existing drainage systems into account. As a result they give a broad indication only of where surface

water flooding might occur, and so have been provided to Local Authorities for use in their flood risk and emergency planning but are not yet generally available to the public.

Aims of PPS25

3.6 The primary aims of PPS25 are to ensure that flood risk is taken into account at all stages in the planning process; to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. Where new development is necessary in such areas, the aim is to make it safe without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

Flood Zone	Definition
Zone 1 Low Probability	This Zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (< 0.1%).
Zone 2 Medium Probability	This Zone comprises land assessed as having between a 1 in 100 and 1 in 1000 (1% – 0.1%) annual probability of river flooding or between a 1 in 200 and 1 in 1000 (0.5% – 0.1%) annual probability of sea flooding in any year.
Zone 3a High Probability	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.
Zone 3b Functional Floodplain	This Zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But 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 should provide a starting point for consideration and discussions to identify the functional floodplain.

Table 3.1 - Flood zone definitions

3.7 PPS25 states that local planning authorities should prepare and implement planning strategies that "help deliver these aims by:-

• *Appraising Risk*

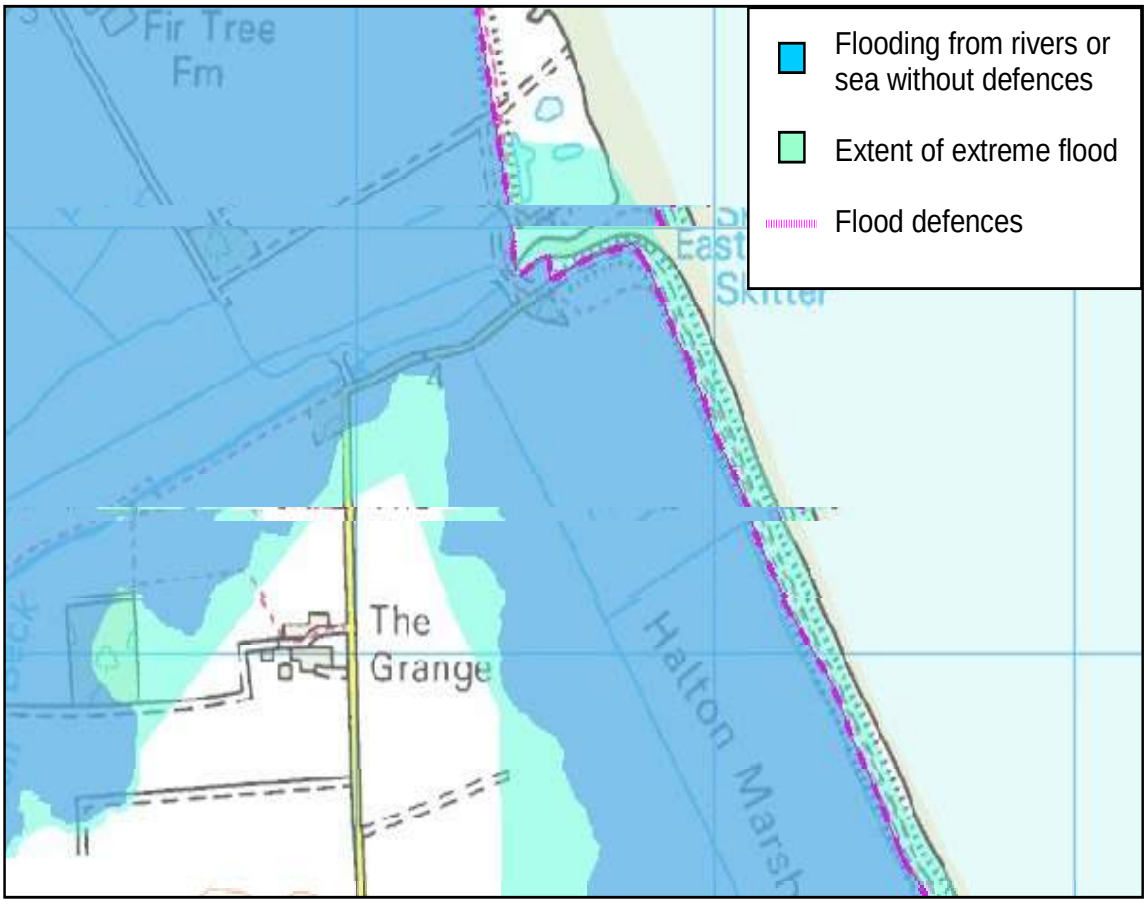
- Identifying land at risk and the probability of flooding from river, sea and other sources in their areas

- Preparing Strategic Flood Risk Assessments (SFRAs) as freestanding assessments that contribute to the Sustainability Appraisal of their plans;

• *Managing Risk*

- Framing policies for the location of development which avoid flood risk to people and property where possible, and manage any residual risk, taking into account the impacts of climate change

- Only permitting development in areas liable to flood when there are no reasonably alternative available sites in areas where the probability of flooding is lower and the benefits of the development outweigh the risks from flooding.



Environment Agency flood zone map

• *Reducing Risk*

- Safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water, and flood defences

- Reducing flood risk to and from new development through location, layout and design, incorporating Sustainable Urban Drainage Systems (SUDS)

- Using opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SUDS; recreating functional floodplain; and setting back defences.

• *A partnership approach*

- Working effectively with the Environment Agency, other operating authorities and other stakeholders to ensure that best use is made of their expertise and information so that plans are effective and decisions on planning applications can be delivered expeditiously and

- Ensuring spatial planning supports flood risk management policies and plans, River Basin Management Plans and emergency planning.

The Sequential Test

3.8 The main way to achieve these aims is by applying the Sequential Test, a risk-based tool intended to steer new development to areas with the lowest probability of flooding and applied at all stages of planning. When doing this, preference should be given to locating new development in Flood Zone 1. If there are no reasonably available sites there, then sites in Flood Zone 2 can be considered, taking into account the 'compatibility' of the proposed land use as set out in Table 3.2 and applying the Exception Test if required. Only if there are no reasonably available sites in Flood Zones 1 and 2 should sites in Flood Zone 3 be considered provided, again taking the vulnerability of the proposed land use into account and applying the Exception Test if required. Further information is given in Appendix C.

3.9 Within each flood zone, new development should be directed first to sites with the lowest probability of flooding. The flood vulnerability of the intended use should be matched to the flood risk of the site, so that higher vulnerability uses are located on parts of the site with the lowest probability of flooding. When applying for planning permission to develop sites allocated in a development plan, developers are required to apply the Sequential Test again but should apply the sequential approach to locating development within the site.

The Exception Test

3.10 The Exception Test should be applied only after the Sequential Test has been undertaken and in the circumstances set out in Table 3.2, i.e. when 'more vulnerable' development and 'essential infrastructure' cannot be located in Flood Zones 1 and 2 and when 'highly vulnerable' development cannot be located in Flood Zone 1.

Key ✓ *Development is appropriate*

× *Development should not be permitted*

Flood Risk Vulnerability Classification (see Appendix C, Table D.2)		**Essential Infrastructure**	**Water Compatible**	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**
Flood Zone (see Appendix B, Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b	Exception Test required	✓	×	×	✓

Table 3.2 - Flood Risk Vulnerability and Flood Zone 'Compatibility'

- Table 3.2 does not show the application of the Sequential Test, which guides development first to Flood Zone 1, then to Flood Zone 2, then to Flood Zone 3

- FRA requirements and the policy aims for each Flood Zone are set out in Appendix C (PPS25 Table D.1, including the amendments proposed in the August 2009 consultation).

3.11 PPS25 states that for the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the Development Plan Document has reached the 'submission' stage – see Figure 4 of PPS12: Local Development Frameworks – the benefits of the development should contribute to the Core Strategy's Sustainability objectives

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

c) A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

'Developable sites' are defined in PPS3: Housing as sites that are in a suitable location for housing development and where there is a reasonable prospect that the site is available and could be developed. Annex B of PPS3 gives a formal definition of 'previously developed sites', commonly known as 'brownfield land'.

The Practice Guide to PPS25

3.12 The Practice Guide complements PPS25 by providing guidelines on how to implement its policies and using case studies and examples to illustrate how they can be applied in a range of circumstances. The Practice Guide follows an overall flood risk management hierarchy based on five steps and summarised in Table 3.3. It was updated and re-issued in December 2009.

Flood Risk Management Stage	What it means	How the planning system deals with it	Who is responsible
Assess	Undertake studies to collect data at the appropriate scale and level of detail to understand what the flood risk is.	Regional Flood Risk Appraisals (RFRAs), Strategic Flood Risk Assessments (SFRAs), Flood Risk Assessments (FRAs) and application of the sequential approach.	Planning bodies and developers.
Avoidance/ prevention	Allocated developments to areas of least flood risk and apportion development types vulnerable to the impact of flooding to areas of least risk.	Use the Sequential approach (including the Sequential Test and Exception Test where relevant) to locate development in appropriate locations. At the plan level, the Sustainability Appraisal should show how flood risk has been weighted against other sustainability criteria.	Planning bodies and developers.
Substitution	Substitute less vulnerable development types for those incompatible with the degree of flood risk.		Planning bodies and developers.

Flood Risk Management Stage	What it means	How the planning system deals with it	Who is responsible
Control	Implement flood risk management measures to reduce the impact of new development on flood frequency and use appropriate design.	Use River Basin Management Plans (RBMPs), Catchment Flood Management Plans (CFMPs), Shoreline Management Plans (SMPs), Surface Water Management Plans (SWMPs), Flood risk Management strategies, appraisal, design and implementation of flood defences.	Planning bodies, Environment Agency and other flood and coastal defence operating authorities, developers and sewerage undertakers. Developers are responsible for design of new developments.
Mitigation	Implement measures to mitigate residual risks.	Flood risk assessments incorporating flood resistance and resilience measures. Emergency Planning Documents. Implementation of flood warning and evacuation measures.	Planning bodies, Environment Agency and other flood and coastal defence operating authorities, developers and sewerage undertakers.

Table 3.3 - Overview of the flood risk management hierarchy

Preparing a Strategic Flood Risk Assessment

3.13 Annex E of PPS25 gives general principles that should be adopted when preparing Flood Risk Assessments (FRA's) and sets out the circumstances in which Regional, Strategic and Site-specific FRA's should be produced.

3.14 The Practice Guide defines two levels of assessment that may need to be undertaken during the preparation of a Strategic Flood Risk Assessment (SFRA):

- A Level 1 Assessment provides the information required to apply the Sequential Test across the whole of the area covered by the SFRA;

- A Level 2 Assessment provides the more detailed information required to undertake the Exception Test, in those areas where the combination of development pressure and the lack of reasonably alternative available sites in SFRA Flood Zones 1 or 2/3a make this necessary.

3.15 The main outputs to be provided by a SFRA are:

For a Level 1 Assessment:

- Plans showing the area covered by the assessment, main sources of river and sea flooding, the SFRA Flood Zones (taking climate change into account) and areas liable to flooding from other sources such as surface water and groundwater
- A review of existing flood management measures including flood defences and flood warning systems
- A review of locations where additional development may significantly increase flood risk elsewhere and where development pressure may require the Exception Test to be applied (i.e. where a Level 2 assessment is needed)
- Guidance on the preparation of site-specific FRAs
- Guidance on the likely applicability of Sustainable Urban Drainage System (SUDS) techniques for managing surface water run-off at key development sites.

For a Level 2 Assessment:

- Additional information about the current condition and future maintenance and improvement of existing flood defences
- An appraisal of the probability and consequences of overtopping or failure of existing flood defences, including plans showing areas where the danger due to high flow velocities or flood depths would be significant
- Guidance on appropriate policies for sites that satisfy parts a) and b) of the Exception Test and requirements concerning part c) to be considered at the planning application stage
- An appraisal of critical drainage areas and identification of the need for Surface Water Management Plans.

Preparing a Site-Specific Flood Risk Assessment

3.16 PPS25 requires that a site-specific Flood Risk Assessment (FRA) should accompany all planning applications for development proposals of 1 ha or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3. The FRA should identify and assess the risks of all forms of flooding to and from the development and should demonstrate how these risks will be managed, taking climate change into account. For major developments in Flood Zone 1, the FRA should identify opportunities to reduce the probability and consequences of flooding.

3.17 A FRA will also be required where the proposals (including change of use to a more vulnerable class) may be affected by other sources of flooding or where the Environment Agency, Internal Drainage Board or other bodies have indicated there may be drainage problems.

4 Study Methodology

4.1 The chapter sets out the methodology used to produce the SFRA Flood Zone maps covering the whole area, as required for the Level 1 Assessment, and the more detailed Breach Hazard maps for areas where the Exception Test may need to be applied, as required for the Level 2 Assessment.

Sources of Data

Existing Flood Risk

4.2 An initial assessment of the current probability of flooding in the study area was obtained from the Environment Agency's flood zone map, shown on Map 2. This shows the extent of PPS25 Flood Zones 1, 2 and 3a based on the results of a broad-scale modelling approach, updated as more detailed information becomes available.

Ground Levels

4.3 The standard Ordnance Survey mapping provides ground level contours at 10m intervals. While these give a general impression of the topography they do not give sufficient detail in broad, low-lying areas, where differences of less than 1m in ground level can have a significant impact on flood risk.

4.4 The Environment Agency has ground level data from Lidar surveys, which are much more accurate than can be obtained from the Ordnance Survey mapping, covering much of the area and made this available for the study. Different parts of the area were surveyed on different dates, and some parts have been surveyed more than once. Although the accuracy of the surveys is generally +/- 0.3m or better, nevertheless it does vary, with more recent surveys generally being more accurate than earlier ones. Accordingly where surveys overlap data from the most recent survey has generally been used.

4.5 The coverage of the Lidar surveys is not complete, as shown on Map 3. The data is provided as a set of 2km x 2km tiles, and the map is colour-coded to show the year of the survey providing most (but not necessarily all) of the data within each tile. Where there is no Lidar data ground levels have been obtained from Ordnance Survey's Land Form Panorama data set.

4.6 The ground level data was used to produce a digital ground model (dgm) covering the whole of the study area. This is shown in Map 4.

Flooding from the sea

4.7 A number of the studies carried out for the Humber Flood Risk Management Strategy (HFRMS) provide information about flooding from the sea (in effect from the Humber Estuary) in the area. In particular, the Joint Probability Analysis gives details about the combinations of water levels and wave heights and periods that are likely to occur throughout the estuary, while the Strategy Report gives information about the approach that will adopted to manage flood risk over the next 100 years.

4.8 The Environment Agency's Northern Area Tidal Model Analysis gives sea levels for a range of annual probabilities at selected sites on the coast between the Wash and the Humber for a reference date of 2006. Two of the sites (Immingham and South Ferriby) are within the area covered by the SFRA. The

results are similar to those given in the Joint Probability Analysis, being on average about 0.05m higher after allowing for sea level rise.

Flooding from rivers

4.9 The Environment Agency is responsible for managing the majority (but not all) of the significant rivers and watercourses in the study area. These are termed 'main river' watercourses and are shown on Map 1. Information about the probability of flooding from these watercourses was obtained from reports of other strategies, flood studies and schemes within the area and from discussions with Environment Agency and local council staff.

Flooding from other sources

4.10 The drainage from most of the low-lying land beside the estuary and in the Trent and Ancholme Valleys is administered by a number of Internal Drainage Boards (IDBs), as shown on Map 5. They have provided information about the drainage arrangements (including watercourses, outfalls, pumping stations and design standards) for which they area responsible.

4.11 There are a number of 'significant ordinary watercourses' (SOWs) within the study area. This classification is no longer used by the Environment Agency but has been retained for this SFRA since, although the watercourses are not classified as main river, they are nevertheless potentially significant sources of flood risk because of their characteristics and the density of development nearby. They are shown, with the 'main river' watercourses, on Map 5. Information about them can be obtained from the organisations responsible for them (generally the IDB or local Authority).

4.12 Not all flooding occurs close to known important watercourses. It can occur in unexpected places and for unexpected reasons, such as a blocked culvert. Such events were identified by collecting details of all flood complaints received by the Local Authority over the last 5 years and plotting them on a map to determine whether there are any places with a particular history of flooding problems.

4.13 The great majority of these events occurred during the extensive flooding that happened in July and August 2007. Both Local Authorities worked very hard with the IDBs, Water Companies, Environment Agency and the public to collect as much information as they could with the aim of identifying and recording where the flooding occurred, what it was caused by and which properties were affected. Both councils are maintaining their records with information from new flood events as they occur.

4.14 The Environment Agency's surface water flooding maps were provided to Local Authorities in July 2009 and were therefore available for this study. They are based on a high-level assessment, however, that does not take existing drainage systems into account, and so give only a broad indication of where surface water flooding might occur.

Historic flooding

4.15 The Environment Agency's historic flood maps show the location and extent of recorded fluvial and tidal flooding. Further information about the events causing the flooding can be obtained from the Environment Agency. The maps are presented as Map 6, which also shows the location of the flood complaints received by the councils over the last 5 years.

Existing flood defences and related information

4.16 Information about the location and condition of existing flood defences is contained in the Environment Agency's National Flood and Coastal Defence Database (NFCDD). A copy of the relevant sections, covering the defences within the study area, were provided and further information was obtained from studies undertaken for the HFRMS, from reports of other strategies, flood studies and schemes within the area and from discussions with Environment Agency and council staff.

Climate change allowances

4.17 In October 2006 Defra published new guidance about the impact of climate change that should be taken into account when assessing future flood risk. The allowances for sea level rise vary across the country due to the effects of vertical movement of the land, which is generally falling in the south and east and rising in the north and west, but the other parameters are the same everywhere. The figures applying to this study are shown in Table 4.1.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Net sea level rise in mm/yr (relative to 1990)	4.0	8.5	12.0	15.0
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Table 4.1 - Recommended allowances for climate change impacts

Breach parameters

4.18 Guidance from the Environment Agency's Anglian Region recommends that the parameters given in Table 4.2 are adopted when assessing the extent of flooding that will occur if existing flood defences breach, on the assumption that the breach extends to ground level at the landward toe of the defence.

Location	Defence type	Breach width (m)	Time to close (hrs)
Open coast	Earth bank Dunes Hard	200 100 50	72 72 72
Estuary	Earth bank Hard	50 20	72 72
Tidal river	Earth bank Hard	50 20	72 72
Fluvial river	Earth bank Hard	40 20	36 36

Table 4.2 - Breach parameters (from EA Anglian Reg Guidance Note)

The Level 1 Assessment

4.19 For the purposes of this study, the aim of the Level 1 Assessment is to produce maps showing the extent of the SFRA Flood Zones 1 to 3, taking into account the effects of climate change. The target date for determining the effects of climate change is taken as 2115, the date adopted for the Environment Agency's overtopping and breach hazard studies.

4.20 The Environment Agency's flood zone maps show the current extent of the flood zones, i.e. without the effect of climate change. The information available from the HFRMS allows the water levels in the estuary needed to identify SFRA Flood Zone 3a, taking into account the effect of climate change, to be determined simply but not the water levels needed to identify SFRA Flood Zone 2. The information about river levels that is available cannot easily be adjusted to take the effect of climate change into account consistently across the whole of the study area; to do so would require extensive re-modelling.

4.21 It was therefore agreed that the Level 1 maps should show only the boundary between SFRA Flood Zones 1 and 2/3a, covering flooding both from the sea (estuary) and from rivers, together with the functional floodplain (SFRA Flood Zone 3b) and areas where drainage problems may lead to flooding from other sources. This assumes that, in effect, SFRA Flood Zone 2 is incorporated into SFRA Flood Zone 2/3a. The methods used to define these areas are described below.

Flooding from the sea (estuary)

4.22 The HFRMS Joint Probability Analysis (JPA) gives combinations of water levels and wave heights likely to occur at ten points along the estuary shoreline, and was therefore selected as the source of water level data rather than the Northern Area Tidal Model Analysis, which only has two points within the Study area.

4.23 The highest water level at each JPA point (ignoring the wave height) with a 1 in 200 (0.5%) annual probability was taken and increased by 1.201 m, the total rise in sea levels between 1991 (the JPA reference date) and 2115 from the Defra guidance, to account for the effect of climate change. The adjusted level was projected horizontally across the floodplain and the line where it intersects with the existing ground surface (from the digital ground model) was taken as the boundary between SFRA Flood Zones 1 and 2/3a.

Flooding from rivers

4.24 The Flood Zone 2 boundary from the Environment Agency's flood zone maps was taken to represent the SFRA Flood Zone 2/3a boundary including the effects of climate change to 2115.

Functional floodplain

4.25 Areas were taken to be in SFRA Flood Zone 3b (functional floodplain) if they were identified:

- within Environment Agency reports (or by Environment Agency staff) as providing flood storage under defined conditions (i.e. during events with return periods greater than a given figure) and so forming part of the flood management system; or

- within publicly available Environment Agency documents as being considered in the HFRMS as potential managed realignment sites.

Flooding from other sources

4.26 The information held by the councils about local flooding during the 2007 and subsequent events was inspected together with the map of flood complaints prior to 2007 and the Environment Agency's historic and surface water flooding maps to identify areas where there may be drainage problems. Council staff concerned with drainage issues carried out this work, to make sure their local knowledge was taken into account.

The Level 2 Assessments

4.27 Level 2 Assessments were undertaken for areas within SFRA Flood Zone 2/3a that are protected by defences providing an acceptable standard of protection and where there is likely to be significant pressure for development. 'Providing an acceptable standard of protection' was taken as being high enough to prevent overtopping by still water levels having a 1 in 100 or less (<1%) annual probability of occurring in a river or a 1 in 200 or less (<0.5%) annual probability of occurring in the estuary and tidal river each year. Waves can be significant in the estuary, and if these are taken into account defences were deemed to provide an acceptable standard of protection provided the rate of overtopping flow was less than the limits adopted for the HFRMS.

4.28 The aim of the Level 2 Assessment is to determine how, if the defences fail during a extreme event (one which would flood all of SFRA Flood Zone 2/3a if there were no defences), the hazard to people will vary across the area they protect. The Practice Guide recommends that flood hazard is determined using the formula given in Defra's FD2320 'Flood Risk Assessment Guidance for New Development', published in 2005, as follows:-

- Flood Hazard = Flood depth (m) x [Flow velocity (m/s) + 0.5] + Debris Factor (DF)

- DF varies as shown in Table 4.3. The flood hazard zones used in this study are based on the classification set out in Table 4.4 (over page).

Flood depth (m)	All areas (rural and urban)
≤ 0.25	0.5
> 0.25	1

Table 4.3 - Guidance on Debris Factor values

4.29 The detailed breach hazard model studies carried out for the Environment Agency and this study simulate the flow of water through a breach of pre-determined width in the defences and spreading across the floodplain behind them. The models used assume each breach remains open for 72 hours and allows flow from the estuary into the floodplain while the tide level is above the water level on the inland side of the breach, and in the reverse direction when it drops below this.

4.30 The models simulate the flood spreading by dividing the floodplain into a grid of cells and determining the flood depth and flow velocity in each cell at intervals of 3 to 5 minutes for a period of 4 days after the breach occurs. As a result they show how the resulting flood would develop and then stabilise once the breach is closed. The flood depths and flow velocities are strongly influenced by the ground level

in each cell, which is taken as the average level across it calculated from Lidar data. This means that significant obstructions to the flow, such as low ridges or raised banks (including road embankments) are likely to be properly represented although smaller ones may not. The Environment Agency's study used a 20m square grid except in the Grimsby urban area, where an 8m grid was used, while the North Lincolnshire Council study used a 10m grid.

Flood Hazard value	Degree of flood hazard	Description	Indicative depth range
< 0.75	Low	Caution 'Flood zone with shallow flowing water or deep standing water'	Up to 0.25 m
0.75 – 1.25	Moderate	Danger for some (i.e. children) 'Danger: flood zone with deep or fast flowing water'	Up to 0.5 m
1.25 – 2.0	Severe	Danger for most 'Danger: flood zone with deep fast flowing water'	0.2 m to 2 m
> 2.0	Extreme	Danger for all 'Extreme danger: flood zone with deep fast flowing water'	0.3 m to over 2 m

Table 4.4 - Guidance on flood hazard classification

4.31 The flood depths and flow velocities are used to determine the flood hazard due to breaching in each cell at each time-step through the simulation. The results are then examined to determine the peak depth, velocity and hazard rating at each point, and these are plotted to produce maps showing how these characteristics vary across the floodplain. The hazard rating maps are marked up to show flood hazard zones based on the classification set out in Table 4.4.

4.32 The Environment Agency's study simulates breaches at 30 locations in the Humber defences within the study area. Each breach is assumed to be 50m wide, except for one at Grimsby intended to simulate the failure of a dock gate. The North Lincolnshire Council's study (for the proposed Lincolnshire Lakes development) simulates breaches, each 50m wide, at 6 locations. The two sets of breaches are shown on Map 7.

4.33 In both studies, the results from all the breach tests for a given event are combined to show the peak depth, velocity and hazard rating across the whole of the area liable to flood. The breach hazard maps derived for this SFRA are based on the combination maps produced for breaches during a 1 in 200 (0.5%) annual probability event in 2115, to account for the effect of climate change. The Environment Agency's study uses estuary levels based on the Northern Area Tidal Model Analysis while the North Lincolnshire Council's study uses a worst-case combined fluvial/tidal event.

5 Outcome of Level 1 Assessment

5.1 The Level 1 Assessment results are presented on SFRA Flood Zone Maps 20 to 23, covering the three parts into which the study area has been divided for convenience:

- **Eastern Coastal Area;** covering the southern shoreline of the Humber Estuary from Humberston Fitties to South Ferriby Cliff and extending inland to the eastern boundary of the River Ancholme catchment.

- **Ancholme Valley Area;** covering the catchment of the River Ancholme, including Brigg, and the Humber Estuary shoreline between South Ferriby Cliff and Whitton.

- **Trent Valley Area;** covering the remaining land including most of Scunthorpe, the River Trent and the Isle of Axholme.

5.2 The maps show the following information:-

- The council boundaries

- The extent of SFRA Flood Zone 2/3a (as defined in paragraph 4.20), with areas where the source of flooding is mainly from the sea shaded blue and from rivers shaded green

- The extent of SFRA Flood Zone 3b (the functional floodplain, as defined in paragraph 4.23), marked with cross-hatching

- The location of all places where surface water flooding due to drainage or other problems has been recorded

- Watercourses designated as main river or as SOWs

- Drainage pumping stations

- Existing flood defences and

- Flood compartments (as described in paragraph 5.11).

5.3 It is important to note that the SFRA Flood Zone 2/3a shown here is different to the PPS25 Flood Zone maps because it:-

- Takes into account the effects of climate change to 2115 and

- Incorporates PPS25 Flood Zone 2.

Nevertheless the areas shown on these maps should be considered as Flood Zone 3 as defined in PPS25 when preparing development plans, making planning allocations or determining planning applications.

5.4 Information about the study area's three parts and the probability of flooding there is given in the following sections. Further information is given in the Flood Compartment Appendices H, I and J. Directions for determining critical flood levels across the study area are given in Appendix D.

Eastern Coastal Area

Location, extent and development potential

5.5 The Eastern Coastal Area stretches from Humberston Fitties, which is east of Cleethorpes, to the high ground outcropping at South Ferriby Cliff, west of Barton-upon Humber and the Humber Bridge. The shoreline of the Humber Estuary forms the northern and eastern boundaries while the council borders form the southern boundary. The watershed dividing the River Ancholme catchment from the catchments draining east to the estuary acts as the western boundary.

5.6 The main centres of population in the area are Cleethorpes, Grimsby, Immingham and Barton-upon-Humber, all lying within 5km of the estuary. The area also contains the major ports of Grimsby and Immingham and wharfage facilities at North Killingholme and New Holland. There are major industrial and commercial facilities beside the coast between Grimsby and North Killingholme, including power stations, chemical works and storage areas. Many of these are either linked to the docks or are associated with the estuary in some other way. The remainder of the area is largely devoted to agriculture.

5.7 The coastal plain between Grimsby and East Halton Skitter (about 3 km along the coast from North Killingholme) has been allocated for estuary-related development in the Regional Spatial Strategy and local plans. A detailed development study is currently being carried out. Between North Killingholme and Grimsby the development will consist primarily of infilling between existing facilities but further north the land is largely undeveloped and is currently used for agriculture. No other parts of the area are allocated for major development.

Main sources of flooding

5.8 The main source of flooding in the area is a combination of large waves and high water levels in the Humber Estuary. The HFRMS Joint Probability Analysis quotes the combinations having a 0.5% probability of occurrence and a selected list of these combinations is given in Table 5.1. The figures in the table are for a base date of 1991 and current guidance indicates that allowance should be made for sea levels to rise by 1.201m and wave heights increase by 10% by 2115.

Humber Bridge		Immingham		Cleethorpes	
Water level (mOD)	**Wave ht (m)**	**Water level (mOD)**	**Wave ht (m)**	**Water level (mOD)**	**Wave ht (m)**
5.44	0.0	4.93	0.0	4.56	0.0
5.25	0.6	4.60	1.0	4.43	1.5
4.80	0.8	4.05	1.5	4.20	2.2
4.14	0.9	3.25	1.8	3.60	3.2

Table 5.1 - Water level and wave height combinations with a 0.5% probability of occurrence; Eastern Coastal Area

5.9 There are nine main river watercourses, ten watercourses that are classified as SOWs and six pumping stations within the area, shown on Map 8. Five of the main river watercourses lie wholly within the tidal flood plain and one (Stallingborough North Beck) has only a very short length (~300m) lying outside. All but five of the SOWs lie within the tidal or fluvial floodplain, as currently defined, and North East Lindsey IDB is responsible for all but two of them.

5.10 The responsibility for draining the low-lying land within the area is shared by two IDBs, Lindsey Marsh (which deals with the Waithe Beck and the Humberston Fitties and surrounding area) and North East Lindsey (which deals with the remainder). The IDB boundaries are also shown on Map 8. The IDB has to approve the drainage arrangements of all significant new development within its boundaries or affecting its watercourses. In principle the site runoff characteristics should remain unchanged, although often the IDB will accept the receiving drainage system being improved so it can accept the increased discharge, at the developer's expense. It is understood that the design standard for these improvements is the event having a 1.0% annual probability of occurrence.

Flood compartments

5.11 To allow more detailed assessment, the area shown as SFRA Flood Zone 2/3a on Flood Zone Map 20 has been divided into flood compartments taking into account the topography, type of defence, drainage arrangements and land use. These compartments are listed in Table 5.2 with the sources of flood risk they include. Further information about the area and its compartments is given in Appendix H.

Compartment Reference	Compartment Name	Primary Sources of Flood Risk
1T1	Cleethorpes	Humber Estuary Lower Buck Beck Little Buck Beck
1T2	Grimsby & Stallingborough	Humber Estuary Lower River Freshney New Cut Mawmbridge Drains Oldfleet Drain Middle Drain, Stallingborough Stallingborough North Beck
1T3	Immingham & North Killingholme	Humber Estuary Stallingborough North Beck Habrough Marsh Drain South Killingholme Main Drain Lower East Halton Beck
1T4	Goxhill	Humber Estuary Lower East Halton Beck Goxhill complaints

Compartment Reference	Compartment Name	Primary Sources of Flood Risk
1T5	Barton upon Humber	Humber Estuary New Holland Main Drain Barrow Beck Butts Beck Midby Drain, Barrow Barrow complaints
1F1	Waithe Beck	Waithe Beck
1F2	Buck Beck & Goosepaddle Drain	Buck Beck Buck Beck, Waltham (a & b)
1F3	River Freshney & Laceby Beck	River Freshney
1F4	East Halton Beck/Skitter Beck	East Halton Beck Brockelsby Beck
1F5	Barrow Beck/Midby Drain	Barrow Beck Midby Drain, Barrow

Table 5.2 - Flood compartments; Eastern Coastal Area

The reference prefix denotes the primary source of flood risk in the compartment;
T = Tidal; F = Fluvial

Ancholme Valley Area

Location, extent and development potential

5.12 The Ancholme Valley Area stretches from the high ground outcropping at South Ferriby Cliff, west of Barton-upon Humber, to the high ground at Whitton and south as far as Waddingham in the Ancholme Valley. The shoreline of the Humber Estuary forms the northern boundary while the NLC boundary forms the southern boundary. The watersheds dividing the River Ancholme catchment from the catchments draining east to the estuary and from the River Trent catchment act as the eastern and western boundaries respectively.

5.13 The main centres of population in the area are Winterton, Broughton and Brigg. Winterton and Broughton are both on high ground well above the floodplain but much of Brigg is in the bottom of the Ancholme Valley, about 14 km from its outfall at South Ferriby on the Humber. A number of villages (or parts of them) also lie within the floodplain, including Winteringham, South Ferriby, Wrawby and Hibaldstow. There are some industrial and commercial facilities at Brigg and a cement works at South Ferriby. The remainder of the area is largely devoted to agriculture.

5.14 In September 2000, the Council identified a number of potential sites for development in Brigg. The Environment Agency objected to any development in the floodplain and the Council appointed WS Atkins to prepare an SFRA for the Local Plan Inquiry. The council modified its proposals in the light of this assessment and the Inspector accepted the revised proposals in his report dated January 2003.

Main sources of flooding

5.15 There are two main sources of flooding in the River Ancholme area, a combination of large waves and high water levels in the Humber Estuary and high river flows in the River Ancholme.

5.16 The Joint Probability Analysis quotes the water level and wave height combinations having a 0.5% probability of occurrence in the estuary and a selected list of these combinations is given in Table 5.3. The figures in the table are for a base date of 1991 and current guidance indicates that allowance should be made for sea levels to rise by 1.201m and wave heights increase by 10% by 2115.

Whitton		South Ferriby		Humber Bridge	
Water level (mOD)	Wave ht (m)	Water level (mOD)	Wave ht (m)	Water level (mOD)	Wave ht (m)
5.54	0.0	5.52	0.0	5.44	0.0
5.42	0.4	5.25	0.6	5.25	0.6
5.26	0.6	4.93	0.7	4.80	0.8
5.04	0.7	4.51	0.8	4.14	0.9

Table 5.3 - Water level and wave height combinations with a 0.5% probability of occurrence; Ancholme Valley Area

5.17 There are two sections of fluvial floodplain within the area, a relatively small one associated with the Winterton Beck that discharges to the estuary at Winteringham Haven, and the main one associated with the River Ancholme that has a gated outfall at South Ferriby. Both sections contain complex drainage systems that are managed by the Ancholme IDB.

5.18 There are twenty-one main river watercourses within the area, shown on Map 10. Throughout the study area the River Ancholme is embanked and acts as a highland carrier (carrying drainage flows from high ground further upstream at levels that are above the local ground level). Two separate main river watercourse systems (for the left and right bank respectively) drain the low-lying land beside the lower reaches of the river to the estuary, again discharging through gated outfalls at South Ferriby. Further upstream more highland carriers drain the uplands on either side of the Ancholme Valley, receiving gravity or pumped flows from the IDB drainage system and discharging them to the River Ancholme. They are all classified as main river watercourses.

5.19 Four watercourses lying within the River Ancholme Area are classified as SOWs. They lie within the tidal or fluvial floodplain (as currently defined), are managed by the Ancholme IDB and are shown on Map 10.

5.20 The responsibility for draining all the low-lying land within the River Ancholme area lies with the Ancholme IDB. Its drainage system is complex and, except near the estuary, much of it is pumped. The areas near the estuary are currently drained by gravity but siltation at the outfalls is becoming a serious problem and the IDB considers in due course most of them will need to be pumped. The IDB boundaries and pumping stations are shown on Map 10.

5.21 The IDB aims to provide a standard of between 10% and 5% annual probability of occurrence (1:10 and 1:20 years return period) for agricultural land throughout the system but this includes a freeboard

of at least 1m below local ground level (to prevent the land from being waterlogged). As a result the standard provided to property (which is not affected by flooding until the water level rises above local ground level) is generally in the range 2.0% and 1.0% annual probability (1:50 to 1:100 years return period). The IDB has to approve the drainage arrangements of all significant new development within its boundaries or affecting its watercourses. In principle the site runoff characteristics should remain unchanged, although the IDB may accept the receiving drainage system being improved so it can accept the increased discharge, at the developer's expense. It is understood that the design standard for these improvements is the event having a 1.0% annual probability of occurrence.

Flood compartments

5.22 To allow more detailed assessment, the area shown as SFRA Flood Zone 2/3a on Flood Zone Map 21 has been divided into flood compartments taking into account the topography, type of defence, drainage arrangements and land use. These compartments are listed in Table 5.4 below, with the sources of flood risk they include. Further information about the area and its compartments is given in Appendix I.

Compartment Reference	Compartment Name	Primary Sources of Flood Risk
2T1	South Ferriby (East)	Humber Estuary New River Ancholme East Drain Lower Fulseas & Marsh Drains
2T2	South Ferriby (West)	Humber Estuary New River Ancholme West Drain
2T3	Winterton	Humber Estuary Winterton Beck
2F1	Lower Ancholme Right Bank	New River Ancholme Land Drain Bonby Catchwater Worlaby Catchwater Little Carr Drain Wrawby Catchwater Humber Estuary
2F2	Lower Ancholme Left Bank	New River Ancholme West Drain Appleby Mill Beck Ella & Moor Beck Spring Dyke West Drain (IDB) Humber Estuary
2F3	Island Carr	Island Carr North

Compartment Reference	Compartment Name	Primary Sources of Flood Risk
2F4	Middle Ancholme Right Bank	New River Ancholme North Kelsey & Grasby Beck Froghall Drain Kettleby Beck
2F5	Middle Ancholme Left Bank	New River Ancholme Castlethorpe Drain Scawby Catchwater Hibaldstow Catchwater Hibaldstow North Drain Redbourne Old River Redbourne Catchwater Sallow Row drain Scawby Brook

Table 5.4 - Flood Compartments; Ancholme Valley Area

Note:- The reference prefix denotes the primary source of flood risk in the compartment;
T = Tidal; F = Fluvial, although note that all compartments north of Brigg are at risk from both tidal and fluvial flooding

Trent Valley Area

Location, extent and development potential

5.23 The Trent Valley Area extends from Whitton Ness on the Humber in the north to the NLC boundary about 4 km south of Haxey, a total distance of some 30 km. The watershed along the Lincolnshire Edge dividing the River Ancholme and River Trent catchments forms the eastern boundary while the NLC boundary forms the northern and western boundary except for a short section between Whitton Ness and Trent Falls, where the boundary is the estuary shoreline.

5.24 The main centre of population in the area is the heavily industrialised town of Scunthorpe. Much of this is on relatively high ground but it extends east as far as the low-lying ground that forms the River Trent floodplain. There are a number of villages, wharves and industrial areas along the river, notably at Burton upon Stather, Flixborough, Gunness, Keadby, Althorpe, East and West Butterwick, Grove Wharf, Burringham and Owston Ferry. Further west, the flat, low-lying floodplain extends well beyond the NLC boundary. Originally marshland, this area was reclaimed in the 16th and 17th Centuries and is very fertile but relies on an extremely complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place. There are a number of villages and small towns within the marsh, generally located on local high spots. The Isle of Axholme is particularly significant in this respect, reaching an elevation of 35mOD and supporting the towns and villages of Belton, Epworth, Haxey and Upperthorpe. Further north, part of Crowle stands on a noticeable high point but the small villages of Eastoft and Garthorpe are only a few metres above the surrounding marsh level.

5.25 There are proposals for a major urban extension (Lincolnshire Lakes) development, the Lincolnshire Lakes, on low-lying land beside the River Trent to the west of Scunthorpe but most other development near the town without existing planning permission is likely to be on relatively high ground above the

floodplain. There may also be some pressure for additional development along the banks of the River Trent in the future as the wharves and industrial facilities there expand.

Main sources of flooding

5.26 There are two main sources of flooding in the Trent Valley area, high water levels in the River Trent and failure of the network of watercourses and pumping stations that together drain the marshland surrounding the river.

5.27 Water levels in the lower section of the River Trent (north of Keadby) are dominated by tidal conditions and so are related to water levels in the Humber Estuary. Work carried out for the HFRMS indicates that the water levels with given probabilities of occurrence in the river are as shown in Table 5.5. The base date for these figures is 1991 and current guidance indicates that allowance should be made for sea levels to rise by 1.201m and wave heights increase by 10% by 2115.

Location	Water level (mOD) for given annual probability		
	1.0%	0.5%	0.2%
Trent Falls	5.61	5.65	5.79
Keadby	5.79	5.82	5.83

Table 5.5 - Water level and wave height combinations with a 0.5% probability of occurrence; Trent Valley Area

5.28 Further upstream water levels during extreme events are due to a combination of tidal and fluvial conditions. An extensive study of the Trent flood defences was carried out during the 1960s and 1970s and included a detailed assessment of extreme fluvial flood levels. The river defences were then raised to provide a consistent standard of 1:100 years against fluvial flooding, equivalent to a 1% annual probability, and have since been maintained to these levels. The Environment Agency has undertaken a Flood Defence Strategy Study of the Tidal Trent (from Trent Falls to the tidal limit at Cromwell Weir) that has reviewed the extreme water levels and flood probability throughout the system and confirmed that the standard is generally 1:200 years or better against tidal flooding, equivalent to a 0.5% annual probability.

5.29 There are three sections of fluvial floodplain within the area, the main one being beside the River Trent (which includes the River Torne, River Idle and other important water courses, as discussed below) with smaller ones beside the Bottesford Beck and the River Eau respectively. The Bottesford Beck collects water from much of the eastern part of Scunthorpe, flowing initially south and then turning west to discharge to the Trent by gravity. The River Eau drains high land further south and much of its indicative floodplain lies outside the NLC boundary. Both the Bottesford Beck and the River Eau are embanked where they cross the Trent floodplain and so act as highland carriers.

5.30 The main river watercourses within the area (there are no SOWs) are shown on Map 12. Those on the right bank of the Trent are discussed above. On the left bank there are four principal watercourse groups connected to the Trent. The most northerly of these is the Stainforth & Keadby Canal, which is managed by British Waterways. This connects the River Don with the River Trent and is separated from the river at either end by a set of locks. There is no flow in the canal but it is embanked for part of its length and is

consequently a potential source of flooding if the embankment fails since the water it contains will drain out. The two Soak Drains (one on either side of the canal) are both main river watercourses.

5.31 South of the canal three main river watercourses (the Hatfield Waste Drain, the River Torne and the South Level Waste Drain, each of which has some lengths of tributary watercourses which are also designated as main river) come together and run parallel with each other to the Keadby pumping station, where the flow is pumped to the River Trent. A number of pumping stations, some operated by the Environment Agency and some by the adjacent IDB, pump water into these watercourses.

5.32 South of the Isle of Axholme is the Warping Drain, which is about 9 km in length but now only collects the discharge from one small pumping station so has a very low flow. It is embanked in places, however, so is a potential source of flooding if an embankment fails. The flow is pumped to the River Trent. Further south again is the River Idle, most of which is outside the study area except for a short section where it forms the NLC boundary. This is an embanked watercourse draining high ground to the south and west of the study area as well as collecting local drainage flows from Environment Agency and IDB pumping stations. The River Idle flows to West Stockwith where it is pumped to the River Trent.

5.33 The responsibility for draining the low-lying land within the Trent Valley Area, and managing the extremely complex drainage system that does this, is shared by 12 IDBs. They are collected together into two groups, one (the Shire Group) of IDBs managed by Grantham Brundell & Farran (GBF, part of JBA Consulting) and one (the Isle of Axholme Group) of those managed by the Lindsay Marsh Drainage Board (LMDB). The areas managed by GBF and LMDB are shown on Map 12.

5.34 The pumping stations that discharge to the main watercourses are shown on Map 12. Only pumping stations within the study area are included, others operated by the same authorities lie just outside the area but are not included in the list.

5.35 As discussed earlier, the River Trent's tidal flood defences provide a standard of protection that is currently better than 0.5% annual probability of occurrence while its fluvial defences are designed to provide a standard of 1.0% annual probability against fluvial events. The standards provided by the internal drainage system are not as good as this, however. The Environment Agency indicates that the Bottesford Beck and River Eau offer a standard of about 3.0% annual probability (a return period of 30 years) while the River Idle provides a standard of about 2.0% annual probability (return period of 1 in 50 years). The watercourses of the Three Rivers system generally give a standard of about 10% (return period of 1 in 10 years) although this rises to about 3.0% for the River Torne and the South Level Engine drain if freeboard is taken into account.

5.36 The IDBs aim to provide a standard of between 10% and 5% annual probability of occurrence (1:10 and 1:20 years return period) for agricultural land throughout the system but this includes a freeboard of at least 1m below local ground level (to prevent the land from being waterlogged). As a result the standard provided to property (which is not affected by flooding until the water level rises above local ground level) is generally in the range 2.0% and 1.0% annual probability (1:50 to 1:100 years return period). The IDBs have to approve the drainage arrangements of all significant new development within their boundaries or affecting their watercourses. In principle the site runoff characteristics should remain unchanged, although the IDB may accept the receiving drainage system being improved so it can accept the increased discharge, at the developer's expense.

5.37 The above discussion concentrates on sources of flooding within the Stage 3 area. The part north of the Stainforth & Keadby Canal is, however, also potentially at risk of flooding from two sources outside the area, the River Ouse and the River Don. The implications of this are discussed in Appendix J under the assessment for compartment 3T4.

Flood compartments

5.38 To allow more detailed assessment, the area shown as SFRA Flood Zone 2/3a on Flood Zone Map 22 has been divided into flood compartments taking into account the topography, type of defence, drainage arrangements and land use. These compartments are shown on Map 13 and listed in Table 5.6 below with the sources of flood risk they include. Further information about the area and its compartments is given in Appendix J.

Compartment Reference	Compartment Name	Primary sources of Flood Risk
3T1	Alkborough	Humber Estuary
3T2	Flixborough	River Trent Scunthorpe IDB
3T3	Gunness	River Trent Bottesford Beck Scunthorpe IDB
3T4	Garthorpe & Keadby	River Trent (River Ouse) (River Don) Stainforth & Keadby Canal North Soak Drain Garthorpe IDB Adlingfleet & Whitgift IDB Tween Bridge IDB Crowle IDB
3F1	Upper Bottesford Beck	Bottesford Beck
3F2	Messingham	River Trent Bottesford Beck River Eau
3F3	Upper River Eau	River Eau Gainsborough IDB
3F4	Three Rivers	River Trent Stainforth & Keadby Canal South Soak Drain North Level Engine Drain Hatfield Waste Drain River Torne Hatfield Chase IDB

Compartment Reference	Compartment Name	Primary sources of Flood Risk
3F5	Isle of Axholme	River Trent River Torne South Level Engine Drain Warping Drain Althorpe IDB West Butterwick IDB South Axholme IDB West Axholme IDB Hatfield Chase IDB
3F6	River Idle	River Trent Warping Drain South Ancholme IDB Finningley IDB

Table 5.6 - Flood compartments; Trent Valley Area

6 Outcome of Level 2 Assessments

6.1 A Level 2 Assessment has been carried out for flood compartments protected by defences high enough to provide the standard required by PPS25 (or where the Environment Agency is planning to improve the defences to this standard) and where there is likely to be significant pressure for development. The compartments falling into this category are:-

- 1T1 - Cleethorpes
- 1T2 - Grimsby and Stallingborough
- 1T3 - Immingham and North Killingholme

6.2 Originally a Level 2 Assessment was also carried out for compartment 3T3 (Gunness and Burringham) but this has been withdrawn as the Lincolnshire Lakes Area Action Plan is currently being prepared and, once completed, will provide a more detailed assessment of flood risk for this area. The SFRA will be updated to include the results when they become available.

6.3 Consideration was given to including compartment 1T5 (Barton upon Humber), in view of the scale of the industrial and commercial development nearby. The existing defences do not provide the required standard of protection, however, and at present there is no pressure for development on land liable to flood, so it was omitted.

6.4 The results of the Level 2 Assessments are presented on Breach Hazard Maps 1 to 3. These maps show the following information:-

- The boundaries of the flood compartment and any significant obstructions to the flow (including road embankments)
- The extent of SFRA Flood Zone 2/3a (as defined in paragraph 4.20) and SFRA Flood Zone 3b (the functional floodplain, as defined in paragraph 4.23), as shown on the relevant Flood Zone Maps
- The flood hazard zones due to breaching (as defined in paragraph 4.31), based on the classification set out in Table 4.4
- The location of all places where surface water flooding due to drainage or other problems has been recorded
- Watercourses designated as main river or as SOWs
- Drainage pumping stations
- Existing flood defences.

The maps may be used to steer new development to areas of lowest hazard when applying the Sequential Test to development proposals in the flood compartments listed above.

6.5 Information about the compartments for which Level 2 Assessments were carried out, the sources of flood risk there and the defences protecting them are given in the relevant Flood Compartment Appendices. Further information about the Flood Hazard Assessments is given in the following sections. Directions for determining critical flood levels for compartments covered by a Level 2 Assessment are given in Appendix D.

Flood Compartment 1T1 – Cleethorpes

6.6 Ground levels below +6.0mOD in the area of Compartment 1T1 are shown in Map 14. The compartment can be divided into two sub-compartments by the line shown on the map, which runs along a road that is generally at a level of between +4.5mOD and +5mOD. The area east and south of this line includes the Thorpe Park Caravan Park and the Humberston Fitties Holiday Camp, which contains a large number of single-storey chalets. The Buck Beck valley lies to the west and north, with residential property on the higher ground to either side of it.

6.7 The eastern area, Sub-Compartment 1, is protected by a combination of earth embankments and sand dunes reinforced by stone-filled gabion boxes. As discussed in Appendix H, there is a significant possibility that these defences will not protect against flooding by events having a 1 in 200 or less (<0.5%) annual probability of occurring, as required by PPS25, and a Level 2 Assessment has therefore not been carried out for this area.

6.8 The earth embankment protecting Sub-Compartment 2, the western area, does meet the requirements for a Level 2 Assessment, and the detailed breach model studies confirm that the area will not be affected by a breach occurring in Sub-Compartment 1 (although Sub-Compartment 1 will be affected by a breach in Sub-Compartment 2). The flood hazard zones for Sub-Compartment 2 are shown on Breach Hazard Map 23.

Flood Compartment 1T2 – Grimsby and Stallingborough

6.9 Ground levels below +6.0mOD in the area of Compartment 1T2 are shown in Map 15. The compartment can be divided into two sub-compartments by the line shown on the map, which runs just west of the Royal Docks to higher ground further south. Ground levels along this line are generally above +4.5mOD, although there are short lengths where the level is between +4mOD and +4.5mOD. Floodwater will not flow overland across this boundary until it rises above these levels, so the two sub-compartments have been assessed separately. The flood hazard zones for them both are shown on Breach Hazard Map 24.

Sub-Compartment 1 – Grimsby Docks and Grimsby

6.10 The eastern area, Sub-Compartment 1, is in effect a shallow dish in which most of the town of Grimsby has been built. The Grimsby Dock area forms the northern edge of this dish, and the ground there is generally above +4.5mOD, although there is a length of about 200m where the level is about +4mOD. This area includes the Fish and the Royal Docks, where under normal circumstances the highest water level is limited to about +3.2mOD and +3.5mOD respectively. The area is protected by a combination of earth embankments and gabion boxes along the outer edge of the Dock area and a concrete wall between the eastern end of the Dock area and the eastern end of the Sub-Compartment.

6.11 The Environment Agency has recently completed a study of the existing defences which indicates they will only protect the town against events having about a 1 in 100 (1%) annual probability, taking into account

the storage provided by the docks and assuming the gates withstand the water and wave loads that will occur. As a result the Environment Agency is planning to look at options for improving the standard to that required by PPS25 or better. The detailed breach model studies show that if the Sub-Compartment 1 defences breach there will be only very limited overland flow into Sub-Compartment 2.

Sub-Compartment 2 – Stallingborough

6.12 Although the defences protecting the western area, Sub-Compartment 2, from the estuary have a concrete slab on the crest, a concrete wave wall and a revetment on the front face, these items rest on top of a simple earth embankment and do not contribute greatly to its innate structural strength. As a result the defences have been treated as earth embankments.

6.13 Sub-Compartment 2 is effectively divided into two by the A180, which is embanked and so could act as a barrier preventing floodwater from a breach in the defences flowing further south. The detailed breach model studies indicate that in practice the presence of culverts and other passages through the embankment mean this will not happen. They also indicate, however, that there will be only very limited flow into Sub-Compartment 1.

6.14 The sub-compartment's western boundary is the flood defence embankment beside the Stallingborough North Beck. If this defence fails floodwater would flow into the southern end of the neighbouring Flood Compartment 1T3 and affect Immingham. The detailed breach model studies indicate this is likely to happen, and that in practice Immingham is at risk of flooding from breaches in the defences to Sub-Compartment 2.

6.15 The HFRMS notes that the foreshore is being eroded along this frontage and the Environment Agency has therefore recommended that in future no permanent buildings should be located immediately behind the defences. A width of 200m has been suggested for this buffer zone, which would provide space for the defences to be moved if this becomes necessary in the future.

Flood Compartment 1T3 – Immingham and North Killingholme

6.16 Ground levels below +6.0mOD in the area of Compartment 1T3 are shown in Map 16. The compartment can be divided into three sub-compartments by the lines shown on the map, one of which is on the raised ground on which the main road and rail access to the raised Immingham Dock area (which is also raised) are located, while the other is on higher land near the oil terminal at North Killingholme. Ground levels along both lines are generally above +4.5mOD, although along the second there are short lengths where the level is between +4mOD and +4.5mOD. Floodwater will not flow overland across these boundaries until it rises above these levels, so the three sub-compartments have been assessed separately. The flood hazard zones for all three are shown on Breach Hazard Map 25.

6.17 The defences protecting this compartment from the estuary have a concrete slab on the crest, a concrete wave wall and a revetment on the front face, these items rest on top of a simple earth embankment and do not contribute greatly to its innate structural strength. As a result the defences have been treated as earth embankments.

6.18 The HFRMS notes that the foreshore is being eroded along this frontage and the Environment Agency has therefore recommended that in future no permanent buildings should be located immediately behind the defences. A width of 200m has been suggested for this buffer zone, which would provide space for the defences to be moved if this becomes necessary in the future.

Sub-Compartment 1 – Immingham

6.19 Most of this sub-compartment is protected from the estuary by defences on top of the relatively high land by Immingham Docks, where the ground level is generally between +4.5mOD and +5mOD. There is, however, a length of about 1.5 km of earth embankment at the east end of the area (between Stallingborough North Beck and Habrough Marsh Drain) where the ground level is about 3.0mOD. The area is also liable to flooding from a breach in the defences protecting the Flood Compartment 1T2 if the embankment beside the Stallingborough North Beck fails, as discussed in the previous section.

6.20 The detailed breach model results confirm this sub-compartment is liable to flooding from a breach in the defences to Flood Compartment 1T2, and also that the reverse will be the case (i.e. there will be flooding in Flood Compartment 1T2 if the defences in this sub-compartment breach). They also show that there will be some limited flooding in Sub-Compartment 2.

Sub-Compartment 2 – Killingholme Marshes

6.21 The ground level behind the defences protecting this sub-compartment is as high as +5mOD in places but there is a significant length where the level is about +2.5mOD. There are no significant ridges or other features that could affect the flow of floodwater across this sub-compartment itself, but if flood levels rise above +4mOD there could be some flow into Sub-Compartment 3 to the north while if they rise above +4.5mOD it could flow into Sub-Compartment 2 to the south as well.

6.22 The detailed flood breach model results indicate that floodwater from a breach in the defences to this sub-compartment will not only flow into Sub-Compartment 3, but also across the East Halton Skitter into Flood Compartment 1T4. In addition there will be some flooding in Sub-Compartment 1.

Sub-Compartment 3 – Halton Marshes

6.23 The ground level behind the defences protecting this sub-compartment varies between about +2mOD and +3mOD. The lower of these was adopted for the Assessment. There are no significant ridges or other features that could affect the flow of floodwater across this sub-compartment itself, but if flood levels rise above +4mOD there could be some flow into Sub-Compartment 2 to the south.

6.24 The detailed flood breach model results indicate that flood water from a breach to the defences in this compartment will flow into both Sub-Compartment 2 and across the East Halton Skitter into the adjacent Flood Compartment 1T4. Similarly, a breach in the defences to the adjacent flood compartment will cause flooding here.

7 Planning Guidance

7.1 Current Government policy places an increasing emphasis on the delivery of significant levels of new development, however it is important that this development takes place within an environmentally responsible framework. As a result PPS25 introduced two tests, the Sequential Test and the Exception Test, and reiterated the requirement for site-specific Flood Risk Assessment.

7.2 A **Site-Specific Flood Risk Assessment (FRA)** is required to identify the flood risk at the site and to demonstrate how this risk can be mitigated without increasing the risk elsewhere. A Site Specific FRA is required for any development proposal of 1 hectare or greater in SFRA Flood Zone 1 and all development proposals in SFRA Flood Zone 2/3a or within an area where there may be drainage problems, irrespective of whether a Sequential or Exception Tests are required. .

7.3 The **Sequential Test** is required to demonstrate that there is no reasonably available sites in a lower flood risk area (e.g. SFRA Flood Zone 1) that could accommodate the development proposal. Therefore a Sequential Test will be required where development is proposed in SFRA Flood Zone 2/3a or where within any SFRA Flood Zone where there may be a drainage problem.

7.4 The **Exception Test** is not always required, whether it is depends on the type of development proposed, the degree of flood risk at the proposed site and if the Sequential Test has determined that there are no reasonably available sites in a lower flood risk area.

- The wider sustainability benefits to the community
- The preference for developing brownfield land
- The need for the development to be safe without increasing flood risk elsewhere.

7.5 Further information about the PPS25 requirements concerning site-specific FRAs and the Sequential and the Exception Tests is given in Chapter 4 and Appendix E, or in PPS25 itself. Some mitigation measures that might be used to help make the development safe are described in Appendix F.

Flood Risk Standing Advice

7.6 The Environment Agency provides National Standing Advice on flood risk, which can be obtained from its website (at www.environment-agency.gov.uk) by entering 'flood risk standing advice' into the search box and following the resulting links.

7.7 In view of the particular development and flood risk issues in North and North East Lincolnshire, planning guidance has been developed specifically for this SFRA and is set out in Appendix E. This includes Local Standing Advice, which replaces the National Standing Advice and should be used when preparing any planning application that is to be submitted to North or North-East Lincolnshire Planning Authorities. Further information specific to each Authority can be obtained from their websites at www.northlincs.gov.uk and www.nelincs.gov.uk respectively.

8 Guidance on the use of Sustainable Drainage Systems

Introduction

8.1 PPS1 'Delivering Sustainable Development' and PPS25 require that local planning authorities should promote the use of sustainable drainage systems (SUDS). SUDS is a term used to describe the various ways that can be used to manage surface water drainage so that it mimics the drainage that would occur from a natural, undeveloped site. The effective management of surface water caused by heavy rain (or from any other source) is essential for reducing flood risk both to the site itself and to the surrounding area.

Types of sustainable drainage systems

8.2 SUDS may improve the sustainable management of surface water at a site by:

- Reducing peak flows to watercourses or sewers and so potentially reducing the probability of flooding downstream
- Reducing the total volume of water flowing directly to watercourses or sewers from developed sites
- Improving water quality, compared with conventional surface water sewers, by removing pollutants from diffuse pollutant sources
- Reducing potable water demand by rainwater harvesting
- Improving amenity through the provision of public open space and wildlife habitat
- Replicating natural drainage patterns, including the recharge of groundwater so base flows are maintained.

8.3 Although the reduction in peak flow or total volume originating from any particular site may be small, the cumulative effect from a number of sites across a catchment can be significant and have a real impact on extent and frequency of flooding.

8.4 There are a number of different types of SUDS that can be incorporated into a development. Their effectiveness depends on the topography and geology of the site and the surrounding area, and careful consideration of the site's characteristics is needed to ensure the most suitable choice is made. The most commonly found components are described in Appendix G.

Use of SUDS techniques in North and North East Lincolnshire

8.5 Priority should be given to the use of infiltration techniques rather than the direct discharge of surface water to watercourses. Where infiltration is not viable (due to a high water table, impermeable soils, or location in a Source Protection Zone, for example), run-off attenuation techniques discharging to open

watercourses should be considered in preference to discharge to a closed sewer. Details of the superficial deposits (soils) across the study area can be obtained from Cranfield University's LandIS Information Service website at www.landis.org.uk and may help to make an initial assessment of the viability of infiltration techniques at a site. Further information, including methods of measuring permeability/ infiltration rates, can be obtained from BRE Digest 365 (Soakaways) and CIRIA 156 (Infiltration Design; Manual of Good Practice).

8.6 If a development leads to a large increase in impermeable area (i.e. through paving or building over an open space) there is likely to be a significant increase in both the volume and rate of surface run-off that could increase flood risk elsewhere unless effective SUDS techniques are implemented. Such techniques could include, for example, the use of permeable rather than impermeable paving combined with surface water collection, infiltration and rainfall harvesting.

8.7 All planning applications will require a site-specific Flood Risk Assessment showing that a full range of SUDS techniques has been considered and that the one adopted will, at the least, attenuate the surface water runoff so that both the peak discharge and the total volume are no greater than would occur from the site in its natural condition (i.e. with no development). This requirement applies also to applications for the re-development of previously developed sites. Full details of how any SUDS elements will be maintained throughout its life should be given together with confirmation that, if adoption by a third party is assumed, that party has agreed to this. Developers should consult with the Environment Agency, the relevant Water Company and other appropriate organisations (e.g. the local SUDS Approving Body) about their SUDS proposals at an early stage.

9 Additional Considerations

Implications of Flood and Water Management Act

9.1 The Flood and Water Management Act, which is the Government's response to Sir Michael Pitt's Review of the flooding in 2007, came into force in April 2010. A key aim of the Act is greater sustainability by helping people and their communities adapt to the increasing likelihood of severe weather events due to climate change. The Act will encourage the use of sustainable drainage systems in new developments as this will provide better protection to communities and the environment against the risk of flooding.

9.2 The Act introduces a range of measures that should be taken into account when considering both the information in this SFRA and in preparing site-specific Flood Risk Assessments (FRA's). At the strategic scale, the Environment Agency will be responsible for Mapping a national strategy for managing flood risk in general and will retain overall responsibility for managing the risk from tidal and fluvial (main river) sources.

9.3 The role of local authorities will be enhanced, with unitary authorities (such as North Lincolnshire and North East Lincolnshire Councils) and county councils taking on the new role of 'lead local flood authority' for their areas. They will be responsible for bringing together all relevant bodies to form local partnerships and will also be required to 'develop, maintain, apply and monitor a strategy for local flood risk management' in their areas. In this context 'local flood risk' covers flooding from all sources not dealt with by the Environment Agency, such as ordinary watercourses, groundwater, surface water, sewers and artificial infrastructure such as canals.

9.4 The Act also supports the use of Sustainable Urban Drainage Schemes (SUDS) by establishing a SUDS Approving Body (SAB) at county or unitary local authority level. SABs will be responsible for approving proposed drainage systems in new developments and redevelopments, subject to exemptions and thresholds. To be approved, a proposed system will have to meet new national standards for sustainable drainage.

9.5 Further information can be obtained from the Defra website at www.defra.gov.uk/environment/flooding/legislation/.

Preparation of Local Flood Risk Management Strategy

9.6 Lead local authorities will in general follow a four-stage process for managing flood risk, as set out in the European Floods Directive (implemented in the UK by the Flood Risk Regulations 2009). The first stage involves undertaking a Preliminary Flood Risk Assessment, a high-level screening exercise aimed at identifying historic and future (potential) flood risk. This identifies Local Flood Areas using the information available at the time and provides the initial basis for the Local Flood Risk Management Strategy. The flood areas and their boundaries will be refined as the Strategy develops through local consultations and more detailed location-specific assessments. The process will be iterative, responding to new information and changing circumstances.

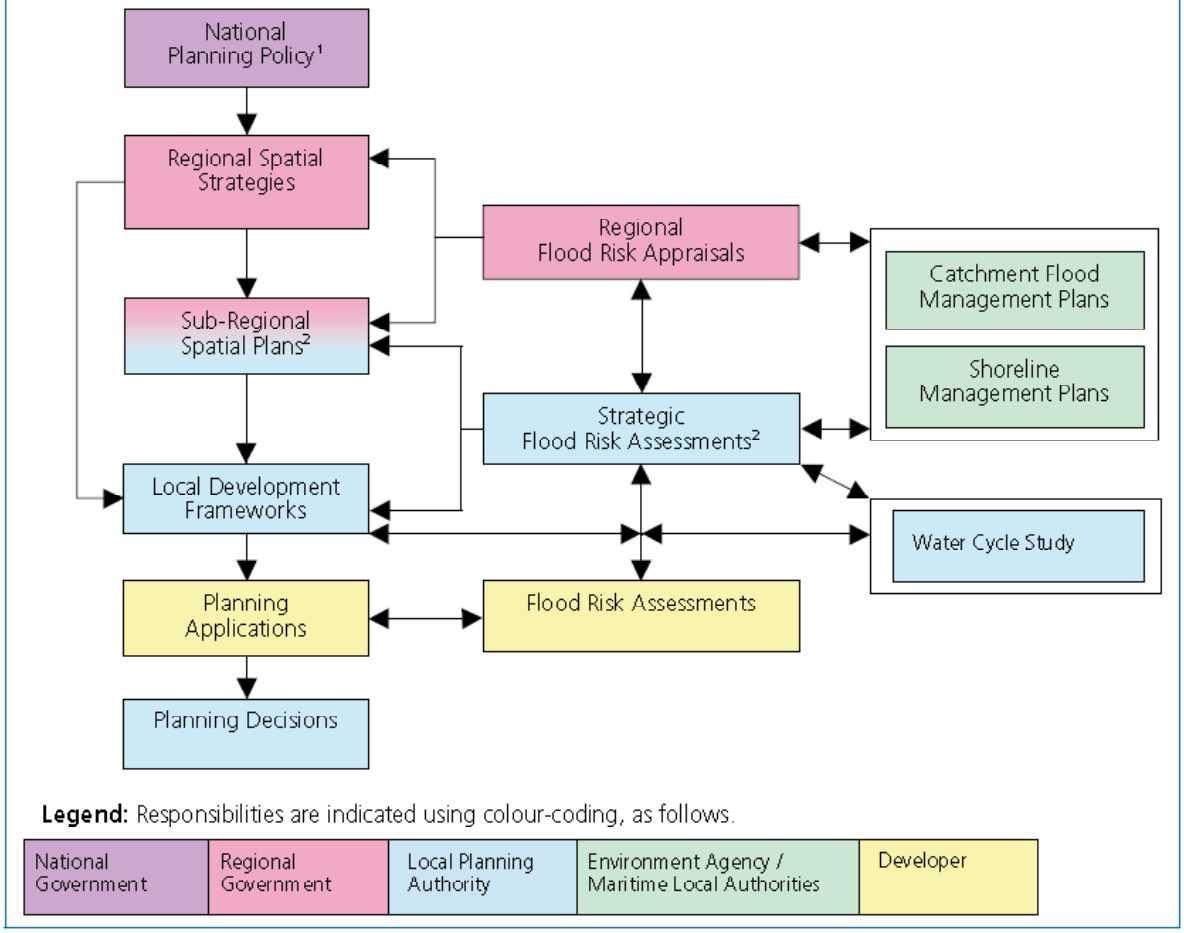
9.7 The two councils are each undertaking a Preliminary Flood Risk Assessment and will publish the resulting reports for consultation in due course.

Procedure for reviewing the SFRA

9.8 This SFRA is a 'living document', and will be reviewed on a regular basis and amended as necessary. The document has been structured so that, as far as possible, such amendments will be limited to information held in tables or appendices. A record of all amendments will be kept on the North Lincolnshire and North East Lincolnshire Council websites.

Appendix A - PPS25 Practice Guide

Figure 2.2 Key documents in the spatial planning process and their links with other key strategies for managing flood risk



Notes

1 Including Planning Policy Statement 25 '*Development and Flood Risk*' and the other flooding-related national planning policies listed in Appendix A of this Practice Guide.

2 Strategic Flood Risk Assessments may cover more than one local planning authority (LPA). The adoption of a catchment-based approach by a number of LPAs working in partnership could be highly beneficial and is strongly recommended as a means of looking strategically at flood risk issues across local authority boundaries.

3 This diagram has been developed from the original within *Flood Risk Assessment Guidance for New Development Phase 2 R&D technical report FD2320/TR2* (Defra and Environment Agency, 2005).

Taken From

Key Documents in the Spatial Planning Process Taken from 'Planning Policy Statement 25: Development and Flood Risk Practice Guide' Updated December 2009

Appendix B - Factors Affecting Flood Risk

Tidal flooding

B.1 On the east coast of England high sea levels are generally caused by a combination of tidal conditions (caused by relative movements of the moon, earth and sun) and a surge (caused by the weather conditions, particularly the movement of low-pressure storm systems). As a result, unusually high sea levels tend to rise fairly rapidly, remain at their peak for one or two hours and then fall away equally rapidly. There will then be a further peak at the following high tide some 12½ hours later, which is generally lower than the first one but could be higher if the surge is particularly prolonged.

B.2 If the strip of low-lying land beside the coast (the coastal/tidal floodplain) is relatively narrow then there will normally be enough time for water from the sea to flood across it and rise to the same peak level that occurs just offshore. If the floodplain is broad, however, or if it lies towards the head of an estuary, then the flow of water from the sea to the area being flooded can be insufficient to fill it before the sea level begins to fall again. As a result the peak water level in the flooded area is less than the peak sea level. This effect is particularly marked in the tidal reaches of the rivers draining to the estuary, where the flooding of a large area of land can lower the water levels in the river as well.

B.3 Historically, the normal response to coastal flooding has been to build flood defences and the whole of the south bank of the Humber is protected in this way (apart from a few points where high land comes to the water's edge). These defences would be high enough to keep out all but the most extreme events if there were no waves. The weather conditions causing large surges, however, often cause waves as well. The spray from these can lead to local flooding nearby and, more importantly, could undermine the defences causing them to breach and allow the sea to flow through.

B.4 The defences can breach for a number of other reasons, including structural failure and accidental damage. A similar effect can be caused by the failure of a floodgate or barrier to close, either because of a mechanical or electrical fault or through operator error. Whatever the cause, if there is a gap in the defences the sea will flow through it and flood low-lying land behind. The extent of flooding will depend on the topography of the area and the volume of water flowing through the defences, which in turn will depend on the peak sea level and the size, number and timing of the breaches.

Fluvial flooding

B.5 When rainfall occurs over land some of the water will be absorbed into the vegetation or other materials on the surface and some will infiltrate into the underlying ground. Surplus water collects on the surface and flows downhill until it enters a ditch or other drainage system. In time some of the infiltration water will also enter the drainage system and from there the water will flow to a river and, eventually, to the sea. This takes time, however, so rain falling in the upper catchment of a large UK river can take several days to arrive at the lower reaches. Rainfall on the lower catchment will reach the same place more quickly, with the effect that the flow from two storms can converge giving results that are more serious than either one alone.

B.6 In most UK rivers, the bank-full capacity of the natural channel is about the mean annual flood (the flow that occurs, on average, once a year). When the flow is greater than this the river comes out of its banks and spreads across the surrounding land (the fluvial floodplain). This increases the area of flow, allowing more water to pass downstream, and provides storage for surplus water until conditions downstream have improved sufficiently for it to flow away. If the river channel is constricted at some point downstream the flow function is limited and the storage function becomes more important. The depth of water on the floodplain will depend on the severity of the flood and the conditions downstream.

B.7 Man's activity in the catchment, particularly urbanisation and agriculture, can affect both the proportion of rainfall entering the drainage system and the rate at which it does so. Urbanisation (the construction of buildings, roads, car parks and their drainage systems) tends to reduce the volume of water infiltrating into the ground (since the surfaces are normally impervious), reduce the volume of water stored on the surface (since puddles are not normally acceptable) and increase the rate of discharge into the river (since water normally flows more rapidly through a designed drainage system than across natural ground). Agricultural practices, such as ploughing down rather than across a slope, can have similar effects. The result will generally be to increase the size and speed of flooding that occurs during small or medium rainfall events. The effect is normally less important during extreme events since prolonged heavy rainfall causes the ground to become sodden and fills the available surface storage, so any subsequent rain runs off into the rivers more rapidly.

B.8 Man's activity on the floodplain can affect both its ability to allow water to flow downstream and its storage capacity. A road across a valley or a wall across a field can obstruct the flow and cause water to pond upstream, raising flood levels. A building raised above the surrounding ground will reduce the volume available for storing floodwater. The water that would have been stored there has to go somewhere else, again raising flood levels.

B.9 Generally the most significant impacts on floodplain function are caused by flood defences. These, until they are overtopped, cut off the floodplain from its river so the water that would have been stored there has to pass further downstream, raising water levels and possibly causing referred flooding if the channel capacity is inadequate. Once the defences are overtopped any surplus water will flow into the floodplain and will be trapped there until the flood has passed. If the defences are breached, either accidentally, due to structural failure or because they are washed out, the flow into the floodplain will increase and is likely to lower the water levels in the river. The extent of flooding will depend on the volume of water stored in the river and the capacity of the channel downstream as well as the size and duration of the flood event. If the system is pumped the extent will also be controlled by the pump capacity and will be seriously affected if the pumps fail to operate.

Surface and groundwater flooding

B.10 During periods of very heavy rainfall the volume of the water flowing off the surface of the ground can exceed the capacity of the existing drainage system, either natural or man-made, to remove it. This can be because the channels, ditches or pipes are not large enough to carry all the flow, or because they have become blocked so their capacity is reduced.

B.11 When this happens the surface water will tend to flow overland where the ground is sloping towards a low point where it will collect. The velocity and depth of flow will depend on the slope of the ground and the volume of water that cannot enter the existing drainage system – the steeper the slope the faster

and more dangerous the flow. The depth of water collecting in low points will depend on the local topography, the level will rise until the water can overflow and flood into an adjacent area.

B.12 Maintenance of the drainage system can be an important factor in surface water flooding. If ditches and culverts are not kept clear they will not operate effectively, increasing the probability of a flood occurring. Not all blockages are due to poor maintenance, however, as a build-up of debris washed into the system during an event will have the same effect.

B.13 Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks, or aquifers. Water levels below the ground rise during wet winter months and fall again during the summer, when water flows out into rivers. During very wet periods the water level can rise above the level of the ground surface, causing flooding of areas that are normally dry. Groundwater flooding may take weeks or months to dissipate because water flows much more slowly through the ground than over the surface so high water levels take a long time to fall.

Future changes

B.14 The assessment of flood probability is based on a statistical analysis of past events, either in the same catchment (or at the same point on the shore for coastal flooding) or in similar catchments elsewhere. These records are generally quite short (possibly 30 or 40 years or less) which introduces some uncertainty when predicting events that may happen on average once every 100 or 200 years. This uncertainty is increasing, as the world's climate appears to be changing. As a result, the UK is expected to experience more frequent winter storms (and less rainfall in summer), which is likely to mean that high river flows, and hence fluvial flooding, will also occur more frequently. The incidence of coastal flooding is also likely to increase, partly because the increased storminess will increase the frequency of waves and surges but also because sea levels are expected to rise.

B.15 The effect of these changes is difficult to estimate but Government guidance currently suggests that sea levels off the East Coast could rise by up to 1m over the next 100 years, flood flows in rivers could increase by perhaps 20% and peak rainfall intensities by 30%.

Appendix C - PPS25 Flood Zones and Flood Risk Vulnerability Classification

Flood Zone 1 Low Probability	Definition	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
	Appropriate Uses	All uses of land are appropriate in this zone.
	FRA Requirements	For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annexe E (in PPS25) for minimum requirements.
	Policy Aims	In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Flood Zone 2 Medium Probability	Definition	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 sea flooding (0.5% - 0.1%) in any year.
	Appropriate Uses	The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone. Subject to the Sequential Test being applied, the highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see paragraph D.9 in PPS25) is passed.
	FRA Requirements	All development proposals in this zone should be accompanied by a FRA. See Annex E (in PPS25) for minimum requirements.
	Policy Aims	In this zone, developers and local authorities 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.

Flood Zone 3a High Probability	Definition	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.
	Appropriate Uses	The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see paragraph D.9 in PPS25) is passed. Essential infrastructure in this zone should be designed and constructed to remain operational and safe for users in times of flood.
	FRA Requirements	All development proposals in this zone should be accompanied by a FRA. See Annex E (in PPS25) for minimum requirements.
	Policy Aims	In this zone, developers and local authorities 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; • relocate existing development to land in zones with a lower probability of flooding • create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Flood Zone 3a High Probability	Definition	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.
	Appropriate Uses	The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see paragraph D.9 in PPS25) is passed. Essential infrastructure in this zone should be designed and constructed to remain operational and safe for users in times of flood.
	FRA Requirements	All development proposals in this zone should be accompanied by a FRA. See Annex E (in PPS25) for minimum requirements.
	Policy Aims	In this zone, developers and local authorities 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; • relocate existing development to land in zones with a lower probability of flooding • create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Zone 3b The Functional Floodplain	Definition	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But 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, should provide a starting point for consideration and discussions to identify the functional floodplain.
	Appropriate Uses	Only the water-compatible uses and essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to: remain operational and safe for users in times of flood; • result in no loss of floodplain storage; • not impede water flows • not increase flood risk elsewhere. Essential infrastructure in this zone should pass the Exception Test (see paragraph D.9 in PPS25).
	FRA Requirements	All development proposals in this zone should be accompanied by a FRA. See Annex E (in PPS25) for minimum requirements.
	Policy Aims	In this zone, developers and local authorities 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 • relocate existing development to land with a lower probability of flooding.

Notes:
1 - These flood zones refer to the probability of river and sea flooding, ignoring the presence of defences)

2 - Taken from Planning Policy Statement 25, Development and Flood Risk Revised March 2010 From PPS25 Table D.1 Flood Zones [Revised version]

From PPS 25 Table D.2 - Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations and water treatment works that need to remain operational in times of flood. • Wind turbines.
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 require hazardous substances consent.[1] (Where there is demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'[2]).
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.[3] • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding • 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 which do not need to remain operational during times of flood. • Sewage treatment plants (if adequate measures to control pollution and manage sewage during flood events are in place).

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, repair 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.

Notes:

1 - This classification is based partly on Defra/Environment Agency research on Flood Risks to People (FD2321/TR2) and also on the need of some uses to keep functioning during flooding.

2 - Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

3 - The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

1 DETR Circular 04/00: Planning controls for hazardous substances (paragraph 18) at: www.communities.gov.uk/publications/planningandbuilding/circularplanningcontrols

2 In considering any development proposal for such an installation, local planning authorities should have regard to Planning Policy Statement 23 'Planning and Pollution Control'.

3 See Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10 for definition. www.communities.gov.uk/index.asp?id=1500757

Appendix D - Critical Flood Levels

Introduction

D.1 Planning guidance for developers and others preparing planning applications for submission to the North and North East Lincolnshire Planning Authorities (Appendix E) and possible mitigation measures (Appendix F) relate floor levels and other features of development proposals to the Critical Flood Level at the proposed site.

D.2 The Critical Flood Level is the water level at the site assessed as having a 1 in 100 probability (1%) of flooding from a river or a 1 in 200 probability (0.5%) of flooding from the sea of occurring each year, with allowance for climate change. This appendix sets out how the Critical Flood Level should be determined for planning applications submitted to the North and North East Lincolnshire Planning Authorities. Different approaches are used for different flood compartments as shown on maps 17, 18 and 19.

D.3 Critical Flood Levels that have been derived as set out below will be accepted without the need for further support. If a developer wishes to propose a different level they will need to provide detailed hydraulic modelling to show the probability of this level being reached is less than given above, even if the flood defences protecting the site are breached.

Areas coloured PINK on Maps 17, 18 and 19 – Compartments 1T1 (sub-compartment 1 only), 1T4, 1T5; 2T1, 2T2, 2T3; 3T1, 3T2, 3T4; 2F1, 2F2; 3F2, 3F4, 3F5, 3F6

D.4 In these compartments a Level 1 Assessment only has been carried out. The resulting Critical Flood Levels are listed in Table D.1. In tidal compartments the levels are based on the highest water levels with a 0.5% probability of occurrence from Tables 5.1, 5.3 and 5.4, adjusted for sea level rise to the year 2115. The fluvial compartments listed are also at risk of flooding from the sea (2F1 and 2F2 from the adjacent tidal compartments; 3F2, 3F4 and 3F5 from the River Trent). Compartments beside the River Ancholme (2F1 and 2F2) have been given the same levels as the adjacent tidal compartments. The levels for compartments beside the River Trent have been adjusted to take account of the effects storage has on flooding in these areas. All development proposals within 500m of the River Trent defences should be accompanied by a hydraulic assessment appropriate to the scale of the proposals showing they will not be adversely affected by rapid flowing water from a potential breach.

D.5 Flood hazard mapping has been carried out for compartments in the Environment Agency's Anglian Region (1T4, 1T5; 2T1, 2T2, 2T3; 2F1, 2F2) and this can be obtained using the contact details given at the end of this appendix. Please speak to the Environment Agency for further advice if development is proposed in areas of Cleethorpes where no raised defences exist and no flood hazard mapping is available.

Areas coloured BROWN on Map 17 – Compartments 1T1 (Sub-Compartment 2 only), 1T2 and 1T3

D.6 In these areas a Level 2 Assessment has been carried out and Critical Flood Levels should be based on the results of the breach modelling study on which this assessment is based. Developers should send a

plan of their site, including a grid reference, to the Environment Agency using the contact details given at the end of this Appendix asking for the flood depth at the location from the breach model results. This should be added to the ground level at the site (related to Ordnance Datum) to give the Critical Flood Level. A charge may be made for this service.

Area coloured PURPLE on Map 19 – Compartment 3T3

D.7 In this area the Lincolnshire Lakes Area Action Plan is being prepared and in due course will provide the information needed to derive a Critical Flood Level. Until then the level derived from the Level 1 Assessment, 4.10 mOD, may be adopted for Minor and Water Compatible development proposals (see the Flood Risk Response Matrix in Appendix E) but all other categories should be accompanied by a suitably detailed hydraulic assessment confirming that the proposed floor level will be safe.

Areas coloured BLUE on Maps 17, 18 and 19 – Compartments 1F1, 1F2, 1F3, 1F4, 1F5; 2F3, 2F4, 2F5; 3F1, 3F3

D.8 In these areas a Level 1 Assessment only has been carried out. The Critical Flood Levels are therefore based on the adjacent river level with a 1% probability of occurrence and as a result vary along the course of the river. The relevant level at a particular point may be obtained from the Environment Agency. A charge may be made for this service.

All other areas

D.9 These areas are in SFRA Flood Zone 1, where the probability of flooding from either rivers or the sea is less than quoted in paragraph D.2 above so in effect there is no Critical Flood Level (since it would be below ground level). There may, nevertheless, be a risk of flooding from other causes, such as surface water, drainage systems or groundwater, that will need to be assessed for each site individually.

Environment Agency contact details:-

By post:-	Environment Agency Corporate Services Waterside House Waterside North LINCOLN LN2 5HA
By telephone:-	03708 506506
By e-mail:-	custanno.lincoln2.an@environment-agency.gov.uk

Flood compartment	Critical flood level (mOD)
Tidal compartments	
1T1 (i) Humberston Fitties	5.75
1T4 Goxhill	6.39
1T5 Barton upon Humber	6.64
2T1 South Ferriby (East)	6.72
2T2 South Ferriby (West)	6.72
2T3 Winterton	6.74
3T1 Alkborough	See Note
3T2 Flixborough	See Note
3T4 Keadby	4.10
Fluvial flood compartments	
2F1 Lower Ancholme (Right Bank)	6.72
2F2 Lower Ancholme (Left Bank)	6.72
3F2 Messingham	4.10
3F4 Three Rivers	4.10
3F5 Isle of Axholme	4.10
3F6 River Idle	4.10

Table D.1 - Critical Flood Levels in areas coloured PINK on Maps D.1 to D.3

Note: These compartments are largely designated as SFRA Flood Zone 3b (Functional floodplain). Contact the Environment Agency about development proposals here.

Appendix E - Local Planning Guidance

Introduction

E.1 This document provides guidance for developers and others preparing planning applications for submission to the North and North East Lincolnshire Planning Authorities. It has been produced in consultation with the Environment Agency and takes into account the particular conditions in the areas covered by these authorities.

Background

E.2 Although current government policy places an increasing emphasis on the delivery of significant levels of new development, it is important that this development takes place within an environmentally responsible framework. At present the government's policy on how flood risk should be taken into account in the planning process is set out in Planning Policy Statement 25 (PPS25) – Development and Flood Risk, originally published in December 2006 and revised in March 2010. PPS25 introduced two tests, the Sequential Test and the Exception Test, and reiterated earlier guidance on the requirement for site-specific Flood Risk Assessments (FRAs).

E.3 The government is currently reviewing its planning policy and is consulting (until October 2011) on a National Planning Policy Framework that will consolidate all existing planning guidance into a single document. As a result guidance on flood risk may change in the future, although the Framework's draft outline indicates that local plans should continue to apply a sequential, risk-based approach to the location of development to avoid flood risk to people and property where possible; to manage any residual risk by applying the Sequential and Exception Tests. It also requires planning applications to be accompanied by site-specific FRAs.

E.4 The local development framework will be set out in the two council's Core Strategies. North Lincolnshire Council's Core Strategy was adopted in June 2011 following a public examination in January 2011, while North East Lincolnshire Council's is now being finalised before submission to the Government Inspectorate.

E.5 The two Core Strategies will confirm that each council will follow government policy as set out in PPS25, taking into account the special circumstances found locally. In particular, they will only support development proposals that can show, through the preparation of site-specific FRAs and the application of the Sequential Test, that they will avoid areas of current or future flood risk where possible (taking sustainability issues into account) and will not increase the risk of flooding elsewhere.

E.6 The Core Strategies will also confirm that both councils will require that land use is related to its vulnerability to flooding and that development will only be permitted in areas of high flood risk if it meets the requirements of the Exception Test. In addition all developments will be required to incorporate Sustainable Urban Drainage Systems (SUDS) to manage surface water drainage wherever practicable.

E.7 Once the Core Strategies have been adopted the councils will draw up other Development Plan Documents (DPD's) and supplementary planning documents supported by an evidence base covering

social, environmental and economic sustainability issues. In each case a key output will be the Housing and Employment Land Allocations Document, which will review possible development sites, assess their suitability taking all material policy issues into account, including the results of the Sequential Test, and make appropriate land allocations. These documents will be important considerations when undertaking Sequential and Exception Tests in support of site-specific planning applications.

Flood Risk Assessment

E.8 A **Site-specific Flood Risk Assessment (FRA)** is required to identify the flood risk at a site and to show how this risk can be mitigated without increasing the risk elsewhere. A site-specific FRA is required for all development proposals, irrespective of whether the Sequential or the Exception Tests are required. FRAs for sites in Flood Zone 1 will generally be limited to addressing drainage issues, including SUDS, only.

Sequential and Exception Tests

E.9 The **Sequential Test** is required to explain why development proposed for a site where there is a risk of flooding cannot take place elsewhere, and so ensure that sites where there is little or no probability of a flood occurring (i.e. in Flood Zone 1) are developed in preference to sites where there is a medium or high probability (in Flood Zones 2 or 3). A Sequential Test is therefore normally required where development is proposed in Flood Zones 2 or 3, or where there may be drainage problems.

E.10 The **Exception Test** is not always required, whether it is depending on the type of development proposed and the degree of flood risk at the proposed site. If it is required, it needs to address the following three issues:-

- The wider sustainability benefits to the community
- The preference for developing brownfield land
- The need for the development to be safe without increasing flood risk elsewhere and, where possible, to reduce flood risk overall.

Undertaking the Sequential and Exception Tests

E.11 This section describes the process that should be followed when preparing a planning application for a proposed development. The key steps are summarised in Table E.1 below.

1	Is the proposal within a flood risk area? (see Step 1)			
	Yes	Go to Section 2	**No**	Sequential and Exception Tests not required, but site-specific Flood Risk Assessment covering drainage and SUDS issues may be required
2	Is the proposal change of use, minor development, a replacement dwelling or a housing renewal scheme? (see Step 2)			
	No	Go to Section 3	**Yes**	Sequential Test not required, but Exceptions Test may and site-specific Flood Risk Assessment covering drainage and SUDS issues may be required
3	Does the Sequential Test indicate that the development could be located in an area where the flood risk is lower than at the proposed site? (see Step 3) Note: At this stage undertake the following steps: • identify appropriate area of search • identify potential sites within area of search • explain why potential sites should be discounted			
	No	Go to Section 4	**Yes**	If the development could be in an area where the flood risk is lower then it has failed the Sequential Test and planning permission will be refused
4	In view of the type of development and the degree of flood risk, is an Exception Test required? (see Step 4)			
	Yes	Go to Section 5	**No**	Site-specific Flood Risk Assessment covering flooding, drainage and SUDS issues required
5	Does the development meet all parts of the Exception Test? (see Step 5)			
	Yes	Flooding issues mitigated	**No**	Exception Test failed, planning permission will be refused

Table E.1 Undertaking the Sequential and Exception Tests

Step 1 – Is the proposal within a flood risk area?

E.12 The SFRA Flood Zone Maps accompanying this document show the areas classified as SFRA Flood Zone 1 (Low probability of flooding), SFRA Flood Zones 2 and 3(a) (Medium and High probability) combined and SFRA Flood Zone 3(b) (Functional floodplain). They are different from the areas shown in the Environment Agency's Flood Zone Maps as they take into account the implications of climate change until 2115.

E.13 Development proposals in combined SFRA Flood Zone 2/3(a) should generally be subjected to the Sequential Test, the overall aim of which is to steer new development to SFRA Flood Zone 1 (there are some exemptions, as discussed in Section 2). Only if there are no reasonably available sites in Flood Zone 1 should sites in combined SFRA Flood Zone 2/3(a) be considered. The Sequential Test will not normally be required for sites in SFRA Flood Zone 1 unless local drainage issues exist.

E.14 When applying the Sequential Test, development proposals should take into account the flood risk vulnerability of the land uses involved, as set out in Appendix C. In general the more vulnerable uses should not be located in the SFRA Flood Zone 2/3(a), although this requirement may be relaxed in exceptional circumstances through the application of the Exception Test. The possibility that this could happen should not influence the outcome of the Sequential Test.

E.15 The Flood Hazard Maps included in the SFRA show the distribution of flood hazard if the defences protecting selected areas ('flood compartments') are breached. They may be used to steer new development to areas of lowest hazard when applying the Sequential Test to development proposals in these areas.

E.16 All development proposals should be accompanied by a Site-Specific Flood Risk Assessment. For sites in SFRA Flood Zone 1 this will normally be limited to drainage-related issues, for all other sites it should cover both drainage and fluvial/tidal flood risks.

Step 2 – Is the proposal a change of use, minor development, replacement dwelling or housing renewal scheme?

E.17 The Sequential Test should be applied to all forms of development other than those listed below. Note that if the Exception Test is required this should be applied after the Sequential Test; the potential to pass the Exception Test does not remove the requirement to pass the Sequential Test beforehand.

E.18 **Change of use** Where no material operational development is proposed, a Change of Use application does not require a Sequential Test provided it does not involve use of land for caravans, camping, mobile homes or similar types of occupancy.

E.19 **Minor development** Minor development does not require either the Sequential Test or the Exception Test. Minor development is defined as:-

- Minor non-residential extensions. Industrial/commercial/leisure etc extensions with a footprint < 250 m^2 (noting that if a subsequent proposal makes the total area of all extensions > 250 m^2 it will require a Sequential Test)

- Alterations. Development that does not increase the size of buildings (e.g. alterations to external appearance)

- Householder development. Sheds, garages, games rooms etc within the curtilage of the existing dwelling as well as physical extensions to the existing dwelling (noting that any proposal to create a separate dwelling within the curtilage of the existing dwelling, e.g. sub-division of a house into flats, is excluded).

E.20 **Sub-division of dwellings** Although the sub-division of a house into flats is specifically excluded from the definition of minor development, where no significant external alterations are required it would be viewed as a Change of Use application and so a Sequential Test would not be required, provided after the sub-division all ground floor accommodation has permanent access to a place of safety as described in Appendix F. So the sub-division of a dwelling into two or more dwellings would not require a Sequential Test provided it does not involve significant external alterations/extensions and all ground floor accommodation has access to a higher floor that will act as a suitable refuge in time of flood. It may need to pass the Exception Test, however, showing how it has been made safe through design and flood resistant and resilient construction and that it does not increase flood risk elsewhere.

E.21 **Replacement dwellings** These will not normally require a Sequential Test provided they do not expose people to an increase in flood risk and, in particular, do not:-

- Increase the number of bedrooms
- Replace houses having more than one floor with single-storey dwellings
- Increase the number of dwellings in an area of flood risk (i.e. by replacing a single dwelling with an apartment block)
- Does not increase the volume of building by more then 20% of the original
- Will not be placed at an unacceptable level of flood risk, irrespective of the risk posed to the existing dwelling.

They may need to pass the Exception Test, however, showing how they have been made safe through design and flood resistant and resilient construction and that they do not increase flood risk elsewhere.

The principles of replacement dwellings will also be applied to new applications on sites that have existing unimplemented permission (i.e. the permission is still live) and for applicants to renew existing residential permissions. For proposals on sites with lapse permission a Sequential Test will be required.

E.22 **Developments partially within SFRA Flood Zone 2/3(a)** A Sequential Test is not required where only a small part of the site is in SFRA Flood Zone 2/3(a) and that part will only be used for soft landscaping or access. In these circumstances the site-specific FRA will need to show clearly how emergency access would be gained in times of flood and how issues of 'islanding' would be dealt with.

Step 3 – Does the Sequential Test indicate that the development could be located in an area where the flood risk is lower than at the proposed site?

Who should apply the Sequential Test?

E.23 Although the council Officer determining a planning application will assess the Sequential Test, it is the responsibility of the applicant to supply all the information needed to do this. The Environment Agency will advise on site-specific FRAs but will not generally comment on the Sequential Test for smaller developments.

What is the Area of Search for Alternative sites?

E.24 PPS25 states that 'where there are large areas in Flood Zones 2 and 3, and development is needed in those areas to sustain the existing community, sites outside them would not be reasonable alternatives'. It is therefore important to clarify the area of search at the pre-application stage. This will normally be the whole of the council area but in some places issues of national or regional policy may restrict the area that needs to be considered. The council's Core Strategies, Development Plans and other policy documents will contain further guidance.

Development with specific location requirements ?

E.25 Where a development proposal will be operationally linked to an existing building (including agriculture) the Sequential Test will only be applied to the land within which the operational link can be maintained. If the current development is located in SFRA Flood Zone 2/3a the applicant will still need to demonstrate (where necessary) that the Exception Test is passed.

What are Reasonably Available Sites?

E.26 Once it has been determined that a development requires a Sequential Test and the area of search has been identified, the next step is to determine the reasonably available sites. It should be noted that a recent appeal decision stated that 'the fact that the appellant personally has no alternative sites within their ownership does not have a bearing on the application of the policies of PPS25 in the public interest'. Where different uses are proposed on different parts of a site (e.g. employment on one part and housing on another, rather than a mixed use site) the Sequential Test should normally be applied to the different elements of the scheme individually. Specific advice on different types of development will be provided in the council's Core Strategies, Development Plan Documents and other Planning policy documents and local guidelines.

Step 4 – In view of the type of development and the degree of flood risk, is an Exception Test required?

E.27 If the Sequential Test is passed (or is not required) the need for an Exception Test needs to be considered based on the Table overleaf. This is a combination of Tables D2 and D3 from PPS25, which should be referred to if further information or clarification is required.

Step 5 – Does the development meet all elements of the Exception Test?

E.28 If it is required, the Exception Test must address the following points:-

- It must demonstrate that the development proposal provides wider sustainability benefits to the community that outweigh flood risk. The applicant is required to produce a Sustainability Statement or complete a Sustainability Checklist which will assess the development proposal against both council Core Strategy DPD Sustainability Appraisal Objectives

- The development must be on developable previously-developed land (otherwise known as 'brownfield' land), unless it can be shown that no such land is reasonably available

- The FRA accompanying the planning application must show that the development will be safe without increasing flood risk elsewhere and, where possible, will reduce flood risk overall

Mitigation measures that may be employed to help make the development safe are described in Appendix F.

E.29 Table E3.2 below shows development which is allowed not allowed within each flood risk zone and whether an Exception Test is required or not.

Flood Risk Zone	Development Allowed	Development Not Allowed
1 Low Probability	All uses, subject to FRA – Essential infrastructure; Highly Vulnerable (e.g. hospitals, mobile home sites); More Vulnerable (e.g. dwellings, landfill sites); Less Vulnerable (e.g. general industrial, transport infrastructure); Water Compatible (e.g. water based recreation, amenity open space, docks, marinas and wharves). Exception Test not needed.	No constraints due to river, tidal or coastal flooding
2/3(a) Medium or High Probability	Less Vulnerable, Water Compatible, subject to FRA. Exception Test needed for More Vulnerable and Essential Infrastructure.	Highly Vulnerable; More Vulnerable and Essential Infrastructure if Exception Test cannot be met or there are alternative sites in Zone 1
3(b) Functional Floodplain	Water Compatible, subject to FRA. Exception Test needed for Essential Infrastructure.	Highly Vulnerable, More Vulnerable, Less Vulnerable; Essential Infrastructure if Exception Test cannot be met or there are alternative sites in Zones 1 or 2/3(a)

Table E.2 - Exception Test guide

Environment Agency Standing Advice

E.30 To simplify the process of deciding planning applications where flood risk is an issue, the Environment Agency has produced National Standing Advice to local planning officers and developers. This identifies situations where the flood risk and vulnerability is sufficiently low to allow the planning authority to make the decision without consulting the Environment Agency. Copies can be obtained from the Environment Agency's website (at www.environment-agency.gov.uk) by entering 'flood risk standing advice' into the search box and following the resulting links.

E.31 In view of the particular development and flood risk issues in North and North East Lincolnshire, local Standing Advice has been developed specifically for this SFRA and is set out in the following sections. This replaces the National Standing Advice and should be used when preparing any planning application that is to be submitted to North or North-East Lincolnshire Planning Authorities. Further information specific to each Authority can be obtained from their websites at www.northlincs.gov.uk and www.nelincs.gov.uk respectively. More detailed advice may be developed for specific areas within each Authority in future reviews of this SFRA.

E.32 The actions that should be taken for development located in the Flood Risk Zones described in this SFRA are set out in the Flood Risk Response Matrix included at the end of this Appendix.

Process for deciding a planning application

E.33 The Standing Advice sets out the procedure to be followed when a planning application is received. In principle this is as follows:-

(i) Check the Flood Risk and Flood Hazard Maps to determine whether the proposed development is located:

- On land within 9m of the top of the bank to a 'main river' (a watercourse managed by the Environment Agency) or a coastal defence, where Environment Agency byelaws apply. Environment Agency consent is required for all such developments and is likely to be refused on the basis that an access strip is needed for maintenance purposes.

- Within an area defined as Flood Zone 3(b) (Functional Floodplain), shaded blue and hatched in dark blue on the Flood Risk Maps.

- Within an area defined as Flood Zone 2/3(a) (High or Medium Risk), shaded blue on the Flood Risk Maps, but where no Level 2 assessment has been carried out;

- Within an area defined as Flood Zone 2/3(a) (High or Medium Risk), shaded blue on the Flood Risk Maps, and where a Level 2 assessment has been carried out to determine whether the Flood Hazard is Extreme, Severe, Moderate or Low, shaded red, orange, yellow and green respectively on the relevant Flood Hazard Map;

- Within an area defined as Flood Zone 1 (Low Risk), not shaded on either the Flood Risk or the Flood Hazard Maps.

This will determine into which column of the matrix the development will fall. Note that if a proposed development is within 9m of a 'significant ordinary watercourse' (SOW), as referred to in paragraph 4.11 of the SFRA Review report, then consent may also be required from the organisation responsible for it. This applies to all categories of development. Similarly, any proposed development located on land administered by an Internal Drainage Board will require consent from that Board

(ii) Determine the development type against the categories set out on the vertical axis of the matrix. This will decide into which row of the matrix the development will fall.

(iii) Determine into which box of the matrix the proposed development falls. Note that if a proposed development falls into more than one development type or flood risk zone then the higher response should be adopted.

(iv) Interpret the information within the relevant box of the matrix. Note that if a proposal falls into a **red** box the application can go straight to the Environment Agency for consultation. If it falls into a **green** box the Environment Agency's response will be as set out in the matrix and the application should go to the Local Planning Authority, which will decide it accordingly.

E.34 Note that although development falling within the **green** boxes can be decided without reference to the Environment Agency on **flood risk** grounds, consultation may still be required in relation to **other environmental issues.** The Environment Agency's standing advice relating to such other issues should therefore always be checked.

Flood Risk Assessments accompanying planning applications

E.35 A site-specific (FRA) must accompany every planning application. General guidance on the scope and content of a FRA is given in PPS25 Annex E and the PPS25 Practice Guide Appendix B. More detailed guidance can be obtained from the Environment Agency's Standing Advice. In principle every FRA should be appropriate to the scale and nature of the development and should address both:-

- The risk to the development itself, from whatever cause
- The risk to others, from whatever cause including surface or flood water from or displaced by the development.

E.36 The FRA will need to show that organisations affected by surface water draining from the development (e.g. the Internal Drainage Board, the Water Company or the council's Drainage Team) have been consulted on and agree with the proposals.

E.37 **Applications not complying with these requirements will be refused.**

E.38 To speed up the application process, pre-application discussions between developers and the Environment Agency (for flood risk issues) and the council's Drainage Team (for drainage issues) are encouraged. The procedure may be summarised as follows:-

(a) Pre-application

(i) Initial inquiry for information on flood risk issues (and surface water issues where appropriate) to the Environment Agency (EA), on drainage issues to the council's Drainage Team (CDT);

(ii) Submission of draft section of FRA covering flood risk or drainage issues to EA or CDT as appropriate;

(iii) Comments by EA/CDT (following site visits, meetings if appropriate);

(iv) Submission of final section of FRA covering drainage issues to EA/CDT.

(b) Application

(i) Submission of planning application with FRA to planning authority;

(ii) Planning authority consults with EA/CDT;

(iii) EA/CDT considers all relevant issues and responds to planning authority.

Approvals and refusals of planning applications

E.39 The Local Planning Authorities are expected to approve the **flood risk aspects** of any planning applications falling within the green boxes of the matrix, provided it complies with the comments contained in the relevant box. They are also expected to refuse any applications that do not comply with this advice. The Environment Agency confirms it will support such decisions to the full. **It should be noted that if a development proposal is satisfactory with regard to flood risk it may still be unacceptable to the Environment Agency with regard to other material considerations.**

E.40 If the Local Planning Authority is considering granting planning permission contrary to the standing advice, the Environment Agency will be notified of the reasons for doing this and given an opportunity to make further representations.

North & North-East Lincolnshire
Flood Risk Standing Advice
Flood Risk Response Matrix
November-2011

Note:

Pages 72 and 73 shows the Flood Risk Response Matrix

Pages 74 - 83 shows the detailed flood risk guidance that lies behind the Flood Risk Response Matrix

See Appendix E paragraph E.33/34 for instructions on use

	Development Category	1 Within 9m of Main River Bank or Sea Defence (brown), or within Flood Zone 3(b) (purple)	2 Within Flood Zone 2/3(a) - Hazard Rating (HR) undefined as no Level 2 Assessment (blue)
A	**Minor** domestic/commercial/industrial extensions (but for extensions to form new dwellings see A11 and A12)	Consult EA	Appropriate Mitigation Sequential and Exception Tests not required
B	**Water Compatible** (including development with essential ancillary sleeping or residential accommodation)	Consult EA	Appropriate Mitigation
C	**Non-Major*** ('Less Vulnerable' Uses) e.g. commercial/ industrial development with less than 1ha site area or 1,000m² floor space	Consult EA	Consult EA
D	**Non-Major*** ('More Vulnerable' Uses) including residential development & residential holiday accommodation with less than 10 dwellings/ units or less than 0.5ha in size (but excluding camping or caravan sites - see A13, A17)	Consult EA	Consult EA
E	**Change of Use** (Flood Risk Sensitive) (but excluding change of use to camping or caravan sites - see A13, A17)	Consult EA	Consult EA
F	**Camping or Caravan Sites** (including log cabins) covered by flood warning and evacuation plans	Consult EA	Consult EA
G	**Essential Infrastructure**	Consult EA	Consult EA
H	**Major*** **('Less Vulnerable' Uses)** e.g. commercial/industrial development greater than 1,000m2 floor space or greater than 1ha site area	Consult EA	Consult EA
I	**Major*** **('More Vulnerable' Uses)** including residential development & residential holiday accom greater than 10 dwellings/units or 0.5ha in size (but excluding camping or caravan sites - see A13, A17)	Consult EA	Consult EA
J	**'Highly Vulnerable' Uses** e.g. caravans, mobile homes and park homes intended for permanent residential use	Consult EA	Consult EA Objection in Principle

*Note - Distinction between 'Non-major' and 'Major' taken from PPS25, p9, footnote 9.

3	4	5	6	7
'Within Flood Zone 2/3(a) - Hazard Rating (HR) defined by Level 2 Assessment Applies to Compartments 1T1 (Sub-Compartment 2 only), 1T2 and 1T3				**NEGLIGIBLE Within Flood Zone 1 (no colour)**
EXTREME (HR > 2) (red)	**SEVERE (HR 1.25 - 2) (orange)**	**MODERATE (HR 0.75 - 1.25) (yellow)**	**LOW (HR < 0.75) (green)**	
Appropriate Mitigation Sequential and Exception Tests not required	Appropriate Mitigation Sequential and Exception Tests not required	Appropriate Mitigation Sequential and Exception Tests not required	Appropriate Mitigation Sequential and Exception Tests not required	No flood risk comments
Appropriate Mitigation	Appropriate Mitigation	Appropriate Mitigation	Appropriate Mitigation	No flood risk comments
Consult EA	Appropriate Mitigation	Appropriate Mitigation	Appropriate Mitigation	No flood risk comments
Consult EA	Appropriate Mitigation	Appropriate Mitigation	Appropriate Mitigation	No flood risk comments
Consult EA	Consult EA	Appropriate Mitigation No self contained GF residential units	Appropriate Mitigation	No flood risk comments
For Sites <1ha Appropriate Mitigation	For Sites <1ha Appropriate Mitigation	For Sites <1ha Appropriate Mitigation	For Sites <1ha Appropriate Mitigation	For Sites <1ha No flood risk comments
'For Sites >1ha Consult EA	'For Sites >1ha Consult EA	'For Sites >1ha Consult EA	'For Sites >1ha Consult EA	'For Sites >1ha Consult EA
Consult EA	Consult EA	Consult EA	Consult EA	Consult EA
Consult EA	Consult EA	Consult EA	Consult EA	Consult EA
Consult EA Objection in Principle	Consult EA Objection in Principle	Consult EA Objection in Principle	Consult EA Objection in Principle	Consult EA

Development Category	Guidance
A1	**Within 9m of Main River or Sea Defence Bank** Environment Agency byelaw consent required and likely to be refused. Agency objection to grant of planning permission likely. Early contact with Environment Agency at pre-application stage is strongly advised. **Within Flood Zone 3(b)** Environment Agency objection to grant of planning permission likely. Early contact with Environment Agency at pre-application stage is strongly advised. **Sequential and Exception Tests not required for Minor Development**
A2, A3, A4, A5, A6	Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant. The Planning Authority will check the planning application to ensure that one or other of the following mitigation measures below has been incorporated into the development. **Either:-** Floor levels within the proposed development will be no lower than existing floor levels AND flood proofing has been incorporated where appropriate. Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F **Or:-** Floor levels within the extension will be set 300mm above the Critical Flood Level determined as described in Appendix D. This must be demonstrated by a plan that shows finished floor levels relative to the Critical Flood Level. All levels should be stated in relation to Ordnance Datum **Sequential and Exception Tests are not required for Minor Development.**
B1, C1, D1, E1, F1, G1, H1, I1, J1	Within 9m of Main River or Sea Defence Bank Environment Agency byelaw consent required and likely to be refused. Agency objection to grant of planning permission likely. Early contact with Environment Agency at pre-application stage is strongly advised. Within Flood Zone 3(b) Environment Agency objection to grant of planning permission likely. Early contact with Environment Agency at pre-application stage is strongly advised.

Development Category	Guidance
B2, B3, B4	Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant. The Planning Authority will check the FRA to confirm the proposal will operate under flood conditions i.e. that essential electrical equipment is raised at least 300mm above the Critical Flood Level determined as described in Appendix D and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F The Environment Agency will **OBJECT** to proposals that include ground floor ancillary sleeping or residential accommodation as an adequate standard of safety is not considered to be achievable, unless the FRA shows this can be achieved.
B5	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6 as follows:- **Depths of 0.25 - 0.5m** Floor levels should be set 500mm above ground level and flood resilent construction used to 300mm above the Critical Flood Level **Depths of 0 - 0.25m** Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F
B6	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6. Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F

Development Category	Guidance
C2, C3, D2, E2,	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which demonstrates that the proposal will be safe for its lifetime.
C4, C5	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be raised as high as possible (minimum 300mm above existing ground level), and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Where practicable the floor level of single storey buildings should be set at least 300mm above the Critical Flood Level determined as described in Appendix D paragraph D.6. If this is not practicable the FRA should identify an area of safe refuge or an appropriate evacuation strategy. Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F
C6	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that the chosen finished floor level is at least,300mm above existing ground level) and that appropriate mitigation measures/ flood resilience techniques have been incorporated into the development. Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F
D3	The Environment Agency will **OBJECT** to proposals for new more vulnerable development in this Hazard Zone as safe development is not considered to be achievable.

Development Category	Guidance
D4	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains a flood warning and evacuation plan, undertaken and agreed in consultation with the LPA's Emergency Planning Officer, together with evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6 as follows:- **Depths of >1m** Proposals should be at least 2 storeys with ground floor levels set not less than 300mm above the Critical Flood Level; if this cannot be achieved the ground floor should be restricted to non-habitable uses (e.g. garages, utility rooms), flood resilient construction used to 300mm above the Critical Flood Level and demountable defences to 600mm above floor level **Depths 0.5 - 1m** Floor levels should be set 1m above ground level and flood resilent construction used to 300mm above the Critical Flood Level - see below for single storey proposals, which should have a boarded loft space and escape windows **Depths of 0.25 - 0.5m** Floor levels should be set 500mm above ground level and flood resilent construction used to 300mm above the Critical Flood Level - see below for single storey proposals **Depths of 0 - 0.25m** Floor levels should be set 300mm above ground level - see below for single storey proposals **The floor level of all single storey proposals should be set not less than 500mm above the Critical Flood Level** Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F

Development Category	Guidance
D5	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6 as follows:- **Depths of 0.25 - 0.5m** Floor levels should be set 500mm above ground level and flood resilent construction used to 300mm above the Critical Flood Level - see below for single storey proposals **Depths of 0 - 0.25m** Floor levels should be set 300mm above ground level - see below for single story proposals **The floor level of all single storey proposals should be set not less than 500mm above the Critical Flood Level** Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F
D6	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6. Floor levels should be set 300mm above ground level - see below for single storey proposals **The floor level of all single storey proposals should be set not less than 500mm above the Critical Flood Level** Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F

Development Category	Guidance
E3, E4	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which demonstrates that the proposal will be safe for its lifetime. The Environment Agency will only support like-for-like vulnerability classification uses and is unlikely to support proposals including ground floor habitable accommodation.
E5	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6 as follows:- **Depths of 0.25 - 0.5m** Floor levels should be set 500mm above ground level and flood resilent construction used to 300mm above the Critical Flood Level **Depths of 0 - 0.25m** Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F If these conditions cannot be met, or if the proposal includes self contained ground floor residential accommodation, the application should be referred to the Environment Agency.
E6	**Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains evidence to justify the chosen finished floor level, which should be determined as set out below, and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6. Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F

Development Category	Guidance
F2	**The Environment Agency will support applications for development of this nature in coastal locations (i.e. in Compartments 1T1 to 1T5, 2T1 to 2T3) provided the conditions listed below are satisfied. If these conditions cannot be met, or if the proposed development is located in any other compartment, the application should be referred to the Environment Agency.** **1. The site should not be occupied between 1st October in any year and 31st March in the following year.** **2. Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains a flood warning and evacuation plan, undertaken and agreed in consultation with the LPA's Emergency Planning Officer. **3. All caravans should be secured to the ground using an adequate mechanism, such as chains and ground anchors.** Finished floor levels should be set at least 300mm above ground level and, where practical, above the flood depth for the location obtained from the Environment Agency as described in Appendix D paragraphs D.5 or D.6.
F3 (a), F4 (a), F5 (a), F6 (a)	**The Environment Agency will support applications for development of this nature in coastal locations (i.e. sites <1ha in Compartments 1T1 to 1T5, 2T1 to 2T3) provided the conditions listed below are satisfied. If these conditions cannot be met, or if the proposed development is located in any other compartment, the application should be referred to the Environment Agency.** **1. The site should not be occupied between 1st October in any year and 31st March in the following year.** **2. Planning applications should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant.** The Planning Authority will check the FRA to confirm that it contains a **flood warning and evacuation plan,** undertaken and agreed in consultation with the LPA's Emergency Planning Officer. **3. All caravans should be secured to the ground using an adequate mechanism, such as chains and ground anchors.** Finished floor levels should be set at least 300mm above ground level and, where practical, above the Critical Flood Level obtained as described in Appendix D paragraph D.6.

Development Category	Guidance
F3 (b), F4 (b), F5 (b) F6 (b), F7 (b)	**Planning applications for sites >1ha should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which includes details of surface water drainage arrangements and demonstrates that the proposal will not increase flood risk elsewhere.
G2, G3, G4, G5, G6, G7, H2, H3, I2,	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which demonstrates that the proposal will be safe for its lifetime. The FRA should also include details of surface water drainage arrangements and demonstrate that the proposal will not increase flood risk elsewhere.
H4, H5,	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant. This should contain evidence to justify the chosen finished floor level, which should be raised as high as possible (minimum 300mm above existing ground level), and confirm that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Where practicable the floor level of single storey buildings should be set at least 300mm above the Critical Flood Level determined as described in Appendix D paragraph D.6. If this is not practicable the FRA should identify an area of safe refuge or an aprropriate evacuation strategy. Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F The FRA should also include details of surface water drainage arrangements and demonstrate that the proposal will not increase flood risk elsewhere.
H6	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which should confirm that the finished floor level is set at least 300mm above existing ground level and that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F The FRA should also include details of surface water drainage arrangements and demonstrate that the proposal will not increase flood risk elsewhere.
H7	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which includes details of surface water drainage arrangements and demonstrates that the proposal will not increase flood risk elsewhere.

Development Category	Guidance
I3	The Environment Agency will **OBJECT** to proposals for new more vulnerable development in this Hazard Zone as safe development is not considered to be achievable.
I4	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant. This should contain a flood warning and evacuation plan, undertaken and agreed in consultation with the LPA's Emergency Planning Officer, together with evidence to justify the chosen finished floor level, which should be determined as set out below, and confirm that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6 as follows:- **Depths of >1m** Proposals should be at least 2 storeys with ground floor levels set not less than 300mm above the Critical Flood Level; if this cannot be achieved the ground floor should be restricted to non-habitable uses (e.g. garages, utility rooms), flood resilient construction used to 300mm above the Critical Flood Level and demountable defences to 600mm above floor level **Depths 0.5 - 1m** Floor levels should be set 1m above ground level and flood resilent construction used to 300mm above the Critical Flood Level - single storey proposals should have a boarded loft space and escape windows **Depths of 0.25 - 0.5m** floor levels should be set 500mm above ground level and flood resilent construction used to 300mm above the Critical Flood Level **Depths of 0 - 0.25m** Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F The FRA should also include details of surface water drainage arrangements and demonstrate that the proposal will not increase flood risk elsewhere.

Development Category	Guidance
I5	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant. This should contain evidence to justify the chosen finished floor level, which should be determined as set out below, and confirm that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6 as follows:- **Depths of 0.25 - 0.5m** Floor levels should be set 500mm above ground level and flood resilent construction used to 300mm above the Critical Flood Level **Depths of 0 - 0.25m** Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F The FRA should also include details of surface water drainage arrangements and demonstrate that the proposal will not increase flood risk elsewhere.
I6, J7	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA) prepared by or for the applicant. This should contain evidence to justify the chosen finished floor level, which should be determined as set out below, and confirm that appropriate mitigation measures/flood resilience techniques have been incorporated into the development. Finished floor levels should be based on the Critical Flood Level determined using flood depth information obtained from the Environment Agency as described in Appendix D paragraph D.6. Floor levels should be set 300mm above ground level Details of any flood resilience and resistance techniques to be included should be in accordance with Appendix F The FRA should also include details of surface water drainage arrangements and demonstrate that the proposal will not increase flood risk elsewhere.
I7	**Planning applications should be referred to the Environment Agency.** Each application should be accompanied by a Flood Risk Assessment (FRA), prepared by or for the applicant, which includes details of surface water drainage arrangements and demonstrates that the proposal will not increase flood risk elsewhere.
J2, J3, J4, J5, J6	The Environment Agency will **OBJECT** to such proposals as, in accordance with PPS25 Annex D, highly vulnerable uses are not appropriate in Flood Zone 3.

Appendix F - Mitigation Measures

Introduction

F.1 PPS25 requires that any development, within SFRA Flood Zone 2/3(a) or elsewhere, should be safe and should not increase the risk of flooding elsewhere. In general, for a development to be safe both pedestrians and vehicles should have safe access to and from the site when a flood occurs. At the very least, and then only in exceptional circumstances, there must be a place of safety able to accommodate the occupants of the development safely for the duration of the flooding.

F.2 Some of the measures that might be considered to help make a development safe are described below. They will not all be suitable in all circumstances and the actual measures adopted will need to be chosen carefully taking the characteristics of the site, the type of development, the proposed construction materials, the nature of the flood risk and the potential impact on flood risk elsewhere into account.

F.3 Where appropriate the Humber Local Resilience Forum and the council's Emergency Planners should be asked to comment on the safety of a proposed development. Further information can be obtained by sending an e-mail to humberlrf@eastriding.gov.uk or from the Forum's website at www.heps.gov.uk/index.asp?docid=1001619.

Possible mitigation measures in SFRA Flood Zone 2/3(a)

Raising floor levels

F.4 Floor levels in new developments should be raised at least 300mm above the Critical Flood Levels determined as described in Appendix D.

Raising ground levels

F.5 Ground levels can be raised to provide safe access to and from the site, provided no areas that would form islands during a flood are created as a result. The ground level should be at the Critical Flood Level determined as described in Appendix D or higher. Any proposal for raising ground levels will need to show that the works will not increase the flood risk to third parties or impede potential surface water flood flows and that appropriate mitigation/compensation (e.g. to replace any loss of floodplain storage) will be provided.

Providing flood defences

F.6 Flood defences can be provided for individual properties or areas and can consist of embankments, walls, gates or other flood-excluding infrastructure (including temporary or demountable defences). The defences will need to be sufficiently high to protect against the Critical Flood Levels determined described in Appendix D with at least 300mm freeboard. It may be necessary to provide pumps to keep the protected area dry during the event and the implications of the defences failing or being overtopped should be considered.

F.7 Any proposal involving the provision of flood defences will need to show that the works will not increase the flood risk to third parties or impede potential surface water flood flows. It will also need to show that appropriate compensation/mitigation (e.g. to replace any loss of floodplain storage) will be provided and that measures to ensure the future maintenance of the defences are in place.

Providing upstairs accommodation or place of safety

F.8 If ground floor levels cannot be raised high enough to avoid the risk of flooding but development is nevertheless deemed appropriate, then where possible non-habitable ground floor uses only should be considered. In exceptional circumstances the provision of unrestricted access to upstairs accommodation that will act as a place of safety may be acceptable. In these circumstances the place of safety must be able to accommodate all potential occupants for the duration of the flooding and its floor level must be at least 300mm above the Critical Flood Level determined as described in Appendix D.

Using flood resistant construction techniques

F.9 Buildings designed and built to keep water out when the surrounding area is flooded are termed 'flood resistant'. Flood resistant construction techniques include:

- Use of water-proof materials for walls and floors below flood level;
- Fitting one-way valves or temporary bungs to sewage pipes and service ducts;
- Providing temporary flood boards (stop logs) for doors, air vents and other features that could allow water to enter the building;
- Providing sumps to collect any water entering the building and pumps (with a greater capacity than the expected inflow) to drain them.

The structural safety of the building during a flood should be considered (brick walls will not generally resist water depths greater than about 0.6m, sometimes less), as should the need to provide timely warnings so that temporary gates, bungs and flood boards etc can be fitted. Further information can be obtained from the PPS25 Practice Guide and from the publication 'Improving the flood performance of new buildings' (May 2007), which can be downloaded from the Department for Communities and Local Government website at www.planningportal.gov.uk/uploads/br/flood_performance.pdf.

Using flood resilient construction techniques

F.10 Buildings designed and built to minimise the damage caused when flooding occurs are termed 'flood resilient'. Flood resilient construction techniques include:

- Using concrete rather than timber floors
- Locating boilers and electrical systems (sockets, cabling) above flood levels
- Using water–resistant materials (plastic, metal) for cupboards and similar items, rather then chipboard or MDF
- Using lime plaster or cement render rather than gypsum plaster.

F.11 Again further information can be obtained from the PPS25 Practice Guide and from the publication 'Improving the flood performance of new buildings' (May 2007), available from the website link given above.

Possible mitigation measures in areas subject to surface water flooding

Managing surface water inflows to the site

F.12 Diverting water away before it enters the site, storing it on the site or encouraging its rapid transmission through the site are all possible methods of managing surface water inflows. They will form part of the overall drainage strategy for the site, which will need to be developed taking SUDS considerations into account (see Appendix G). The potential impact on flood risk elsewhere will need to be considered.

Improving the existing drainage network

F.13 Improving the existing drainage network may also be a means of mitigating surface water flooding. Again this will form part of the overall drainage strategy for the site, and the potential impact on flood risk elsewhere will need to be considered.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Appendix G - Types of Sustainable Drainage Systems

Introduction

G.1 Sustainable drainage systems (SUDS) may improve the sustainable management of surface water at a site by:

- Reducing peak flows to watercourses or sewers and so potentially reducing the probability of flooding downstream
- Reducing the total volume of water flowing directly to watercourses or sewers from developed sites
- Improving water quality, compared with conventional surface water sewers, by removing pollutants from diffuse pollutant sources
- Reducing potable water demand by rainwater harvesting
- Improving amenity through the provision of public open space and wildlife habitat
- Replicating natural drainage patterns, including the recharge of groundwater so base flows are maintained.

Although the reduction in peak flow or total volume originating from any particular site may be small, the cumulative effect from a number of sites across a catchment can be significant and have a real impact on extent and frequency of flooding.

G.2 There are a number of different types of SUDS that can be incorporated into a development. Their effectiveness depends on the topography and geology of the site and the surrounding area, and careful consideration of the site's characteristics is needed to ensure the most suitable choice is made. The most commonly found components are described below.

Types of sustainable drainage systems

Permeable surfaces

G.3 Surfaces that allow rainwater to flow through them into the underlying construction or soil.

Green roofs

G.4 Roofs that are vegetated and so provide some natural storage of rainwater, reducing the volume and rate of runoff and helping to remove pollution.

Filter drains

G.5 Linear drains consisting of trenches filled with a permeable material that can store and conduct water, and may also encourage infiltration into the underlying soil. They may have a perforated pipe in the base to assist drainage.

Filter strips

G.6 Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and filter out silt and other particulates.

Swales

G.7 Shallow vegetated channels that retain and conduct water, and may also permit infiltration. The vegetation filters particulate matter.

Basins

G.8 Ponds and wetland areas that can be used to store surface water runoff.

Infiltration devices

G.9 Any sub-surface structure, such as a trench, basin or soakaway, that promotes the infiltration of surface water to the ground.

Bio-retention areas

G.10 Vegetated areas designed to collect and treat surface water before discharging it through a piped system or allowing it to infiltrate the ground.

Pipes and accessories

G.11 A series of conduits and their accessories, normally laid below ground, that convey surface water to a suitable location for treatment and disposal. Although sustainable, this approach should be used only where other SUDS techniques are not practicable.

G.12 As well as a formal SUDS, there are a number of other measures that can be designed into new developments and will, in the right circumstances, provide the same benefits. These include the re-contouring of land levels to form green spaces that can hold rainwater, or the installation of water butts to store rainwater runoff from roofs (although it should be noted that the capacity of water butts is limited so their success depends on regular emptying, either for garden watering or some other purpose).

Appendix H - Eastern Coastal Area Flood Compartments

General Description of Area

Location, extent and development potential

H.1 The Eastern Coastal Area stretches from Humberston Fitties, which is east of Cleethorpes, to the high ground outcropping at South Ferriby Cliff, west of Barton-upon Humber and the Humber Bridge. The shoreline of the Humber Estuary forms the northern and eastern boundaries while the council borders form the southern boundary. The watershed dividing the River Ancholme catchment from the catchments draining east to the estuary acts as the western boundary.

H.2 The main centres of population in the area are Cleethorpes, Grimsby, Immingham and Barton-upon-Humber, all lying within 5km of the estuary. The area also contains the major ports of Grimsby and Immingham and wharfage facilities at North Killingholme and New Holland. There are major industrial and commercial facilities beside the coast between Grimsby and North Killingholme, including power stations, chemical works and storage areas. Many of these are either linked to the docks or are associated with the estuary in some other way. The remainder of the area is largely devoted to agriculture.

H.3 The coastal plain between Grimsby and East Halton Skitter (about 3 km along the coast from North Killingholme) has been allocated for estuary-related development in the local plans and a detailed development study (the South Humber Bank study) is currently being carried out. Between North Killingholme and Grimsby the development will consist primarily of infilling between existing facilities but further north the land is largely undeveloped and is currently used for agriculture. No other parts of the area are allocated for major development.

Main sources of flood risk

H.4 The main source of flood risk in the area is a combination of large waves and high water levels in the Humber Estuary. The Joint Probability Analysis quotes the combinations having a 0.5% probability of occurrence and a selected list of these combinations is given in Table 5.1. Combinations with water levels 0.2 to 0.4m higher are likely to have a 0.1% probability of occurrence. The base date for these figures in 1991 and current guidance indicates that allowance should be made for sea levels to rise by 1.201m and wave heights increase by 10% by 2115.

Humber Bridge		Immingham		Cleethorpes	
Water level (mOD)	Wave ht (m)	Water level (mOD)	Wave ht (m)	Water level (mOD)	Wave ht (m)
5.44	0.0	4.93	0.0	4.56	0.0
5.25	0.6	4.60	1.0	4.43	1.5
4.80	0.8	4.05	1.5	4.20	2.2
4.14	0.9	3.25	1.8	3.60	3.2

Table H.1 - Water level and wave height combinations with a 0.5% probability of occurrence; Eastern Coastal Area

H.5 There are nine main river watercourses, ten watercourses that are classified as SOWs and six pumping stations within the area, listed in Tables H.1 to H.4 respectively and shown on Map 8. Five of the main river watercourses lie wholly within the tidal flood plain and one (Stallingborough North Beck) has only a very short length (~300m) lying outside. All but five of the SOWs lie within the tidal or fluvial floodplain, as currently defined and North East Lindsey Internal Drainage Board (IDB) is responsible for all but two of them.

Ref No	Name of watercourse	Wholly within tidal floodplain
M1	Waithe Beck	—
M2	Buck Beck & Goosepaddle Drain	—
M3	River Freshney & Laceby Beck	—
M4	New Cut, Grimsby	—
M5	Oldfleet Drain	Yes
M6	Stallingborough North Beck	Mostly
M7	East Halton Beck & Brockelsby Beck	—
M8	Barrow Beck	Mostly
M9	Butts Beck & Tributary	Yes

Table H.2 - Main river watercourses; Eastern Coastal Area

Ref No	Name of watercourse	Wholly within tidal floodplain	Managed by
S1	Buck Beck, Waltham (a)	—	NELC
S2	Buck Beck, Waltham (b)	—	NELIDB
S3	Little Buck Beck	—	NELIDB
S4	Gooseman's Drain	—	NELC
S5	Mawmbridge Drains	Yes	NELIDB
S6	Middle Drain, Stallingborough	Yes	NELIDB
S7	Haborough Marsh Drains	Yes	NELIDB
S8	South Killingholme Main Drain	Yes	NELIDB
S9	New Holland Main Drain	Yes	NELIDB
S10	Midby Drain, Barrow	—	NELIDB

Table H.3 - Significant Ordinary Watercourses (SOWs); Eastern Coastal Area

- NELC North East Lincolnshire Council
- NELIDB North East Lindsey Internal Drainage Board

Ref No	Pumping Station	Operated by
P1	Little Buck Beck	NELIDB
P2	Mawmbridge	NELIDB
P3	Middle Drain	NELIDB
P4	Immingham	NELIDB
P5	New Holland Estate	NELIDB
P6	New Holland Outfall	NELIDB

Table H.4 - Drainage pumping stations; Eastern Coastal Area

H.6 The responsibility for draining the low-lying land within the area is shared by two IDBs, Lindsey Marsh (which deals with the Waithe Beck and the Humberston Fitties and surrounding area) and North East Lindsey (which deals with the remainder). The IDB boundaries are also shown on Map 8. The IDB has to approve the drainage arrangements of all significant new development within its boundaries or affecting its watercourses. In principle the site runoff characteristics should remain unchanged, although often the IDB will accept the receiving drainage system being improved so it can accept the increased discharge, at the developer's expense. It is understood that the design standard for these improvements is the event having a 1.0% annual probability of occurrence.

Flood compartments

H.7 To allow more detailed assessment, the area shown as SFRA Flood Zone 3 on Flood Risk Map 9 has been divided into flood compartments taking into account the topography, type of defence, drainage arrangements and land use. These compartments are listed in Table H.5 with the sources of flood risk they include. Further information about each flood compartment is given in the following sections.

Compartment reference	Compartment name	Sources of flood risk
1T1	Cleethorpes	Humber Estuary Lower Buck Beck Little Buck Beck
1T2	Grimsby & Stallingborough	Humber Estuary Lower River Freshney New Cut Mawmbridge Drains Oldfleet Drain Middle Drain, Stallingborough Stallingborough North Beck
1T3	Immingham & North Killingholme	Humber Estuary Stallingborough North Beck Habrough Marsh Drain South Killingholme Main Drain Lower East Halton Beck

Compartment reference	Compartment name	Sources of flood risk
1T4	Goxhill	Humber Estuary Lower East Halton Beck Goxhill complaints
1T5	Barton upon Humber	Humber Estuary New Holland Main Drain Barrow Beck Butts Beck Midby Drain, Barrow Barrow complaints
1F1	Waithe Beck	Waithe Beck
1F2	Buck Beck & Goosepaddle Drain	Buck Beck Buck Beck, Waltham (a & b)
1F3	River Freshney & Laceby Beck	River Freshney
1F4	East Halton Beck/Skitter Beck	East Halton Beck Brockelsby Beck
1F5	Barrow Beck & Midby Drain	Barrow Beck Midby Drain, Barrow

Table H.5 - Flood compartments; Eastern Coastal Area

The reference prefix denotes the primary source of flood risk in the compartment;
T = Tidal; F = Fluvial

Tidal Flood Compartments

1T1: Cleethorpes

Description of site

H.8 The estuary frontage of this compartment runs from the northern end of the Cleethorpes Promenade to the North East Lincolnshire Council (NELC) boundary at the southern end of Humberston Fitties. In practice the compartment extends further south but the land there lies outside the Study Area and so is not covered by this SFRA. If the land floods, however, this flooding could extend into the Study Area and this possibility is considered in the assessment. Along Cleethorpes Promenade the boundary defines the area that could be subject to significant wave washover during a severe event and is taken as 30m from the seawall.

H.9 The compartment is about 6 km long and varies in width from 30m along the promenade to about 4 km along the Buck Beck and behind Humberston Fitties. Ground levels in the area indicate that most of the land is above +3.0 mOD except behind Humberston Fitties.

H.10 Most of the area is open and devoted either to agriculture or to recreational activities, the latter including the Discovery Centre and Theme Park on the front. There are some residential areas, however, in Cleethorpes and Humberston along the edges of the Buck Beck valley. The Thorpe Park Caravan Park

is close to the beach at Humberston and abuts the Humberston Fitties Holiday Camp, which lies to the south. This contains a large number of single-storey holiday chalets, mainly of wooden construction but with an air of permanence. Ground levels in the Fitties area generally vary between +3.5 and +3.9 mOD and occupancy restrictions are placed on the chalets because of the high flood risk there. In view of this a supplementary assessment covering this area alone has been undertaken and is included at the end of this section.

Sources of flood risk

H.11 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table 5.1 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at Cleethorpes as +4.56 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

H.12 In addition to this tidal source there are three fluvial sources of flood risk, the Buck Beck (and its tributary the Goosepaddle Drain), which discharges to the estuary through a gravity sluice between Cleethorpes and Humberston) and the Little Buck Beck which is pumped into the Buck Beck. The Buck Beck and Goosepaddle Drain are designated as main river and managed by the Environment Agency while the Little Buck Beck is managed by NELIDB. The third source is a system of ditches managed by LMIDB and draining the area behind Humberston Fitties through a gravity discharge to the Louth Canal seaward of Tetney Lock.

H.13 A hydraulic model of the Buck Beck and Goosepaddle Drain system was carried out in 2009. This indicates that during a 1.0% annual probability event the water level in the Buck Beck varies from +3.6 mOD at the outfall to + 4.8 mOD at the compartment boundary. The level in the Goosepaddle Drain varies from +3.7 mOD at the junction with the Buck Beck to +3.8 mOD at its head. A further study is planned to examine the effect of a recent rise in beach levels as this may have reduced the outlet discharge capacity.

H.14 The two IDB drainage systems are understood to be capable of accommodating the 1.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

H.15 The Cleethorpes Promenade is fronted by a seawall with a crest level that varies between +5.8 and +6.3 mOD and is in good condition (Grade 2). This will provide adequate protection against wave overwash during a 1.0% annual return period event for the next 100 years (including the effects of sea level rise) provided beach levels remain as high as they are at present. Between the end of the promenade and Humberston an earth embankment with crest level varying between +6.6 and +8.3 mOD forms the defence. The condition is generally Grade 2 (good) with some sections being Grade 3 (fair) and the defence will protect the area behind against events with a 0.5% annual probability for the next 100 years.

H.16 South of Humberston the embankment is set back from the shore and acts as a secondary line of defence behind the Humberston Fitties. The main defence to the Fitties is formed by sand dunes reinforced by gabion boxes at the toe and rated as generally in good condition (Grade 2) with some elements in fair condition (Grade 3). The top of the boxes is about +4.7 mOD while the top of the sand dunes varies

between +6.4 and +6.9 mOD except at points where they have been lowered locally to provide access to the beach. As a result of these low points the standard of protection is significantly less than the 0.5% annual probability requirement set out in PPS25.

H.17 A combination of earth embankments and dwarf floodwalls provide protection against flooding from the Buck Beck and Goosepaddle Drain. They are generally in good condition (Grade 2) with some sections in fair condition (Grade 3). The model studies indicate that they currently provide protection against a 1.0% annual probability event throughout this system.

1T1 Supplementary Assessment: Humberston Fitties

Description of site

H.18 The area covered by this flood risk assessment is at Humberston Fitties Holiday Camp, south of Cleethorpes. It is bounded by the shoreline of the Humber estuary to the north-east and by the Environment Agency's flood defence embankment to the south-west. The northern boundary is a line drawn perpendicular to the coast at the car park separating the Holiday Camp from the Thorpe Park Caravan Park while the southern boundary is just beyond the Humber Mouth Yacht Club. The site is roughly rectangular, approximately 1km long by 200m wide and has a total area of about 0.2 km^2.

H.19 The site is fully developed, containing a large number of holiday chalets, generally of timber construction but most nevertheless having an air of permanence, together with access roads and services. Ground levels within the site generally vary between +3.5 and +3.9 mOD and most of the chalets appear to be founded between these levels although a few at the southern end are located on higher ground, up to +5.0 mOD.

H.20 The site is bounded by higher ground on all sides. To seaward there is a line of dunes, reinforced by gabion boxes at their base and rising to between +6.4 and +6.9 mOD, except at selected points where the dunes have been lowered locally to provide access to the beach. The crest of the Environment Agency's embankment varies between +4.4 and +5.0 mOD while the high ground to the south varies between +4.7 and +5.7 mOD. The car park at the northern boundary is at about +6.0 mOD. The site therefore acts, in effect, as a basin, with any water entering being prevented from leaving (except by infiltration or through the local drainage system) until the level has risen enough to allow the embankment along the south-west boundary to overflow.

Sources of flood risk

H.21 The main source of flood risk to the site is a combination of large waves and high water levels in the Humber Estuary. Work carried out for the Humber Estuary Shoreline Management Plan (Humber Tidal Database Joint Probability Analysis; Environment Agency; 1999) quotes the combinations having a 1 in 200 (0.5%) annual probability of occurrence. A selected list of these combinations is given in Table H.6. Note that current guidance suggests sea level could rise by 1.201m and wave heights increase by 10% by 2115.

H.22 Two other potential sources of flood risk exist, the Buck Beck to the north and a local drainage channel on the other side of the Environment Agency embankment. The Buck Beck discharges to the estuary about 800m north of the site, through a flapped outfall which also carries the main discharge from the Grimsby/Cleethorpes drainage system. If the outfall is blocked during an extreme rainstorm flooding

will ensue but this will be restricted to low-lying areas of the Golf Course and Country Park further inland to the west. The risk of this flooding extending to the Fitties is very remote, significantly less than 0.5%. The drainage channel on the other side of the Environment Agency embankment discharges to the outfall channel below Tetney Lock and could suffer from backing up when water levels in the estuary are high (or if the defences south of the Fitties are breached). The land further inland is low-lying, however, and any flooding would take place there as the Fitties site would be protected by the embankment. These sources are therefore not considered further.

Wave height (m)	Water level (mOD)
3.78	3.0
3.44	3.3
3.20	3.6
2.79	3.9
2.22	4.2
1.5	4.43
0.0	4.56

Table H.6 Wave height and water level combinations near Cleethorpes with a 0.5% probability of occurrence.

Existing flood defences

H.23 The site is protected against flooding from the estuary by a row of sand dunes along its north-eastern edge. The crest of these dunes is generally between +6.4 and +6.9 mOD (except as discussed below) and they are reinforced at the toe by a line of gabions consisting of a framework of concrete piles lined with wire mesh and filled with stone. These gabions are about 1.5m high and their crest level is about +4.7 mOD.

H.24 The width of the dune line varies but is generally between 20m and 30m. The rear face slopes gradually back to the chalets and is generally grassed. The crest of the dunes is lowered, by up 1.5m (i.e. to just above the top of the gabions), at a number of points to provide access to the beach for pedestrians. The sand at these access points and the paths leading to them is generally loose and without grass.

H.25 The standard of protection provided by these defences is difficult to determine. The crest of the gabions is slightly above the 0.5% probability still water level at present and is likely to be slightly below it in 50 years time. This is not the key issue, however, since the critical event is likely to be one with a combination of a high water level (say +4.2 mOD) and large waves (say 2.2m). During such an event large volumes of water will wash over the reinforcing gabions and could erode the loose and unprotected sand at the top of the dunes. The backwash could also undermine the gabions themselves, leading to their collapse and exposing more of the dune face to erosion. In these circumstances the security of the defence will depend on whether the erosion hole can extend through the full width of the dunes (allowing a continuous flow of sea water through rather than just wave overwash) in the 3 to 4 hours that the tide is at its highest. The probability of this happening is very difficult to predict with confidence, nevertheless caution suggests there is a significant risk that failure could occur during an event having a 0.5% probability of occurrence.

Assessment of flood risk

H.26 The highest water level in the estuary (with no waves) having a 0.5% probability of occurrence is +4.56 mOD but water levels of +4.2 mOD and above together with waves higher than 2.0m are equally likely to occur. All these water levels are above the ground level in the site (+3.5 to +3.9 mOD), which therefore lies within Flood Zone 3 (High Risk) as defined in PPS25.

H.27 Although the area is protected from flooding by the reinforced sand dunes, there appears to be a significant (but difficult to define) risk that a failure could occur. The extent and depth of flooding that would occur during such an event have been determined using a simple spreadsheet breach-flooding model. The model shows that the depth of flooding will depend on assumptions about the peak water level in the estuary, the width of the breach and the time at which it occurs relative to the time of the peak water level. Selected results are given in Table H.7 below.

Peak estuary level (mOD)	Breach width (m)	Water level (mOD) if breach occurs at time of		
		PL – 1 hr	Peak level, PL	PL + 1 hr
4.56	30	4.11	3.98	3.88
	100	4.34	4.24	4.08
	300	4.46	4.38	4.17
4.20	30	3.82	3.75	3.72
	100	3.99	3.92	3.87
	300	4.10	4.04	3.95

Table H.7 - Flood levels in compartment for range of possible conditions

H.28 These results indicate that the greatest depth of flooding in the area is likely to be between 0.2m and 0.6m, possibly higher if a breach occurs during an event that is water level rather than wave height dominated. Note that once water depths exceed the latter figure the Environment Agency embankment will begin to overflow, limiting any further increase in level.

1T2: Grimsby & Stallingborough

Description of site

H.29 This flood compartment runs from the right bank of the Stallingborough North Beck to high ground between Grimsby and Cleethorpes. The north-east boundary is formed by the flood defences beside the Humber Estuary. The compartment is about 10km long and varies between about 2 and 4 km in width except where it extends up the valley of the River Freshney. Ground levels indicate that much of the area lying between Stallingborough and the coast is lower than + 3.0 mOD, as is much of Grimsby.

H.30 The compartment contains a number of major industrial facilities at its western end, some of which are sited close to the estuary while others are set back. Undeveloped land between these sites is generally devoted to agriculture. The eastern end, covering about 50% of the whole area, is largely urbanised and contains industrial, commercial and residential property, including the central district of Grimsby. The A180 trunk road connecting Grimsby and Cleethorpes to the M180 and points west passes through it as does the main railway line.

H.31 The western part of the compartment (outside Grimsby) has been designated in the NELC Local Plan for estuary-related industry. Various development studies for the area of the South Humber Gateway have been undertaken by North Lincolnshire Council and North East Lincolnshire Council and have either been completed or are still progressing.

Sources of flood risk

H.32 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table H.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at Cleethorpes as +4.56 mOD. Water levels rise up the estuary and the Joint Probability Analysis gives the highest level at Immingham as +4.93 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

H.33 In addition to this tidal source there are six fluvial sources of flood risk. These are the main river watercourses of Stallingborough North Beck at the north end of the compartment, the Oldfleet Drain near the centre, the River Freshney (which discharges by gravity to the Docks at Grimsby) and the New Cut which runs beside the River Freshney for much of its course but flows direct to the estuary at its outfall, together with two SOWs managed by NELIDB. These are the Middle Drain and the Mawmbridge Drain, both of which are pumped to the estuary..

H.34 Studies of the lower reaches of the River Freshney, carried out in 1982 and 1996, indicated that flood flows from the river spilled into the New Cut Drain during events with a 10% annual probability of occurrence or greater. Under these conditions the capacity of the New Cut Drain is limited to the 10% annual probability flood flows, so flooding would occur during a more severe event. A further study, completed in 2009, indicates that the flood level during a 1.0% annual probability event varies between +4.31 mOD at the upstream end of Town's Holt to +3.17 mOD at New Haven Terrace.

H.35 Hydraulic model studies have also been carried out for the Stallingborough North Beck and the Oldfleet Drain. The Stallingborough North Beck study indicates that the water level having a 1.0% annual probability of occurrence varies from +3.37 mOD at the outfall to +4.40 mOD at the upstream end of the model (some 300m upstream of the A1173). The flood risk from this watercourse is discussed further in relation to compartment T3 (Immingham and North Killingholme). The Oldfleet Drain Study indicates that the water level with the same probability of occurance in this watercourse is +2.58 mOD from the outfall to just upstream of the A180 road bridge.

H.36 The NELIDB have examined conditions in the Middle Drain and Mawmbridge Drains in the past, generally to assess the drainage implications of large industrial developments in the area. These studies indicate that the existing systems were mostly designed to cater for events with a 1.0% probability of occurrence but that the design was generally based on the Flood Studies Report (FSR) approach used until 2000 and so may give lower water levels than would be found using the Flood Estimation Handbook (FEH) approach introduced in that year. Although the systems generally include a reasonable freeboard allowance (between the peak water level and the surrounding ground level), this may not always provide sufficient storage to accommodate the more onerous FEH requirements, indicating that some flooding above the local ground level may occur during a 1% annual probability event. The extent of this flooding is not currently known.

H.37 Many of the proposed developments in the compartment (or discharging to watercourses passing through it) would increase the runoff during an extreme event significantly and hence reduce the standard of protection to the surrounding area. One approach in these circumstances is to provide additional on-site storage, so the additional water can be kept until the flood is past. This can require relatively large areas of land, however, and it is often cheaper (and more effective) to improve the drainage system so it can accommodate the increased flows. The NELIDB is keen to support such an approach where it is suitable.

Existing defences

H.38 From the Stallingborough North Beck outfall to Pyewipes (near Grimsby) the compartment is protected against flooding from the estuary by an earth embankment with a revetment on the front face and a wave wall on the crest. The crest level is +6.3 mOD and the condition is generally Grade 2 (Good) or 3 (Fair) although along some lengths the toe is at risk because foreshore levels are falling. The Environment Agency is aware of this and it will be addressed in the long-term programme of works being prepared for the HESMP. Work carried out for the HESMP indicates that, ignoring freeboard, these defences will protect the area behind against events with a 0.2% annual probability of occurring or better. The standard will remain above the 0.5% annual probability requirement set out in PPS25 for the next 50 years, taking the effect of sea level rise into account.

H.39 Between Pyewipes and the entrance to Grimsby Dock protection is provided by a gabion wall and rubble mound, in condition Grade 2 (Good) and 3 (Fair) respectively and with a crest level of +4.9 mOD. The HESMP studies indicate that severe overtopping due to wave activity could occur during a 0.2% annual probability event but that this would be unlikely to cause significant flooding outside the dock area and its approaches. East of the dock entrance a seawall formed of gabion baskets with a revetted slope provides the protection. The crest level is +7.0 mOD, which is considered to provide an adequate standard of protection during the 0.2% annual probability event, and its condition is currently graded as 3 (Fair) with some sections as 4 (Poor). One section is graded as 5 (Very poor), failure here will not result in flooding as the defence is backed by high ground. The Agency's long-term plan includes an allowance for improvement works.

H.40 Further to the east, the northern end of Cleethorpes is protected by a concrete revetment with a wave return wall and a splash wall behind. The crest levels of the two walls are +7.0 mOD and +8.0 mOD respectively. The defence condition is generally good and the standard of protection will remain above the 0.5% annual probability requirement set out in PPS25 for the next 50 years, taking the effect of sea level rise into account.

H.41 Earth embankments provide protection against flooding from the Stallingborough North Beck between the outfall and the A1173 road bridge. They are generally in good condition (Grade 2) although there are short lengths of Grade 3 (Fair). The model studies indicate that they currently provide protection against a 1.0% annual probability event downstream of the railway bridge but that significant flooding would occur between this point and the A1173 road bridge. A small amount of flooding would also occur upstream of the road bridge. There are some lengths of earth embankment acting as flood defences along the Oldfleet Drain, mostly of condition Grade 2 (Good) with some of 3 (Fair). The standard of protection provided by these defences is variable. Some places will be flooded during an event with 20% annual probability of occurring while elsewhere flooding will not occur during events with more than 2% annual probability. The standard of protection is nowhere better than the 1.0% annual probability requirement set out in PPS25 for fluvial flooding.

H.42 The Environment Agency has recently completed a scheme along the lower reaches of the River Freshney to provide protection against events with a 1.0% annual probability of occurrence. This has involved raising flood defences and creating flood storage areas at Town's Holt, Freshney Bog and Church Lane Meadows. All the defences on this river and its tributary the Laceby Beck are classified as condition Grade 3 (Fair) or better.

H.43 The New Cut Drain lies close to but outside the River Freshney defences. It has no separate defences of its own and the standard of protection it provides is currently unknown, although the Environment Agency is planning to carry out the studies needed to determine this standard. The two SOW drainage systems managed by the NELIDB (Middle Drain and Mawmbridge Drains) are understood to have been designed to accommodate events with 0.1% annual probability by a combination of storage and pumping, without flooding the surrounding area. The designs were undertaken some years ago, however, and may not be able to deal with the more stringent standards currently applied. The Board is understood to adopt the current approach to define the 1.0% annual probability event used as the standard when assessing the works needed to deal with the drainage implications of new developments.

1T3: Immingham and North Killingholme

Description of site

H.44 The south-east boundary of this flood compartment is formed by the left bank of the Stallingborough North Beck and the north-west boundary initially by the right bank of the East Halton Beck but connected back to high ground near The Grange (north of East Halton). Both watercourses are main river and therefore operated by the Environment Agency. The flood defences beside the Humber Estuary form the north-east boundary. The compartment is about 10 km long and up to 5 km wide. Ground levels in the area indicate that most of the site is above +4.0 mOD but there are areas, particularly near South Killingholme Haven and near Immingham, where the levels are lower. There is a significant low point in the south-east corner, where the ground level falls below +1.0 mOD.

H.45 The compartment contains major industrial developments including the port areas of Immingham, South Killingholme Haven and North Killingholme Haven with their associated storage capabilities and petro-chemical and related facilities, together covering about 50% of the total area. It also includes part of the town of Immingham. The remaining land is currently devoted primarily to agriculture.

H.46 The whole area has been designated in the relevant Local Plans for estuary-related industry. Various development studies for the area of the South Humber Gateway have been undertaken by North Lincolnshire Council and North East Lincolnshire Council and have either been completed or are still progressing.

Sources of flood risk

H.47 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table H.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at Immingham as +4.93 mOD. Water levels rise up the estuary and the Joint Probability Analysis gives the highest level near East Halton Beck as +5.11 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

H.48 In addition to this tidal source there are four fluvial sources of flood risk. These are the main river watercourses at the north and south ends of the compartment (East Halton Beck and Stallingborough North Beck) and two SOWs managed by NELIDB, the Habrough Marsh Drains which discharge partly to the estuary and partly to the Stallingborough North Beck through the Immingham Pumping Station and the South Killingholme Main Drain which discharges to the estuary at South Killingholme.

H.49 Hydraulic model studies have been carried out for the two main river watercourses. The Stallingborough North Beck discharges by gravity to the estuary through a gated sluice and was modelled in 2009 using an approach based on the Flood Estimation Handbook (FEH). The model extended from the outfall about 3 km upstream to a point some 300 m upstream of the A1173 road crossing. The results indicate that the water level having a 1.0% annual probability of occurring varies from +3.37 mOD at the outfall to +4.40 mOD at the upstream end of the model. The East Halton Beck, which also discharges by gravity, was also modelled in 2009, again using an approach based on the FEH. The model extended from the outfall to the road bridge carrying the B1210 between Brocklesbury and Habrough. The results indicate that during severe events the water ponds in the lower 3.5 km reach of the Beck, reaching a level of +2.84 mOD during an event with a 1.0% annual probability of occurring.

H.50 The studies demonstrate that critical conditions in the lower reaches of both watercourses are strongly influenced by the assumed tidal conditions, with the floodwater ponding there while the outfall is tide-locked. In these circumstances the water level is controlled by volume of storage available. The East Halton Beck study used reservoir units to represent the floodplain and found that a difference of about 400 mm between the peak water levels that occur during the 1.0% and 10.0% probability events.

H.51 The NELIDB have examined conditions in the watercourses they manage on a number of occasions in the recent years to generally assess the drainage implications of large industrial developments in the area. These studies indicate that the existing systems were mostly designed to cater for events with a 1.0% probability of occurrence but that the design was generally based on the FSR approach and so may give lower levels than would be found using the FEH approach. The designs generally include a freeboard of between 300 mm and 450 mm between the peak water level and the surrounding ground level. If this additional storage is taken into account the studies suggest that the drainage systems will accommodate the 1% annual probability flood from the area in its undeveloped state without water levels rising above the local ground level.

H.52 Many of the proposed developments in the compartment (or discharging to watercourses passing through it) would increase the runoff during an extreme event significantly and hence reduce the standard of protection to the surrounding area. One approach in these circumstances is to provide additional on-site storage, so the additional water can be kept until the flood is passes. This can require relatively large areas of land, however, and it is often cheaper (and more effective) to improve the drainage system so it can accommodate the increased flows. The NELIDB is keen to support such an approach where it is suitable.

Existing defences

H.53 Along most its frontage the compartment is protected against flooding from the estuary by an earth embankment with a revetment on the front face and a wave wall on the crest. The crest level is generally +6.3 mOD although there are sections where it is slightly lower at +6.2 mOD. The condition is generally Grade 2 (Good) or 3 (Fair) although along some lengths the toe is at risk because foreshore levels are falling. The Environment Agency is aware of this and, except as discussed in the next paragraph, it will

be addressed in the long-term programme of works being prepared for the HESMP. Work carried out for the HESMP indicates that, ignoring freeboard, these defences will protect the area behind against events with a 0.2% annual probability of occurring or better. The standard will remain above the 0.5% annual probability requirement set out in PPS25 for the next 50 years, taking the effect of sea level rise into account.

H.54 A relatively small area at the north end of the compartment, just south of East Halton Beck, is currently undeveloped and it is possible that the Environment Agency will choose to build a cross-bank to protect the developed land further south rather than maintain the existing defences along this reach. If this happens the condition of these defences will continue to deteriorate and the standard they provide will fall below the 0.5% annual probability requirement set out in PPS25.

H.55 The Immingham Dock area is protected by a combination of gabion walls, a lock structure and a stone embankment, generally in fair condition (Grade 3). The crest level here is about +5.5 mOD, which will also protect against events with a 0.5% annual probability of occurrence for the next 50 years but there is likely to be significant overtopping due to wave run-up. This could cause local flooding within the dock area but is unlikely to damage the defences sufficiently to cause a breach and so threaten the rest of the compartment.

H.56 Earth embankments provide protection against flooding from the Stallingborough North Beck between the outfall and the A1173 road bridge. They are generally in good condition (Grade 2) although there are short lengths of Grade 3 (Fair). The model studies indicate that they currently provide protection against a 1.0% annual probability event downstream of the railway bridge but that significant flooding would occur between this point and the A1173 road bridge. A small amount of flooding would also occur upstream of the road bridge.

H.57 There are no significant flood defences along the East Halton Beck. The surrounding area therefore begins to flood when water levels rise above bank level, which varies between +2.2 and +3.6 mOD within the compartment. Flooding is likely to occur during events with a 30% to 20% annual probability of occurrence (i.e. every 3 to 5 years on average).

H.58 The drainage systems managed by the NELIDB are understood to be able to accommodate events with 0.1% annual probability by a combination of storage and pumping, without flooding the surrounding area. The Board are understood to adopt this standard when assessing the works needed to deal with the drainage implications of new developments.

1T4: Goxhill

Description of site

H.59 This flood compartment falls into two parts, one beside the Humber Estuary and one along the valley of the East Halton Beck. The western boundary of the part beside the estuary is formed by the right bank of the New Holland Main Drain and the south-eastern boundary initially by the left bank of the East Halton Beck but is connected back to high ground near The Grange, north of East Halton. The flood defences beside the Humber Estuary form the northern and eastern boundary. This part of the compartment is about 6 km long and up to 3 km wide. The second part of the compartment lies along the valley of the East Halton Beck and extends as far as the limit of the tidal floodplain, which is taken as the more downstream of the two railway bridges north of Ulceby Railway Station. This is about 9 km from the

tidal outfall, measured along the channel. This part of the compartment is also about 6 km long and is up to about 2 km wide. Ground levels in the area indicate that most of the part beside the estuary is below +4.0 mOD and that there is a significant area at the eastern end (near the East Halton Beck) which is below +2.0 mOD.

H.60 The compartment is almost entirely devoted to agriculture except for a small area of dock-related development by New Holland, at its western end. It contains small pockets of residential housing at New Holland, at the northern and southern ends of Goxhill and at South End, East Halton and Ulceby.

H.61 A relatively small part of the compartment has been identified by the Environment Agency as a potential site for managed realignment. The suitability of this site is currently being examined further as part of the HESMP studies.

Sources of flood risk

H.62 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table H.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at Immingham as +4.93 mOD. Water levels rise up the estuary and the Joint Probability Analysis gives the highest level as +5.11 mOD near East Halton Skitter and +5.35 mOD near New Holland (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

H.63 In addition to this tidal source there are two fluvial sources of flood risk, the East Halton Beck at the eastern end of the compartment and the New Holland Main Drain at the western end. The East Halton Beck is a main river watercourse (and therefore managed by the Environment Agency) and discharges to the estuary by gravity at East Halton Skitter. The New Holland Main Drain is a SOW, managed by the NELIDB, and is pumped to the estuary at the New Holland Outfall. NELIDB also manages a system of drains that discharge to the estuary through a gravity outfall at Goxhill Haven and a drainage system at New Holland that is understood to have been sized to accommodate industrial expansion (although this hasn't taken place). This system is partly piped and discharges to the New Holland Drain through the New Holland Estate pumping station.

H.64 A hydraulic model study was carried out in 2009 for the East Halton Beck, using an approach based on the Flood Estimation Handbook. The model extended from the outfall to the road bridge carrying the B1210 between Brocklesbury and Habrough. The study demonstrates that critical conditions in the lower reaches of the Beck are strongly influenced by the assumed tidal conditions, with the floodwater ponding there while the outfall is tide-locked. In these circumstances the water level is controlled by the volume of storage available. The study used reservoir units to represent the floodplain and found that during severe events the water will pond in the lower 3.5 km, reaching a level of +2.84 mOD during an event with a 1.0% annual probability of occurring. This will be higher if the floodplain width is reduced and, conversely, will be lower if it is enlarged. Further upstream the water level during such an event will rise at roughly the same slope as the river bank.

Existing defences

H.65 Along most of its length the compartment is protected against flooding from the estuary by an earth embankment, some lengths of which have a revetment on the front face. Upstream of the Humber Bridge some lengths have a short wave wall. The crest level varies between +5.4 mOD and +6.1 mOD and the condition is generally Grade 2 (Good) or 3 (Fair). Work carried out for the HESMP

indicates that in some places unacceptably high rates of overtopping due to wave run-up are likely to occur during events with a 5% annual probability of occurring (i.e. every 20 years on average) while elsewhere the annual probability of this occurring is lower, reaching about 1% (i.e. every 50 years on average) at best. This is significantly less than the 0.5% annual probability requirement set out in PPS25. The standard will reduce further in the future as sea levels rise.

H.66 The New Holland Dock area is protected by a combination of dock walls and other retaining walls, generally in poor condition (Grade 4). The crest level is about +5.6 mOD, which will protect against events with a 0.5% annual probability of occurrence for the next 50 years provided significant overtopping due to wave run-up can be tolerated. This could cause local flooding within the dock area but is unlikely to damage the defences sufficiently to cause a breach and so threaten the rest of the compartment.

H.67 Barrow Haven is protected by a sheet-pile retaining wall and revetted bank, with crest levels of +5.6 mOD. The condition is Poor (Grade 4) to Fair (Grade 3), but failure would not directly lead to flooding. Earth embankments, also with a crest level of +5.6 mOD, protect Barton Haven. Their condition is Good (Grade 2) but the crest is narrow and they are prone to seepage. Repairs are planned for 2004, when the crest level will be raised to +6.0 mOD.

H.68 There are no significant flood defences along the East Halton Beck. The surrounding area therefore begins to flood when water levels rise above bank level, which varies between +2.2 and +6.4 mOD within the compartment. Flooding is likely to occur during events with a 30% to 20% annual probability of occurrence (i.e. every 3 to 5 years on average).

H.69 The drainage systems managed by the NELIDB are understood to be able to accommodate events with 0.1% annual probability by a combination of storage and pumping, without flooding the surrounding area. The Board are understood to adopt this standard when assessing the works needed to deal with the drainage implications of new developments.

1T5: Barton upon Humber

Description of site

H.70 This compartment runs from high ground at South Ferriby Cliff in the west to the left bank of the New Holland Main Drain in the east. The flood defences beside the Humber Estuary form the northern boundary. The compartment is about 8 km long and up to 2 km wide except where it extends up the valley of the Barrow Beck. Ground levels indicate that most of the area is higher than +3.0 mOD.

H.71 The compartment contains the villages of New Holland and Barrow Haven with the largely dock-related industry near them and the low-lying parts of Barton upon Humber (beside Barton Haven) and Barrow upon Humber. A branch railway line connecting Barton upon Humber to New Holland and then to Grimsby passes through it, as does the A15 trunk road from the Humber Bridge to the M180 (although this section of the road is elevated above the flood levels).

H.72 Except at Barton upon Humber, the area immediately behind the estuary defences contains a number of large water-filled clay pits. These have a high nature conservation value due to the wide range of wetland birds and habitats they support and at the end of 2003 were designated under the Birds Directive as part of the Humber Flats, Marshes and Coast Phase 2 potential Special Protection Area (pSPA).

Sources of flood risk

H.73 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table H.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at the Humber Bridge as +5.44 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

H.74 There are also three fluvial sources of flood risk, the Butts Drain and the Barrow Beck, both of which are main river and so managed by the Environment Agency, and the New Holland Main Drain, which is a SOW managed by NELIDB. The Barrow Beck has a tributary, the Midby Drain, which is also a SOW managed by NELIDB. Butts Drain and Barrow Beck both discharge by gravity to the estuary, via Barton Haven and Barrow Haven respectively. The New Holland Main Drain is pumped to the estuary at the New Holland Outfall.

H.75 The Environment Agency completed a model study of the Barrow Beck and Midby drain system in 2009 but has not assessed the flood risk from the Butts Drain system recently. The drainage system leading to the New Holland Main Drain is understood to have been sized to accommodate industrial expansion. It is assumed that this was designed to protect against flooding from an event with 0.1% annual probability of occurring after allowing for additional run-off from developable areas so it is likely that this standard is currently exceeded.

Existing defences

H.76 Along most of its length the compartment is protected against flooding from the estuary by an earth embankment, some lengths of which have a revetment on the front face. The crest level varies between +5.5 mOD and +5.8 mOD although there are sections where it is slightly higher at +6.2 mOD. The condition is generally Grade 2 (Good) or Grade 3 (Fair). Work carried out for the HESMP indicates that in some places there are unacceptably high rates of overtopping due to wave run-ups which are likely to occur during events with a 5% annual probability of occurring (i.e. every 20 years on average) while elsewhere the annual probability of this occurring is about 2% (i.e. every 50 years on average). This is significantly less than the 0.5% annual probability requirement set out in PPS25. The standard will reduce further in the future as sea levels rise.

H.77 The New Holland Dock area is protected by a combination of dock walls and other retaining walls, generally in Poor condition (Grade 4). The crest level is about +5.6 mOD, which will protect against events with a 0.5% annual probability of occurrence for the next 50 years provided significant overtopping due to wave run-up can be tolerated. This could cause local flooding within the dock area but is unlikely to damage the defences sufficiently to cause a breach and so threaten the rest of the compartment.

H.78 The Barrow Beck has some lengths of embankment and retaining wall that act as flood defences. These are generally in Fair condition (Grade 3) with some lengths in Good condition (Grade 2). There are no significant flood defences along the Butts Drain.

H.79 The drainage systems managed by the NELIDB are understood to be able to accommodate events with 0.1% annual probability by a combination of storage and pumping, without flooding the surrounding area. The Board are understood to adopt this standard when assessing the works needed to deal with the drainage implications of new developments.

Fluvial Flood Compartments

1F1: Waithe Beck

Description of site

H.80 The Waithe Beck drains a catchment of about 108 km^2 in the Lincolnshire Wolds between Ludford and Beelsby. It enters the NELC area just west of Hatcliffe, flows north–east for a distance of some 5 km until it crosses the A18 trunk road, then swings to just south of east, passes Brigsley and leaves the NELC area shortly before it crosses the A16 trunk road. From here it flows east past Tetney and meets the Louth Canal at Tetney Lock and then discharges to the estuary through Tetney Haven. Although the Beck is main river (and therefore managed by the Environment Agency) its lower reaches are within the LMIDB drainage area.

H.81 About 10 km of the Waithe Beck lies within the NELC boundaries and its valley, which along all this length is well-defined, contains the main part of this flood compartment. A second section lies within a narrow tributary valley leading from the Waithe Beck to the south through the villages of West Ravendale, East Ravendale and Wold Newton. Most of the land within the compartment is farmed although there is some woodland in the upper reaches and some residential property at Hatcliffe and Brigsley. As well as crossing the A18, the Waithe Beck section of the compartment also crosses the B1203 at Brigsley and two minor roads, at Hatcliffe and where it leaves the NELC area. The tributary section runs along the B1203 within East Ravendale and along the minor road connecting West Ravendale to Wold Newton.

Sources of flood risk

H.82 The Waithe Beck is the main source of flood risk in this compartment with the tributary valley being a secondary source. The Waithe Beck was modelled as part of the Louth Catchment Flood Map Improvements project in 2003, indicating that Brigsley is protected against flooding from events with a 1.0% annual probability of occurring whereas Hartcliffe is at risk of being flooded from an event with an annual probability of about 8% (i.e. every 12 years on average).

Existing defences

H.83 The only significant flood defences along the Waithe Beck within this flood compartment are at Hatcliffe and consist of some lengths of floodwall and retaining wall along both banks. The hydraulic model studies carried out in 2003 indicate that these defences do not provide the 1.0% annual probability requirement set out in PPS25.

1F2: Buck Beck and Goosepaddle Drain

Description of site

H.84 The Buck Beck drains a catchment of about 21 km^2 to the south of Cleethorpes, including all of Waltham, Humberston and New Waltham. From its source near Waltham the Buck Beck crosses the B1203 within the town then flows through fields and crosses the B1219 and then the A16 northwest of New Waltham. It then crosses the A1098 and the A1031 before flowing through Cleethorpes golf course and past a Theme Park to a gated outfall discharging to the estuary. About 2 km from the outfall it is joined by the Goosepaddle Drain, which carries surface water from the southern part of Cleethorpes. Drainage flows from Humberston are pumped into the channel by the NELIDB's Little Buck Beck pumping station.

H.85 This flood compartment runs from the Buck Beck's source near Waltham to the point where the channel crosses the A1098. The area further downstream lies within the tidal flood compartment 1T1 (Cleethorpes).

H.86 The Buck Beck is main river (and therefore managed by the Environment Agency) downstream of the point where it crosses the A16. Between the A16 and the B1219 and further upstream towards the built-up area of Waltham it is designated as a SOW, the downstream reach being managed by NELIDB and the upstream one by NELC.

Sources of flood risk

H.87 The Buck Beck is the only identified source of flood risk in this compartment. A hydraulic model study of the main river reaches was carried out in 2009, indicating that all these reaches are protected against flooding from events with a 1.0% annual probability of occurring. The SOW reaches have not been studied but there is concern that the standard provided is significantly less than is available downstream and may not achieve the 1.0% annual probability requirement set out in PPS25.

Existing defences

H.88 A flood defence scheme was implemented along the main river sections of the Buck Beck in the 1970's. This mostly involved widening and deepening the channel and bridge structures and constructing dwarf walls along some of the banks. The condition of these defences is generally classed as Good (Grade 2) with a small proportion classed as Fair (Grade 3). The hydraulic model studies carried out in 2009 indicate that these defences do provide the 1.0% annual probability requirement set out in PPS25. There are no significant defences further upstream.

1F3: River Freshney and Laceby Beck

Description of site

H.89 The River Freshney, which becomes the Laceby Beck in its upper reaches and then becomes the Team Gate Drain, drains a catchment of about 50 km^2 to the south and west of Grimsby. From its source near Waltham the stream flows in a generally northwest direction to the outskirts of Laceby, where it crosses the A46 and turns to flow to the northeast, discharging to the estuary at Grimsby.

H.90 The main part of this flood compartment runs from the River Freshney's source near Waltham to the limit of the tidal indicative floodplain about 2 km downstream of the point where the channel crosses the A46. The area further downstream lies within the tidal flood compartment 1T2 (Grimsby and Stallingborough). A subsidiary section lies in the valley of a tributary stream that flows past Aylesby and joins the river just east of Laceby. The land in the compartment is largely devoted to agriculture, part from a small built-up area through Laceby.

H.91 The River Freshney/Laceby Beck is main river (and therefore managed by the Environment Agency) downstream of the point southeast of Laceby where it becomes the Team Gate Drain. Further upstream it is an ordinary watercourse and is managed by NELIDB.

Sources of flood risk

H.92 The River Freshney/Laceby Beck is the main source of flood risk in this compartment. The hydraulic model study carried out in 2009 covers this area and the results can be obtained from the Environment

Agency. Otherwise the most convenient source of information about flood risk within the compartment is the Environment Agency's flood zone map.

Existing defences

H.93 There are no significant flood defences beside the River Freshney/Laceby Beck within this compartment.

1F4 East Halton Beck and Skitter Beck

Description of site

H.94 The East Halton Beck, which becomes the Skitter Beck in its upper reaches, drains a catchment with a total area of about 124 km^2 to the south and west of Immingham. From its source near Keelby it flows in a generally northwest direction for about 6 km to Ulceby where it is joined by the Brocklesby Beck, turns north and then gently bends to the northeast to discharge to the estuary through a gated outfall some 10 km downstream at East Halton Skitter.

H.95 This flood compartment has two sections, containing the Skitter Beck and the Brocklesbury Beck respectively. The main section runs from the Skitter Beck's source near Keelby to the limit of the tidal floodplain at the downstream of the two railway bridges north of Ulceby Railway Station. This is about 9 km from the outfall at East Halton Skitter. The area further downstream lies within the tidal flood compartment T3 (Immingham and North Killingholme). The subsidiary section follows the Brocklesbury Beck from Ulceby to the east.

H.96 Within the compartment the East Halton Beck crosses the A180 trunk road, the A1077, the branch railway line between Grimsby and Barton upon Humber and a sub-branch to the Immingham and North Killingholme industrial areas. The Brocklesby Beck also crosses the A180 and in addition the main Scunthorpe to Grimsby railway line and the B1211 (both twice). The land is devoted almost entirely to agriculture except for a small built-up area at Ulceby.

H.97 The East Halton Beck/Skitter Beck is main river (and therefore managed by the Environment Agency) from its source to its outfall, as is the lower 2 km of the Brocklesbury Beck. There are a large number of tributary drains that are managed by NELIDB.

Sources of flood risk

H.98 The East Halton Beck/Skitter Beck is the main source of flood risk in this compartment. A feasibility study of options for improving the standard of the defences was carried out in 1995. This included hydraulic modelling of the current standard of protection and concluded that flooding is likely during an event with a 20% or greater annual probability of occurring (i.e. once every 5 years or less on average). It also concluded that improving the standard could not be justified economically. The area was also modelled as part of the 2009 Flood Map Improvements Study which broadly confirmed the earlier conclusions.

Existing defences

H.99 There are no significant flood defences beside the East Halton Beck/Skitter Beck or its tributaries within this compartment.

1F5: Barrow Beck and Midby Drain

Description of site

H.100 The Barrow Beck and its tributary, the Midby Drain, drain a small catchment to the south of Barrow upon Humber. The Midby Drain rises south-west of the town and flows through it towards the north-east, joining the Barrow Beck just to the north and discharging to the estuary through the Barrow Haven.

Sources of flood risk

H.101 Although the Barrow Beck is the larger of the two watercourses, the main source of flood risk is actually the Midby Drain as it flows through the town of Barrow upon Humber. There was significant flooding in the area during the 2007 flood event, which led to a model study of the system being undertaken. This was completed in 2009 and as a result a flood alleviation scheme is planned for the near future.

H.102 The watercourses are classified as main river between Barrow Haven and the confluence and for a short distance upstream. The responsibility for managing the flood risk from these reaches therefore lies with the Environment Agency, which commissioned the model study, while further upstream it lies with North Lincolnshire Council (NLC), which will undertake the alleviation scheme.

Existing defences

H.103 The Barrow Beck has some lengths of embankment and retaining wall that act as flood defences. These are generally in Fair condition (Grade 3) with some lengths in Good condition (Grade 2). Further works are likely to be constructed as part of the flood alleviation scheme.

Appendix I - Ancholme Valley Flood Compartments

General Description Of Area

Location, extent and development potential

I.1 The Ancholme Valley Area stretches from the high ground outcropping at South Ferriby Cliff, west of Barton-upon Humber, to the high ground at Whitton and south as far as Waddingham in the Ancholme Valley. The shoreline of the Humber Estuary forms the northern boundary while the NLC boundary forms the southern boundary. The watersheds dividing the River Ancholme catchment from the catchments draining east to the estuary and from the River Trent catchment act as the eastern and western boundaries respectively.

I.2 The main centres of population in the area are Winterton, Broughton and Brigg. Winterton and Broughton are both on high ground well above the floodplain but much of Brigg is in the bottom of the Ancholme Valley, about 14 km from its outfall at South Ferriby on the Humber. A number of villages (or parts of them) also lie within the floodplain, including Winteringham, South Ferriby, Wrawby and Hibaldstow. There are some industrial and commercial facilities at Brigg and a cement works at South Ferriby. The remainder of the area is largely devoted to agriculture.

I.3 North Lincolnshire Council's Local Plan, published for consultation in September 2000, identified a number of potential sites for development in Brigg. The Environment Agency advised that it would object to any development in the floodplain and the council therefore appointed WS Atkins Ltd to carry out a Strategic Flood Risk Assessment in preparation for the Local Plan Inquiry. The council modified its proposals in the light of this assessment and the Inspector accepted the revised proposals in his report dated January 2003.

Main sources of flood risk

I.4 There are two main sources of flood risk in the River Ancholme area, a combination of large waves and high water levels in the Humber Estuary and high river flows in the River Ancholme.

I.5 The Joint Probability Analysis quotes the water level and wave height combinations having a 0.5% probability of occurrence in the estuary and a selected list of these combinations is given in Table I.1. Combinations with water levels 0.2 to 0.4m higher are likely to have a 0.1% probability of occurrence. The base date for these figures in 1991 and current guidance indicates that allowance should be made for sea levels to rise by 1.201m and wave heights increase by 10% by 2115.

Whitton		South Ferriby		Humber Bridge	
Water level (mOD)	**Wave ht (m)**	**Water level (mOD)**	**Wave ht (m)**	**Water level (mOD)**	**Wave ht (m)**
5.54	0.0	5.52	0.0	5.44	0.0
5.42	0.4	5.25	0.6	5.25	0.6
5.26	0.6	4.93	0.7	4.80	0.8
5.04	0.7	4.51	0.8	4.14	0.9

Table I.1 - Water level and wave height combinations with a 0.5% probability of occurrence ; Ancholme Valley Area

I.6 There are two sections of fluvial floodplain within the area, a relatively small one associated with the Winterton Beck that discharges to the estuary at Winteringham Haven, and the main one associated with the River Ancholme that has a gated outfall at South Ferriby. Both sections contain complex drainage systems that are managed by the Ancholme IDB.

I.7 There are twenty-one main river watercourses within the area, as listed in Table I.2 and shown on Map 10. Throughout the study area the River Ancholme is embanked and acts as a highland carrier (carrying drainage flows from high ground further upstream at levels that are above the local ground level). Two separate main river watercourse systems (for the left and right bank respectively) drain the low-lying land beside the lower reaches of the river to the estuary, again discharging through gated outfalls at South Ferriby. Further upstream more highland carriers drain the uplands on either side of the Ancholme Valley, receiving gravity or pumped flows from the IDB drainage system and discharging them to the River Ancholme. They are all classified as main river watercourses.

I.8 Four watercourses lying within the River Ancholme Area are classified as SOWs. They are listed in Table I.3, lie within the tidal or fluvial floodplain, as currently defined, are managed by the Ancholme IDB and are shown on Map 10.

Ref No	Name of watercourse	Watercourse type	Discharging to
M1	East Drain Lower	Highland carrier	Humber Estuary
M2	Land Drain	Highland carrier	East Drain Lower
M3	Bonby Catchwater	Highland carrier	Land Drain
M4	Worlaby Catchwater	Highland carrier	Land Drain
M5	Little Carr Drain	Floodplain drain	Land Drain
M6	Wrawby Catchwater	Floodplain drain	Land Drain
M7	West Drain	Floodplain drain	Humber Estuary
M8	Appleby Mill Beck	Floodplain drain	West Drain
M9	Ella & Moor Beck	Floodplain drain	West Drain
M10	New River Ancholme	Highland carrier	Humber Estuary
M11	Spring Dyke	Highland carrier	New River Ancholme
M12	Scawby Catchwater	Highland carrier	New River Ancholme
M13	Hibaldstow Catchwater	Highland carrier	New River Ancholme
M14	Hibaldstow North Drain	Floodplain drain	Hibaldstowe Catchwater
M15	Redbourne Old River	Highland carrier	New River Ancholme
M16	Redbourne Catchwater	Highland carrier	Redbourne Old River
M17	Sallow Row Drain	Highland carrier	New River Ancholme
M18	North Kelsey & Grasby Beck	Highland carrier	New River Ancholme
M19	Froghall Drain	Floodplain drain	Kettleby Beck
M20	Kettleby Beck	Highland carrier	New River Ancholme
M21	Winterton Beck	Floodplain drain	Humber Estuary

Table I.2 Main river watercourses; Ancholme Valley Area

Ref No	Name of watercourse	Watercourse type	Discharging to
S1	Fullseas & Marsh Drains	Gravity outfall	Humber Estuary
S2	West Drain (IDB)	Pumped outfall	New River Ancholme
S3	Island Carr North	Pumped outfall	New River Ancholme
S4	Scawby Brook	Gravity outfall	New River Ancholme

Table I.3 -Significant Ordinary Watercourses (SOWs); Ancholme Valley Area

I.9 The responsibility for draining all the low-lying land within the River Ancholme area lies with the Ancholme IDB. Its drainage system is complex and, except near the estuary, much of it is pumped. The areas near the estuary are currently drained by gravity but siltation at the outfalls is becoming a serious problem and the IDB considers in due course most of them will need to be pumped. The IDB boundaries and pumping stations are shown on Map 10 and the pumping stations are listed in Table I.4.

I.10 The IDB aims to provide a standard of between 10% and 5% annual probability of occurrence (1:10 and 1:20 years return period) for agricultural land throughout the system but this includes a freeboard of at least 1m below local ground level (to prevent the land from being waterlogged). As a result the standard provided to property (which is not affected by flooding until the water level rises above local ground level) is generally in the range 2.0% and 1.0% annual probability (1:50 to 1:100 years return period). The IDB has to approve the drainage arrangements of all significant new development within

its boundaries or affecting its watercourses. In principle the site runoff characteristics should remain unchanged, although the IDB may accept the receiving drainage system being improved so it can accept the increased discharge, at the developer's expense. It is understood that the design standard for these improvements is the event having a 1.0% annual probability of occurrence.

Ref No	Pumping Station	Discharging to
P1	Appleby	New River Ancholme
P2	Broughton	New River Ancholme
P3	Hibaldstow	New River Ancholme
P4	Redbourne Hayes	New River Ancholme
P5	North Kelsey	New River Ancholme
P6	Thirty Foot	New River Ancholme
P7	Cadney	New River Ancholme
P8	Candley	Froghall Drain
P9	Bently	New River Ancholme
P10	Island Carr	New River Ancholme
P11	Worlaby	New River Ancholme

Table I.4 - Drainage pumping stations; Ancholme Valley Area

Flood compartments

I.11 To allow more detailed assessment, the area shown as Flood Zone 3 on Flood Risk Map 2 has been divided into flood compartments taking into account the topography, type of defence, drainage arrangements and land use. These compartments are shown on Map 11 and listed in Table I.5 with the sources of flood risk they include. Further information about each compartment is given the following sections.

Compartment reference	Compartment name	Sources of flood risk
2T1	South Ferriby (East)	Humber Estuary New River Ancholme East Drain Lower Fulseas & Marsh Drains
2T2	South Ferriby (West)	Humber Estuary New River Ancholme West Drain
2T3	Winterton	Humber Estuary Winterton Beck

2F1	Lower Ancholme Right Bank	New River Ancholme Land Drain Bonby Catchwater Worlaby Catchwater Little Carr Drain Wrawby Catchwater Humber Estuary
2F2	Lower Ancholme Left Bank	New River Ancholme West Drain Appleby Mill Beck Ella & Moor Beck Spring Dyke West Drain (IDB) Humber Estuary
2F3	Island Carr	Island Carr North
2F4	Middle Ancholme Right Bank	New River Ancholme North Kelsey & Grasby Beck Froghall Drain Kettleby Beck
2F5	Middle Ancholme Left Bank	New River Ancholme Castlethorpe Drain Scawby Catchwater Hibaldstow Catchwater Hibaldstow North Drain Redbourne Old River Redbourne Catchwater Sallow Row drain Scawby Brook

Table I.5 - Flood compartments; Ancholme Valley Area

Note:- The reference prefix denotes the primary source of flood risk in the compartment; T = Tidal; F = Fluvial, although note that all compartments north of Brigg are at risk from both tidal and fluvial flooding

Tidal Flood Compartments

2T1: South Ferriby (East)

Description of site

I.12 This compartment is about 2.5 km long and 1.5 km wide at its widest point. Its estuary frontage runs from high ground at South Ferriby Cliff to the outfall of the River Ancholme at Ferriby Sluice. From the estuary it extends south to a low ridge of land that LIDAR maps produced by the Environment Agency show running east-west between the New Ancholme River, which forms the western boundary, and high ground to the east. It is assumed that this ridge would limit flooding from the estuary extending further south. Ground levels in the area indicate that some of the land is below +2.0 mOD.

I.13 The compartment contains low-lying properties in South Ferriby and a section of the A1077, connecting Scunthorpe and Barton-upon Humber. Otherwise, the land is devoted to agriculture.

Sources of flood risk

I.14 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table 5.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at South Ferriby as +5.52 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

I.15 In addition to this tidal source there are three fluvial sources of flood risk, the New River Ancholme itself, the East Drain Lower and the Fulseas & Marsh Drain (which is a SOW managed by the Ancholme IDB). The New River Ancholme is embanked along part of its length within the compartment, carries water draining from land south of Brigg and discharges by gravity through Ferriby Sluice. The East Drain Lower is also embanked and drains the low-lying land north of Brigg. It also receives drainage flows from the escarpment edge. In this compartment it runs beside the River Ancholme and discharges through a tidal sluice beside Ferriby Sluice. The Fulseas & Marsh Drain carries water from land within the compartment and discharges to the estuary by gravity through a sluice at South Ferriby, the outfall channel of which currently suffers from siltation.

I.16 The Environment Agency's studies of the River Ancholme system have concentrated on conditions at Brigg and further upstream, where they suggest that the existing defences provide a standard of between 1:10 years and 1:20 years (i.e. 10% to 5% annual probability of flooding). The standard provided below Brigg is difficult to assess since it will depend on what happens above the town; if the upstream defences fail the land there will flood reducing the risk further downstream. If they do not fail, however, the flooding will be transferred downstream. Overall, the annual probability of flooding downstream of Brigg probably lies between 10% and 2.0%, which is significantly below the 1.0% limit required by PPS25. The East Drain Lower was modelled in 2009 as part of the Grimsby and Ancholme Flood Map Improvements Study.

I.17 The Fulseas & Marsh Drain is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.18 The estuary flood defences consist of a combination of earth embankments and brick walls with crest levels varying between +5.3 and +6.3 mOD. They are generally in good condition (Grade 2) although some relatively short lengths are in fair or poor condition (Grades 3 and 4 respectively). Parts of the defence are sufficiently high to prevent overtopping during events with a 0.5% annual probability, as required by PPS25, but significant lengths are not and in places overtopping could occur during an event with less than 10% annual probability of occurring.

I.19 The New River Ancholme provides a standard of protection that is well below the 1.0% annual probability of occurring required by PPS25. The banks are generally revetted and about 25% of the revetment is in good condition (Grade 2) but the remainder is poor (Grade 4) or worse. The East Drain Lower embankments are in fair condition (Grade 3) or better.

2T2: South Ferriby (West)

Description of site

I.20 The estuary frontage of this compartment extends from the outfall of the River Ancholme at Ferriby Sluice to the outfall of the Winterton Beck at Winteringham Haven, a distance of about 5 km. From the estuary it extends south about 3 km along the Ancholme Valley to the ridge of higher ground running from Maltby Farm to the New Ancholme River, which forms the compartment's eastern boundary. This ridge is assumed to limit flooding from the estuary extending further south. Ground levels in the area indicate that some of the land is below +2.0 mOD.

I.21 The compartment contains a cement works at Ferriby Sluice and some isolated farm buildings together with a section of the A1077, connecting Scunthorpe and Barton-upon Humber. The remaining land is devoted to agriculture.

Sources of flood risk

I.22 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table 5.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at South Ferriby as +5.52 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

I.23 In addition to this tidal source there are three fluvial sources of flood risk, the New River Ancholme itself, the West Drain and the Winterton Beck. The New River Ancholme is embanked along part of its length within the compartment, carries water draining from land south of Brigg and discharges by gravity through Ferriby Sluice. The West Drain carries drainage flows from low-lying land west of the River Ancholme and north of Brigg. It discharges through a tidal sluice beside Ferriby Sluice. The Winterton Beck carries drainage flows from the Winterton Valley, which extends south as far as the north-eastern part of Scunthorpe.

I.24 The Environment Agency's studies of the River Ancholme system have concentrated on conditions at Brigg and further upstream, where they suggest that the existing defences provide a standard of between 1:10 years and 1:20 years (i.e. 10% to 5% annual probability of flooding). The standard provided below Brigg is difficult to assess since it will depend on what happens above the town; if the upstream defences fail the land there will flood reducing the risk further downstream. If they do not fail, however, the flooding will be transferred downstream. Overall, the annual probability of flooding downstream of Brigg probably lies between 10% and 2.0%, which is significantly below the 1.0% limit required by PPS25. The West Drain and the Winterton Beck were modelled in 2009 as part of the Grimsby and Ancholme Flood Map Improvements Study.

I.25 The Ancholme IDB drainage system currently discharges by gravity, either to the West Drain or directly to the estuary. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.26 The estuary flood defences consist of earth embankments with crest levels varying between +5.5 and +6.2 mOD. The embankments are generally in fair to good condition (Grade 3 to 2) but there has

been significant erosion at the toe opposite the western end of Read's Island. Toe piling has been installed but is being undermined and further measures will be required in the near future. Parts of the defence are sufficiently high to prevent overtopping during events with a 0.5% annual probability, as required by PPS25, but significant lengths are not and in places overtopping could occur during an event with less than 10% annual probability of occurring.

I.27 The New River Ancholme provides a standard of protection that is well below the 1.0% annual probability of occurring required by PPS25. The banks are generally revetted and about 25% of the revetment is in good condition (Grade 2) but the remainder is poor (Grade 4) or worse.

2T3: Winterton

Description of site

I.28 This compartment is about 4 km wide and extends up the valley of the Winterton Beck for a distance of about 7 km. Its estuary frontage runs from Winteringham Haven to Whitton, where high ground reaches the shoreline. Ground levels in the area indicate that the land is generally at about +4.0 mOD.

I.29 The lower parts of the villages of Whitton and Winteringham lie within the compartment, as do a number of isolated farm buildings. The remaining land is devoted to agriculture.

Sources of flood risk

I.30 The primary source of flood risk to this compartment is a combination of large waves and high water levels in the Humber Estuary. Table 5.6 lists selected combinations having a 0.5% annual probability of occurrence and shows the highest water level at Whitton as +5.54 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

I.31 There is in addition one fluvial source of flood risk, the Winterton Beck, which carries drainage flows from the north-eastern part of Scunthorpe. There has been major landscaping work in this area, making it difficult to identify the watershed between the vallies of the Winterton Beck and the Bottesford Beck, which drains to the River Trent. For the purposes of this study the watershed has been taken as the A1077.

I.32 The Winterton Beck was modelled in 2009 as part of the Grimsby and Ancholme Flood Map Improvements Study. The Ancholme IDB drainage system currently discharges by gravity, either to the Winterton Beck or directly to the estuary near Whitton Ness. The IDB has applied for grant aid to build a pumping station at the Whitton outfall. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.33 The estuary flood defences consist of earth embankments with crest levels varying between +6.1 and +6.9 mOD. The embankments are generally in good condition (Grade 2). Although most of the defences are sufficiently high to prevent overtopping during events with a 1.0% annual probability of occurrence they do not achieve the 0.5% annual probability required by PPS25 for tidal defences.

Fluvial Flood Compartments

2F1: Lower Ancholme Right Bank

Description of site

I.34 This compartment extends from the landward boundary of Compartment 2T1 southwards as far as the town of Brigg, a distance of some 11.5 km. The New River Ancholme forms the western boundary. Ground levels in the area indicate that in places the land is below +1.0 mOD.

I.35 The M180 motorway crosses the compartment north of Brigg and forms the northern limit of NLC's development boundary for the town. The majority of the land within the compartment south of this limit is either already developed or has been scheduled for development in the NLC Local Plan. Land north of the motorway contains isolated farm buildings and is devoted to agriculture.

Sources of flood risk

I.36 The main sources of flood risk in this compartment are the New River Ancholme, which carries water draining from land south of Brigg, and the local drainage system on the right bank of the river, although there is also a risk of tidal flooding from the Humber Estuary. This system includes 5 lengths of main river, the Land Drain (which is the primary drain, into which the others discharge, and carries the flow to the estuary at South Ferriby) and the Bonby Catchwater, Worlaby Catchwater, Little Carr Drain and Wrawby Catchwater (each draining a sub-area of the compartment). The Land Drain and the Bonby and Worlaby Catchwaters are embanked over at least part of their length and act as high-level carriers.

I.37 The Environment Agency's 2009 study of the River Ancholme system suggests that the existing defences at Brigg and further upstream provide a standard of between 1:10 years and 1:20 years (i.e. 10% to 5% annual probability of flooding). The study also indicates that the 1:100 years peak water level (1.0% annual probability of flooding) through Brigg is +2.64 mOD. The standard provided below Brigg is difficult to assess since it will depend on what happens above the town; if the upstream defences fail the land there will flood reducing the risk further downstream. If they do not fail, however, the flooding will be transferred downstream. Overall, the annual probability of flooding downstream of Brigg probably lies between 10% and 2.0%, which is significantly below the 1.0% limit required by PPS25. No assessment of the risk from the Land Drain and its tributaries has been made recently.

I.38 Some of the Ancholme IDB drainage system discharges to the Land Drain (or a tributary) by gravity but much of it is pumped to the New River Ancholme. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.39 Downstream of the M180 motorway bridge the New Ancholme River is partly embanked and these embankments are generally in good condition (Grade 2). The embankments to the Land Drain and the Bonby and Worlaby Catchwaters are also generally in good condition, with some lengths in fair condition (Grade 3).

I.40 The condition and standard of the defences within the compartment at Brigg (upstream of the motorway bridge) has been assessed by W S Atkins1as part of their flood risk assessment for the NLC Local Plan Inquiry. They determined that the defences along the New Ancholme River are in good to fair condition (Grades 2 and 3) and will contain a water level of +2.8 mOD in the river with adequate freeboard. They also undertook a breach analysis of the land south of the motorway bridge and confirmed that the depth of flooding will not exceed 0.23m and the peak flow velocity will not exceed 0.26 m/s.

2F2: Lower Ancholme Left Bank

Description of site

I.41 This compartment extends from the landward boundary of Compartment 2T2 southwards as far as the A18 road (Bridge Street) by the town of Brigg, a distance of some 11.5 km. The New River Ancholme forms the eastern boundary. Ground levels in the area indicate that in places the land is below +1.0 mOD.

I.42 The M180 motorway crosses the compartment about 1 km north of the A18. The NLC Local Plan shows an area about 500 m by 150 m between the two roads, of which part has already been developed and the remainder is allocated for development. The rest of the compartment contains only isolated farm buildings and is devoted to agriculture.

Sources of flood risk

I.43 The main sources of flood risk in this compartment are the New River Ancholme, which carries water draining from land south of Brigg, and the local drainage system on the left bank of the river, although there is also a risk of tidal flooding from the Humber Estuary. This system includes 3 lengths of main river, the West Drain, Appleby Mill Beck and Ella & Moor Beck. The West Drain is the primary watercourse and carries the flow to the estuary at South Ferriby. The other two watercourses discharge to the West Drain. There is also a short length of main river, the Spring Dyke, which lies between the M180 and the A18 and drains to the New Ancholme River by gravity.

I.44 The Environment Agency's 2009 study of the River Ancholme system suggests that the existing defences at Brigg and further upstream provide a standard of between 1:10 years and 1:20 years (i.e. 10% to 5% annual probability of flooding). The study also indicates that the 1:100 years peak water level (1.0% annual probability of flooding) through Brigg is +2.64 mOD. The standard provided below Brigg is difficult to assess since it will depend on what happens above the town; if the upstream defences fail the land there will flood reducing the risk further downstream. If they do not fail, however, the flooding will be transferred downstream. Overall, the annual probability of flooding downstream of Brigg probably lies between 10% and 2.0%, which is significantly above the 1.0% limit required by PPS25. The West Drain and its tributaries were modelled in 2009 as part of the Grimsby and Ancholme Flood Map Improvements Study.

I.45 Some of the Ancholme IDB drainage system discharges to the Land Drain (or a tributary) by gravity but much of it is pumped to the New River Ancholme, through either the Broughton or the Appleby Pumping Stations. The system is understood to be capable of accommodating the 2.0% annual probability

1 North Lincolnshire District council Local Plan Inquiry, Strategic Flood Risk Assessment for Brigg WS Atkins, November 2001

event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.46 Downstream of the M180 motorway bridge the New Ancholme River is partly embanked and these embankments are generally in good condition (Grade 2). The other main river watercourses contain only short lengths of embankment, most of which are in fair condition (Grade 3).

I.47 The condition and standard of the defences within the compartment upstream of the motorway bridge has been assessed by W S Atkins as part of their flood risk assessment for the NLC Local Plan Inquiry. They determined that the defences along the New Ancholme River are in good to fair condition (Grades 2 and 3) but do not consistently meet the 1.0% annual probability flood level in the river of +2.8 mOD with adequate freeboard.

2F3: Island Carr

Description of site

I.48 This compartment is the island on the western side of Brigg that lies between the channels of the New and the Old River Ancholme. It is approximately 1 km long and 0.5 km wide at its widest point. Ground levels in the area indicate that in places the land is below +2.0 mOD.

I.49 The northern part of the compartment lies within the NLC's development boundary for Brigg. Much of this area is already developed, mainly for industrial purposes, and the NLC Local Plan shows a relatively small area close to the A18 allocated for housing and a larger area allocated for mixed use development. The southern part of the compartment (which is crossed by the Gainsborough to Grimsby railway line) is devoted to agriculture.

Sources of flood risk

I.50 The main sources of flood risk in this compartment are the two River Ancholme channels. The Environment Agency's studies indicate that the 1:100 years peak water level (1.0% annual probability of occurrence) through Brigg is +2.64 mOD.

I.51 Drainage from the compartment is difficult. The northern part is pumped to the Old River Ancholme through the Ancholme IDB's Island Carr pumping station but the southern part of the site relies on drainage by gravity.

Existing defences

I.52 The condition and standard of the compartment's defences has been assessed by W S Atkins as part of their flood risk assessment for the NLC Local Plan Inquiry. They determined that the defences along the New Ancholme River are in good to fair condition (Grades 2 and 3) and do consistently meet the 1.0% annual probability flood level in the river of +2.8 mOD with adequate freeboard. There are multiple defences protecting the compartment, however, and these defences are not consistent in either form or type. As a result the possibility of failure is higher than would be the case with a uniform defence system.

2F4: Middle Ancholme (Right Bank)

Description of site

I.53 This compartment lies south of Brigg and east of the New River Ancholme and is limited partly by topography and partly by the NLC boundaries. As a result, although the compartment is hydraulically a single unit, a strip of land across it falls within Lindsey District council. This strip divides the area within the NLC boundaries into two parts, a small one on the town's outskirts and a considerably larger one further south.

I.54 The boundaries of the small area by the town are the Old River Ancholme, the NLC boundary and high ground at the edge of Flood Zone 3. The northern boundary of the larger area further south is the Kettleby Beck, its eastern boundary is the Kettleby Beck and the Searby & Howsham Drain (operated by the Ancholme IDB) and its southern boundary is the North Kelsey Beck. Its western boundary is the New River Ancholme. There is, however, a significant area of high ground within these boundaries that is not at risk of flooding (i.e. lies within Flood Zone 1) and is therefore excluded from the assessment.

I.55 The smaller area is about 0.5 km by 1 km and is partly urbanised. Although some of it lies within the NLC's development boundary for Brigg the Local Plan shows no sites allocated for development within it. The larger area is about 3 km by 6 km, is used for agriculture and contains isolated farm buildings. Ground levels in the area indicate that in places close to the River Ancholme the land is below +2.0 mOD.

Sources of flood risk

I.56 The main sources of flood risk in this compartment are the New River Ancholme, which is embanked and carries water from further south, and the local drainage system. This includes two main river watercourse systems, the Kettleby Beck with its tributary the Froghall Drain, and the North Kelsey & Grasby Beck. Both of these systems are embanked in their lower reaches and act as high-level carriers, discharging to the New River Ancholme by gravity.

I.57 The Environment Agency's studies of the River Ancholme system suggest that the 1:100 years peak water level (1.0% annual probability of flooding) through Brigg is +2.64 mOD. The studies also indicate that upstream of Brigg the existing defences provide a standard of between 1:10 years and 1:20 years (i.e. 10% to 5% annual probability of occurrence). The Kettleby and the North Kelsy & Grasby Becks were modelled in 2009 as part of the Grimsby and Ancholme Flood Map Improvements Study.

I.58 Some of the Ancholme IDB drainage system discharges by gravity to the upper reaches of the two becks but the remainder is pumped, either to the Kettleby Beck or to the New River Ancholme. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.59 The New and Old Ancholme river defences within the compartment and standard of the compartment's defences are generally in good to fair condition (Grades 2 and 3), although some toe boarding is noted as being in poor condition (Grade 4). The defences to the Kettleby and North Kelsy & Grasby Becks are generally in mixed condition, with some lengths good (Grade 2) and some fair (Grade 3).

2F5: Middle Ancholme (Left Bank)

Description of site

I.60 This compartment lies south of Brigg and west of the New River Ancholme. Its northern boundary is the A18 road (Bridge Street) by Brigg and its southern boundary is the NLC's southern border, which here follows the Sallow Row Drain. Hydraulically, its eastern boundary is the New River Ancholme but for convenience it is taken as the Old River Ancholme south of the North Kelsey Beck outfall, since this is also the NLC boundary there. The western boundary is the Zone 2 boundary shown on the Environment Agency's Flood Maps. The compartment is about 8.5 km long and 3.5 km wide at its widest point.

I.61 The Gainsborough to Grimsby railway line crosses the compartment about 1 km south of its northern end. This marks the southern limit of the NLC's development boundary for Brigg, although the Local Plan shows no sites allocated for development in this area (which already includes some industry and housing). Further south the land is used for agriculture and, apart from the village of Hibaldstow, contains only isolated farm buildings. Ground levels in the area indicate that much of the land close to the River Ancholme is below +2.0 mOD.

Sources of flood risk

I.62 The main sources of flood risk in this compartment are the New River Ancholme, which is embanked and carries water from further south, and the local drainage system. This includes four main river watercourse systems, the Scawby Catchwater, the Hibaldstow Catchwater and its tributary the Hibaldstow North Drain, the Redbourne Old River and its tributary the Redbourne Catchwater, and the Sallow Row Drain. These systems are all embanked in their lower reaches and act as high level carriers, discharging to the New River Ancholme by gravity. The Scawby Brook, a SOW managed by the Ancholme IDB, also discharges to the New River Ancholme by gravity.

I.63 The Environment Agency's studies of the River Ancholme system suggest that the 1:100 years peak water level (1.0% annual probability of flooding) through Brigg is +2.64 mOD. The studies also indicate that upstream of Brigg the existing defences provide a standard of between 1:10 years and 1:20 years (i.e. 10% to 5% annual probability of occurrence). Environment Agency data shows that the lowest ground level in Hibaldstow is above +5.0 mOD, so the village is not at risk of flooding from the River Ancholme. The risk from the Hibaldstow Catchwater and North Drain has recently been assessed, leading to the conclusion that, contrary to earlier belief, it is less than 1.0% annual probability. The Scawby Catchwater, Redbourne and Sallow Row drainage systems were modelled in 2009i as part of the Grimsby and Ancholme Flood Map Improvements Study.

I.64 Apart from the Scawby Brook, most of the Ancholme IDB drainage system is pumped to the New River Ancholme. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

I.65 The New and Old Ancholme river defences within the compartment and standard of the compartment's defences are generally in good to fair condition (Grades 2 and 3), although some toe boarding is noted as being in poor condition (Grade 4). The defences to the main river sections of the local drainage systems are also in mixed condition, with some lengths good (Grade 2) and some fair (Grade 3).

Appendix J - Trent Valley Flood Compartments

General Description of Area

Location, extent and development potential

J.1 The Trent Valley Area extends from Whitton Ness on the Humber in the north to the NLC boundary about 4 km south of Haxey, a total distance of some 30 km. The watershed along the Lincolnshire Edge dividing the River Ancholme and River Trent catchments forms the eastern boundary while the NLC boundary forms the northern and western boundary except for a short section between Whitton Ness and Trent Falls, where the boundary is the estuary shoreline.

J.2 The main centre of population in the area is the heavily industrialised town of Scunthorpe. Much of this is on relatively high ground but it extends east as far as the low-lying ground that forms the River Trent floodplain. There are a number of villages, wharves and industrial areas along the river, notably at Burton Stather, Flixborough, Gunness, Keadby, Althorpe East and West Butterwick, Burringham and Owston Ferry. Further west, the flat, low-lying floodplain extends well beyond the NLC boundary. Originally marshland, this area was reclaimed in the 16th and 17th Centuries and is very fertile but relies on an extremely complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place. There are a number of villages and small towns within the marsh, generally located on local high spots. The Isle of Axholme is particularly significant in this respect, reaching an elevation of 35mOD and supporting the settlements of Belton, Epworth and Haxey. Further north, Crowle stands on a noticeable high point but the small villages of Eastoft and Garthorpe are only a few metres above the surrounding marsh level.

J.3 There are plans for a major development, the Lincolnshire Lakes, on low-lying beside the River Trent to the west of Scunthorpe but most other development near the town is likely to be on relatively high ground above the floodplain. There may be some pressure for development along the banks of the River Trent as the wharves and industrial facilities there expand. No other parts of the area are allocated for major development.

Main sources of flood risk

J.4 There are two main sources of flood risk in the Trent Valley area, high water levels in the River Trent and failure of the network of watercourses and pumping stations that together drain the marshland surrounding the river.

J.5 Water levels in the lower section of the River Trent (north of Keadby) are dominated by tidal conditions and so are related to water levels in the Humber Estuary. Work carried out for the HFRMS indicates that the water levels with given probabilities of occurrence in the river are as shown in Table J.1. The base date for these figures in 1991 and current guidance indicates that allowance should be made for sea levels to rise by 1.201m and wave heights increase by 10% by 2115.

J.6 Further upstream water levels during extreme events are due to a combination of tidal and fluvial conditions. An extensive study of the Trent flood defences was carried out during the 1960s and 1970s and included a detailed assessment of extreme water levels. The river defences were then raised to

provide a consistent standard of 1:100 years, equivalent to a 1% annual probability of flooding and have since been maintained to these levels. The Environment Agency has undertaken a Flood Defence Strategy Study of the Tidal Trent (from Trent Falls to the tidal limit at Cromwell Weir) that has reviewed the extreme water levels and flood risk throughout the system.

Location	Water level (mOD) for given annual probability		
	1.0%	0.5%	0.2%
Trent Falls	5.61	5.65	5.79
Keadby	5.79	5.82	5.83

Table J.1 - Water level and wave height combinations with a 0.5% probability of occurrence; Trent Valley Area

J.7 There are three sections of fluvial floodplain within the area, the main one being beside the River Trent with smaller ones beside the Bottesford Beck and the River Eau respectively. The Bottesford Beck collects water from much of the eastern part of Scunthorpe, flowing initially south and then turning west to discharge to the Trent by gravity. The River Eau drains high land further south and much of its indicative floodplain lies outside the NLC boundary. Both the Bottesford Beck and the River Eau are embanked where they cross the Trent floodplain and so act as highland carriers.

J.8 The main river watercourses within the area are listed in Table J.2 (there are no SOWs) and shown on Map 12. Those on the right bank of the Trent are discussed above. On the left bank there are four principal watercourse groups connected to the Trent. The most northerly of these is the Stainforth & Keadby Canal, which is managed by British Waterways. This connects the River Don with the River Trent and is separated from the river at either end by a set of locks. There is no flow in the canal but it is embanked for part of its length and there is consequently a potential risk of flooding if the embankment fails since the water it contains will drain out. The two Soak Drains (one on either side of the canal) are both main river watercourses.

Ref No	Name of watercourse	Watercourse type	Discharging to
M1	River Trent	Tidal river	Humber Estuary
M2	Bottesford Beck	Highland carrier	River Trent
M3	River Eau	Highland carrier	River Trent
M4	North Soak Drain	Pumped drain	River Trent
M5	South Soak Drain	Pumped drain	River Trent
M6	North Level Engine Drain	Pumped drain	Hatfield Waste Drain
M7	Hatfield Waste Drain	Pumped drain	River Trent
M8	River Torne	Pumped drain	River Trent
M9	South Level Engine Drain	Pumped drain	River Trent
M10	Warping Drain	Pumped drain	River Trent
M11	River Idle	Pumped drain	River Trent

Table J.2 - Main river watercourses; Trent Valley Area

J.9 South of the canal three main river watercourses (the Hatfield Waste Drain, the River Torne and the South Level Waste Drain, each of which has some lengths of tributary watercourses which are also designated

as main river) come together and run parallel with each other to the Keadby pumping station, where the flow is pumped to the River Trent. A number of pumping stations, some operated by the Environment Agency and some by the adjacent IDB, pump water into these watercourses.

J.10 South of the Isle of Axholme is the Warping Drain, which is about 9 km in length but now only collects the discharge from one small pumping station so has a very low flow. It is embanked in places, however, so there is a potential risk of flooding if an embankment fails, and the flow is pumped to the River Trent. Further south again is the River Idle, most of which is outside the study area except for a short section where it forms the NLC boundary. This is an embanked watercourse draining high ground to the south and west of the study area as well as collecting local drainage flows from Environment Agency and IDB pumping stations. The River Idle flows to West Stockwith where it is pumped to the River Trent.

J.11 The responsibility for draining the low-lying land within the Trent Valley Area, and managing the extremely complex drainage system that does this, is shared by the 12 IDBs listed in Table J.3. They are collected together into two groups, as shown on the table, one (the Shire Group) of IDBs managed by Grantham Brundell & Farran (GBF, part of JBA Consulting) and one (the Isle of Axholme Group) of those managed by the Lindsay Marsh Drainage Board (LMDB). The areas managed by GBF and LMDB are shown on Map 12.

Name of IDB	Location
Managed by GBF	
Messingham	Right bank
Scunthorpe	Right bank
Gainsborough	Right bank
Finningly	Left bank
Garthorpe	Left bank
Hatfield Chase	Left bank
Tween Bridge	Left bank
Managed by LMDB	
Adlingfleet & Whitgift	Left bank
Althorpe	Left bank
Crowle	Left bank
South Axholme	Left bank
West Axholme	Left bank
West Butterwick	Left bank

Table J.3 - Internal Drainage Boards (IDBs); Trent Valley Area

J.12 The pumping stations that discharge to the main watercourses are listed together with operating authority and the receiving watercourse in Table J.4 and shown on Map 12. Only pumping stations within the study area are included, others operated by the same authorities lie just outside the area but are not included in the list.

J.13 The HFRMS indicates that the River Trent's tidal flood defences provide a standard of protection that is currently better than 0.5% annual probability of occurrence while its fluvial defences are designed to provide a standard of 1.0% annual probability against fluvial events. The standards provided by the internal drainage system are not as good as this, however. The Environment Agency indicates that the

Bottesford Beck and River Eau offer a standard of about 3.0% annual probability (a return period of 30 years) while the River Idle provides a standard of about 2.0% annual probability (return period of 1 in 50 years). The watercourses of the Three Rivers system generally give a standard of about 10% (return period of 1 in 10 years) although this rises to about 3.0% for the River Torne and the South Level Engine drain if freeboard is taken into account.

Ref No	Operating authority	Pumping Station	Discharging to
P1	Environment Agency	Belton Grange	Hatfield Waste Drain
P2		Bull Hassocks	South Level Engine Drain
P3		Candy Farm (North)	River Torne
P4		Candy Farm (South)	River Torne
P5		Dirtness	South Level Engine Drain
P6		Goodcop	Hatfield Waste Drain
P7		Keadby	River Trent
P8		Low Bank	River Trent
P9		New Zealand	North Soak Drain
P10		Snow Sewer Drainhead	River Trent
P11		Tunnel Pits (North)	River Torne
P12		Tunnel Pits (South)	River Torne
P13		West Stockwith	River Trent
P14		Woodcarr	Hatfield Waste Drain
P15	Adlingfleet & Whitgift IDB	Cow Lane	Adlingfleet Drain
P16	Althorpe IDB	Althorpe	Three Rivers
P17	Crowle IDB	Grange Farm	(River Trent)
P18		Common Carrs	Paupers Drain
P19		Goodnow	North Soak Drain
P20		Paupers Drain	River Trent
P21		Bewcarrs	(River Trent)
P22	Finningly IDB	Snow Sewer	Warping Drain
P23	Hatfield Chase IDB	Blaxton Quarry	River Torne
P24		Cadmans	(South Level Engine
P25		Franklins	Drain)
P26		South Thorne Bank	(South Level Engine Drain) (South Level Engine Drain)
P27	Messingham IDB	East Butterwick	River Trent
P28		Black Bank	River Trent
P29	Scunthorpe IDB	Burringham	River Trent
P30		Flixborough	River Trent
P31		Lysaghts	River Trent

Ref No	Operating authority	Pumping Station	Discharging to
P32	South Axholme IDB	South Street	River Trent
P33		Heckdyke	River Trent
P34		Three Bridges	Warping Drain
P35		Four Bridges	Warping Drain
P36	Tween Bridge	North Soak Drain	North Soak Drain
P37	West Axholme IDB	Greenham	South Level Engine Drain
P38		Derrythorpe	River Trent
P39		Kelfield	River Trent
P40	West Butterwick	Blackdyke	River Trent
P41		Rushcarrs	Rushcarr Drain
P42		Trentside	River Trent
P43		Southfields	River Trent

Table J.4 - Drainage pumping stations; Trent Valley Area

J.14 The IDBs aim to provide a standard of between 10% and 5% annual probability of occurrence (1:10 and 1:20 years return period) for agricultural land throughout the system but this includes a freeboard of at least 1m below local ground level (to prevent the land from being waterlogged). As a result the standard provided to property (which is not affected by flooding until the water level rises above local ground level) is generally in the range 2.0% and 1.0% annual probability (1:50 to 1:100 years return period). The IDBs have to approve the drainage arrangements of all significant new development within their boundaries or affecting their watercourses. In principle the site runoff characteristics should remain unchanged, although the IDB may accept the receiving drainage system being improved so it can accept the increased discharge, at the developer's expense.

J.15 The above discussion concentrates on sources of flood risk within the Stage 3 area. The part north of the Stainforth & Keadby Canal is, however, also potentially at risk of flooding from two sources outside the area, the River Ouse and the River Don. The implications of this are discussed under the assessment for compartment 3T4.

Flood compartments

J.16 To allow more detailed assessment, the area shown as SFRA Flood Zone 3 on Flood Risk Map 13 has been divided into flood compartments taking into account the topography, type of defence, drainage arrangements and land use. These compartments are listed in Table J.5 overleaf with the sources of flood risk they include. Further information for each compartment is given in the following sections.

Compartment reference	Compartment name	Sources of flood risk
3T1	Alkborough	Humber Estuary
3T2	Flixborough	River Trent Scunthorpe IDB
3T3	Gunness	River Trent Bottesford Beck Scunthorpe IDB
3T4	Garthorpe & Keadby	River Trent (River Ouse) (River Don) Stainforth & Keadby Canal North Soak Drain Garthorpe IDB Adlingfleet & Whitgift IDB Tween Bridge IDB Crowle IDB
3F1	Upper Bottesford Beck	Bottesford Beck
3F2	Messingham	River Trent Bottesford Beck River Eau
3F3	Upper River Eau	River Eau Gainsborough IDB
3F4	Three Rivers	River Trent Stainforth & Keadby Canal South Soak Drain North Level Engine Drain Hatfield Waste Drain River Torne Hatfield Chase IDB
3F5	Isle of Axholme	River Trent River Torne South Level Engine Drain Warping Drain Althorpe IDB West Butterwick IDB South Axholme IDB West Axholme IDB Hatfield Chase IDB
3F6	River Idle	River Trent Warping Drain South Ancholme IDB Finningley IDB

Table J.5 - Flood compartments; Trent Valley Area

Tidal Flood Compartments

3T1: Alkborough

Description of site

J.17 This compartment is a triangular area of land about 4 km long and 2 km wide at its widest point and located at the mouth of the Trent on its right bank. It is backed by a high and steep escarpment, which reaches the estuary shore at Whitton and the Trent bank north of Burton Stather. The northern and western boundaries are formed by the Environment Agency's flood defences. Ground levels in the area indicate that some of the land is below +2.0 mOD.

J.18 The land in the compartment has been bought by a group including the Environment Agency, Natural England and NLC and has been developed as a managed realignment site to create new inter-tidal habitat and flood storage. As a result the whole area is classified as Flood Zone 3(b), functional floodplain.

Sources of flood risk

J.19 The primary source of flood risk to this compartment is high water levels at Trent Falls, the junction between the River Trent and the Humber Estuary. Table 5.11 shows the water level with a 0.5% annual probability of occurrence there to be +5.65 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

J.20 There are no significant fluvial watercourses flowing through the area. Scunthorpe IDB manage the drainage, which discharges to the estuary by gravity.

Existing defences

J.21 The flood defences consist of earth embankments, a length of which has been lowered as part of the managed realignment scheme to allow water to flow into the site during an extreme tidal event, where it can be stored until water levels in the estuary fall. The remaining defences have crest levels of about +6.1 mOD and are generally in good condition (Grade 2) although some lengths are fair (Grade 3).

3T2: Flixborough

Description of site

J.22 This compartment is on the right bank of the River Trent and extends from high ground just north of Burton Stather to the minor road running between Flixborough Stather and Flixborough village. The Trent's defences form its western boundary. It is about 4 km long and 1.2 km wide at its widest point. Ground levels in the area indicate that some of the land is below +2.0 mOD.

J.23 The compartment contains some industrial development at its two ends (at Burton Stather in the north and Flixborough Industrial Estate in the south. The industrial estate is almost separated from the rest of the compartment by a railway embankment. The area between the two developed areas is currently used for agriculture but has been identified by the Environment Agency as potentially suitable for managed realignment with the aim of creating flood storage. This area is therefore classified as Flood Zone 3(b), functional floodplain.

Sources of flood risk

J.24 The primary source of flood risk to this compartment is high water levels in the River Trent. Table 5.11 shows the water level with a 0.5% annual probability of occurrence there to be between +5.65 mOD and +5.82 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115.

J.25 There are no significant fluvial watercourses flowing through the area. Scunthorpe IDB manage the drainage, most of which discharges to the estuary by gravity apart from the Flixborough Industrial Estate, which is pumped. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.26 The estuary flood defences consist of earth embankments with crest levels of between +6.1 and +6.3 mOD. They are generally in good to fair condition (Grades 2 and 3) and are sufficiently high to prevent overtopping during events with a 0.5% annual probability, as required by PPS25.

3T3: Gunness

Description of site

J.27 This compartment is on the right bank of the River Trent and extends from the minor road running between Flixborough Stather and Flixborough village to the Bottesford Beck. The Trent and Bottesford Beck defences form its western and southern boundaries respectively. The compartment is about 8.5 km long and 4 km wide at its widest point. Ground levels in the area indicate that some of the land is below +1.0 mOD.

J.28 The compartment contains some industrial development beside the River, particularly at Grove Wharf and Gunness, together with a number of important communication links including the A18 and A1077 main roads, the M180 motorway and the Scunthorpe to Doncaster railway line. It also includes the western fringe of Scunthorpe, where there is both housing and industry. The remainder of the area is used for agriculture.

Sources of flood risk

J.29 The primary source of flood risk to this compartment is high water levels in the River Trent. The Environment Agency's indicative flood plain map shows the area north of the M180 motorway as being subject to tidal flooding and the area further south as subject to either tidal or fluvial flooding. Table 5.11 shows the tidal water level at Keadby Bridge with a 0.5% annual probability of occurrence to be +5.82 mOD (with a base date of 1991). Current guidance suggests sea levels could rise by 1.201m and wave heights increase by 10% by 2115. Fluvial flood levels are influenced by tidal conditions as well as by rainfall and catchment characteristics, in particular floodplain storage further upstream. Design levels were produced for the Trent Tidal Reach Improvement Scheme, which was implemented over the period 1960 – 1980 with the aim of providing protection against flooding with a 1.0% annual probability of occurrence.

J.30 There is only one other main river watercourse that could affect the compartment, the Bottesford Beck. This is an embanked high-level conveyor draining the eastern and southern parts of Scunthorpe and

discharging to the River Trent by gravity. The local drainage system is managed by Scunthorpe IDB. Although there are some gravity outfalls most of the flow is pumped to the River Trent through the Lysaghts and Burringham pumping stations. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.31 The River Trent flood defences consist largely of earth embankments with short sections of quay wall in the wharf areas. The crest level varies between +6.1 and +6.3 mOD are sufficiently high to prevent overtopping during events with a 0.5% annual probability, as required by PPS25. The defences are generally in good to fair condition (Grades 2 and 3), although some of the quay walls are classified as poor (Grade 4). These walls are generally backed by wide paved areas, however, so the risk of progressive failure leading to widespread flooding during an extreme event is low.

J.32 The Bottesford Beck defences consist entirely of earth embankments, generally in good to fair condition (Grades 2 and 3). They provide a 1:30 years standard of protection (3.0% annual probability of flooding) to the surrounding area.

3T4: Garthorpe & Keadby

Description of site

J.33 This compartment is on the left bank of the River Trent and extends from the NLC boundary to the Stainforth & Keadby Canal. The Trent and the Canal form its eastern and southern boundaries respectively while the NLC boundary forms its remaining boundary. The compartment is about 8 km from north to south and 12 km east to west at its widest point. Ground levels in the area indicate that much of the land is below +2.0 mOD.

J.34 The flat, low-lying land that forms the Trent floodplain extends well beyond the NLC boundary. Originally marshland, this area was reclaimed in the 16th and 17th Centuries and is very fertile but relies on an extremely complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place. There are a number of villages within the marsh, generally located on local high spots. Crowle, for example, stands on a noticeable high point but the small villages of Eastoft, Garthorpe, Luddington and Adlingfleet are only a few metres above the surrounding marsh level. There is a major power station at Keadby but apart from this the area is devoted largely to agriculture.

Sources of flood risk

J.35 In principle this compartment is part of a floodplain that is surrounded by four watercourses (the Trent, Ouse and Don Rivers and the Stainforth & Keadby Canal, which connects the Don and Trent) and is therefore at risk of flooding from them all. In practice the Canal poses only a limited risk since it carries no flow (if it breaches the water stored in the canal would drain out but gates at either end would prevent more water entering the channel). The River Don could affect the western part of the compartment (beyond Crowle) and the River Ouse the northern part. The primary sources of flood risk, however, are the River Trent and the local drainage system.

J.36 Table 5.11 shows the tidal water level in the River Trent with a 0.5% annual probability of occurrence to be between +5.65 and +5.82 mOD (with a base date of 1991). Current guidance suggests sea

levels could rise by 1.201m and wave heights increase by 10% by 2115. During such an event the tidal water level in the River Ouse will be similar or slightly higher while levels in the Don will be higher still and may also be influenced by fluvial conditions.

J.37 The only main river watercourse in the area is the North Soak drain, which runs beside the Stainforth & Keadby Canal and collects local drainage flows and pumped discharges from Crowle and Tween Bridge IDBs. These two IDBs, with Garthorpe and Adlingfleet & Whitgift, manage the local drainage within the compartment. Flows from the Garthorpe system are discharged to the River Trent by gravity but the remaining flows are largely pumped, either directly or indirectly, to the Trent or (for some of the Adlingfleet & Whitgift area) to the Ouse. The systems are understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.38 The River Trent flood defences consist largely of earth embankments although there are some short lengths of wall near Keadby. The crest level varies between +6.0 and +6.3 mOD so the embankments are sufficiently high to prevent overtopping during events with a 0.5% annual probability. The defences are generally in good to fair condition (Grades 2 and 3).

J.39 The River Ouse flood defences also consist largely of earth embankments although there are some lengths of sheet-pile and other walls. They are sufficiently high to prevent overtopping during events with a 0.5% annual probability except near Reedness, where the standard is currently estimated to be lower than 2.0% annual probability. The Environment Agency is studying a scheme to improve the standard here. The defences are generally in good to fair condition (Grades 2 and 3).

J.40 Although much of the land lying within Zone 3 is apparently adequately protected against water levels with a 0.5% (tidal) or 1.0% (fluvial) annual probability of occurring in the Trent, nevertheless the very flat and low-lying nature of the land, the complexity of the drainage system, the low standard of protection it affords and the heavy reliance on pumping mean that during an extreme event flooding could be widespread and in locations that are difficult to predict.

Fluvial Flood Compartments

3F1: Upper Bottesford Beck

Description of site

J.41 The Bottesford Beck drains the southern and eastern parts of Scunthorpe. Its lower reaches are embanked and act as a high-level conveyor, carrying the drainage flows across the floodplain to the River Trent. This compartment begins at the limit of compartment 3T3, which covers the River Trent floodplain. It is thus relatively narrow where the watercourse flows down the steep valley across the escarpment before it meets compartment 3T3 but broadens out further upstream where the ground slopes more gently.

J.42 The lower, narrow, part of the compartment includes some properties on the edge of existing developments. Some of the upper part is open ground (where, for example, a golf course is located) but a significant proportion is heavily industrialised, including part of Scunthorpe Steelworks.

Sources of flood risk

J.43 The Bottesford Beck is the only source of flood risk in the compartment. Downstream (in compartment 3T3) the embankments flanking the watercourse provide a 1:30 years standard of protection (about 3% annual probability of occurrence) across the Trent floodplain. The channel within this compartment was improved in the 1980s to accommodate the extra discharge from a major development in the catchment but nevertheless the return period of the event causing the flow to come out of bank (i.e. the onset of flooding) is believed to be quite low, although no model studies to confirm this have been carried out.

J.44 A major source of concern is the sensitivity of the flood risk to future development in the catchment. The outflow from the upper part of the compartment is likely to be constricted, causing flood levels to respond more strongly to changes in flow rate than catchments where the outflow is less constrained. As a result any development within this catchment that increases the rate of runoff will have a greater impact on flood risk than a development in a less sensitive catchment.

J.45 There has been major landscaping work to the north-east of Scunthorpe, making it difficult to identify the watershed between the valleys of the Bottesford Beck and the Winterton Beck, which drains to the Humber Estuary. For the purposes of this study the watershed has been taken as the A1077.

Existing defences

J.46 There are no flood defences (embankments, walls or formal storage areas) within this compartment.

3F2: Messingham

Description of site

J.47 This compartment is on the right bank of the River Trent and extends from the Bottesford Beck (opposite West Butterwick) to the River Eau (which also marks the NLC boundary). These two watercourses form its northern and southern boundaries respectively while the Trent forms its western boundary. The compartment is about 3 km from north to south and 4.5 km from east to west. Ground levels in the area indicate that much of the land is below +2.0 mOD.

J.48 The compartment is largely devoted to agriculture and contains a number of farms, most of which are relatively isolated.

Sources of flood risk

J.49 The primary source of flood risk to this compartment is high water levels in the River Trent. These levels are influenced by tidal conditions as well as by rainfall and catchment characteristics, in particular floodplain storage further upstream. Design levels were produced for the Trent Tidal Reach Improvement Scheme, which was implemented over the period 1960 – 1980 with the aim of providing protection against flooding with a 1.0% annual probability of occurrence.

J.50 The two other main river watercourses that could affect the compartment are the Bottesford Beck and the River Eau. These are both embanked high-level conveyors draining land to the east and discharging to the River Trent by gravity. The flow from the local drainage system, which is managed by Messingham IDB, is pumped to the River Trent through the East Butterwick and Black Bank pumping stations. The system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.51 The River Trent flood defences consist largely of earth embankments that are sufficiently high to prevent overtopping during events with a 1.0% annual probability. The defences are generally in good to fair condition (Grades 2 and 3). The Bottesford Beck and River Eau defences consist entirely of earth embankments, generally in good to fair condition (Grades 2 and 3). They provide a 1:30 years standard of protection (3.0% annual probability of flooding) to the surrounding area.

J.52 There is a flood storage area upstream of the embanked section on the left bank of the River Eau (and therefore outside the NLC boundary and so outside the compartment). This is capable of taking the flow during events of up to 1:30 years return period (and providing this standard of protection to the village of Scotter, further upstream). More severe events will overtop the banks and, by restricting backing up, limit the threat to the village.

3F3: Upper River Eau

Description of site

J.53 Although the NLC boundary and the River Eau diverge upstream of compartment 3F2, the border then turns south and crosses the river again further upstream. As a result there is a small area of land at risk of flooding west of Kirton in Lindsey, which is this compartment. The NLC boundary forms its western boundary and the other boundary is the Environment Agency's indicative fluvial floodplain or the Gainsborough IDB boundary, whichever lies furthest from the river. The compartment is about 5 km long and 2 km wide at its widest point.

Sources of flood risk

J.54 The River Eau is the only source of flood risk in the compartment. The return period of the event causing the flow to come out of bank (i.e. the onset of flooding) is believed to be less than 1:30 years (3% annual probability), although no model studies to confirm this have been carried out. Gainsborough IDB manages the local drainage.

Existing defences

J.55 There are no flood defences (embankments, walls or formal storage areas) within this compartment.

3F4: Three Rivers

Description of site

J.56 This compartment is on the left bank of the River Trent and lies between the Stainforth & Keadby Canal and the River Torne, which is one of the watercourses that are together known as the Three Rivers. The River Torne forms the compartment's southern boundary to the point where it reaches the NLC

boundary. The compartment is about 10 km from east to west and 9 km north to south at its widest point. Ground levels in the area indicate that much of the land is below +2.0 mOD.

J.57 The compartment is within the Trent floodplain and, like the rest of the area, relies on a complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place. The area contains small villages and isolated farms, is extremely flat and very fertile and is devoted largely to agriculture. The M180 motorway, the A18 and A161 main roads and a number of minor roads cross the compartment.

Sources of flood risk

J.58 In principle the main sources of flood risk are the River Trent, the Stainforth & Keadby Canal, which connects the Don and Trent, and four main river watercourses, the South Soak Drain (which flanks the Canal), the North Level Engine Drain, the Hatfield Waste Drain and the River Torne. In practice the Canal poses only a limited risk since it carries no flow (if it breaches the water stored in the canal would drain out but gates at either end would prevent more water entering the channel). The North Level Engine Drain runs beside the Hatfield Waste Drain for much of its length and eventually joins it.

J.59 High water levels in the River Trent are influenced by tidal conditions as well as by rainfall and catchment characteristics, in particular floodplain storage further upstream. The existing defences are intended to provide protection against fluvial flooding with a 1.0% annual probability of occurrence (and are likely to protect against a 0.5% annual probability of tidal flooding). The River Torne is a highland carrier receiving water from the Doncaster area and carrying it across the Trent floodplain to the Keadby pumping station, which discharges to the River Trent. The three other main river watercourses collect local drainage flows discharged or pumped to them from Hatfield Chase IDB drainage system, which is responsible for drainage from the land east of a point close to Belton Grange pumping station, and convey them to Keadby pumping station also.

J.60 The main river watercourses provide a nominal 1:10 years (10% annual probability) standard of protection to the surrounding area, although the River Torne's standard rises to 1:30 years (3% annual probability) if freeboard is taken into account. The IDB's system is understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.61 The defences along the very short length of the River Trent beside the compartment are in good condition (Grade 2). The River Torne is embanked over part of its length and these defences are generally in good to fair condition (Grades 2 and 3). There are no other significant formal flood defences within the compartment.

J.62 Although much of the land is apparently adequately protected against water levels with a 0.5% (tidal) or 1.0% (fluvial) annual probability of occurring in the Trent, nevertheless the very flat and low-lying nature of the land, the complexity of the drainage system, the low standard of protection it affords and

the heavy reliance on pumping mean that during an extreme event flooding could be widespread and in locations that are difficult to predict.

3F5: Isle of Axholme

Description of site

J.63 This compartment is on the left bank of the River Trent and lies between the River Torne, which is one of the watercourses that are together known as the Three Rivers, and the Warping Drain. The River Torne forms the compartment's southern and most of its western boundaries while the River Trent and the Warping Drain form its eastern and southern boundaries respectively. The NLC boundary forms the rest of the external boundary. The compartment contains a large area of land (the Isle of Axholme) that is above the general floodplain level and is therefore excluded from this assessment. The overall compartment dimensions are about 13 km from east to west and the same distance from north to south. Ground levels in the area indicate that much of the land is below +2.0 mOD.

J.64 The compartment is within the Trent floodplain and, like the rest of the area, relies on a complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place. Most of the larger villages (e.g. Epworth and Haxey) are located on high ground out of the floodplain but parts of some of them (e.g. West Woodside and Westgate) have spread onto lower-lying land and some (e.g. Owston Ferry, East and West Butterwick) are almost entirely on the floodplain. The floodplain itself is flat, very fertile and devoted largely to agriculture. The M180 motorway, the A18 and A161 main roads and a number of minor roads cross the compartment.

Sources of flood risk

J.65 The main source of flood risk to the compartment is the River Trent. North of the M180 motorway crossing the flood risk from the Trent is tidal while to the south it is both tidal and fluvial, indicating that high water levels are influenced by tidal conditions and by rainfall and catchment characteristics, in particular floodplain storage further upstream. The existing defences provide protection against tidal flooding with a 0.5% annual probability of occurrence (and are intended to protect against a 1.0% annual probability of fluvial flooding).

J.66 The other sources of flood risk are the other three main river watercourses (River Torne, South Level Engine Drain and Warping Drain) and the local IDB systems (managed by Althorpe, West Butterwick, West Axholme, South Axholme and Hatfield Chase IDBs). The River Torne is a highland carrier receiving water from the Doncaster area and conveying it across the Trent floodplain to the Keadby pumping station, which discharges to the River Trent. The South Level Engine Drain collects local drainage flows discharged or pumped to it from the Althorpe, West Axholme and Hatfield Chase IDB drainage systems and also conveys them to Keadby pumping station. The Warping Drain collects flows pumped to it from the South Axholme IDB (and the Finningly IDB, outside the compartment) and conveys them to the Snow Sewer Drainhead pumping station, which discharges to the River Trent.

J.67 The main river watercourses provide a nominal 1:10 years (10% annual probability) standard of protection to the surrounding area, although the River Torne's standard rises to 1:30 years (3% annual probability) if freeboard is taken into account and flows in the Warping Drain are very low indicating

that in practice the flood risk is relatively low. The IDBs' systems are understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.68 The River Trent flood defences consist largely of earth embankments that are sufficiently high to prevent overtopping during events with a 0.5% (tidal) and 1.0% (fluvial) annual probability of occurrence. The defences are generally in good to fair condition (Grades 2 and 3). The River Torne and the Warping Drain are embanked over part of their length and these defences are also in good to fair condition (Grades 2 and 3), providing protection against flooding from events with a 3% annual probability (possibly better in the case of the Warping Drain).

J.69 Although much of the land is apparently adequately protected against water levels with a 0.5% (tidal) or 1.0% (fluvial) annual probability of occurring in the Trent, nevertheless the very flat and low-lying nature of the land, the complexity of the drainage system, the low standard of protection it affords and the heavy reliance on pumping mean that during an extreme event flooding could be widespread and in locations that are difficult to predict.

3F6: River Idle

Description of site

J.70 This compartment is on the left bank of the River Trent and lies between the Warping Drain and the southern NLC boundary (which runs along the River Idle for part of its length. The River Trent and the Warping Drain form its eastern boundary. The compartment is 9 km from east to west and 4 km from north to south at its widest part. Ground levels in the area indicate that much of the land is below +2.0 mOD.

J.71 The compartment is within the Trent floodplain and, like the rest of the area, relies on a complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place. The land is flat, very fertile, devoted largely to agriculture and contains no significant villages. The A161 main road crosses it.

Sources of flood risk

J.72 The main source of flood risk to the compartment is the River Trent. High water levels in the Trent at this point are influenced by tidal conditions and by rainfall and catchment characteristics, in particular floodplain storage further upstream. The existing defences provide protection against tidal flooding with a 0.5% annual probability of occurrence and are intended to protect against a 1.0% annual probability of fluvial flooding.

J.73 The other sources of flood risk are the other two main river watercourses (Warping Drain and River Idle) and the local IDB systems (managed by Finningly and South Axholme IDBs). The Warping Drain collects flows pumped to it from the IDBs and conveys them to the Snow Sewer Drainhead pumping station, which discharges to the River Trent. The River Idle is a highland carrier draining the greater part of North Nottinghamshire together with parts of Derbyshire and South Yorkshire. It conveys the flow to the West Stockwith Pumping Station, which discharges to the River Trent.

J.74 The IDBs' systems are understood to be capable of accommodating the 2.0% annual probability event if the additional storage provided by the freeboard allowance included in the design is taken into account.

Existing defences

J.75 The River Trent flood defences consist largely of earth embankments that are sufficiently high to prevent overtopping during events with a 0.5% (tidal) and 1.0% (fluvial) annual probability of occurrence. The defences are generally in good to fair condition (Grades 2 and 3). The River Idle is embanked and these defences are also in good to fair condition (Grades 2 and 3). They work in conjunction with flood storage areas further upstream (outside the compartment) to provide protection against flooding from events with a 2% annual probability. The Warping Drain is also embanked and its defences are again in good to fair condition (Grades 2 and 3).

J.76 Although much of the land is apparently adequately protected against water levels with a 0.5% (tidal) or 1.0% (fluvial) annual probability of occurring in the Trent, nevertheless the very flat and low-lying nature of the land, the complexity of the drainage system, the low standard of protection it affords and the heavy reliance on pumping mean that during an extreme event flooding could be widespread and in locations that are difficult to predict.