Rochford District Council

Strategic Flood Risk Assessment

Level 1 & 2 Final Report

February 2011

Prepared for:

Rochford District Council

Revision Schedule

Rochford DC Strategic Flood Risk Assessment – Level 1 & 2 Report
February 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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Non Technical Summary

Overview

Rochford District Council, in partnership with Basildon Borough Council and Castle Point Borough Council, has commissioned Scott Wilson to produce a Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25): *Development and Flood Risk*[1] and its accompanying Practice Guide[2].

This SFRA provides a revision to the Thames Gateway South Essex SFRA which was published in November 2006 and prepared under previous policy Planning Policy Guidance (PPG25) Development and Flood Risk.

The following report constitutes a Level 1 and Level 2 SFRA for Rochford District Council which will contribute to the evidence base for the plan-making process of the Local Development Framework (LDF), in particular the Core Strategy.

The purpose of the Level 1 SFRA is to collate existing data and information with respect to flood risk, sufficient to enable the application of the Sequential Test by the Council, i.e. to steer development towards areas of lowest flood risk. It is the role of the Council to undertake the application of the Sequential Test within their administrative area, guidance to assist in this process is included in Chapter 6.

Given the existing level of flood risk and the development pressure facing parts of Rochford, an 'increased scope' Level 2 SFRA has also been included in this report to provide more detailed flood risk information for those areas at medium or high risk of flooding. Hydrodynamic breach modelling has been undertaken at 7 locations around the tidal frontage to provide more detail on the nature of the residual tidal flood risk. In addition, modelling has been undertaken to simulate overtopping of the existing defences in order to assess the actual flood risk. Details of the modelling are included in Chapter 6 and Appendix E. The outputs of this modelling include maximum depth maps, hazard mapping and time to inundation mapping which are included in Appendices B, C and D respectively.

The findings from these assessments provide further specific information which will facilitate the application of the Exception Test, where required, and inform the preparation of site specific Flood Risk Assessments for individual development sites in the potential main development areas.

Review of Flood Risk in Rochford District

The results from the increased scope Level 2 SFRA confirm that parts of the district of Rochford are at significant residual risk of flooding from tidal sources.

Overtopping or a breach in the flood defences has the potential to result in flooding to depths of greater than 3m throughout Shoeburyness, Paglesham, Wallasea Island and South Fambridge putting existing development and occupants at great risk. Given the low lying nature of the coastline in this part of the district, flood waters are likely to propagate rapidly, greatly reducing the time available for warning and evacuation of residents, as was the case in the 1953 flood.

[1] CLG (December 2006, revised March 2010) Planning Policy Statement 25: Development and Flood Risk
[2] CLG (June 2008, revised December 2009) Planning Policy Statement 25: Development and Flood Risk

Policies adopted as part of the Catchment Flood Management Plan for the tidal parts of the Rochford district aim to reduce or cease existing levels of flood risk management now and into the future. It is therefore likely that the flood risk from tidal sources in this district will continue to increase over time.

In addition to flood risk from tidal sources, fluvial systems also pose a risk to parts of the Rochford district. The impermeable underlying geology and seasonally wet, deep clay soils in the western parts of the district lead to rapid runoff of surface water into local watercourses. The channelization of these watercourses increases the rapid conveyance of water downstream and leads to problems where watercourses converge.

Fluvial flooding primarily affects Rochford town, where the River Roach, Nobles Green Ditch and Eastwood Brook meet. A number of other smaller watercourses in Rawreth and Rayleigh also pose a fluvial flood risk.

Recommendations

It is strongly recommended that the mapping in this SFRA is used by Rochford Council Emergency Planners to continue to inform and update the development of Emergency Response and Evacuation Plans for the existing development and occupants throughout the district. Flood depth, hazard and time to inundation mapping should be used to inform routes of safe access and egress for existing development.

Under the Core Strategy proposals no development is proposed within areas defined as being at risk of flooding from tidal sources. However, it is possible that planning applications may come forward for redevelopment of individual properties within areas at risk of tidal flooding. Where this is the case, it is strongly recommended that development proposals are carefully assessed to ensure that they are safe in line with the recommendations provided in Chapter 10 of this report.

Information with respect to flood depths, hazard rating and time to inundation should be used to inform part c) of the Exception Test and the preparation of site specific Flood Risk Assessments. It is noted that this document is a strategic document, and therefore site specific assessments may need to be carried out, (for example consideration of an additional breach location of more significance to the site under assessment), however the SFRA should provide indicative information and Chapter 10 provides detailed guidance on the issues that need to be addressed as part of these assessments.

Similarly, where development is proposed in areas at risk of fluvial flooding, development control recommendations provided in Chapter 10 of this report should be used to determine the safety of the proposed development (in consultation with the councils emergency planners) and to ensure that the proposed development does not increase flood risk to surrounding areas or impact upon the ability of Rochford DC and their emergency services to safeguard the current population.

Table of Contents

Glossary of Terms

Climate change - a change in average weather or a change in the distribution of weather events around an average over a period of time e.g. greater or fewer extreme weather events.

Core Strategy - The Development Plan Document which sets the long-term spatial planning vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.

Development Plan Documents (DPDs) - Spatial planning documents within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination. They are required to include a core strategy and a site allocations document, and may include area action plans if required; other DPDs may also be included, e.g. development control policies.

Defra - Department for Environment, Food & Rural Affairs.

Emergency Planning – Planning for and response to emergencies such as flooding, including consideration of the resilience of emergency infrastructure that will need to operate during flooding.

Environment Agency Flood Zones - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

Flood Risk Assessment (FRA) – A site specific investigation carried out by site developers to be submitted as part of their planning applications. It assesses both current flood risk to the site and ensures development does not increase flood risk to the site or surrounding areas.

Flood Risk Vulnerability - PPS25 provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.

Flood Zone 1 - Low Probability - Flood Zone comprising land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any one year (<0.1%)

Flood Zone 2 - Medium Probability – Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Flood Zone 3a - High Probability – Land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year

Flood Zone 3b - Functional Floodplain - Land where water has to be stored or flow in times of flood

Formal Flood Defence - A structure built and maintained specifically for flood defence purposes.

Greenfield Runoff - The surface water runoff regime from a site before development. This is normally taken to mean the site in its natural state (i.e. no man-made developments on site).

LiDAR – 'Light Detection and Ranging' is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground. It therefore provides accurate topographical/contour mapping.

Local Development Framework (LDF) - The name for the portfolio of Local Development Documents. It consists of the Local Development Scheme, a Statement of Community Involvement, Development Plan Documents, Supplementary Planning Documents, and the Annual Monitoring Report.

Local Lead Flood Authority (LLFA) – Unitary authorities responsibly for implementing the requirements of the Flood and Water Management Act, which gained Royal Assent in April 2010.

Mitigation – where flood risk cannot be avoided or controlled, mitigation measures should be applied to further reduce the risk of flooding and/or minimise the danger and damage caused by flooding to acceptable levels. This could include options such as non-habitable ground floors, resistant and resilient design, flood warning and evacuation plans.

Previously Developed (Brownfield) Land - Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land. Land used for mineral working and not subject to restoration proposals can also be regarded as brownfield land.

Residual Risk - The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

Return Period – Return Period is a statistical measure of how often, on average, an event could occur. It is the inverse of Annual Exceedance Probability (AEP), where AEP is the probability of a storm event of given magnitude or greater occurring in any given year. It should be noted that both return period and AEP are probability measures, so for example an event which has a 5 year return period (or 20% AEP) has a 1 in 5 chance of occurring in any given year, and is expected to occur once every 5 years on average. The on average term is important - just because it has happened one year does not mean it will not occur again for the next 4 years; there is still a 1 in 5 chance each year of the storm, or a larger storm, occurring, but over a long period of time it is expected that a fifth of the years will have had a storm of that magnitude or larger.

Storm surge - An offshore rise of water level associated with a low pressure weather system. Water levels rise primarily due to the action of high winds upon the oceans surface.

Sustainable Development – "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987).

The Exception Test - If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS25 sets out strict requirements for the application of the Test.

The Sequential Test - Informed by a Strategic Flood Risk Assessment, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

1 in 200 year event - Event that on average will occur once every 200 years. Also expressed as an event that has a 0.5% probability of occurring in any one year.

1 in 200 year design standard - Flood defence that is designed for an event, which has an annual probability of 0.5%. In events more severe than this the defence would be expected to fail or to allow flooding.

1 in 1000 year event - Event that on average will occur once every 1000 years. Also expressed as an event that has a 0.1% probability of occurring in any one year.

1 Introduction

1.1 Background

1.1.1 Scott Wilson Ltd has been commissioned by Rochford District Council, in partnership with Basildon Borough and Castle Point Borough Councils to produce a Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25): Development and Flood Risk[3] and its accompanying Practice Guide[4].

1.1.2 This SFRA provides a revision to the Thames Gateway South Essex SFRA which was published in November 2006 under previous policy Planning Policy Guidance (PPG25) Development and Flood Risk. The TGSE SFRA was prepared by Scott Wilson Ltd to aid the South Essex Strategic Planning Authorities of Essex County Council, Southend-on-Sea and Thurrock Borough Council and the Local Planning Authorities of Rochford District, Castle Point Borough and Basildon Borough Council in their planning and development control processes.

1.1.3 Due to differing timescales for the publication of their Local Development Framework, Thurrock Council and Southend-on-Sea Borough Council have commissioned separate SFRAs for their administrative areas. To this end the new partnership now includes Basildon Borough Council, Rochford District Council and Castle Point Borough Council. This report covers the area of Rochford District Council.

1.2 SFRA Structure

1.2.1 PPS25 defines a two staged approach to the completion of a SFRA as follows:

Level 1 – A strategic overview of all potential sources of flooding which is sufficiently detailed to enable the application of the Sequential Test within the district, i.e. to steer development towards areas of Low flood risk.

Level 2 – An 'increased scope' SFRA to provide more detail of flood risk where there is development pressure in areas that are at Medium and High risk and to facilitate the application of the Exception Test where necessary.

1.2.2 It is usual for the Level 1 and Level 2 report to be completed as separate reports. However, the completion of the previous SFRA and the more recent Scoping Report highlighted that due to the presence of fluvial systems in the district, as well as the impact of tidal flooding propagating from the east, there will naturally be areas where development pressure and flood risk conflict and where an increased scope Level 2 SFRA will be required. For ease of reference and in order to prevent duplication of material, a single SFRA report encompassing the requirements of Level 1 and Level 2 SFRA has been prepared for Rochford District Council.

1.3 Objectives

1.3.1 The objectives of the **Level 1** SFRA are as follows:

[3] CLG (December 2006, revised March 2010) Planning Policy Statement 25: Development and Flood Risk
[4] CLG (June 2008, revised December 2009) Planning Policy Statement 25: Development and Flood Risk

- Collate and review all available existing information on flood risk within the Rochford District Council study area from relevant stakeholders including the Environment Agency, Water Utility (Anglian Water), Highways Authority (Essex County Council) and the Local Authority;
- Map the tidal and fluvial Flood Zones based on the most up to date information at the time of writing provided by the Environment Agency, including the functional floodplain (fluvial outlines only) and an allowance for climate change;
- Map areas liable to suffer from surface water flooding through the use of the Environment Agency dataset 'Areas Susceptible to Surface Water Flooding' and local historical records;
- Provide an assessment of groundwater flooding including mapping based on British Geological Survey data;
- Refer to Anglian water data to provide an assessment of flood risk from sewer flooding using DG5 data and local historical records where available;

1.3.2 The objectives of the **Level 2** SFRA are as follows:

- Carry out an appraisal of the current condition of flood defence infrastructure and of likely future policy with regard to its maintenance and upgrade;
- Complete an appraisal of the likelihood and consequence of failure of flood risk management infrastructure, including an appropriate allowance for climate change;
- Provide mapping to illustrate the distribution of flood risk across flood zones to enable a sequential approach to site allocations within Flood Zones;
- Use Environment Agency areas susceptible to surface water flooding maps to identify critical drainage areas and the need for surface water management plans;
- Identify policies and practices required to ensure development satisfies the Exception Test

1.3.3 Overarching objectives:

- Provide guidance on the preparation of site specific Flood Risk Assessments (FRAs);
- Provide meaningful recommendations to inform policy, development control and technical issues;
- Provide guidance on the likely applicability of sustainable drainage techniques for managing surface water from key development sites.

1.4 Consultation

Anglian water

1.4.1 Anglian Water have been consulted in capacity as sewerage undertakers as part of this assessment. They are responsible for surface water drainage from development areas via ***adopted sewers*** and in some cases are responsible for the maintenance of SuDS systems. Anglian water maintain trunk sewers, however, they are not responsible for the gulleys or local drainage connections to trunk sewers.

Essex County Council

1.4.2 Essex County Council is the Highways Authority and is responsible for maintaining an effective ***highway drainage system*** including kerbs, road gulleys and the pipes which connect the gulleys to the trunk sewers and soakaways. The Highways Authority has been contacted and has provided information to this study with regard to highway flooding hot spots.

1.4.3 Essex County council as lead local flood authority in accordance with the Flood and Water Management Act *'must develop, maintain, apply and monitor a strategy for flood risk management in its area'* including flood risk from surface runoff, groundwater and ordinary watercourses.

The Environment Agency

1.4.4 The Environment Agency is the principal flood defence operating authority in England with permissive powers for the management of flood risk arising from ***designated Main Rivers and the sea***. The Flood and Water Management Act 2010 has given the Environment Agency a statutory duty for the strategic overview of all flood and coastal flood risk management issues in England. The Environment Agency is also responsible for flood forecasting, flood warning and general supervision over matters relating to flood defence. The Environment Agency have been consulted and have provided Flood Zone outlines, information on flood history, flood defences and have reviewed this document prior to publication.

Rochford District Council

1.4.5 Rochford DC is responsible for undertaking flood defence works on ***ordinary watercourses*** which have not been designated as 'Main River'. Information provided on these watercourses as part of the Strategic Flood Risk Assessment was limited.

2 Study Area

2.1 Rochford District Study Area

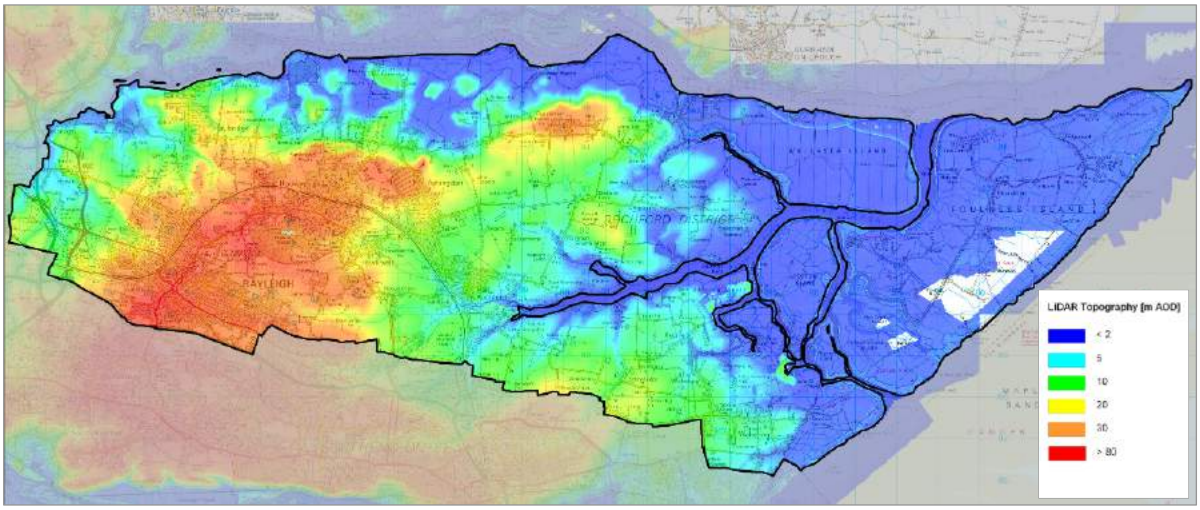
2.1.1 Figure A-1 identifies the study area covered by this SFRA. The administrative area of Rochford District Council is bordered by the North Sea in the east, the River Crouch in the north and the developed boroughs of Southend-on-Sea and Castle Point to the south. To the west, Rochford borders Basildon BC.

2.1.2 The district covers an area of approximately 17,000 hectares and has a resident population of approximately 83,200[5]. It is characterised by small scattered villages in the eastern part of the district and larger settlements on the western side including Ashingdon, Hullbridge, Hockley, Rayleigh and Rochford. The main centre of population in the district is Rayleigh in the southwest of the district.

2.2 Topography

2.2.1 The topography of the study area is shown in Figure A-2, an extract of which is provided in Figure 2-1 below. The eastern part of the district comprises low lying marshlands at or below mean high tide level. Further inland, levels rise and areas in the southwest of the district are located at elevations of approximately 80m AOD. The settlement of Canewdon in the north of the district is also elevated above the surrounding lower land. In the western parts of the district there are some significant slopes contributing to a greater likelihood for overland flow.

Figure 2-1 Extract from Figure A-2 Topography (LiDAR data, Environment Agency 2010)



2.3 Geology & Soils

2.3.1 The type of geology and soils in a particular region influence how surface water is conveyed and absorbed and therefore directly affects the likelihood and characteristics of flooding. The presence of impermeable rocks will lead to rapid and greater volumes of runoff, thereby increasing the risk of flooding downstream.

[5] S1KS01 Usual resident population: Census 2001, Key Statistics of Urban Areas

2.3.2 Data from the British Geological Survey showing the solid and drift geology underlying the study area has been mapped in Figures A-3 and A-4. The predominant solid geology underlying the study area is Thames Group which comprises clay, silt, sand and gravel. This is impermeable and therefore rapid runoff into local watercourses can be expected.

2.3.3 Drift deposits are present across approximately half of the district. River terrace deposits are present either side of the River Roach around Little Wakering and Great Wakering and Rochford. These deposits comprise sand and gravel.

2.3.4 Deposits of alluvium are present along the eastern part of the district including Foulness Island and Wallasea Island. In addition, parts of the River Crouch floodplain are characterised by alluvial deposits including Hullbridge, and the area north of Ashingdon and Canewdon.

2.3.5 Soil characteristics have a significant affect on how the catchment responds to rainfall. The South Essex CFMP identifies a divide across the district with respect to soil characteristics. The west of the district around Rayleigh, Hullbridge, Hockley, Ashingdon and Hawkwell is characterised by seasonally wet, deep clay soils. These soils are relatively impermeable and therefore contribute to rapid runoff of surface water runoff, resulting in a greater risk of surface water flooding and causing watercourses to respond rapidly to rainfall.

2.3.6 The east of the district, including Rochford, Great Wakering and Foulness Island is characterised by the presence of silty and loamy soils. These are relatively permeable and therefore result in a relatively low rainfall to runoff conversion rate.

2.4 Hydrology

2.4.1 Main Rivers are defined as large or locally significant watercourses in England and Wales designated by Defra or the Welsh Assembly Government. A map of the Main Rivers is maintained by the Environment Agency and those within the Rochford District are shown in Figure A-6. Under the terms of the Water Resources Act 1991, prior written consent from the Environment Agency is required for any proposed works or structures in, under, over or within 9m of the top of the bank of a designated ‘main river.

2.4.2 The entire northern and eastern boundary of the Rochford district is formed by tidally influenced watercourses including the River Crouch, River Roach and the North Sea. Extensive tidal floodplains associated with the estuarine extents of the River Roach and Crouch and the North Sea are present in the east of the district. These areas are sparsely populated.

2.4.3 Small, narrow floodplains associated with the Eastwood Brook and upper reaches of the River Roach affect localised areas of existing development in Rochford and Great Wakering.

3 Level 1 Assessment – Flood Risk Review

3.1 Overview

3.1.1 Strategic Flood Risk Assessments are required to consider all sources of flooding as set out in Annex C of PPS25 'Forms of Flooding'. This Chapter provides an overview of the different sources of flooding in the Rochford study area along with details regarding how each source is mapped and presented.

3.2 Fluvial Flooding

Sources

3.2.1 Fluvial flooding results from large rainfall events in the upper reaches of the catchment causing flows in excess of the carrying capacity of the channel. Where land is protected by fluvial flood defences, flooding can occur as a result of overtopping of the defences when the flood event is greater than that which the defences are designed for.

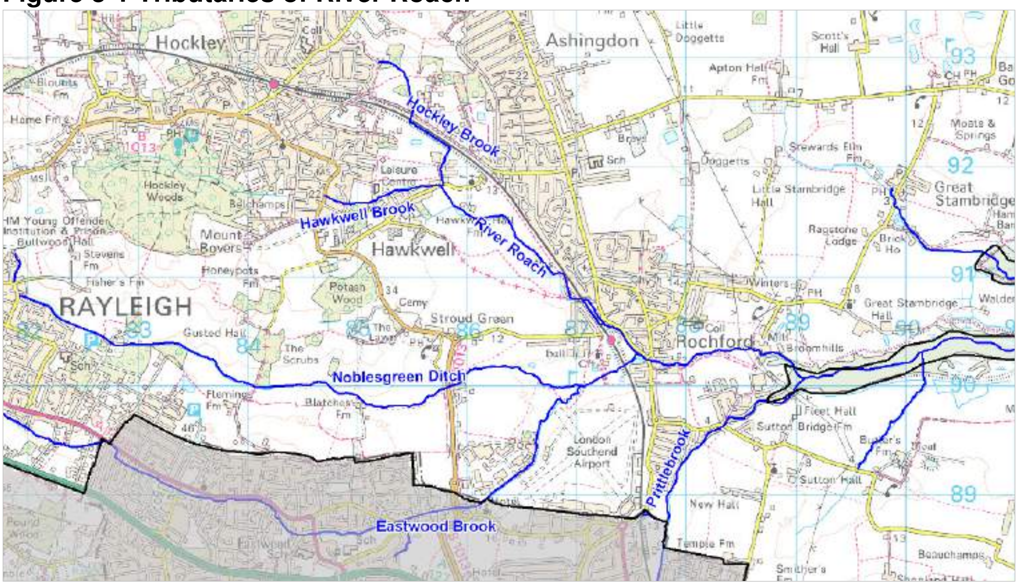
3.2.2 The main source of fluvial flood risk in the Rochford district is the upper reaches of the River Roach. There are five tributaries that contribute to flooding which are shown in Figure 3-1.

3.2.3 The Hawkwell Brook becomes a Main River at Thorpe Close in Hawkwell. It flows easterly through Hawkwell and joins the Hockley Brook at a confluence to become the River Roach. The Noblesgreen Ditch flows easterly from Rayleigh, towards Rochford where it then joins the River Roach.

3.2.4 The Eastwood Brook and Prittle Brook are predominantly located within the borough of Southend-on-Sea and have highly urbanised catchments. The Eastwood Brook follows the line of the A1015 and joins the Noblesgreen Ditch to the west of Rochford. The Prittle Brook flows easterly through Southend-on-Sea before turning northwards to meet the River Roach at Sutton Ford Bridge.

3.2.5 The River Roach is tidally influenced downstream of the Rochford Railway Station.

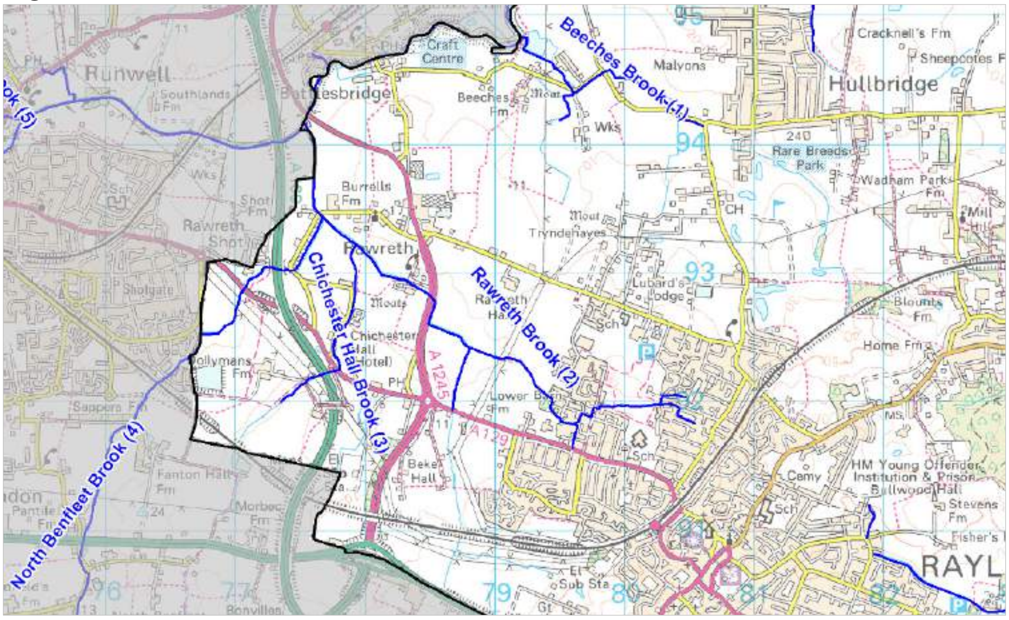
Figure 3-1 Tributaries of River Roach



3.2.6 The River Crouch is not a significant source of fluvial flooding in the study area as the river is tidally influenced along the length adjacent to the Rochford district. However there are several tributaries of the River Crouch within the western border of Rochford that pose a source of fluvial flood risk. These are the Rawreth Brook, Chichester Hall Brook, North Benfleet Brook and Beeches Brook and these watercourses are shown in Figure 3-2.

3.2.7 All of these watercourses are known to react rapidly to intense rainfall.

Figure 3-2 Tributaries of River Crouch



Historic Flooding

3.2.8 In 1968 exceptionally heavy rainfall led to extensive flooding within the Rochford district from tributaries of the River Roach including the Eastwood Brook and Prittle Brook. Rochford Golf Course was flooded to a depth of nine foot and up to 50 properties in Glenwood Avenue, to the south of Hockley, were affected. 78 properties were flooded in Rochford, located on Ashingdon Road, Church Street, St Andrews Road, Oak Road, Hall Road, Newlyn Lane and South Street.

3.2.9 In September 1958, 76mm of rainfall fell in two hours leading to flooding of properties in Rawreth and the evacuation of a number of families by boat.

3.2.10 Similar conditions of heavy rainfall in February 2001 were combined with high tides which led to tide locks on several Essex Rivers. Three properties were flooded in Rochford and 5 in Rawreth during these high water levels.

3.2.11 Following the event of 1968, several structural flood mitigation measures were undertaken along the channels of the River Roach tributaries to improve the standard of protection against flooding.

3.2.12 Given the risk of flooding from fluvial systems in Rochford, much of the area is covered by Environment Agency Flood Warning systems, further details of which are included in Section 4.3.

Flood Zones

3.2.13 Flood Zones are based on the probability of flooding occurring and are defined in accordance with the definitions in PPS25, which are shown in Table 3-1. The definition of flood zones does not take into account the presence of flood defences.

Table 3-1 PPS25 Fluvial Flood Zones (Table D.2 of PPS25, CLG 2010)

Flood Zone	Fluvial Flood Zone	Probability of Flooding
Flood Zone 1	Land assessed as having a less than 1 in 1000 annual probability of sea flooding in any year (less than 0.1%).	**Low**
Flood Zone 2	Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of sea flooding in any year (between 1.0% and 0.1%)	**Medium**
Flood Zone 3a	Land assessed as having a 1 in 100 or greater annual probability of river flooding in any year (greater than 1.0%)	**High**
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The 1 in 20 year annual probability floodplain is the starting point for consideration but local circumstances should be considered and an alternative probability can be agreed between the Local Planning Authority and the Environment Agency	**Functional Floodplain**

Flood Zone 3b – Functional Floodplain

3.2.14 The Functional Floodplains have the highest probability of flooding of all the Flood Zones defined within PPS25. A functional floodplain is defined as an area of land where water has to flow or be stored at times of flood or has an annual probability of flooding of 5% (i.e. from a 1 in 20 year return period event).

Flood Zone 3a with Climate Change

3.2.15 To ensure delivery of development that is sustainable now and in the future, PPS25 requires that the effects of climate change are taken into account and that Flood Zones with allowances for climate change should be presented.

3.2.16 PPS25 suggests that when completing an SFRA, planning bodies will need to agree how to factor climate change and over what time frame. The standard approach adopted by the Environment Agency in their Strategic Flood Risk Mapping is to include a net increase of 20% over and above peak flows, which is added to the 1 in 100 year flood event to account for climate change.

3.2.17 In areas where Flood Zone 3a plus climate change has not been modelled or mapped, Flood Zone 2 should be used as a surrogate for Flood Zone 3 plus climate change until such time that more detailed information is available, such as an EA Strategic Flood Risk Mapping (SFRM) study or a site-specific FRA.

Mapping

3.2.18 Flood Zone outlines have been provided by the Environment Agency for fluvial systems within the district. Table 3-2 provides a summary of the Flood Zones that have been provided. This information is mapped in Figures A-7 – A-10.

Table 3-2 Fluvial Watercourses in Rochford Study Area

Watercourse	Mapped in this SFRA			
	Flood Zone 3b	Flood Zone 3a	Flood Zone 3a + CC	Flood Zone 2
Prittle Brook	✓	✓	✓	✓
Eastwood Brook	✓	✓	✓	✓
Hawkwell Brook	✓	✓	✓	✓
Hockley Brook	✓	✓	✓	✓
Noblesgreen Ditch	Not available	✓	Not available	✓
Chichester Hall Brook	Not available	✓	Not available	✓
Rawreth Brook	Not available	✓	Not available	✓
Beeches Brook	Not available	✓	Not available	✓
North Benfleet Brook	Not available	✓	Not available	✓

Fluvial Flood Defences

3.2.19 Data from the National Flood and Coastal Defence Database (NFCDD) has been provided by the Environment Agency for the study area. Information regarding the standard of protection afforded by the fluvial and tidal flood defences is mapped in Figure A-12.

3.2.20 Flood defences along the fluvial watercourses are predominantly in the form of maintained channels. Figure A-12 demonstrates that there is some significant variation in the standard of protection provided by these channels in the area.

3.2.21 The Hawkwell Brook and Hockley Brook have maintained channels providing protection against the 100 year flood event. Along the fluvial section of the River Roach, the level of protection drops to the 30 year standard.

3.2.22 Sections of the Eastwood Brook and Prittle Brook are designed to protect against the 100 year event. In some sections of this watercourse, this decreases to just 10 – 17 year event.

3.2.23 The Rawreth Brook has maintained channels providing protection against the 50 year event.

3.3 Tidal Flooding

Sources

3.3.1 Rochford is at risk of tidal flooding from the North Sea and the River Crouch estuary. Tidal flooding is most likely to occur during storm surge conditions characterised by wind driven waves and low atmospheric pressure coupled with high spring tides. In areas protected from flooding by sea defences, tidal flooding can occur as a result of a breach in the defences, failure of a mechanical barrier or overtopping of defences. Where defences are not present, flooding is typically widespread.

Historic Flooding

3.3.2 In January 1953 a tidal surge, 2.5m above the spring tide level, caused widespread flooding and loss of life across the whole region. Along the south bank of the River Crouch, from Battlesbridge to Canewdon, water overtopped the defences and propagated inland by up to a mile. In South Fambridge a breach, a mile and half long, occurred close to Land End Point leading to flooding of agricultural land and properties.

3.3.3 On Wallasea Island, 37 people were resident and trapped inside buildings or on roofs due to the rising water levels. On Foulness Island, 350 – 400 people were resident. A breach at Morris Point caused the waters to surge towards Landwick. Due to the low lying nature of the topography, the majority of the island was flooded. All access roads to the island were flooded and residents had no means of communication with the mainland.

3.3.4 Given the risk of tidal flooding in Rochford, much of the area is covered by Environment Agency Flood Warning systems, further details of which are included in Chapter 4.

3.3.5 As demonstrated during the events of January 1953, given the wide flat topography of the surrounding area, large areas are inundated very quickly following a breach event as flooding pathways are not very well defined.

Mapping

3.3.6 Tidal flood risk is mapped in a similar manner to fluvial flood risk. The definition of Flood Zone 3a is based on the 1 in 200 year flood event (0.5% AEP), rather than the 1 in 100 year event (1% AEP) used to map fluvial Flood Zones.

Table 3-3 Tidal Flood Zones (Table D.2 of PPS25, CLG 2010)

Flood Zone	Tidal Flood Zone	Probability of Flooding
Flood Zone 1	Land assessed as having a less than 1 in 1000 annual probability of sea flooding in any year (less than 0.1%).	**Low**
Flood Zone 2	Land assessed as having between a 1 in 200 and 1 in 1000 annual probability of sea flooding in any year (between 0.5% and 0.1%)	**Medium**
Flood Zone 3a	Land assessed as having a 1 in 200 or greater annual probability of sea flooding in any year (greater than 0.5%)	**High**
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The 1 in 20 year annual probability floodplain is the starting point for consideration but local circumstances should be considered and an alternative probability can be agreed between the Local Planning Authority and the Environment Agency	**Functional Floodplain**

3.3.7 Flood Zones 2 and 3a with respect to tidal flood risk have been mapped on Figure A-7 along with the fluvial Flood Zones. The definition of flood zones does not take into account the presence of flood defences.

Tidal Flood Defences

3.3.8 The flood defences present in the Rochford district study area are typically earth embankments fronted by areas of intertidal mudflats or salt marsh habitats. The salt marsh acts to dissipate wave energy and reduce the probability of erosion due to tidal and river flow. The embankments work to protect an area from flooding by providing a mass of earth, which raises the surrounding land level and prevents inundation from a specific direction. Bunds may be reinforced with piles, concrete retaining wall structures or sheet pile walls driven through the crest to provide structural stability, additional resistance to breaching and to raise the level of protection. Where these reinforcements are absent, the earth embankment may be more susceptible to breaching, particularly in circumstances when the crest is overtopped by floodwaters.

3.3.9 Where bunds may be subject to high flow velocities or wave action the embankment may have a revetment or rock armour constructed on its seaward flank to prevent scour and erosion. Such flood defences are present around much of the frontage including Wallasea, Paglesham, South Fambridge and Shoeburyness.

3.3.10 Where access through the flood defences is required, floodgates may be constructed. These are usually manually operated and consist of a gate that is generally watertight with an appropriate crest height to prevent overtopping. The Environment Agency is responsible for floodgates and for issuing tidal flood warnings during which floodgates are closed as necessary.

3.3.11 Figure A-12 shows the level of protection provided by tidal flood defences in the study area. There is a manmade tidal seawall surrounding the tidal frontage of Paglesham and a secondary manmade clay embankment across Clements Marsh which protects the area from flooding up to a 1 in 50 year standard.

3.3.12 On the north bank of the tidal Roach estuary a blockwork revetment sea wall provides protection to Great Stambridge Hall and Rochford up to the 1 in 6 year flood event. On the southern bank of the estuary the level of protection varies between 1 in 4 to 1 in 8 year standard.

3.3.13 Around Wallasea Island new flood defences were completed in 2006 which included the restoration of the salt marshes.

3.3.14 The National Flood Risk Assessment dataset has also been mapped in Figure A-13. This dataset provides a broad assessment of the likelihood of flood risk to a site by predicting the likelihood that the centre of a 50m cell will be flooded. The methodology considers a number of different flood scenarios including a change in the distance from a given area to a river or the sea and the probability that flood defences fail. The dataset is constantly being updated with improved terrain data, local knowledge and the current condition of defences.

3.3.15 Figure A-13 demonstrates that a large part of the Rochford district is at ‘significant’ risk of flooding. This means that there is a 1 in 75 or greater annual probability (>1.3%) of flooding from the sea and or fluvial sources in any year.

3.3.16 More detailed information regarding the residual risk of flooding from overtopping and breaches of these flood defences at specific locations along the tidal frontage is included in Chapter 5.

3.4 Pluvial & Sewer Flooding

3.4.1 Pluvial flooding typically arises when intense rainfall, often of short duration, is unable to soak into the ground and/or enter drainage systems. It can run quickly off land, resulting in localised flooding. The Pitt Review (2008) revealed that two-thirds of the flooding in Summer 2007 was a result of surface runoff in urban areas, as rainwater runs over the surface of the ground or ponds in low lying areas, and there is a growing likelihood of similar flooding in the future.

National Level Pluvial Modelling

3.4.2 Following extensive surface water flooding across England in July, the Environment Agency has undertaken a broad scale national mapping exercise of 'areas susceptible to surface water flooding'. This dataset has been mapped for the Rochford district study area in Figure A-11. When using this dataset, the following limitations should be considered:

- The mapping does not show the interface between the surface water network, the sewer systems and the watercourses;
- It does not show the susceptibility of individual properties to surface water flooding;
- The mapping has significant limitations for use in flat catchments e.g. the eastern portion of the district, including Wallasea Island and Foulness;
- This mapping excludes buildings, and uses a single rainfall event.

3.4.3 This mapping is intended for use by the Local Resilience Forums solely to inform emergency planning and should not be used for spatial planning decisions. In addition, the Environment Agency strongly recommend that local knowledge is applied to assess the suitability of the mapping as an indicator of surface water flooding before emergency planners make decisions based upon it.

3.4.4 In line with these recommendations, local flooding records supplied by Anglian Water (from their DG5 register), Rochford DC, Essex Fire & Rescue and the Environment Agency have been overlaid onto Figure A-11 to verify this data.

3.4.5 The Rochford District Multi Agency Flood Plan, which forms an appendix to the Essex Resilience Forum Multi Agency Flood Plan, also provides details of surface water flooding. In February 2001, a long period of consistent rainfall followed by 25mm of rainfall in 24 hours led to widespread surface water flooding in Rochford. Three properties are known to have experienced flooding in Rochford as well as five in Rawreth. In addition, in December 2002 – January 2003, heavy rainfall falling on already saturated ground led to rapid runoff and the flooding of four properties on Church Lane, Rawreth.

3.4.6 The Areas Susceptible to Surface Water Mapping highlights that the surface water flow paths follow the general topography of the area, as shown in Figure A-2. As to be expected, the predominant flow paths shown in the modelling correlate with the natural topographic depressions and the tributaries of the Rivers Roach and Crouch.

3.4.7 Incidents of surface water and sewer flooding recorded in Rochford, Rayleigh and Hawkwell correlate well with the modelled dataset. In addition, incidents recorded in Little Wakering also correlate with the modelling.

3.4.8 There are fewer incidents recorded to the north of the River Roach, which is to be expected given the lower concentration of urban development in this area.

3.4.9 When mapped against the national property database Defra reports that approximately 2360 properties are estimated to be susceptible to surface water flooding within the Rochford district. The following table provides a summary of the number of properties that may be susceptible to surface water flooding in each of the key settlement areas in Rochford.

Table 3-4 Number of properties susceptible to pluvial flooding in Rochford BC (Defra 2009)

Rank	Settlement	Properties
242	Rochford	1400
645	Rayleigh	400
741	Hockley	320
1046	Maylandsea	180
1897	Hullbridge	50
3336	Canewdon	10
	TOTAL	**2360**

3.4.10 Surface Water flood risk is clearly a concern in the district and there is an increasing need to consider the impact of rising sea levels as a result of climate change on the discharge of surface water runoff to tidal systems.

3.4.11 It is noted that the Environment Agency have commissioned a second edition of the Areas Susceptible to Surface Water Flooding dataset with greater accuracy anticipated called the 'Flood Map for Surface Water'. This models two storm events, incorporates the influence of buildings, and includes the influence of the sewer system and infiltration. This dataset was unavailable at the data collection stage of this project and has not been included in the SFRA. However, the 'Flood Map for Surface Water' and further borough wide pluvial modelling will be undertaken as part of the Surface Water Management Plan to be undertaken by Rochford District Council (also in partnership with Basildon BC and Castle Point BC) in spring 2011. Both of these datasets should be used to continue to develop and improve understanding of surface water flood risk posed to the study area and the potential options for mitigation and management of surface water flood risk.

3.5 Groundwater Flooding

3.5.1 Groundwater flooding occurs when water levels in the ground rise above surface elevations. Groundwater flooding may take weeks or months to dissipate, as groundwater flow is much slower than surface water flow therefore water levels take much longer to recede.

3.5.2 An assessment of the risk of groundwater flooding needs to be carried out; however, a quantified assessment of risk from groundwater flooding is difficult to undertake, especially on a strategic scale. This is due to lack of groundwater level records and the lack of predictive tools (such as modelling) that can assess the risk of groundwater flow and flooding following rainfall events.

3.5.3 The risk of groundwater flooding is considered to be greatest where areas area underlain by permeable rocks that form major aquifers. Data from the British Geological Survey showing the solid and drift geology underlying the study area has been mapped in Figures A-3 and A-4. The predominant solid geology underlying the study area is Thames Group which comprises clay, silt, sand and gravel.

3.5.4 The predominance of clay and deep loam to clay soils lead to a relatively impermeable surface where rapid runoff of surface water can be expected. This results in a greater risk of surface water flooding and causes local watercourses to respond rapidly to rainfall. However, the presence of such geology and soils also create an impermeable barrier to prevent groundwater rising to the surface and reduces the risk of flooding from groundwater.

3.5.5 The Environment Agency has been contacted and has confirmed that they have no records of groundwater flooding in the Rochford district study area.

3.5.6 Further detail with regard to groundwater flood risk across the district will be provided in the Surface Water Management Plan for Rochford DC which is anticipated in early 2011.

3.6 Artificial Sources

3.6.1 PPS25 requires that artificial water sources within the study area are identified as part of a SFRA. These include canals, reservoirs, ponds, and any feature where water is held above natural ground level.

3.6.2 There are a number of gravel pits along Creeksea Ferry Road to the east of Canewdon, however water is not held above the natural ground level and therefore these pits do not pose a significant flood risk to the surrounding area. In addition, these are located close to the tidal River Crouch and the Paglesham Ditch which drains to the tidal River Roach and therefore any potential overland flow from these gravel pits will be directed towards these watercourses rather than the Canewdon area.

3.6.3 There is an embanked water feature between Great Stambridge and Paglesham Eastend. The risk is considered to be low due to enforced management measures. In addition, this feature is located in a topographic depression in a rural location and the nearest properties are approximately 1km away, at a few metres higher. As a result the risk to surrounding areas is considered to be low.

4 Flood Risk Management & Warning Systems

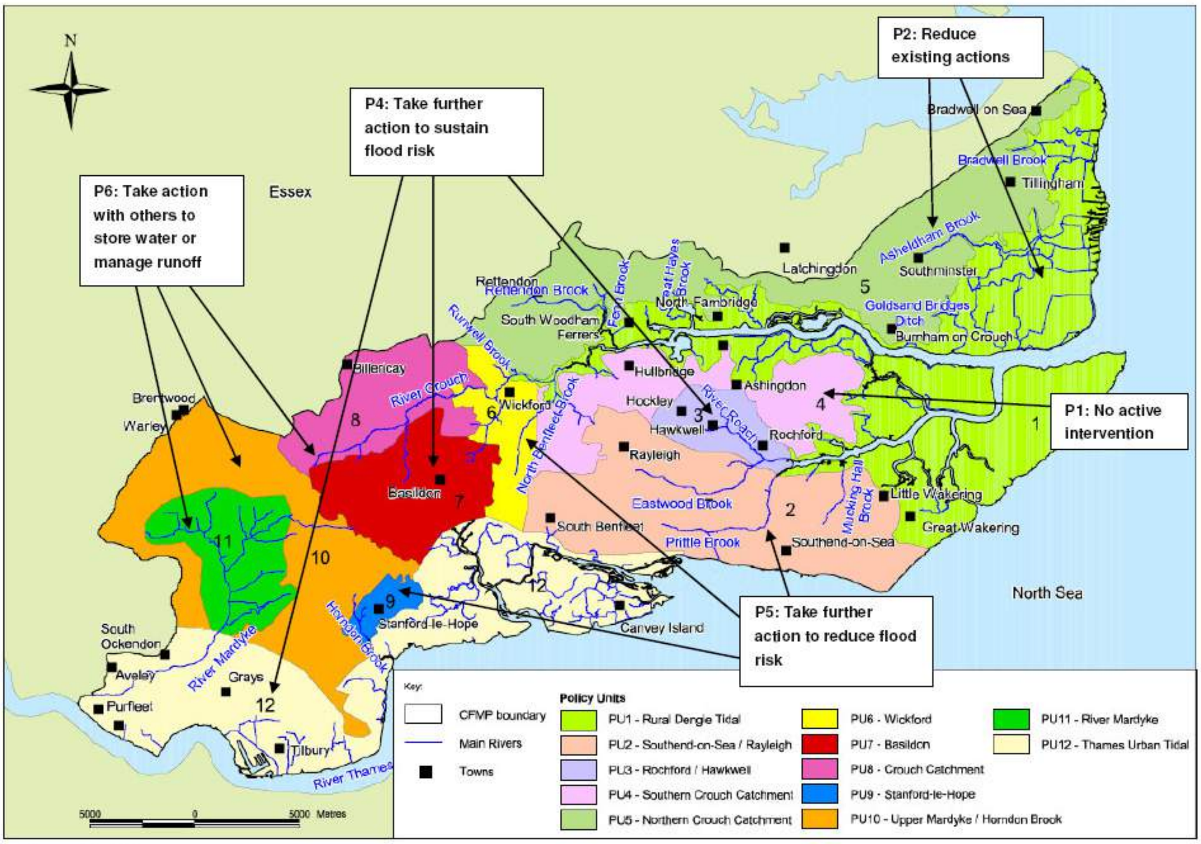
4.1 Introduction

4.1.1 Strategic Flood Risk Assessments are part of a wider collection of documents relating to flood risk management and warning. It is emphasised that SFRA reports are living documents which should be updated when Environment Agency datasets and other documents such as Catchment Flood Management Plans, Strategic Warning Systems and Shoreline Management Plans are updated and revised. This helps to contribute to a joined-up approach to flood risk management as a whole.

4.2 South Essex Catchment Flood Management Plan

4.2.1 The Catchment Flood Management Plan for South Essex was prepared by the Environment Agency and published in August 2008. The purpose of the CFMP is to develop policies for the long-term management of flood risk within the catchment, taking into account the likely effects of changes in climate, land use and land use management, and urban development. The policy approaches are defined for particular areas in the catchment and entail accepting, maintaining, reducing or transferring the flood risk. The policies for areas within Rochford District are shown in Figure 4-1 and summarised below.

Figure 4-1 South Essex CFMP Policy Areas (extracted from South Essex CFMP, 2008)



Preferred Policies

Policy Unit 1: Dengie Rural Tidal

4.2.2 This policy unit includes the tidal areas along the Rivers Crouch and Roach. Existing flood risk management measures include the extensive maintenance of arterial drains, rivers and brooks in the area. The selected policy for this area is Policy 2 to reduce existing flood risk management actions in this area, accepting that flood risk will increase with time.

Policy Unit 2: Rayleigh

4.2.3 Policy unit 2 includes the Rayleigh urban area and the Noblesgreen Ditch and Eastwood Brook. Existing flood risk management measures include dissemination of flood warnings and channel maintenance and improvements. The selected policy for this area is Policy 5, to take further action to reduce the flood risk, now and/or in the future, predominantly through improved flood warning service in the area and development control.

Policy Unit 3: Rochford & Hawkwell

4.2.4 This policy unit includes the upstream parts of the River Roach, Hawkwell Brook and Hockley Brook and urban areas of Rochford, Hawkwell and Hockley. Fluvial influences dominate in the upstream areas and tidal influences are present between Stambridge Mills and Rochford train station.

4.2.5 The selected policy for this area is Policy 4, to take further action to sustain the current level of flood risk into the future, responding to the potential increases in risk from urban development, land use change and climate change.

Policy Unit 4: Southern Crouch Catchment

4.2.6 This unit includes the rural areas to the south of the Crouch estuary including the urban areas of Ashingdon and Hullbridge. Current flood risk management in this area includes limited maintenance of the North Benfleet Brook, Rawreth Brook and a number of agricultural drains and ditches.

4.2.7 Within this area there is potential to restore the channels and floodplains thereby encouraging geomorphological and ecological biodiversity. Accordingly the selected policy for this unit is Policy 1, to cease all flood risk management activities.

4.3 Flood Warning Systems

4.3.1 The Civil Contingencies Act (2004) requires that the Environment Agency *'maintain arrangements to warn the public of emergencies'* including flood risk. The existing warning service provided by the Environment Agency applies only to flooding from rivers and the sea. There is no obligation on Water Companies to provide warnings of flooding from sewers or drains.

4.3.2 The Environment Agency are responsible for issuing flood warnings to the public based on meteorological reports and forecasts, including the use of radar to track storms and rainfall intensity, and data from the national tide gauge network. If flooding is forecast, warnings are issued using a set of four codes via the Environment Agency website, through TV and radio, SMS, fax, direct to your home via an automatic voice message and in some areas via public address systems. All existing development is included in the service under the 'opt out' policy; however any new development in the area will need to 'opt in' in order to benefit from the service.

4.3.3 The Environment Agency Flood Warning service consists of three warning messages as follows:

- **Flood Alert** - flooding is possible and that you need to be prepared.
- **Flood Warning** - flooding is expected and that you should take immediate action. You should take action when a flood warning is issued and not wait for a severe flood warning.
- **Severe Flood Warning** - there is severe flooding and danger to life. These are issued when flooding is posing significant risk to life or disruption to communities.

4.3.4 It should be noted that while it is a significant challenge to provide warning of a possible flood defence failure (breach) the likelihood of a failure is significantly increased during an extreme tide event. In this scenario, warnings of a high tide will have been issued to the local community who should be on alert.

4.3.5 The degree of advance warning that can be provided is critical to the amount of action that can be taken to prevent damage. It is anticipated that the Environment Agency will be able to provide at least 12 hours of warning time of extreme tides (i.e. 200 year event or greater (0.5% annual probability)).

4.3.6 Lead times for flood warnings from the Environment Agency with respect to fluvial systems are generally much shorter. For example, a lead time of 2 hours is expected for flooding on the Eastwood Brook close to the London Southend Airport site. Warning lead time availability is compounded by the rapid rate of water level rise in these watercourses in response to intense rainfall, the closeness of urban settlement to the Environment Agency's river level monitoring stations and the relatively short pathway from the sources of the watercourses to their respective points of outfall to estuary.

4.4 Rochford Emergency Flood Plan

4.4.1 The Civil Contingencies Act 2004 delivers a single framework for civil protection. Rochford DC are designated as a Category 1 responder and have a legal duty to assess local risks and use this information to inform emergency planning, put in place emergency plans and put in place arrangements to warn, inform and advise the public in the event of an emergency.

4.4.2 The Civil Contingencies Act (2004) defines an emergency as:

- *An event or situation which threatens serious damage to human welfare (e.g. loss of life, injury, damage to property).*
- *An event or situation which threatens serious damage to the environment (e.g. contamination).*

4.4.3 Flood Warning and Emergency Procedures tend to form part of a higher level emergency management plans for the wider area including information such as repair procedures, evacuation routes, refuge areas, flood warning dissemination and responsibilities.

4.4.4 Evacuation is where flood warnings provided by the Environment Agency can enable timely evacuation of residents to take place unaided, i.e. without the deployment of trained personnel to help people from their homes, businesses and other premises. Rescue by the emergency services is likely to be required where flooding has occurred and prior evacuation has not been possible.

4.4.5 Rochford DC has prepared a Multi Agency Flood Plan which should be read in conjunction with the Essex Resilience Forum (EFR) Multi Agency Flood Plan, of which it forms an appendix. The document includes details of the coverage of Environment Agency flood warnings and sets out the expected responses for individual agencies in line with the Essex Resilience Forum MAFP.

4.4.6 Six rest centres have been identified within the district. These are all located within Flood Zone 1 – Low Probability of flooding from tidal and fluvial sources.

4.4.7 The plan highlights that early consideration must be given to the evacuation of residents from Foulness Island and Paglesham due to the limitations of access and egress. It is recommended that the results from the Level 2 SFRA are provided to the Essex Resilience Forum to inform emergency planning procedures and update the MAFP where necessary.

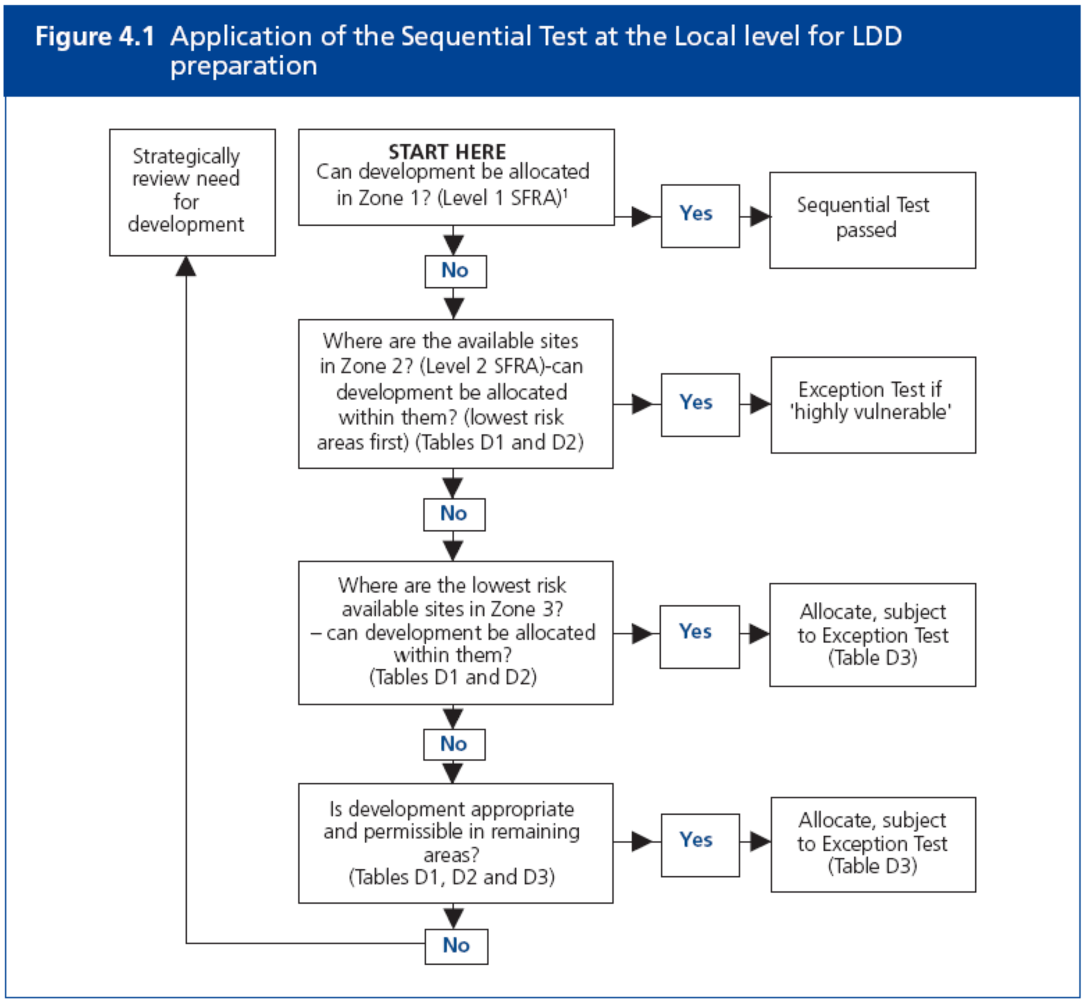
5 Guidance on the Application of the Sequential Test

5.1 Background

5.1.1 The sequential approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk. It should be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

5.1.2 The Sequential Test refers to the application of the sequential approach by Local Planning Authorities (LPA). This allows the determination of site allocations based on flood risk and vulnerability. Development should be directed to Flood Zone 1 wherever possible, and then sequentially to Flood Zones 2 and 3. In addition, development should be directed to areas of least flood risk within Flood Zone 2 and then Flood Zone 3, as identified within this SFRA. A flow diagram, extracted from the Practice Guide to PPS25, illustrating the application of the Sequential Test is provided in Figure 5-1.

Figure 5-1 Application of the Sequential Test, PPS25 Practice Guide, CLG 2009



Note

1 Other sources of flooding need to be considered in Flood Zone 1

Table 5-2 PPS25 Table D.2 Flood Risk Vulnerability Classification (CLG 2010)

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 critical operational reasons, including electricity generating power stations and grid and primary substations; water treatment plants; and sewage treatment plants if adequate measures to control pollution and manage sewage during flooding events are in place. • 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 requiring hazardous substances consent.6 (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'.
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan.**
Less Vulnerable	• 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 works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding 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, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, **subject to a specific warning and evacuation plan.**

[6] DETR Circular 04/00, paragraph 18: *Planning controls for hazardous substances.*
See www.communities.gov.uk/index.asp?id=1144377

5.1.3 PPS25 classifies developments according to their vulnerability and stipulates where the differing types of vulnerability are considered appropriate based on flood risk. The vulnerability classifications are shown in Table 5-2 and the compatibility matrix is shown in Table 5-3.

Table 5-3 PPS25 Table D.3 Flood Risk Vulnerability & Flood Zone Compatibility (CLG 2010)

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
FLOOD ZONE	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) ✗ – Development should not be permitted

5.1.4 The application of the sequential approach aims to manage the risk from flooding by avoidance. This will help avoid the promotion of sites that are inappropriate on flood risk grounds.

5.1.5 Rochford District Council must demonstrate that it has considered a range of possible sites in conjunction with the Flood Zone information from the SFRA and applied the Sequential Test, and where necessary, the Exception Test (see Appendix D of PPS25), in the site allocation process. In cases where development cannot be fully met through the provision of site allocations, LPAs are expected to make a realistic allowance for windfall development, based on past trends.

5.1.6 PPS25 acknowledges that some areas will (also) be at risk of flooding from flood sources other than fluvial or tidal systems. All sources of flooding must be considered when looking to locate new development. The other sources of flooding requiring consideration when situating new development allocations include:

- Surface Water;
- Groundwater;
- Sewers; and
- Artificial Sources.

5.1.7 These sources (as sources of flooding) are typically less understood than tidal and fluvial sources. Data primarily exists as point source data or through interpretation of local conditions. In addition, there is no guidance on suitable return periods to associate with floods arising from these sources. For example modern storm water drainage systems are constructed to a 1 in 30 year standard. Any storm event in excess of the 30 year return period storm would be expected to cause flooding. If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

5.2 Using the SFRA to Apply the Sequential Test

5.2.1 The Sequential Test should be undertaken by Rochford DC and accurately documented to ensure decision processes are consistent and transparent. The Sequential Test should be carried out on potential development sites, seeking to balance the flood probability and development vulnerability of sites throughout the Local Planning Authority area.

5.2.2 The recommended steps required to undertaking the Sequential Test are detailed below. This is based on the Flood Zone and Flood Risk Vulnerability, and is summarised in Figure 5-1.

Recommended stages for LPA application of the Sequential Test

5.2.3 The information required to address many of these steps is provided in the accompanying GIS layers and maps included in this SFRA Report.

1. Assign potential developments with a vulnerability classification (Table 5-2). Where development is mixed, the classification should be determined by the element of greatest vulnerability.
2. The location and identification of potential development should be recorded.
3. The Flood Zone classification of potential development sites should be determined based on a review of the Environment Agency Flood Zone maps for fluvial and tidal sources and upon the Flood Zones presented in this SFRA. Where these span more than one Flood Zone, all zones should be noted.
4. The design life of the development should be considered with respect to climate change:
   - 75 years – up to 2085 for commercial / industrial developments; and
   - 100 years – up to 2110 for residential developments
5. Identify existing flood defences serving the potential development sites. However, it should be noted that for the purposes of the Sequential Test, flood zones ignoring defences should be used.
6. Highly vulnerable developments to be accommodated within the LPA area should be located in those sites identified as being within Flood Zone 1. If these cannot be located in Flood Zone 1, because the identified sites are unsuitable or there are insufficient sites in Flood Zone 1, sites in Flood Zone 2 can then be considered. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development or seek opportunities to locate the development outside their administrative area. Highly vulnerable development within Flood Zone 2 must pass the Exception Test. Highly vulnerable development is not appropriate within Flood Zones 3a and 3b.
7. Once all highly vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as more vulnerable. In the first instance more vulnerable development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate more vulnerable development, sites in Flood Zone 3a can be considered. More vulnerable developments in Flood Zone 3a will require the application of the Exception Test. More vulnerable developments are not appropriate within Flood Zone 3b.
8. Once all more vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as less vulnerable. In the first instance less vulnerable development should be located in any remaining unallocated sites in Flood Zone

1, continuing sequentially with Flood Zone 2, then 3a. Less vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.

9. Essential infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is fulfilled.
10. Water compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last.
11. On completion of the Sequential Test, the LPA may have to consider the risks posed to a site within a flood zone in more detail in a Level 2 SFRA. By undertaking the Exception Test, this more detailed study should consider the detailed nature of flood hazard to allow a sequential approach to site allocation within a flood zone with the most vulnerable land uses being sited in the areas of least flood risk. Consideration of flood hazard within a flood zone would include:
    - flood risk management measures,
    - the rate of flooding,
    - flood water depth and or,
    - flood water velocity.

5.2.4 Where the development type is Highly Vulnerable, More Vulnerable, Less Vulnerable or Essential Infrastructure and a site is found to be impacted by a recurrent flood source (other than tidal or fluvial), the site and flood sources should be investigated further and the sequential test applied in line with paragraphs 4.8 to 4.12 of the PPS25 Practice Guide.

Windfall Sites

5.2.5 Windfall Sites are sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan.

5.2.6 Should a site become available that has not been allocated as part of the LDF process, the Sequential Test should be applied on an individual site basis and the developer will need to provide evidence to the LPA that they have adequately considered other reasonably available sites across the district. This will involve considering windfall sites against other sites allocated as suitable for housing plans.

5.2.7 The following steps should be followed for windfall sites:

1. Identify if the Sequential Test is required; Paragraph D.15 of PPS25 states that if the application is minor development or for a change of use, the Sequential and Exception Tests are not required. However, the application will still need to meet the requirements for FRAs and flood risk reduction as set out in Table D.1 of PPS25.
2. If the Sequential Test is required, identify which Flood Zone the site is located within using the Environment Agency flood maps and the Flood Zones presented within this SFRA. If comparing sites within the same Flood Zone the SFRA should be used to compare the variation in risk throughout the Flood Zone or site specific Flood Risk Assessments where available.
3. Agree scope and considerations for the site-specific Sequential Test and, where necessary, Exception Test with the LPA.

6 Level 2 Assessment of Tidal Flood Risk

6.1 Overview

6.1.1 It has been established that a large proportion of the study area is at residual risk of tidal flooding in the event that the existing defences are overtopped or fail.

6.1.2 In accordance with PPS25 and the Practice Guide, part of the requirement of the Level 2 SFRA is to provide an assessment of the residual risk, i.e. the risk remaining after flood risk management measures have been taken into account. As a result, hydrodynamic modelling has been undertaken at seven locations around the tidal frontage of Rochford to model the impact of a breach or overtopping of these defences.

6.2 Potential Flooding Mechanisms

6.2.1 Flood defences are designed and constructed to rigorous structural and geotechnical codes to a specific standard of protection or return period. If defences are subjected to a loading greater than the standard of protection, there is a significant likelihood that they will fail.

6.2.2 A breach in flood defences is defined as:

> *'The failure of a flood defence mechanism by which the structural integrity of the flood defence is compromised and part or all of the defence collapses allowing water to flow through'.*

6.2.3 Overtopping of defences can be caused when:

> *'Flood waters exceed the lowest crest height of the flood defences or if high winds begin to generate significant swells in the ocean that bring waves crashing over the top of defences'*

6.2.4 There are a number of potential circumstances and mechanisms which may lead to failure of flood defences, such as:

- Collision of shipping traffic with tidal wall;
- Hydrostatic water pressure during high tides;
- Vehicle collision;
- Floating object such as a partly submerged container;
- Damage to a pipeline running through a tidal wall;
- Damage or explosion of an installation on the landward side of the tidal wall;
- Floodgate being left open;
- Scouring and erosion of the landward side of the defence in the event of overtopping;
- Fissuring and desiccation of clay fill.

6.2.5 Breaches are more likely to occur during high water level events including extreme tides when loads on the defence will be greater.

6.2.6 The time taken for a breach to be blocked can have a major impact on the extent and depth of flood experienced. The highest flood hazard typically exists in the period immediately following a breach and usually but not necessarily in the areas closest to a breach.

6.2.7 Floodwater flowing through a breach in the defences will generally be of high velocity and volume, dissipating rapidly across large low lying areas. Flooding as a result of a breach in defences from tidal sources such as this can be life threatening with far reaching consequences. Breaching of the flood defences has the potential to generate considerable flood hazard and damage to homes and infrastructure.

6.2.8 As part of this SFRA, 2D modelling has been carried out to assess the impact of residual risks following a breach or overtopping scenario. A brief overview of the methodology is provided below and a full modelling methodology is provided in Appendix E.

Figure 6-1 Flood Defences & Modelled Flood Cells in Rochford District

ROC07 Block revetment on earth embankment. **ROC07** Steel capped revetment.

ROC06 Loftmans Sluice.

ROC05 Block revetment on earth embankment.

ROC04 Flood Gate at Paglesham.

ROC04 Block revetment on earth embankment.

ROC03 Block revetment on earth embankment.

6.3 Modelling Methodology

Breach Assessment

6.3.1 Details of the seven breach locations are included in Table 4-1 and their location is shown on Figure A-1 in Appendix A and Figure 6-1.

Table 6-1 Breach Names and Characteristics

Code	Flood Cell	Breach Name	Easting	Northing	Breach Width [m]
ROC01	Shoeburyness	Morrin's Point	596298	186654	200
ROC02	Shoeburyness	Wakering Stairs	596900	187100	50
ROC03	Shoeburyness	Oxenham Farm	595745	188694	50
ROC04	Paglesham	Paglesham Eastend	594816	192185	50
ROC05	Wallasea	Grapnells, Wallasea Island	594700	195000	50
ROC06	Paglesham	Loftmans Farm, Paglesham Creek	592310	193790	50
ROC07	South Fambridge	South Fambridge	585500	196200	50

6.3.2 The following flood events were simulated for each of the breach locations:

- 1 in 200 year event (0.5% AEP) present day, 2010
- 1 in 200 year event (0.5% AEP) with climate change, 2110
- 1 in 1000 year event (0.1% AEP) present day, 2010
- 1 in 1000 year event (0.1% AEP) with climate change, 2110

Overtopping

6.3.3 Modelling has also been undertaken in order to assess the impact of overtopping of the existing defences, without consideration of a breach in the flood defences. The following flood events were simulated for each of the four flood cells (Shoeburyness, Paglesham, Wallasea & South Fambridge):

- 1 in 200 year event (0.1% AEP) with climate change, 2110
- 1 in 1000 year event (0.1% AEP) with climate change, 2110

6.3.4 A detailed description of the modelling methodology is included in Appendix E. The following section describes the generation and mapping of the outputs from the hydrodynamic modelling.

6.4 Modelling Outputs

Maximum Flood Depth

6.4.1 The flood depth maps included in Appendix B show the maximum depth of flooding which is experienced at each individual element in the model throughout the entire simulation. The maximum flood depth is obtained from the water level achieved at each point in the model, minus the LiDAR topographic level at that point.

6.4.2 The peak depth will occur at different times depending upon the location of the model under consideration. For example, immediately adjacent to the breach location or defences that experience overtopping, the peak depth will be experienced around the same time as when the tidal water level boundary peaks. However peak depths inland, some distance away from the defences will be experienced at a later time when water has spread further throughout the model. The flood depth map therefore presents a worst case and conservative scenario.

6.4.3 Figures B-1 to B-4 in Appendix B show the maximum flood depth for all of the modelled breach scenarios. These are 'composite' maps and therefore illustrate the maximum depth experienced from all seven breach locations.

6.4.4 Figures B-5 and B-6 show the maximum flood depths as a result of overtopping of the defences.

Hazard Rating

6.4.5 Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain. Each element within the model is assigned one of four hazard categories 'Extreme Hazard', 'Significant Hazard', 'Moderate Hazard', and 'Low Hazard'.

6.4.6 The derivation of these categories is based on the methodology in Flood Risks to People FD2320[7] using the following equation:

*Flood Hazard Rating = ((v+0.5)*D) + DF* *Where v = velocity (m/s)*

D = depth (m)

DF = debris factor

6.4.7 The depth and velocity outputs from the 2D hydrodynamic modelling are used in this equation, along with a suitable debris factor. For this SFRA, a precautionary approach has been adopted inline with FD2320; a debris factor of 0.5 has been used for depths less than and equal to 0.25m, and a debris factor of 1.0 has been used for depths greater than 0.25m.

Table 6-2 Hazard categories based on FD2320, Defra & Environment Agency 2005

Flood Hazard		Description
Low	HR < 0.75	**Caution** – Flood zone with shallow flowing water or deep standing water
Moderate	0.75 ≥ HR ≤ 1.25	**Dangerous for some** (i.e. children) – Danger: flood zone with deep or fast flowing water
Significant	1.25 > HR ≤ 2.0	**Dangerous for most people** – Danger: flood zone with deep fast flowing water
Extreme	HR > 2.0	**Dangerous for all** – Extreme danger: flood zone with deep fast flowing water

6.4.8 Figures C-1 to C-4 in Appendix C are composite maps showing the maximum flood hazard rating for all of the modelled breach scenarios. These are 'composite' maps and therefore illustrate the maximum depth experienced from all seven breach locations.

6.4.9 Figures C-5 and C-6 show the flood hazard as a result of overtopping of the defences.

[7] Defra and Environment Agency (2005) FD2320 Flood Risks to People

Time to Inundation

6.4.10 The time taken for floodwaters to propagate from the breach location has also been mapped using the following methodology. This information is useful for assessing the length of time before floodwaters reach a particular site and therefore the time available for evacuation to a place of safety.

6.4.11 Time zero is set to the time when tidal water enters the breach. This means that the <1 hour band encompasses all areas that are inundated (wet) within the first hour of water travelling through the breach and into the flood cell. Further bands have been produced to show wet cells at: 1-4 hours, 4-8 hours, 8-12 hours, 12-16 hours and 16-20 hours.

6.4.12 Time to inundation is specific to each breach location; therefore mapping of each of the 7 breach locations is provided in Appendix D. Mapping has been provided for the 1 in 1000 year plus climate change to 2110 event and the 1 in 200 year plus climate change to 2110 event. The 1 in 1000 year plus climate change to 2110 event represents the most conservative scenario and should be used for emergency planning purposes. Lower return period events including scenarios for present day scenarios are likely to lead to a lower time to inundation across the flood cells.

6.5 Limitations

Flood Depth and Hazard Rating

6.5.1 It should be noted when using flood hazard zone maps that they **represent the hazard arising from one or more specific breach locations, and that the hazard will almost certainly vary spatially if the breach locations are moved.** This is also the case for the flood depth maps and time to inundation maps.

6.5.2 Other limitations that should be noted include:

- Not all possible breach locations have been considered. The modelling study had to be limited to those locations thought most likely to lead to flood risk for specific development areas.
- Breach width and depth, though based on Environment Agency guidance, are arbitrary and do not necessarily represent the actual dimensions of a possible breach in a given location.
- Changes in inundation extent or hazard zone are non-linear to changes in breach location.
- Hazard mapping is developed as a product of the depth, velocity and a debris factor from a particular breach event or combined breach event within a given flood cell. These hazard classifications do not indicate a change in the flood probability.

Time to Inundation

6.5.3 The values presented for time to inundation are indicative only. The modelling methodology used for this study produces results from a breach occurring prior to the second and largest tidal cycle. This allows water to overtop where defences are below the water level during the first tidal cycle. The modelling method also allows the rapid inundation of land immediately behind the breach where water has accumulated on the seaward side of the breach.

6.6 Modelling Results

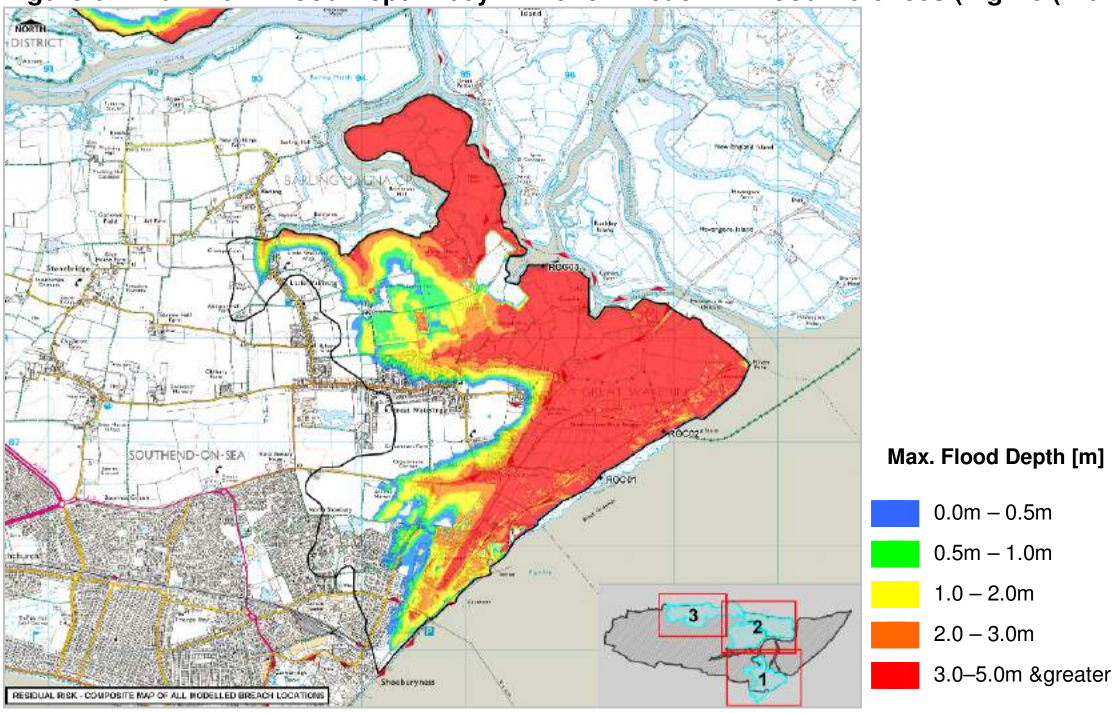
6.6.1 The remainder of this Chapter comprises a review of the residual tidal flood risk within each of the flood cells. All mapping is provided in full in Appendices B, C and D.

Shoeburyness Flood Cell: Review of Residual Flood Risk

Breaches (ROC01, ROC02, ROC03)

6.6.2 Three breach locations have been modelled within this flood cell. Figure 6-2 shows the composite flood depth map for these three breach events for the 1 in 200 year flood event, including allowances for climate change to 2110. Flood depths are shown to reach greater than 3m across the eastern part of the flood cell. Existing development at Oxenham, Cupid's Corner, Halfway House Farm, Landwick Cottages and Samuel's Corner, the Sewage Works adjacent to Havengore Creek and the northern part of Great Wakering experiences significant flood depths.

Figure 6-2 Maximum Flood Depth 200yr 2110 for Breach in Flood Defences (Fig B3 (View 1))

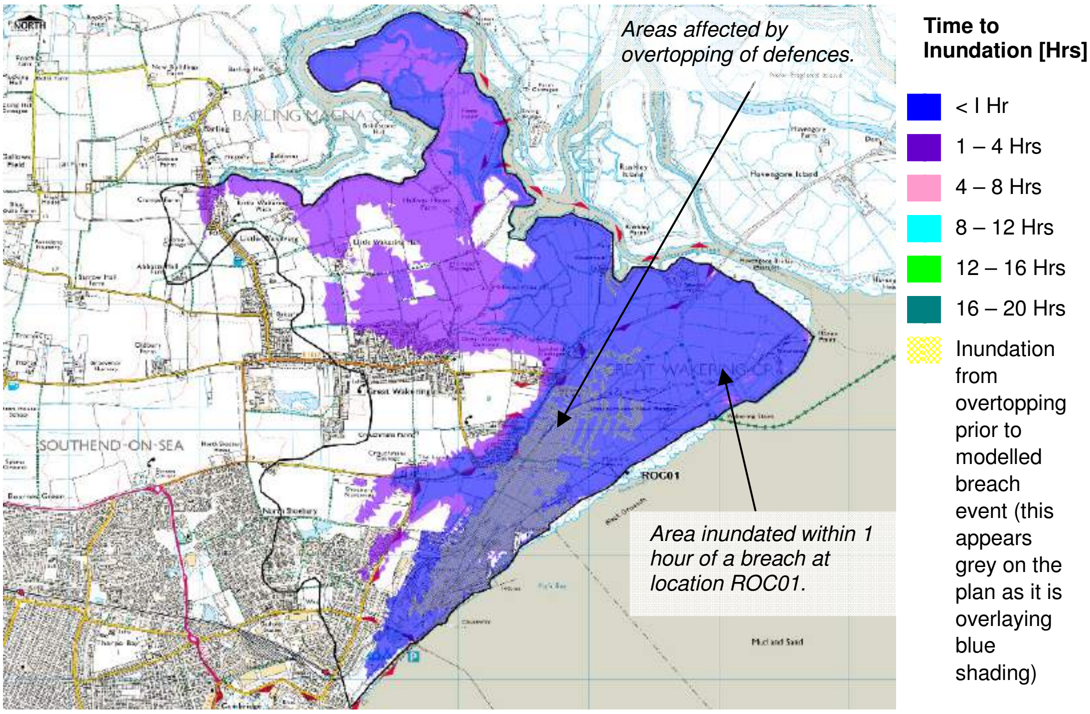


6.6.3 Figure 6-3 overleaf demonstrates that during the 1in 200 year flood event, including allowance for climate change to 2110, flood waters inundate the flood cell rapidly. Floodwaters inundate the Shoeburyness New Ranges and reach Landwick Cottages within 1 hour, and the whole flood cell is inundated within 2 hours of the breach event, providing limited time for evacuation of residents.

6.6.4 The B1017 forms the primary evacuation route from Great Wakering. Access and egress from the smaller villages is not possible during these flood events.

6.6.5 There are no new developments planned within this area as part of the Rochford Core Strategy. However ad hoc planning applications may be submitted for the redevelopment of individual properties. Where this is the case, proposals should meet the requirements of PPS25 and those outlined in Chapter 9 of this report.

Figure 6-3 Time to Inundation from ROC01, 1000yr plus Climate Change (Fig D1)



Overtopping

6.6.6 Modelling shows that the flood defences along the Shoeburyness frontage are overtopped during the 1 in 200 year event including an allowance for climate change. Figures B5 and B6 demonstrate that this overtopping leads to similar flood depths and extents to those experienced during a breach event.

Paglesham Flood Cell: Review of Residual Flood Risk

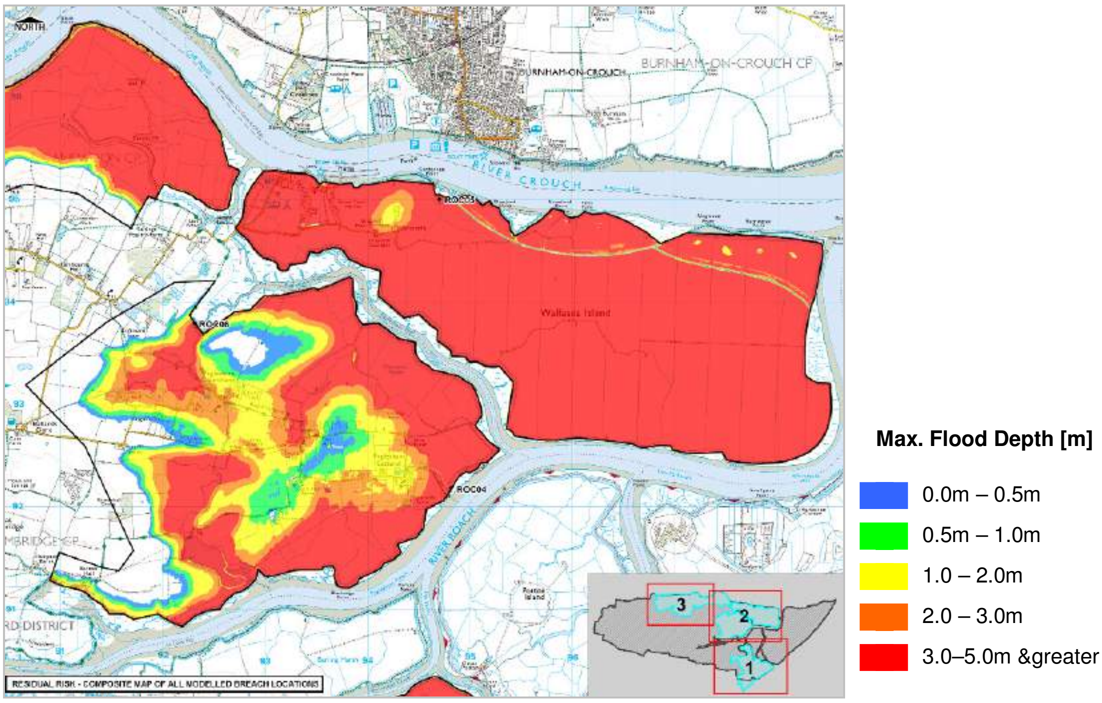
Breaches (ROC04, ROC06)

6.6.7 Two breach locations have been modelled in the Paglesham flood cell. Figure 6-4 shows the composite flood depth map for these breach events for the 1 in 200 year flood event, including allowances for climate change to 2110.

6.6.8 Floodwaters initially spread around the eastern edge of Paglesham where the topography is low lying. Maximum flood depths are experienced in Clements Marsh and in the south of the flood cell. Floodwaters spread inland and inundate Paglesham Churchend and Pagelsham Eastend to depths of between 1-3m. The access routes to these settlements are also inundated to depths of 3m causing significant problems for access and egress for occupants.

6.6.9 Current development comprises small villages and isolated buildings and connecting minor roads. Although there is no development proposed for this part of the district, ad hoc planning applications may be submitted for redevelopment of individual properties. Where this is the case, proposals should meet the requirements of PPS25 and those outlined in Chapter 9 of this report.

Figure 6-4 Maximum Flood Depth 200yr 2110 for Breach in Flood Defences (Fig B3 (View 2))



Overtopping

6.6.10 Modelling shows that the flood defences along the Paglesham frontage are overtopped during the 1 in 200 year event including an allowance for climate change. Figures B5 and B6 demonstrate that this overtopping leads to flood depths and extents very similar to those experienced during a breach event.

Wallasea Island Flood Cell: Review of Residual Flood Risk

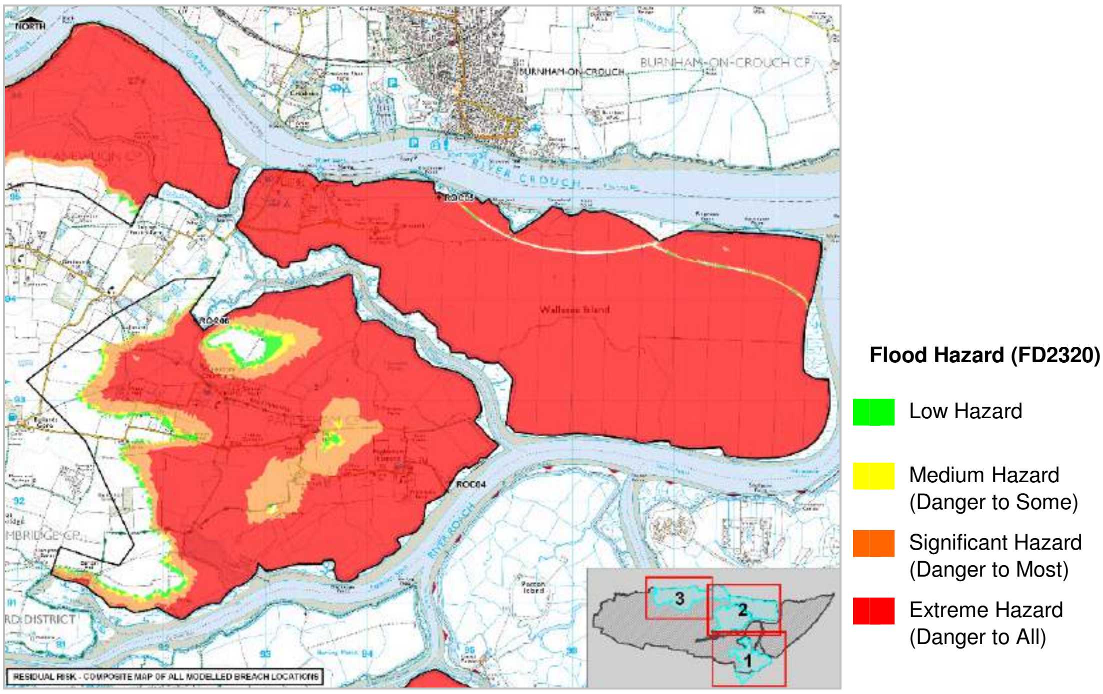
Breach (ROC05)

6.6.11 One breach location, ROC05, has been modelled within the Wallasea Island flood cell. Figure 6-4 shows the composite flood depth map for the 1 in 200 year flood event, including allowances for climate change to 2110. This figure shows that Wallasea Island experiences significant flooding and floodwaters cover the whole of the island to depths of greater than 3m. Such depths of flooding correspond to an ‘extreme’ hazard rating, which signifies ‘danger to all people’, as shown in Figure 6-5.

6.6.12 Access to existing development is severely restricted during a breach which has implications for emergency services and the safe evacuation of occupants of the island.

6.6.13 Apart from the marina, there is limited development on Wallasea Island; two small villages and a caravan and camping park. In light of the extreme hazard, no development is planned in this area. However ad hoc planning applications may be submitted for the redevelopment of individual properties. Where this is the case, proposals should meet the requirements of PPS25 and those outlined in Chapter 9 of this report.

Figure 6-5 Flood Hazard 200yr 2110 for Breach in Flood Defences (Fig C3 (View2))



Overtopping

6.6.14 Modelling shows that the flood defences around Wallasea Island are overtopped during the 1 in 200 year event including an allowance for climate change. Figures B5 and B6 demonstrate that this overtopping leads to similar flood depths and extents to those experienced during a breach event.

South Fambridge Flood Cell: Review of Residual Flood Risk

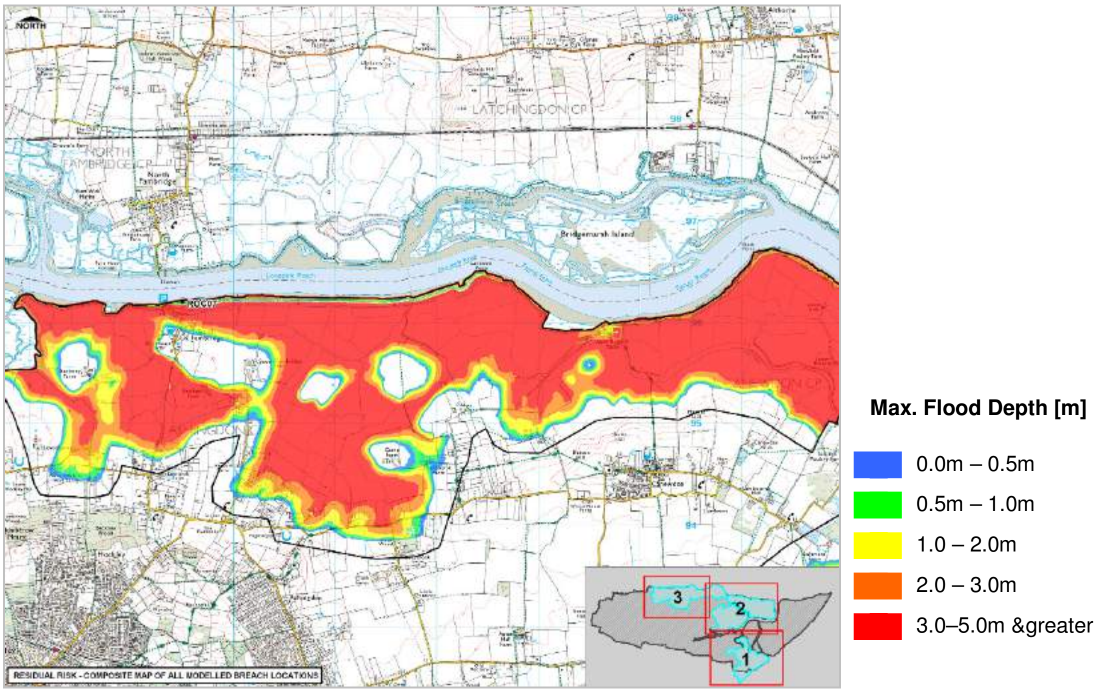
Breach (ROC07)

6.6.15 One breach location, ROC07, has been modelled in the South Fambridge flood cell. Figure 6-6 shows the composite flood depth map for the 1 in 200 year flood event, including allowances for climate change to 2110. This figure shows that floodwaters propagate along the riverfront to the east of the breach with depths of 3m and greater. A number of isolated farms such as Raypitts Farm, Brenham Farm and Scaldhurst Farm are shown to be at risk of flooding, as well as the northern part of South Fambridge.

6.6.16 The majority of the remaining area of inundation is allocated Landscape Improvement Area, Coastal Protection Belt and Special Landscape Area. No development is planned for this area, however ad hoc planning applications may be submitted for the redevelopment of individual properties. Where this is the case, proposals should meet the requirements of PPS25 and those outlined in Chapter 9 of this report.

6.6.17 It should also be noted that under the policy for this area as part of the Catchment Flood Management Plan is to reduce existing flood risk management actions in this area, accepting that flood risk will increase with time. Therefore future development in this area should be restricted where possible to ensure that the risks are not increased.

Figure 6-6 Maximum Flood Depth 200yr 2110 for Breach in Flood Defences (Fig B3 (View 3))



6.6.18 These flood risk maps should be used to inform emergency planning in the area, in order to help to reduce the risks associated with flooding in this part of the district.

Overtopping

6.6.19 Modelling shows that the flood defences along this part of the tidal frontage are overtopped during the 1 in 200 year event including an allowance for climate change. Figures B5 and B6 demonstrate that this overtopping leads to similar flood depths and extents to those experienced during a breach event.

7 Guidance on the Application of the Exception Test

7.1 Overview

7.1.1 The aim of the Sequential Test is to steer all development towards areas of lowest risk. However, PPS25 recognises that in some exceptional circumstances, it may not be possible to locate development within areas of low flood risk. Where the Sequential Test has been carried out and it is shown that there are no reasonably available sites in lower flood risk areas, the Exception Test will then be required in some circumstances.

7.1.2 Through the application of the Exception Test any additional wider sustainability benefits resulting from development can be taken into account in order to demonstrate that the benefits for development of a site outweigh the flood risks to the development and its occupants.

7.2 What is the Exception Test?

7.2.1 The Exception Test comprises three criteria, described below, all of which must be satisfied for development in a flood risk area to be considered acceptable.

Part A – Wider Sustainability to the Community

7.2.2 It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by this SFRA.

7.2.3 For this element to be passed, the site must be shown to positively contribute to the aims and objectives of the Council's Sustainability Appraisal. Where this is not the case, it must be considered whether the use of planning conditions or S106 agreements could make it do so. If neither of these are possible, the site is not deemed to pass part 'a' and the allocation should be refused.

Part B – Redevelopment of Previously Developed Land

7.2.4 The development should be on developable previously developed land or, if not, it must be demonstrated there is no such alternative land available.

7.2.5 Planning Policy Statement 3: Housing defines previously developed land as:

'Previously-developed land is that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.'

7.2.6 The definition includes defence buildings, but excludes:

- Land that is or has been occupied by agricultural or forestry buildings.
- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures.
- Land in built-up areas such as parks, recreation grounds and allotments, which, although it may feature paths, pavilions and other buildings, has not been previously developed.
- Land that was previously-developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

7.2.7 There is no presumption that land that is previously-developed is necessarily suitable for housing development nor that the whole of the curtilage should be developed.

Part C – Safe from Flood Risk

7.2.8 A Flood Risk Assessment (FRA) must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall. At the level of strategic planning the SFRA must be used in order to assess the potential feasibility of providing flood risk management measures for site allocations/broad development locations.

7.2.9 Further detail regarding the definition of 'safe' development is included in Chapter 9 'Site Specific Flood Risk Assessments'.

8 Site Specific FRA Guidance

8.1 Overview

8.1.1 This Level 1 and Level 2 SFRA provide a comprehensive collation of existing flood risk information in the area. The hydrodynamic breach modelling undertaken as part of the Level 2 assessment provides new information on the potential risks and hazards from tidal sources. However the scope of this document is strategic and therefore it is vital that site specific Flood Risk Assessments are produced by those proposing development in flood risk areas.

8.1.2 It is probable that flood risk exists within an area that has not been highlighted in the SFRAs either because the information has not existed or due to other factors, for example the location of breach assessments relative to development areas. Therefore, site specific FRAs are required to assess the flood risk posed to proposed developments and to ensure that where necessary and appropriate, suitable mitigation measures are included in the development. They should use information from the SFRA, where this is helpful or strengthens the assessment.

8.1.3 This section presents recommendations and guidance for site-specific FRAs prepared for submission with planning applications within the Rochford district.

8.2 When is a Flood Risk Assessment required?

8.2.1 PPS25 states that in the following situations a Flood Risk Assessment should always be provided with a planning application:

1. The development site is located in Flood Zones 2 or 3;
2. The area of the proposed development site area is 1 hectare or greater in Flood Zone 1. This is to ensure surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property. Surface water management will also need to be considered as part of the Flood Risk Assessment for sites of 1 hectare or greater in Flood Zone 2 and 3; and
3. The development site is located in an area known to have experienced flooding problems from any flood source.

8.2.2 The Environment Agency provides flood risk standing advice for applicants and agents on their website http://www.environment-agency.gov.uk/research/planning/82587.aspx. This includes information on when a Flood Risk Assessment is required and advice on the contents of FRAs for various development types in Flood Zones 1, 2 and 3.

8.3 What does a Flood Risk Assessment include?

8.3.1 The PPS25 Practice Guide (CLG 2010) sets out a staged approach to site specific Flood Risk Assessments, with the findings from each stage informing both the next level and the site Masterplan throughout the development process. Table 8-1 provides a summary of these levels.

8.3.2 FRAs should always be proportionate to the degree of flood risk in each case and appropriate to the scale, nature and location of the proposed development as well as its vulnerability.

Table 8-1 Levels of Site Specific FRA, PPS25 Practice Guide (CLG 2009)

FRA Level	Description of Report Content
Level 1 **Screening Study**	The Level 1 Flood Risk Assessment is intended to identify any flooding or surface water management issues related to the development site that may require further investigation. The study should be based on readily available existing information, including: • SFRA, • Environment Agency Flood Maps, • Standing Advice The Level 1 Flood Risk Assessment will determine the need for a Level 2 or 3 FRA.
Level 2 **Scoping Study**	Where the Level 1 Flood Risk Assessment indicates that the site may lie in an area at risk of flooding, or may increase flood risk elsewhere due to runoff, a Level 2 Flood Risk Assessment should be carried out. This report will confirm sources of flooding which may affect the site and should include the following; • Appraisal of available and adequacy of existing information; • Qualitative appraisal of the flood risk posed to the site, the potential impact of the development on flood risk on and off the site; • An appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. This Level may identify that sufficient quantitative information is already available to complete a Flood Risk Assessment appropriate to the scale and nature of the development.
Level 3 **Detailed Study**	Undertaken if the Level 2 Flood Risk Assessment concludes that further quantitative analysis is required in order to assess flood risk issues related to the development site. This Level should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of development on the site under investigation on flood risk on and off the site; • Quantitative demonstration of the effectiveness of any proposed mitigation measures.

8.3.3 Annex E of PPS25 presents the minimum requirements for a Flood Risk Assessment as follows:

- Consider the risk of flooding off-site arising from the development in addition to the risk of flooding on-site to the development;
- Identify and quantify the vulnerability of the development to flooding from different sources and identify potential flood risk reduction measures;
- Assess the remaining ‘residual’ risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development;
- Consider the vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access as prescribed by Planning Policy Statement 25 (PPS25) and associated guidance;
- Consider the ability of the soil to receive surface water runoff generated on site, and how it would be stored and managed, along with how the proposed layout of development may affect drainage systems; and
- All calculations must fully account for current climate change scenarios and their effect on flood zoning and risk.

8.3.4 At all stages, Rochford DC and where necessary the Environment Agency and Anglian Water should be consulted to ensure the Flood Risk Assessment provides the necessary information to fulfil the requirements for Planning Applications.

8.3.5 The following Chapter provides more detailed guidance and best practice on specific requirements that should be addressed as part of a site specific FRA for developments in Rochford, in order to demonstrate that the proposed development is 'safe' in accordance with PPS25.

9 Guidance for Developers & Emergency Planning

9.1 Overview

9.1.1 The following sections provide guidance and best practice on what should be addressed within a site specific FRA for developments in Rochford in order to demonstrate that the proposed development is 'safe' in line with PPS25. The FRA Checklist in Appendix B of the PPS25 Practice Guide is also a useful tool for developers or others involved in the preparation of a planning application for which an FRA is required.

9.1.2 It should be noted that the specific definition of 'safe' development will vary for each individual site based on location and development vulnerability. It is therefore recommended that developers liaise with Rochford Emergency Planners on a site by site basis to establish whether the consideration of evacuation potential, inundation onset times, rates of rise, flood hazard and depth, floor levels, refuge potential and the key points for working up a site level Response Plan are likely to help in delivering a safe development.

9.2 Risks of Developing in Flood Risk Areas

9.2.1 Developing in flood risk areas can result in significant risk to a development and site users. It is possible to reduce the risk through the incorporation of mitigation measures; however, these do not remove the flood risk altogether and developments situated in the floodplain will always be at risk from flooding. This creates Health and Safety considerations, possible additional costs and potential displacement of future residents during flood events, which could result in homes and businesses being uninhabitable for substantial periods of time.

9.2.2 The guidance in this chapter should identify the requirements of a FRA and the main flood risks posed to the site; additional issues to consider include the following:

- Failure to consider wider plans prepared by the Environment Agency or other operating authorities may result in a proposed scheme being objected to;
- Failure to identify flood risk issues early in a development project could necessitate redesign of the site to mitigate flood risk;
- Failure to adequately assess all flood risk sources and construct a development that is safe over its lifetime could increase the number of people at risk from flooding and/or increase the risk to existing populations;
- Failure to mitigate the risk arising from development may lead to claims against the developer if an adverse effect can be demonstrated (i.e. flooding didn't occur prior to development) by neighbouring properties/residents;
- Properties may be un-insurable and therefore un-mortgageable if flood risk management is not adequately provided for the lifetime of the development;
- By installing SuDS without arranging for their adoption or maintenance, there is a risk that they will eventually cease to operate as designed and could therefore present a flood risk to the development and/or neighbouring property;
- The restoration of river corridors and natural floodplains can significantly enhance the quality of the built environment whilst reducing flood risk. Such an approach can significantly reduce the developable area of sites or lead to fragmented developments,

however positive planning and integration throughout the master planning process should resolve these potential issues.

9.3 Planning Requirements

PPS25 Sequential & Exception Tests

9.3.1 A site specific FRA for a proposed development should demonstrate that the development is in accord with the LPA's site allocations. Where the site has not been sequentially tested, the FRA should provide the necessary information to enable the LPA to do so. If the Exception Test is required, the FRA should provide the necessary evidence to support part c) of the test.

Development behind existing flood defences

9.3.2 'Development should not normally be permitted where flood defences, properly maintained and in combination with agreed warning and evacuation arrangements, would not provide an acceptable standard of safety taking into account climate change[8].

9.3.3 Rochford DC as the planning authority must take the flood hazard fully into account when drafting Local Development Documents and considering planning applications.

9.3.4 Risks will be greatest close to flood defences and as such where possible Rochford DC should seek opportunities to set back developments from defences. This will also facilitate the need for the Environment Agency to gain access to defences for maintenance and upgrades.

9.3.5 Other raised infrastructure such as roads or rail embankments should be considered in terms of their potential to provide secondary defences.

Flood Zone 3b Functional Floodplain

9.3.6 PPS25 defines Flood Zone 3b Functional Floodplain as *'land where water has to flow or be stored in times of flood'*. The definition remains open to interpretation and agreement between the Environment Agency and the Local Planning Authority, however, areas which would naturally flood with an annual exceedance probability of 1 in 20 (5%) or greater are often used as a starting point for delineation of Functional Floodplain and have been used to map Flood Zone 3b in this SFRA.

9.3.7 Paragraph 4.91 of the PPS25 Practice Guide states that existing developed areas are not generally defined as part of the Functional Floodplain. In these cases, PPS25 advocates an approach whereby the high level of flood risk is acknowledged and recognised without applying the strict policy restrictions associated with Functional Floodplain.

9.3.8 Existing developed areas lying within Flood Zone 3b are present within the district, for example in the southern parts of Rochford town. The classification of whether or not a site within these areas lies within the Functional Floodplain should be identified on a site by site basis as part of a site specific Flood Risk Assessment.

9.3.9 Where it can be demonstrated that the existing buildings exclude floodwater, these buildings are not considered to be part of the Functional Floodplain. Where the existing buildings do not exclude floodwaters, the site is Functional Floodplain and further redevelopment of the site is only permitted for Water Compatible land uses or Essential Infrastructure subject to the satisfaction of the Sequential Test and Exception Test, in accordance with PPS25.

[8] PPS25 Development and Flood Risk CLG 2010

9.3.10 Where a site is not considered to be located within Functional Floodplain, any future redevelopment should be restricted to less vulnerable land uses. More vulnerable land uses should be actively discouraged and should only be considered within sites of an equivalent existing land use.

9.3.11 Any future redevelopment within this area must result in a reduction in the flood risk to and from the proposed development, and opportunities should be sought to create areas for the storage and conveyance of floodwaters. Further information and guidance for potential developers is included in Section 9.5.

9.4 Emergency Planning Considerations

9.4.1 Details regarding Flood Warning Systems and provision for Emergency Planning have been discussed in Chapter 4.

9.4.2 It is recommended that the results from the hydrodynamic modelling with respect to anticipated flood depths and time to inundation is used by the Essex Resilience Forum to inform emergency planning procedures and update the MAFP where necessary.

9.4.3 The figures included in Appendix D demonstrate that the time available for the safe evacuation of occupants located in the floodplain is extremely limited. In most of the modelled scenarios, floodwater inundates the majority of the flood cell within 1 hour. As a result, it is vital that flood warnings are adhered to and acted upon during periods when the risk of high tides and overtopping is increased.

9.4.4 Evacuation Plans for individual developments located within areas at risk of flooding should be prepared by developers in conjunction with the borough-wide Emergency Plan to direct people to safety during times of flood. This may include details of flood warning mechanisms and an evacuation route away from the site to an area outside the floodplain, or to a place of safe refuge within the development itself.

9.4.5 When submitting FRAs for developments within flood risk areas, developers should make reference to this strategic Emergency Plan and Environment Agency flood warning systems to demonstrate that their development will not impact on the ability of Rochford DC and the emergency services to safeguard the current population. The flood hazard in a particular area must be viewed in the context of the potential evacuation and rescue routes to and from that area and discussed as part of a site specific FRA.

9.5 Development Control Recommendations

Sequential Approach

9.5.1 Where the development includes development types of varying vulnerability in accordance with the definitions in PPS25, Paragraph D8 of PPS25 states that developers should apply the sequential approach to the allocation of land uses *within* the development site. This process should ensure that elements of the redevelopment that are of greater vulnerability are located in parts of the site at lowest risk.

Access and Egress

9.5.2 Paragraph 8 of PPS25 requires that the LPA, in determining planning applications should "ensure that all new development in flood risk areas is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed".

9.5.3 Wherever possible, access routes should be provided above the design flood level for the 1 in 200 year + CC level. Where this is not possible limited depths of flooding may be appropriate, provided that the proposed access is designed with appropriate signage and other measures to make it safe. The acceptability of the proposed access should be assessed using Table 13.1 of Defra Research document FD2320/TR2: FRA Guidance for New Developments which takes into account the flood depth, velocities and risk of debris within the water. The access/egress route should fall within the "white cells" of this document.

9.5.4 When assessing access and egress, the following should also be considered:

- The **vulnerability and mobility** of those in danger of flooding; development for highly vulnerable users e.g. disabled or the elderly, should be located away from high-risk areas. Whilst the Sequential Test accounts for the vulnerability of the intended use of the development, no specific consideration is made for the vulnerability of the end users of the site. A proposed residential development for highly vulnerable end users (elderly, physically impaired etc) will still fall under the 'More Vulnerable' classification in Table D.2 of PPS25 and the Sequential and Exception Tests will apply accordingly. Where development for highly vulnerable end users cannot be avoided, safe and easy evacuation routes are essential.
- The **time to inundation** mapping relates to the amount of time it takes for a flood event to reach a specific point. Flood events with a very short time to peak provide very little time and opportunity for evacuation. This is typically the case if a defence structure is breached or fails because the inundation will be rapid, resulting in a short time to peak for the areas local to the breach. On the other hand, during tidal events, should a breach occur early in the tidal cycle, the time to peak could be a lot slower which would allow evacuation procedures to be undertaken. Typically, areas immediately adjacent to a breach location will have a shorter time to peak than areas set back from the flood defence.

9.5.5 It may not be possible for all developments to be proposed in areas where both safe access and egress can be guaranteed during a flood. In this situation, the potential implications for development should be considered by assessing the following:

- Probability of flooding;
- Expected flood hazard;
- Likelihood of occupancy during flooding, based on the proposed use;
- Acceptability of disruption based on the proposed use;
- Availability of safe refuge;
- Potential for the provision of key services (e.g. water, electricity, telecommunications)
- Expected rate and rise of inundation by floodwaters.

9.5.6 The following aspects are considerations for development with respect to inundation times from a residual risk event. Actual flood risk may be require stricter considerations and should be agreed early in the planning process with the LPA (in consultation with emergency planners and the Environment Agency).

9.5.7 1-4 Hours – For any residential development located within areas defined by a time to inundation of less than 4 hours, finished floor levels for sleeping accommodation should be set above the flood level. Refuge should be provided for all developments in this area above the flood level. It is noted that although provision of a place of dry refuge plays an important role in reducing the overall level of flood risk, it does not by itself make a development 'safe'. Further consultation should be sought from Rochford District Emergency Planners regarding this issue.

9.5.8 4-8 Hours – For residential development classified within the 4-8 hour time to inundation, where possible finished floor levels should be located 300mm above the 1 in 200 year flood level including allowances for climate change. Safe refuge should also be provided above the flood level and egress and access routes determined to Flood Zone 1. For redevelopment of existing residential units that are ground floor level, finished floor levels should be raised as high as practically possible, with resilience measures used up to the 1 in 200 year floor level where necessary.

9.5.9 8-12 Hours – For development located within the 8-12 hour extent and greater, there is a greater period of time before inundation by floodwaters and therefore potential for occupants to evacuate developments and move to the Flood Zone 1 on the mainland. For redevelopment of existing residential units that are ground floor level, finished floor levels should be raised as high as practically possible, with resilience measures used up to the 1 in 200 year flood level where necessary.

Provision of Safe Refuge

9.5.10 In exceptional circumstances, a building may remain safe during a flood event but safe access and egress to and from the building may not be guaranteed. The acceptability of the development will then be dependent upon an assessment of the probability of flooding; expected flood hazard; likelihood of occupancy during flooding; how acceptable the disruption would be; the provision of safe refuge; availability of key services; and the expected duration of inundation by floodwaters.

9.5.11 Safe refuge must be located above the design flood level and be freely accessible by all occupants of the development via internal staircases from all areas that are below the design flood level. Paragraph E3 of PPS5 states that consideration should also be made of the impact of the extreme flood and that users of the development should not be placed in danger from associated flood hazards.

Finished Floor Levels

9.5.12 Where development in flood risk areas is unavoidable, the most common method of mitigating flood risk to people is to ensure habitable floor levels are raised above the maximum flood water level with an allowance of 300mm freeboard. This can substantially reduce the damage to property and risk of injury and fatalities.

9.5.13 Where minimal depths of floodwater are experienced, raising finished floor levels may be included into building design. This may be possible in areas of fluvial and/or surface water flood risk. Where floodwater depths are more substantial the practice of raising finished floor levels may not be possible.

9.5.14 In some cases it may be considered appropriate for ground floor uses to be restricted to Less Vulnerable uses, such as commercial use, garage, utility areas and public space, with habitable areas above.

9.5.15 Any hazardous substances held in commercial properties should be stored above the flood level to reduce the risk of contamination during a flood event.

Basement Dwellings

9.5.16 Basement dwellings are classified as 'Highly Vulnerable' according to PPS25 (CLG 2010). As such they are not permitted within Flood Zone 3a and must pass the Sequential & Exception Test should they be proposed for Flood Zone 2. Basements dwellings should therefore be discouraged within areas at risk of fluvial, surface water or groundwater flooding. Where they are constructed, access must be situated 300mm above the design flood level, and waterproof construction techniques should be employed to avoid seepage during flood events. An assessment of groundwater conditions will also be required to inform the structural integrity of the basement construction. Similar problems can also occur where excessive surface water ponding occurs close to the sides of buildings, leading to significant infiltration. Surface water flow paths should be assessed to ensure that this does not occur, and to inform the strategic location of SuDS and techniques to route flows around the edge of buildings.

9.5.17 It is recommended that Rochford DC adopt a policy of refusing applications for basement dwellings that are within the Flood Zone 2 extent (1 in 1000 year flood outline).

Flood Resilient / Resistant Design

9.5.18 The Association of British Insurers in cooperation with the National Flood Forum has published guidance on how homeowners can improve the food resilience of their properties (ABI, 2004). These measures not only reduce flood risk to properties, by reducing residual risk, but can also improve the insurability of homes in flood risk areas. The guidance identifies the key flood resistant measures for different construction methods, further details can be found in the CLG's 2008 report, Improving the Flood Resilience of New Buildings and the ODPM's 2003 report, 'Preparing for Floods' (ODPM, 2003b).

9.5.19 In the document '*Improving the Flood Performance of New Buildings, Flood Resilient Construction'*, a number of design strategies are detailed including the Water Exclusion Strategy and Water Entry Strategy. Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m.

9.5.20 For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, i.e. the Water Entry Strategy.

9.5.21 The principle behind the Water Entry Strategy is not only to allow water through the property to avoid the risk of structural damage, but also to implement careful design in order to minimise damage and allow rapid re-occupancy of the building. PPS25 considers these measures to be appropriate for both changes of use and for less vulnerable uses where temporary disruption is acceptable and suitable flood warning is received.

9.5.22 Materials will be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

9.5.23 Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction' (CLG, 2007).

Flow Paths and Floodplain Compensation

9.5.24 Where development plans result in a reduction of the ***fluvial*** floodplain it is essential that new floodplain storage capacity is provided to compensate for any lost storage. The Environment Agency requires this to be provided on a 'Level for Level, Volume for Volume Basis'. *N.B. Any encroachment into tidal floodplains does not normally require compensation storage unless the flood cell is small or should there be concerns that flood flow paths would be altered to the detriment of existing development.*

9.5.25 Potential overland flow paths should be determined and appropriate solutions proposed to mitigate the impact of the development, for example through the configuration of road and building layouts to preserve existing flow paths and improve flood routing whilst ensuring that flows are not diverted towards other properties. In addition, any raising of the land as part of the development, for example, to achieve safe access, will need to be carefully considered as part of the FRA to ensure that no obstruction is made to flood flow routes.

Land Raising

9.5.26 Land raising can have mixed results when used as a secondary flood alleviation measure. It can be an effective method of reducing flood inundation on certain areas or developments by raising the finished ground levels above the predicted flood level. However, it can result in the reduction in flood storage volume within the flood cell. As a result, floodwater levels within the remainder of the cell can be increased and flooding can be exacerbated elsewhere. Level for level compensatory storage should be provided where any loss of fluvial floodplain storage has occurred as a result of land raising or developing within the undefended floodplain.

9.5.27 Partial land raising can be considered in larger, particularly low lying, areas such as marshlands. It may be possible to build up the land in areas adjacent to flood defences in order to provide secondary defences. However, again the developer should pay due regard to the cumulative effects of flooding such as increasing flood risk elsewhere.

9.5.28 It should also be remembered that although land raising may allow for development above the flood level, it may also create a 'dry island' which may still not overcome the issue of a safe access/egress route from the site. This must be considered where land raising is suggested as mitigation for developing in an area liable to flooding.

Recreation, Amenity and Ecology

9.5.29 Recreation, amenity and ecological improvements can be used to mitigate the residual risk of flooding either by substituting less vulnerable land uses or by attenuating flows or both. Examples include the development of parks and open spaces through to river restoration schemes. The aim of these techniques is to increase flood storage and the storage and conveyance of rainwater. Typical schemes include arrangements of pools, ponds and ditches, although these are best suited to larger sites and masterplan areas.

Secondary Defences

9.5.30 Secondary defences are those that exist on the dry side of primary defences. Typically, their main function is to reduce the risk of residual flooding following a failure or overtopping of the primary defences.

9.5.31 Secondary defences can relocate floodwaters away from certain areas or reduce the rate of flood inundation following a residual event. Examples of secondary defences include embankments or raised areas behind flood defence walls, raised infrastructure e.g. railways or roads and, on a strategic level, canals, river and drainage networks. The latter are a form of secondary defence as they are able to convey or re-direct water away from flood prone areas even if this is not their primary function.

9.5.32 The benefits of a secondary defence to a new development must be weighed up against the potential adverse effects to existing development in the same area, since Paragraph 5 of PPS25 requires that new development should be 'safe without increasing risk elsewhere'.

Sewer Flooding

9.5.33 In areas at risk of sewer flooding, a site specific FRA should assess the level of risk to the site. Anglian Water should be approached to obtain any information regarding sewer flooding records in the area and any recent capital improvement works undertaken, which should be reviewed in relation to local topography and potential flow paths to determine the actual risk to the site. This will allow appropriate mitigation measures to be incorporated where necessary.

Groundwater Flooding

9.5.34 Due to the scarcity of information with respect to groundwater flood risk in the district and the limitations in using historic data to define current flood risk, it is recommended that a site specific investigation of geology and groundwater levels is undertaken in proportion to the nature and scale of the proposed development. Local groundwater monitoring should be identified and where possible analysed to assess ground water levels as part of a FRA, in addition to detailed geology mapping which identifies potential spring lines.

9.5.35 In addition, consideration should be made for the impact of excavation works prior to construction on the risk of groundwater flooding to the site.

Surface Water Flooding

9.5.36 Development typically increases the coverage of impermeable areas and therefore contributes to increased overland flows. As part of a site specific FRA for new developments, an assessment of surface water runoff and temporary flood storage on the site should be undertaken. Development should seek to reduce surface water runoff rates through the appropriate application of Sustainable Drainage Systems (SuDS).

9.5.37 Potential overland flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere.

9.5.38 Under the Flood and Water Management Act (2010), all new development must demonstrate that all measures have been taken to manage runoff on site before connection to the sewer is permitted. Due to the highly urbanised nature of parts of Rochford, source control options will be an important method of surface water management. Rainwater harvesting, green roofs, permeable gardens and landscaped public realm areas, will be essential elements of new developments to facilitate the minimisation of runoff.

9.5.39 It is essential that the design of SuDS is considered early in the design process for a development area to ensure that a coordinated and integrated system can be implemented. Under the Flood and Water Management Act (2010), it will become the responsibility of Essex County Council to adopt and maintain these drainage systems into the future and therefore an integrated approach to surface water management across new development areas will need to be established.

10 Core Strategy Development Locations

10.1 Future Growth & Development

10.1.1 Under the provisions of the Planning and Compulsory Act 2004, Rochford DC is in the process of preparing a folder of policy documents called the Local Development Framework which translate strategic policies for wider the area into locally applicable planning policies.

10.1.2 The Core Strategy sets out the proposed allocation of future development within the district in order to meet the housing requirements set by the Regional Spatial Strategy for the East of England; the East of England Plan. A summary of the position of this SFRA with respect to the relevancy of Regional Spatial Strategy is provided in the following position statement.

SFRA Position Statement
Regional Spatial Strategy (RSS) for the East of England: The East of England Plan

The East of England Plan published by the Communities and Local Government (CLG) provided a broad development strategy for the region for a 15 to 20 year period. It also informed the preparation of Local Development Documents (LDD) and regional and sub-regional strategies.

Following the election of a coalition government in May 2010, a Devolution and Localism Bill has been confirmed which intends to *'shift power from the central state back to the hands of individuals, communities and councils'.* This Bill includes legislation to scrap the RSS.

While the Secretary for State for Communities and Local Government has confirmed that RSS will be revoked, at the time of writing there is no replacement for the RSS, therefore the RSS will be referred to as the current planning policy document for the purposes of this report.

10.1.4 The East of England Plan requires a minimum of 4600 dwellings to be provided in the District between 2001 and 2021. In addition, the LPA is required to plan for delivery of housing for at least 15 years from the date of adoption of the Core Strategy (2010) and in so doing assume that the average annual requirement of 250 units will continue beyond 2021 to 2025.

10.1.5 In order to deliver these dwellings, the Core Strategy identifies a number of extensions to the existing residential envelope within the district. In addition, opportunities for the redevelopment of employment land for residential units have also been identified at four locations across the district. The key areas for future development within Rochford are summarised in the Table 10-1 and included in Figure A-5 of Appendix A.

10.1.6 The majority of the locations allocated for potential residential development have been located in accordance with the sequential approach, advocated by PPS25 and are within Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources. However four of the development locations are located wholly or partially within Flood Zones 2 and 3, as shown in Table 10-1.

Table 10-1 Core Strategy Development Locations

Core Strategy Policy	Development Location	Dwellings pre 2021	Dwellings post 2021	Flood Zone(s)
H2 – Extensions to residential envelope pre-2021	North of London Road, Rayleigh		550	1,2,3
	West Rochford	450	150	1,2
	West Hockley	50		1
	South Hawkwell	175		1
	East Ashingdon	100		1
	South West Hullbridge		250	1
	South Canewdon		60	1
H3 – Extensions to residential envelope post-2021	South East Ashingdon		500	1
	West Great Wakering		250	1
H1 – Redevelopment of employment land for residential use	Rawreth Lane Industrial Estate			1,2,3
	Eldon Way / Foundry Industrial Estate			1
	Stambridge Mills			1,2,3
	Star Lane Industrial Estate			1

10.1.7 In addition to these proposals for future housing development, a number of Area Action Plans are being developed in the Rochford district, including:

- Hockley Area Action Plan;
- Rochford Area Action Plan;
- Rayleigh Area Action Plan; and
- London Southend Airport and Environs Joint Area Action Plan (in collaboration with Southend-on-Sea Borough Council).

10.1.8 The Area Action Plans for Rayleigh and Hockley are located within Flood Zone 1, associated with low probability of flooding from fluvial and tidal sources. The Rochford Area Action Plan and the Southend London Airport and Environs Joint Area Action Plan are located within or close to Flood Zones associated with greater flood risk.

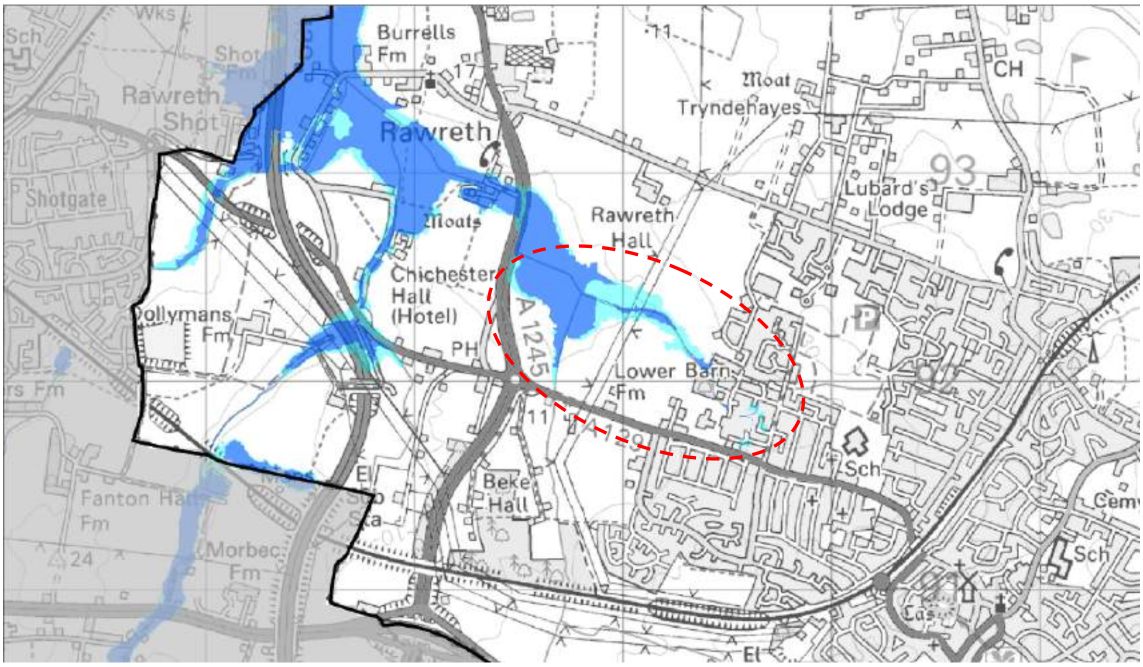
10.2 Area Assessments

10.2.1 The remainder of this Chapter provides an individual assessment of the development locations and Area Action Plan areas that are at risk of flooding. A summary of the proposed use of the site and the vulnerability classifications is provided, along with recommendations regarding development control and emergency planning requirements, specific to these areas.

North of London Road, Rayleigh

Proposed Site Use	PPS25 Vulnerability Classification
Residential development	More Vulnerable
Primary School	More Vulnerable
Park land in between built environment and A1245	Water-compatible
Youth and community facilities	Less Vulnerable
Play space	Water-compatible

Environment Agency Flood Zone Map



This area is at risk of flooding associated with the Rawreth Brook. Parts of the site are classified as Flood Zone 2 – Medium Probability of flooding, and Flood Zone 3a – High Probability.

Development Control Recommendations

Sequential Approach
All future development should be steered towards Flood Zone 1 in accordance with the sequential approach. More vulnerable development, including residential, should be located within Flood Zone 1.

Finished Floor Levels
Detailed modelling may be required to more accurately determine the flood zones in this area and determine the flood level to inform development design.
Finished floor levels should be set 300mm above the 1 in 100 year flood level, including allowances for climate change for the lifetime of the development (100 years for residential development).

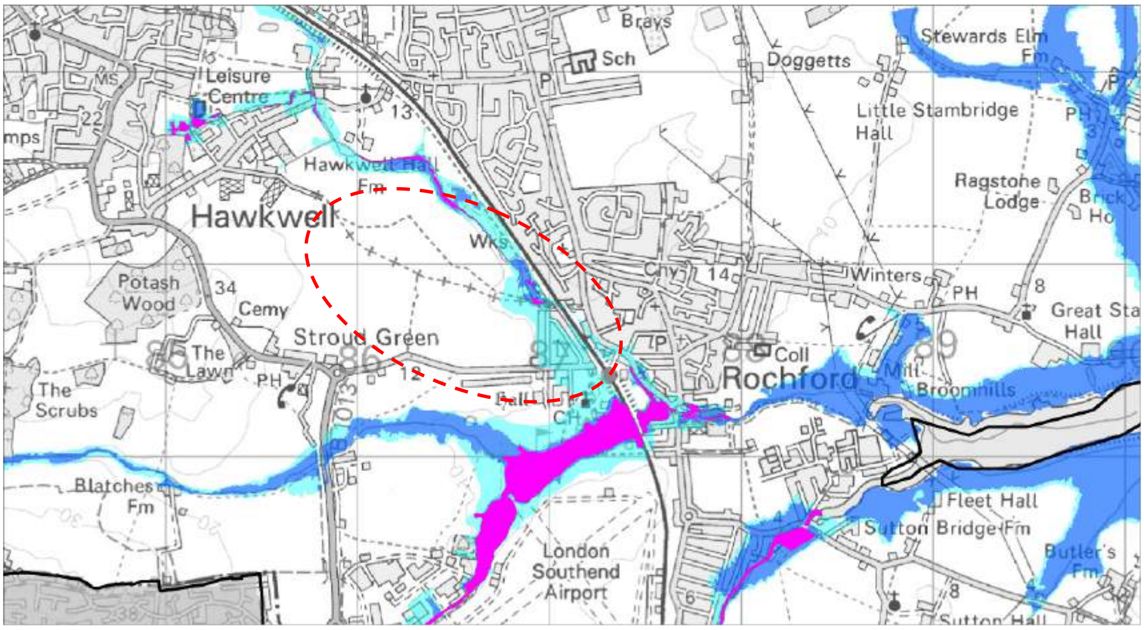
Floodplain Compensation
Any encroachment into Flood Zone 3a that results in loss of storage in the floodplain should be compensated for on a level for level and volume for volume basis.

Surface Water Management
Future development must make adequate provision for the sustainable management of surface water on the site. Due to the underlying geology, infiltration techniques are unlikely to be suitable and therefore attenuation techniques are recommended. Further guidance regarding SuDS is supplied in Chapter 11 of this report.

West Rochford

Proposed Site Use	**PPS25 Vulnerability Classification**
Residential development	More Vulnerable
Primary School and Early Years Childcare Provision	More Vulnerable
Youth facilities and community facilities	Less Vulnerable
Public Open Space & Play space	Water-compatible

Environment Agency Flood Zone Map



The fluvial section of the River Roach flows along the eastern edge of the site. This part of the site is located in Flood Zone 2 Medium Probability of flooding associated with this watercourse.

Development Control Recommendations

Sequential Approach
All future development should be steered towards Flood Zone 1 in accordance with the sequential approach. More vulnerable development, including residential, should be located within Flood Zone 1.

Finished Floor Levels
Finished floor levels should be set 300mm above the 1 in 100 year flood level, including allowances for climate change for the lifetime of the development (100 years for residential development).

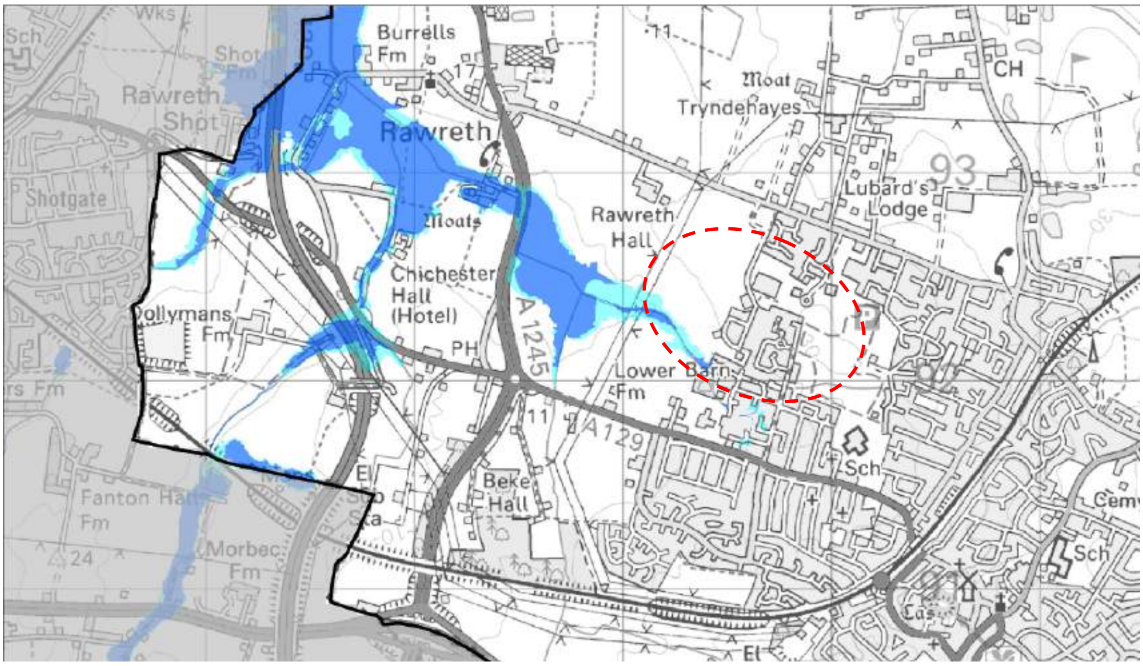
Floodplain Compensation
Any encroachment into Flood Zone 3a that results in loss of storage in the floodplain should be compensated for on a level for level and volume for volume basis.

Surface Water Management
Future development must make adequate provision for the sustainable management of surface water on the site. The geology within this part of the district is River Terrace Deposits, underlain by Thames Group Clay. Infiltration testing will be required to determine the prospect of using infiltration drainage techniques. Further guidance regarding SuDS is supplied in Chapter 11 of this report.

Rawreth Industrial Estate

Proposed Site Use	PPS25 Vulnerability Classification
Residential development	More Vulnerable
Contribution towards new primary school in North of London Rd, Rayleigh residential development	More Vulnerable
Public Open Space & Play space	Water-compatible
Public transport infrastructure improvements and service enhancements	Essential Infrastructure

Environment Agency Flood Zone Map



This area is at risk of flooding associated with the Rawreth Brook. Parts of the site are classified as Flood Zone 2 – Medium Probability of flooding, and Flood Zone 3a – High Probability.

Development Control Recommendations

Sequential Approach
All future development should be steered towards Flood Zone 1 in accordance with the sequential approach. More vulnerable development, including residential, should be located within Flood Zone 1.

Finished Floor Levels
Detailed modelling may be required to more accurately determine the flood zones in this area and determine the flood level to inform development design.
Finished floor levels should be set 300mm above the 1 in 100 year flood level, including allowances for climate change for the lifetime of the development (100 years for residential development).

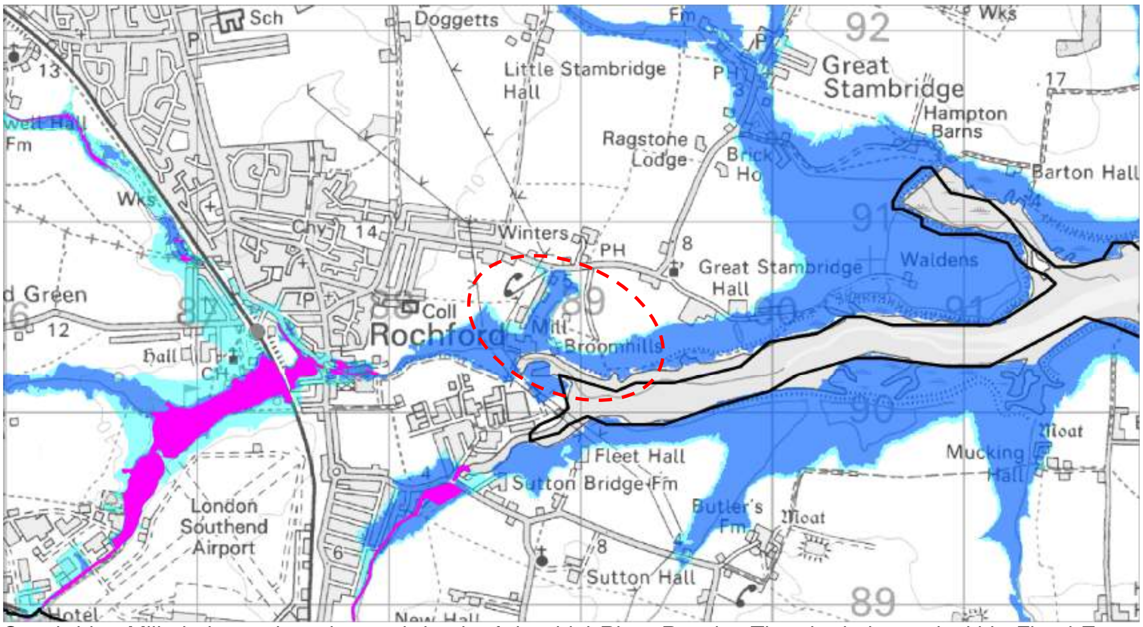
Floodplain Compensation
Any encroachment into Flood Zone 3a that results in loss of storage in the floodplain should be compensated for on a level for level and volume for volume basis.

Surface Water Management
Future development must make adequate provision for the sustainable management of surface water on the site. Due to the underlying geology, infiltration techniques are unlikely to be suitable and therefore attenuation techniques are recommended. Further guidance regarding SuDS is supplied in Chapter 11.

Stambridge Mills, Rochford

Proposed Site Use	**PPS25 Vulnerability Classification**
Residential development	More Vulnerable
Flood defence	Water-compatible
Public transport infrastructure improvements and service enhancements	Essential Infrastructure
Public Open Space & Play space	Water compatible

Environment Agency Flood Zone Map



Stambridge Mills is located on the north bank of the tidal River Roach. The site is located within Flood Zone 3a – High Probability of flooding from tidal sources.

Development Control Recommendations

Sequential Approach
It should be noted that at the time of writing the approach of favouring non-Green Belt, PDL, Flood Zone 2/3 sites ahead of Green Belt, Flood Zone 1 locations is currently being considered through the examination of the Core Strategy. When asked whether is was appropriate for RDC to include Stambridge Mills within its schedule of potential residential development site, the Inspector at a recent appeal concluded: "I agree with the Council that, having regard to the presumption against inappropriate development in PPG2 and to the encouragement in PPS3 to direct new housing to previously-developed land, land in the Green Belt should not be considered to be suitable for housing development in preference to Stambridge Mills" (para. 236 of Inspector's report).

Finished Floor Levels
Finished floor levels should be set 300mm above the 1 in 200 year flood level, including allowances for climate change for the lifetime of the development (100 years for residential development).

Access & Egress
Safe access and egress, above the 1 in 200 year flood level (0.5% AEP) including allowances for climate change must be provided from all parts of the development to an area in Flood Zone 1.

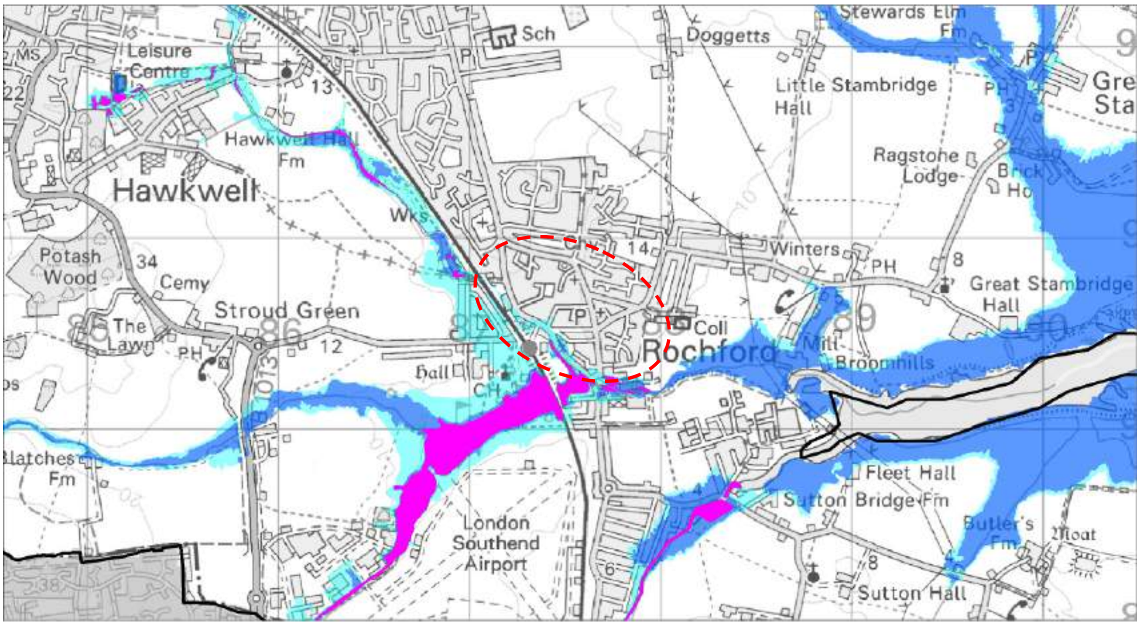
Surface Water Management
Future development must make adequate provision for the sustainable management of surface water on the site. The geology within this part of the district is River Terrace Deposits, underlain by Thames Group Clay. Infiltration testing will be required to determine the prospect of using infiltration drainage techniques. Further guidance regarding SuDS is supplied in Chapter 11 of this report.

Emergency Planning
This area is covered by the Environment Agency's Flood Warning Service. A Flood Evacuation Plan should be prepared for future occupants of the site detailing access and egress routes and evacuation procedures.

Rochford Area Action Plan (AAP)

Proposed Site Use	**PPS25 Vulnerability Classification**
Mixed Use	Various

Environment Agency Flood Zone Map



Rochford is located at the confluence of the Noblesgreen Ditch, the Eastwood Brook and the River Roach from flowing from Hawkwell. The majority of the Area Action Plan is located in Flood Zone 1 – Low Probability, however the River Roach flows along the southern edge of the Area Action Plan area and is tidally influenced in this area.

Development Control Recommendations

Sequential Approach
All future development should be steered towards Flood Zone 1 in accordance with the sequential approach. More vulnerable development, including residential, should be located within Flood Zone 1.

Finished Floor Levels
In areas affected by fluvial flooding, finished floor levels should be set 300mm above the 1 in 100 year flood level, including allowances for climate change for the lifetime of the development (100 years for residential development). In areas at risk of tidal flooding from the tidal River Roach, the 1 in 200 year flood level including allowances for climate change should be used to set the finished floor levels.

Access & Egress
Safe access and egress, above the 1 in 200 year flood level (0.5% AEP) including allowances for climate change must be provided from all parts of the development to an area in Flood Zone 1.

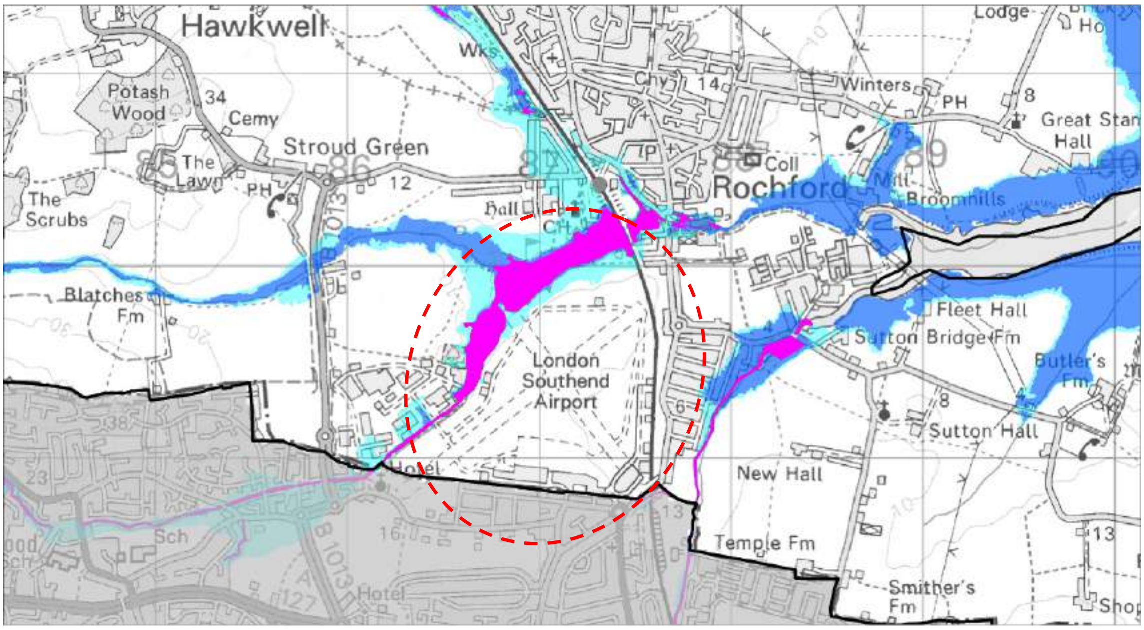
Surface Water Management
Future development must make adequate provision for the sustainable management of surface water on the site. The geology within this part of the district is River Terrace Deposits, underlain by Thames Group Clay. Infiltration testing will be required to determine the prospect of using infiltration drainage techniques. Further guidance regarding SuDS is supplied in Chapter 11 of this report.

Emergency Planning
This area is covered by the Environment Agency's Flood Warning Service. A Flood Evacuation Plan should be prepared for future occupants of the site detailing access and egress routes and evacuation procedures.

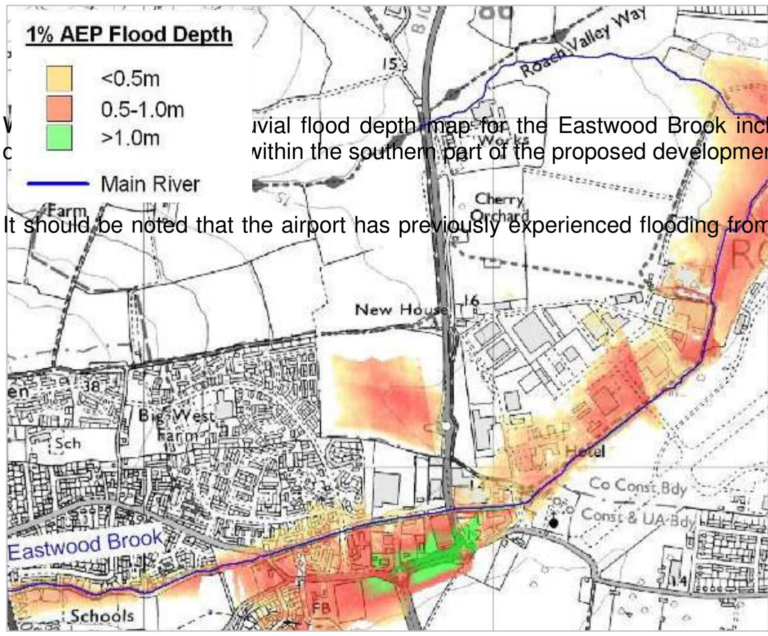
London Southend Airport and Environs Joint Area Action Plan (JAAP)

Proposed Site Use	**PPS25 Vulnerability Classification**
Airport	Essential Infrastructure
Business Use	Less Vulnerable
Leisure and Public Open Space	Water-compatible
Railway Station	Essential Infrastructure
Car Parking	Less Vulnerable

Environment Agency Flood Zone Map



The Eastwood Brook flows along the western and northern edge of the London Southend Airport. The flooding mechanism for this watercourse is described as ‘overtopping of river banks leading to low velocity flooding in most areas with flood depths ranging between 0.3m and 0.5m’ (Table 3.17 included in the Catchment Flood Management Plan). The Environment Agency has assigned this watercourse a ‘high priority’ natural channel maintenance regime and they provide flood warning with a 2 hour lead time.



...vial flood depth map for the Eastwood Brook included in the CFMP it can be seen that flood ... within the southern part of the proposed development area.

It should be noted that the airport has previously experienced flooding from the Eastwood Brook including in 1981 when the brook burst its banks leading to flooding of the airport hanger.

Source: Environment Agency, South Essex Catchment Flood Management Plan, 2008

Development Control Recommendations
Sequential Approach All future development should be steered towards Flood Zone 1 in accordance with the sequential approach. No development is permitted within Flood Zone 3b.
Finished Floor Levels In areas affected by fluvial flooding, finished floor levels should be set 300mm above the 1 in 100 year flood level, including allowances for climate change for the lifetime of the development (100 years for residential development).
Flood Resilient Design For the buildings located adjacent to the Eastwood Brook, it is recommended that flood resilient construction methods are used up to the 1 in 100 year flood level including allowances for climate change.
Floodplain Compensation Any encroachment into Flood Zone 3a that results in loss of storage in the floodplain should be compensated for on a level for level and volume for volume basis.
Surface Water Management Future development must make adequate provision for the sustainable management of surface water on the site. Given the proximity of the Eastwood Brook, there may be potential to discharge to this watercourse. It should be noted that in the if a rainfall event coincides with the Eastwood Brook being in flood, the outfall for the development drainage system may become surcharged leading surface water flooding. Any discharge to this main river will require consent from the Environment Agency and will require attenuation to discharge at a flow rate to be confirmed with the Environment Agency (potentially Greenfield runoff rate). SuDS should be used in order to manage surface water on site to meet the discharge requirements. The geology within this part of the district is River Terrace Deposits, underlain by Thames Group Clay. Infiltration testing will be required to determine the prospect of using infiltration drainage techniques. Further guidance regarding SuDS is supplied in Chapter 11 of this report.
Emergency Planning This area is covered by the Environment Agency's Flood Warning Service and flood warnings are issued for the Eastwood Brook with a lead time of 2 hours. It is recommended that a Flood Evacuation Plan is prepared for future occupants of the site detailing flood response procedures and evacuation routes.

10.2.2 It is noted that flood risk advice and guidance for the JAAP area has also been provided as part of the Level 2 Strategic Flood Risk Assessment prepared on behalf of Southend-on-Sea Borough Council. This information is reproduced in Appendix G of this report for reference.

11 Guidance for the Application of SuDS

11.1 Introduction

11.1.1 In addition to tidal and fluvial flooding, there is a risk of localised surface water flooding in Rochford as a result of the increased occurrence of extreme rainfall events and underlying clay soils, particularly in the western half of the district. This risk is likely to increase over time as a result of climate change and changes in the local environment such as paving of front gardens.

11.1.2 The risk from surface water flooding can be mitigated through the use of Sustainable Urban Drainage Systems (SuDS). SuDS seek to manage surface water as close to its source as possible, mimicking surface water flows arising from the site, prior to the proposed development. Typically this approach involves a move away from piped systems to softer engineering solutions inspired by natural drainage processes. PPS25 indicates that Regional Planning Bodies and Local Authorities should promote the use of SuDS for the management of surface water runoff generated by development.

11.1.3 SuDS should be designed to take into account the surface run-off quantity, rates and also water quality ensuring their effective operation up to and including the 1 in 100 year design standard flood including an increase in peak rainfall up to 30% to account from climate change.

11.1.4 Wherever possible, a SuDS technique should seek to contribute to each of the three goals identified below with the favoured system contributing significantly to each objective:

1. Reduce flood risk (to the site and neighbouring areas),
2. Reduce pollution, and,
3. Provide landscape and wildlife benefits.

11.1.5 These goals can be achieved by utilising a management plan incorporating a chain of techniques, (as outlined in Interim Code of Practice for Sustainable Drainage Systems 2004), where each component adds to the performance of the whole system:

Prevention	**good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping)**
Source Control	runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements)
Site Control	water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site)
Regional Control	Integrate runoff management systems from a number of sites (e.g. into a detention pond)

11.1.6 This chapter presents a summary of the SuDS techniques currently available and a review of the soils and geology of the study area, enabling Rochford DC to identify where SuDS techniques could be employed in development schemes.

11.1.7 The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be “traded” between developments.

11.2 Regulatory Position

11.2.1 Until 2010 there were no legally binding obligations relating to the provision and maintenance of SuDS. In April 2010, the Flood and water Management Act gained Royal Assent and with it came a number of responsibilities for Unitary and County Authorities, defined as Lead Local Flood Authorities (LLFAs), which in this case is Essex County Council. In relation to Rochford DC, Essex County Council are required to:

- Investigate and record flooding incidents;
- Produce an asset register of all flood risk related assets;
- Develop a preliminary flood risk assessment;
- Adopt and maintain SuDS.

11.2.2 In their document, ‘Flood and Water Management Act 2010 – What the Flood and Water Management Act means for property developers’, Defra set out details regarding the process of SuDS approval by the relevant Local Lead Flood Authority as follows:

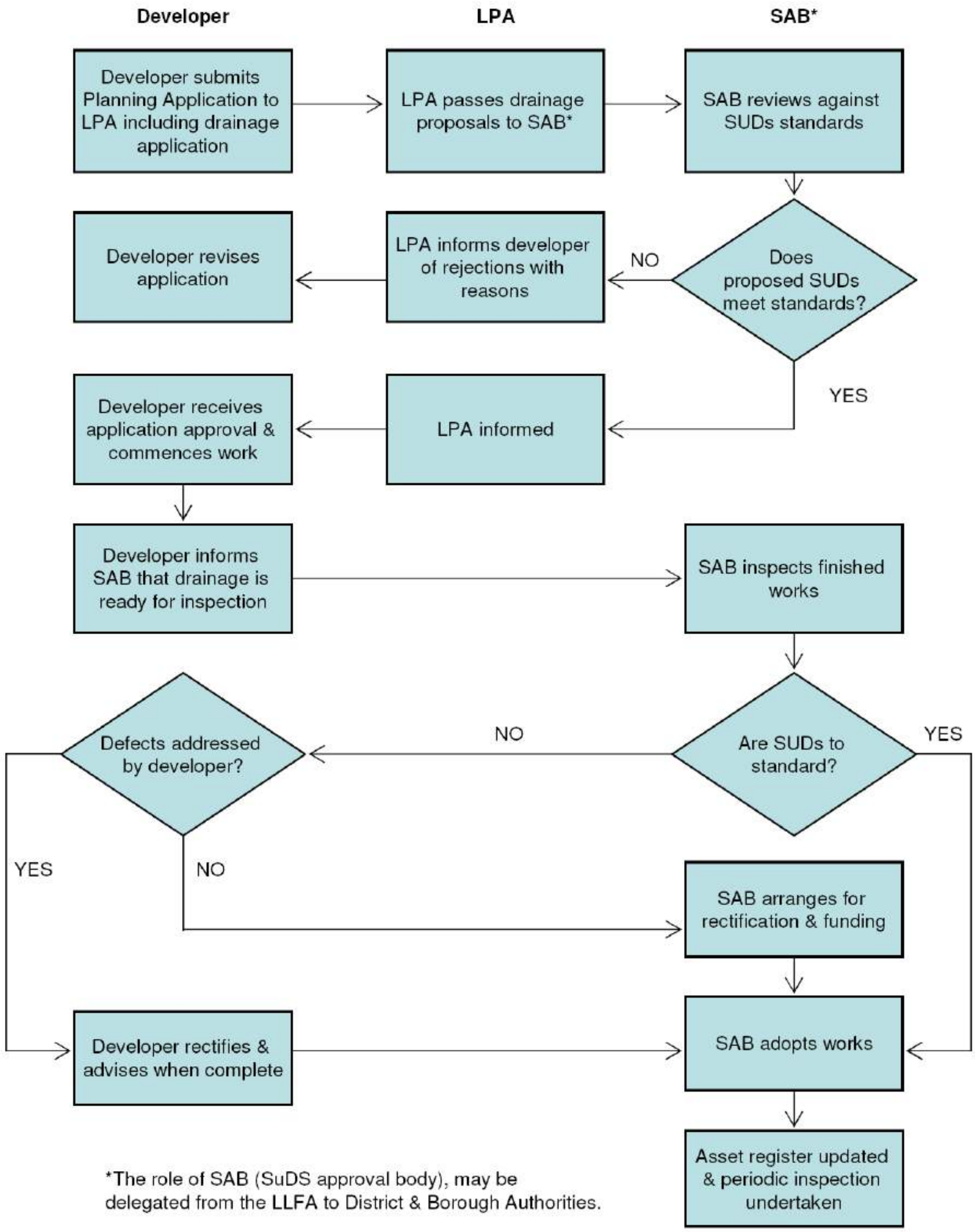
11.2.3 Plans for a proposed drainage system will need to be approved prior to construction, by the SuDS Approving Body (SAB) which will be the unitary or county council for the area, in this case Essex County Council. This applies to both permitted developments and those that require planning permission. This will ensure that SuDS are also included in construction that may cover large surface areas, but does not require planning permission.

11.2.4 Where both planning permission and SuDS approval are required, it is anticipated that the processes will run together. Applications for the drainage system and for planning permission will be submitted together to reduce burdens for the applicant. The planning authority will notify the developer of the outcome of both the planning permission and drainage approval at the same time, including any conditions of approval. Regulations will set out a timeframe for the approval of drainage application by the SAB, so the planning process is not delayed.

11.2.5 At the time of writing, the organisational arrangements for SuDS approval adoption in Essex County Council are still to be clarified. Figure 11-1 provides a suggestion of a potential overview process that could be used when a planning application is submitted. However, it is noted that it is also possible for the role of SuDS Approving Body to be delegated by the Lead Local Flood Authority to Local Planning Authorities.

11.2.6 In addition, Anglian Water, the local waste water provider has set out adoption standard for SuDS. The Council currently expect all new SuDS systems to meet the adoption standards outlined by Anglian Water to ensure their long term maintenance.

Figure 11-1 Potential SuDS Approval Process (Scott Wilson 2011)



11.3 SuDS Techniques

11.3.1 SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc). Various SuDS techniques are available and operate on two main principles:

- Infiltration
- Attenuation

11.3.2 All systems generally fall into one of these two categories, or a combination of the two.

11.3.3 The design of SuDS measures should be undertaken as part of the drainage strategy and design for a development site. A ground investigation will be required to access the suitability of using infiltration measures, with this information being used to assess the required volume of on-site storage. Hydrological analysis should be undertaken using industry approved procedures, to ensure a robust design storage volume is obtained.

11.3.4 During the design process, liaison should take place with the Local Planning Authority, the LLFA, the Environment Agency and if necessary, the Water Undertaker to establish a satisfactory design methodology and permitted rate of discharge from the site.

11.3.5 Reference should be made to the SuDS Manual CIRIA C697 for best practice on the planning, design, construction, operation and maintenance of SuDS.

11.4 Infiltration SuDS

11.4.1 This type of Sustainable Drainage System relies on discharges to ground, where suitable ground conditions are suitable. Therefore, infiltration SuDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as a potable resource) for their successful operation.

11.4.2 Development pressures and maximisation of the developable area may reduce the area available for infiltration systems. This can be overcome through the use of a combined approach with both attenuation and infiltration techniques e.g. attenuation storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway or as a pond/water feature.

Permeable Surfaces

11.4.3 Permeable surfaces are designed to intercept rainfall and allow water to drain through to a sub-base. The use of a permeable sub-base can be used to temporarily store infiltrated run-off underneath the surface and allows the water to percolate into the underlying soils. Alternatively, stored water within the sub-base may be collected at a low point and discharged from the site at an agreed rate.

11.4.4 Permeable paving reduces runoff during low intensity rainfall, however, during intense rainfall events some runoff may occur from these surfaces.

11.4.5 Programmes should be implemented to ensure that permeable surfaces are kept well maintained to ensure the performance of these systems is not reduced. The use of grit and salt during winter months may adversely affect the drainage potential of certain permeable surfaces.

11.4.6 Types of permeable surfaces include:

- Grass/landscaped areas
- Gravel
- Solid Paving with Void Spaces
- Permeable Pavements

Sub-surface Infiltration

11.4.7 Where permeable surfaces are not a practical option more defined infiltration systems are available. In order to infiltrate the generated run-off to ground, a storage system is provided that allows the infiltration of the stored water into the surrounding ground through both the sides and base of the storage. These systems are constructed below ground and therefore may be advantageous with regards to the developable area of the site. Consideration needs to be given to construction methods, maintenance access and depth to the water table. The provision of large volumes of infiltration/sub-surface storage has potential cost implications. In addition, these systems should not be built within 5 m of buildings, beneath roads or in soil that may dissolve or erode.

11.4.8 Various methods for providing infiltration below the ground include:

- Geocellular Systems
- Filter Drain
- Soakaway (Chamber)
- Soakaway (Trench)
- Soakaway (Granular Soakaway)

Table 11-1 Suitability of Infiltration Methods towards with respect to the wider aims of SuDS

Infiltration Method	Reduce Flood Risk (Y/N)	Reduce Pollution (Y/N)	Landscape and Wildlife Benefits (Y/N)
Permeable Surface	Y	Y	N
Sub-surface Infiltration	Y	Y	N

11.5 Attenuation SuDS

11.5.1 If ground conditions are not suitable for infiltration techniques then management of surface water runoff prior to discharge should be undertaken using attenuation techniques. This technique attenuates discharge from a site to reduce flood risk both within and to the surrounding area. It is important to assess the volume of water required to be stored prior to discharge to ensure adequate provision is made for storage. The amount of storage required should be calculated prior to detailed design of the development to ensure that surface water flooding issues are not created within the site.

11.5.2 The rate of discharge from the site should be agreed with the Local Planning Authority and the Environment Agency. If surface water cannot be discharged to a local watercourse then liaison with the Sewer Undertaker should be undertaken to agree rates of discharge and the adoption of the SuDS system.

11.5.3 Large volumes of water may be required to be stored on site. Storage areas may be constructed above or below ground. Depending on the attenuation/storage systems implemented, appropriate maintenance procedures should be implemented to ensure continued performance of the system.

On-site storage measures include basins, ponds, and other engineered forms consisting of underground storage.

Basins

11.5.4 Basins are areas that have been contoured (or alternatively embanked) to allow for the temporary storage of run-off from a developed site. Basins are designed to drain free of water and remain waterless in dry weather. These may form areas of public open space or recreational areas. Basins also provide areas for treatment of water by settlement of solids in ponded water and the absorption of pollutants by aquatic vegetation or biological activity. The construction of basins uses relatively simple techniques. Local varieties of vegetation should be used wherever possible and should be fully established before the basins are used. Access to the basin should be provided so that inspection and maintenance is not restricted. This may include inspections, regular cutting of grass, annual clearance of aquatic vegetation and silt removal as required.

Ponds

11.5.5 Ponds are designed to hold the additional surface water run-off generated by the site during rainfall events. The ponds are designed to control discharge rates by storing the collected run-off and releasing it slowly once the risk of flooding has passed. Ponds can provide wildlife habitats, water features to enhance the urban landscape and, where water quality and flooding risks are acceptable, they can be used for recreation. It may be possible to integrate ponds and wetlands into public areas to create new community ponds. Ponds and wetlands trap silt that may need to be removed periodically. Ideally, the contaminants should be removed at source to prevent silt from reaching the pond or wetland in the first place. In situations where this is not possible, consideration should be given to a small detention basin placed at the inlet to the pond in order to trap and subsequently remove the silt. Depending on the setting of a pond, health and safety issues may be important issues that need to be taken into consideration. The design of the pond can help to minimise any health and safety issues (i.e. shallower margins to the pond reduce the danger of falling in, fenced margins).

11.5.6 Various types of ponds are available for utilising as SuDS measures. These include:

- Balancing/Attenuating Ponds
- Flood Storage Reservoirs
- Lagoons
- Retention Ponds
- Wetlands

Table 11-2 Suitability of Attenuation Methods towards the 3 Goals of SuDS

Infiltration Method	Reduce Flood Risk (Y/N)	Reduce Pollution (Y/N)	Landscape and Wildlife Benefits (Y/N)
Basins	Y	Y	Y
Ponds	Y	Y	Y

11.6 Alternative Forms of Attenuation

11.6.1 Site constraints and limitations such as developable area, economic viability and contamination may require engineered solutions to be implemented. These methods predominantly require the provision of storage beneath the ground surface, which may be advantageous with regards to the developable area of the site but should be used only if methods in the previous section cannot be used. When implementing such approaches, consideration needs to be given to construction methods, maintenance access and to any development that takes place over the storage facility. The provision of large volumes of storage underground also has potential cost implications.

11.6.2 Methods for providing alternative attenuation include:

- Deep Shafts
- Geocellular Systems
- Oversized Pipes
- Rainwater Harvesting
- Tanks
- Green Roofs

11.6.3 In some situations it may be preferable to combine infiltration and attenuation systems to maximise the management of surface water runoff, developable area and green open space.

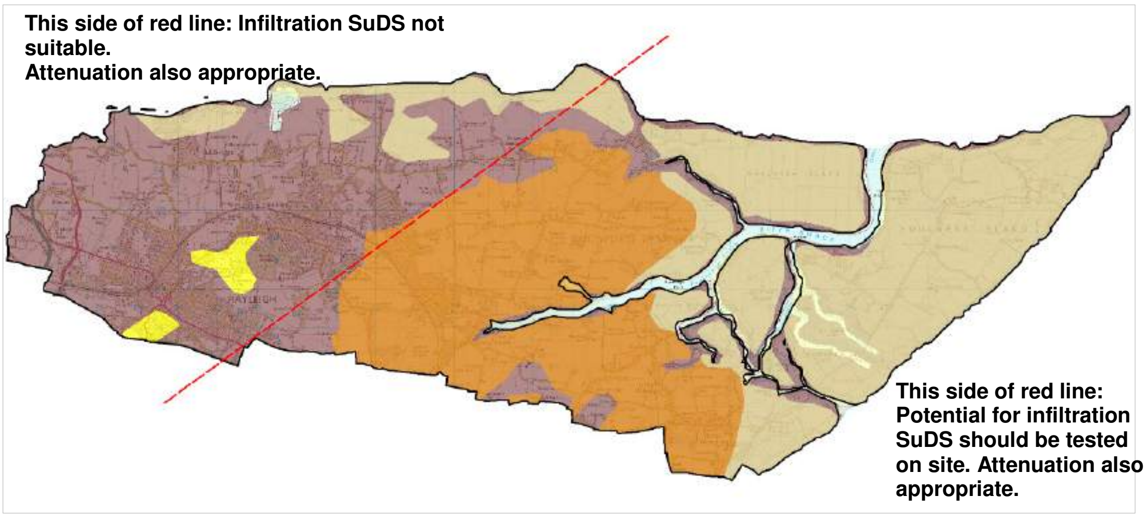
11.7 SuDS Suitability in Rochford District

11.7.1 Figure 11-2 provides a generalised summary of the underlying geology and suitability of sustainable drainage systems within the Rochford district. A divide across the district can be seen with respect to geology and soil characteristics, and thereby the suitability of SuDS.

11.7.2 In the west of the district, including the area around Rayleigh, Hullbridge, Hockley, Ashingdon and Hawkwell, the geology is predominantly clay and are no drift deposits overlying this area. The soils are relatively impermeable and surface water typically runs off rapidly. As a result infiltration SuDS are not deemed suitable for this area. The use of attenuation measures should be explored when considering site design and layout.

11.7.3 The east of the district, including Rochford, Great Wakering and Foulness Island is characterised by the presence of river terrace deposits and alluvium. These are relatively permeable and therefore result in a relatively low rainfall to runoff conversion rate. There may be potential for the use of infiltration SuDS in these areas, however on site infiltration testing should be undertaken on a site by site basis to determine its suitability. The underlying geology in this area is still clay and therefore it is likely that attenuation measures will be more suitable in this area as well.

Figure 11-2 Indicative Geology & SuDS Suitability in Rochford



11.7.4 As stated above, it should be noted that Figure 11-2 provides an indicative overview of the potential suitability of infiltration SuDS throughout the district. The suitability of a proposed site for the use of different SuDS will need to be determined on a site by site basis. Investigation will be required including geology, infiltration rates and groundwater vulnerability. Where infiltration SuDS are used, consideration may need to be given to pollution control.

12 Conclusions & Recommendations

12.1 Conclusions

12.1.1 The results from the increased scope Level 2 SFRA have confirmed that the district of Rochford is at risk of flooding from tidal sources.

12.1.2 Overtopping or a breach in the flood defences has the potential to result in flooding to depths of greater than 3m throughout Shoeburyness, Paglesham, Wallasea Island and South Fambridge putting existing development and occupants at great risk. Given the low lying nature of the coastline in this part of the district, flood waters are likely to propagate rapidly, greatly reducing the time available for warning and evacuation of residents, as was the case in the 1953 flood.

12.1.3 Policies adopted as part of the Catchment Flood Management Plan for the tidal parts of the Rochford district aim to reduce or cease existing levels of flood risk management now and into the future. It is therefore likely that the flood risk from tidal sources in this district will continue to increase over time.

12.1.4 In addition to flood risk from tidal sources, fluvial systems also pose a risk to parts of the Rochford district. The impermeable underlying geology and seasonally wet, deep clay soils in the western parts of the district lead to rapid runoff of surface water into local watercourses. The channelization of these watercourses is also leading to rapid conveyance of water downstream and leading to problems where watercourses converge.

12.1.5 Fluvial flooding primarily affects Rochford, where the River Roach, Noblesgreen Ditch and Eastwood Brook meet. A number of other smaller watercourses in Rawreth and Rayleigh also pose a fluvial flood risk.

12.2 Recommendations

12.2.1 It is strongly recommended that the mapping in this SFRA is used by Rochford Council Emergency Planners to continue to inform and update the development of Emergency Response and Evacuation Plans for the existing development and occupants throughout the district. Flood depth, hazard and time to inundation mapping should be used to inform routes of safe access and egress for existing development.

12.2.2 Under the Core Strategy proposals no development is proposed within areas defined at risk of flooding from tidal sources. However, it is possible that planning applications may come forward for redevelopment of individual properties within areas at risk of tidal flooding. Where this is the case, it is strongly recommended that development proposals are carefully assessed and that both developers and the LPA take advice from the emergency services and emergency planners when considering the safety of future users of the proposed developments to ensure that they are safe in line with the recommendations provided in Chapter 10 of this report.

12.2.3 Information with respect to flood depths, hazard rating and time to inundation should be used to inform part c) of the Exception Test and the preparation of site specific Flood Risk Assessments. It is noted that this document is a strategic document, and therefore specific assessments may need to be carried out, (for example consideration of an additional breach location of more significance to the site under assessment), however the SFRA should provide indicative information and Chapter

10 provides detailed guidance on the issues that need to be addressed as part of these assessments.

12.2.4 Similarly, where development is proposed in areas at risk of fluvial flooding, development control recommendations provided in Chapter 9 of this report should be used to determine the safety of the proposed development and to ensure that the proposed development does not increase flood risk to surrounding areas or impact upon the ability of Rochford DC and their emergency services to safeguard the current population.

12.3 Living Document – SFRA Maintenance & Updates

12.3.1 For an SFRA to serve as a practical planning tool now and in the future, it will be necessary to undertake a periodic update and maintenance exercise. This section clarifies what specific actions are recommended to ensure correct maintenance and updating of the SFRA.

GIS Layers

12.3.2 GIS layers used in this SFRA have been created from a number of different sources, using the best and most suitable information available at the time of publishing. Should new Flood Zone information become available, the data should be digitised and geo-referenced within a GIS system. A copy of the current dataset should be created and backed up and the new data should then be merged or combined with the current data set.

12.3.3 For example, should updated modelled outlines delineating Flood Zone 3b on the Prittle Brook become available, the current FZ3b outline should be edited to ensure that the newest data is displayed and that the old data is overwritten.

12.3.4 For other GIS layers such as the historical flood outlines or the sewer flooding information, it is likely that data will be added rather than be replaced. For example, where a new sewer flooding incident is reported in the catchment, a point should be added to the sewer flooding GIS layer rather than creating a new layer.

12.3.5 All GIS layers used in the SFRA have meta-data attached to them. When updating the GIS information, it is important that the meta-data is updated in the process. Meta-data is additional information that lies behind the GIS polygons, lines and points. For example, the information behind the SFRA Flood Zone Maps describes where the information came from, what the intended use was together with a level of confidence.

OS Background Mapping

12.3.6 The SFRA has made use of the OS 1:25000 and 1:50000 digital raster maps. Periodically these maps are updated. Under the HDC OS License, it is likely that these maps will be updated throughout the whole of the Rochford GIS system. Updated maps are unlikely to alter the findings of the SFRA.

Data Licensing Issues

12.3.7 Prior to any data being updated within the SFRA, it is important that the licensing information is also updated to ensure that the data used is not in breach of copyright. The principal licensing bodies relevant to the SFRA at the time of publishing were the Environment Agency (Thames Region), Ordnance Survey and Anglian Water. Updated or new data may be based on datasets from other licensing authorities and may require additional licenses.

Flooding Policy and PPS25 Practise Guidance Updates

12.3.8 This SFRA was updated inline with policy and guidance that was current in September 2010, principally PPS25 (DCLG December 2009) and the accompanying Practice Guide (March 2010). Furthermore, guidance and recommendations issued in the Pitt Review (Pitt 2008) and the subsequent Floods and Water Management Act (2010) have been incorporated into this updated revision. Should new flooding policy be adopted nationally, regionally or locally, the SFRA should be checked to ensure it is still relevant and updates made if necessary.

Stakeholder Consultation and Notification

12.3.9 The key stakeholders consulted in the SFRA were Rochford District Council, Anglian Water and the Environment Agency. It is recommended that a periodic consultation exercise is carried out with the key stakeholders to check for updates to their datasets and any relevant additional or updated information they may hold. If the SFRA is updated, it is recommended that the Environment Agency and the Emergency Planning Department are notified of the changes and instructed to refer to the new version of the SFRA for future reference.

Frequency of Updates and Maintenance

12.3.10 It is recommended that the SFRA is maintained on an annual basis. Should any changes be necessary, the SFRA should be updated and re-issued.

References

CLG (March 2010) Planning Policy Statement 25: Development and Flood Risk

CLG (December 2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide

CLG (May 2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction'

Defra/Environment Agency (2005) Flood Risk Assessment Guidance for New Development: Phase 2, R&D Technical Report FD2320/TR2

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Defra (March 2010) Surface Water Management Plan Technical Guidance: Living Draft

Defra. (2009) National Rank Order of Settlements Susceptible to Surface Water Flooding.

Environment Agency (August 2008) South Essex Catchment Flood Management Plan.

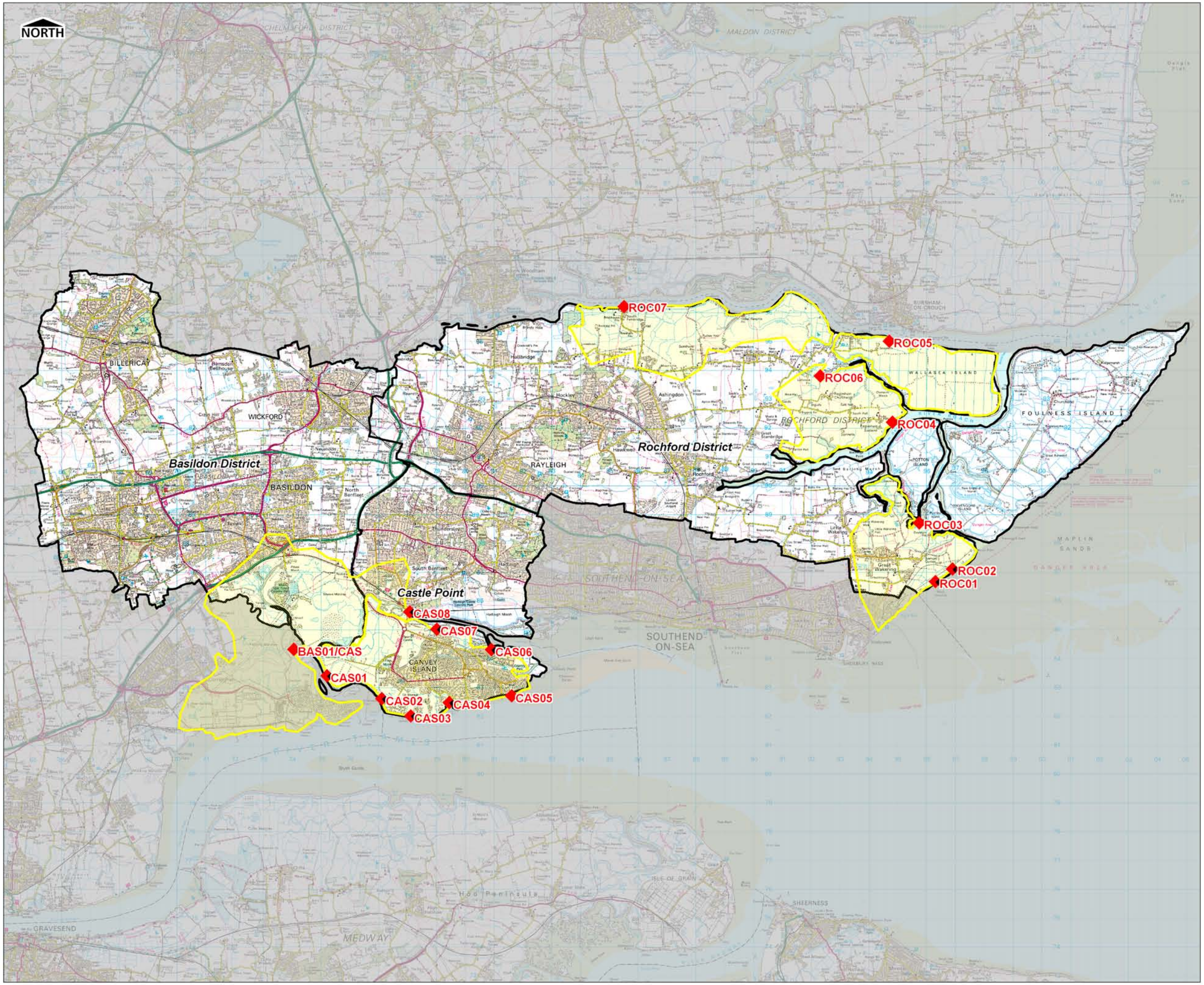
The Flood Risk Regulations 2009 (November 2009)

HMSO (April 2010) Flood and Water Management Act Chapter 29

Pitt, M. (2008) Pitt Review - Learning Lessons from the 2007 Floods.

Rochford District Council Multi Agency Flood Plan Version 1 July 2010.

Appendix A: General Figures



KEY

District/Borough Boundary

Breach Modelling Flood Cells

Breach Locations & Label

Overview Map

DRAWN BY	CHECKED BY	PASSED BY	DATE
SL	EG	JR	OCT 2010

SCALE @ A3	ISSUING OFFICE
1 : 125,000	London

THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

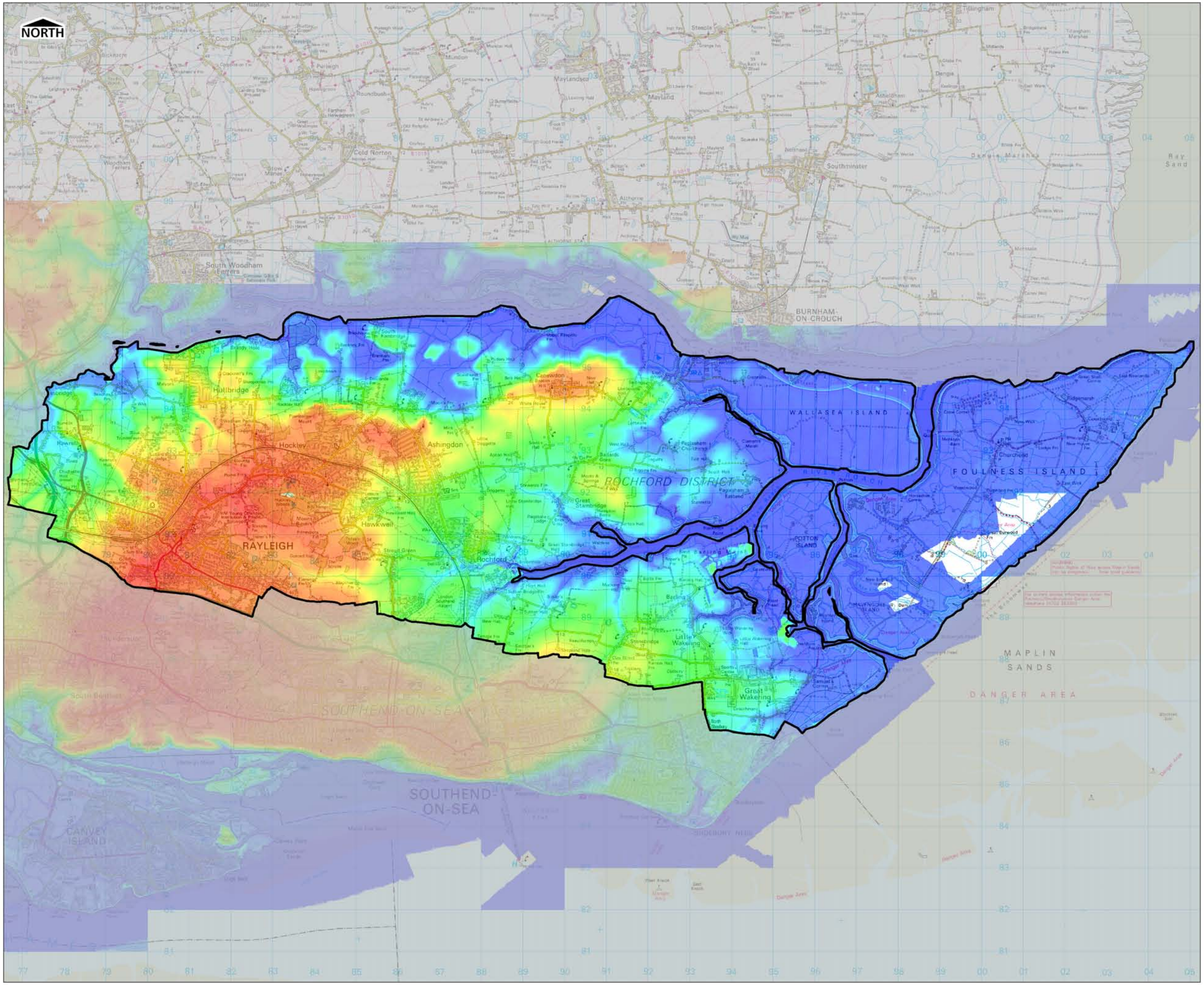
THAMES GATEWAY SOUTH ESSEX
STUDY AREA

Basildon Council | castlepoint | Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE A-1



KEY

Rochford District Boundary

LiDAR Topography [m AOD]

- < 2
- 5
- 10
- 20
- 30
- > 80

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SL	EG	JR	OCT 2010

SCALE @ A3	ISSUING OFFICE
1 : 90,000	London

THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

LiDAR TOPOGRAPHIC DATA

Basildon Council | castlepoint | Rochford District Council

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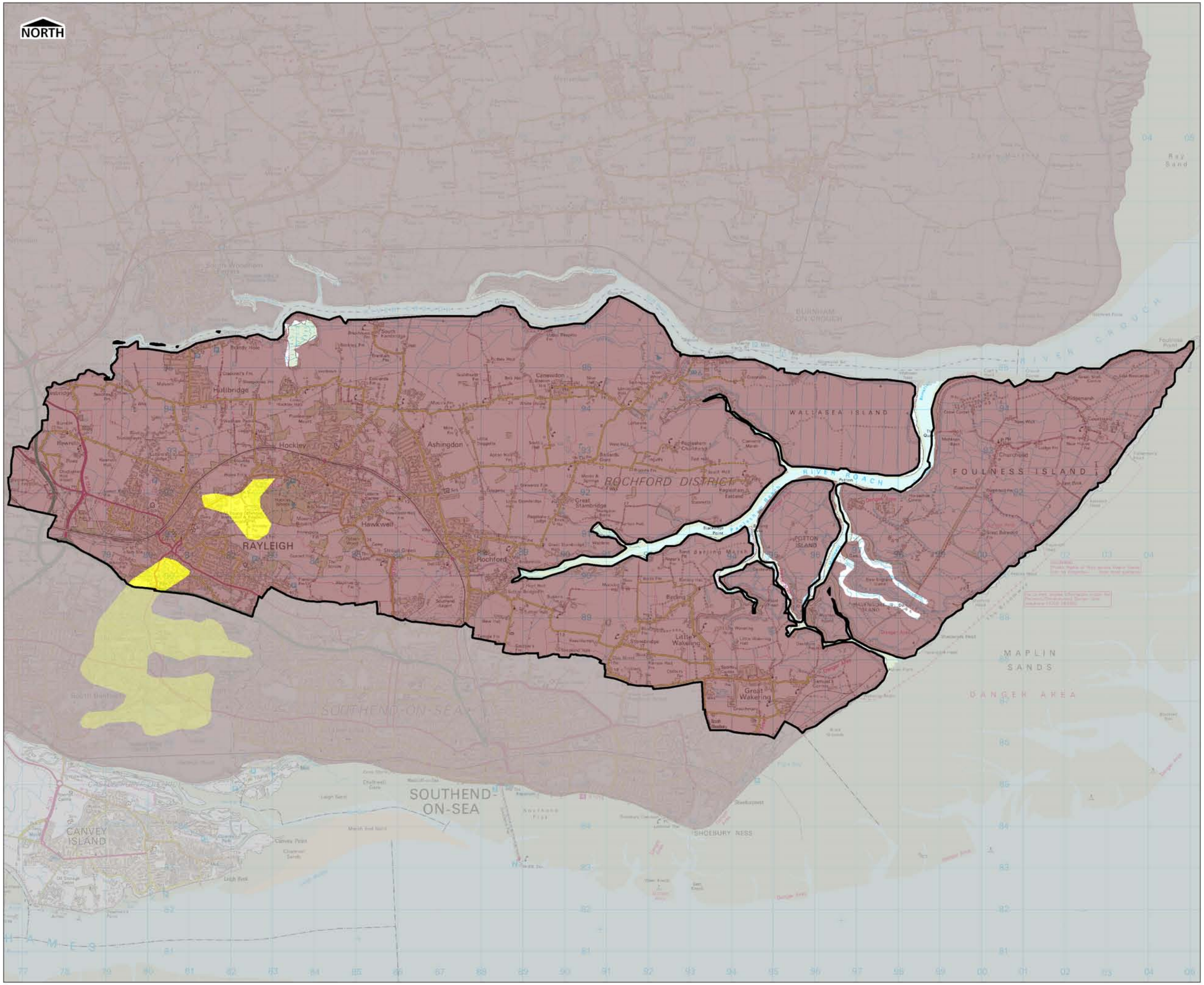
FIGURE A-2



KEY

Rochford District Boundary

Bedrock Geology

Thames Group
(Clay, Silt, Sand, Gravel)

Bracklesham & Barton Groups
(Sand, Silt, Clay)

Lambeth Group
(Clay, Silt, Sand, Gravel)

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

BEDROCK GEOLOGY

BasildonCouncil castlepoint Rochford District Council

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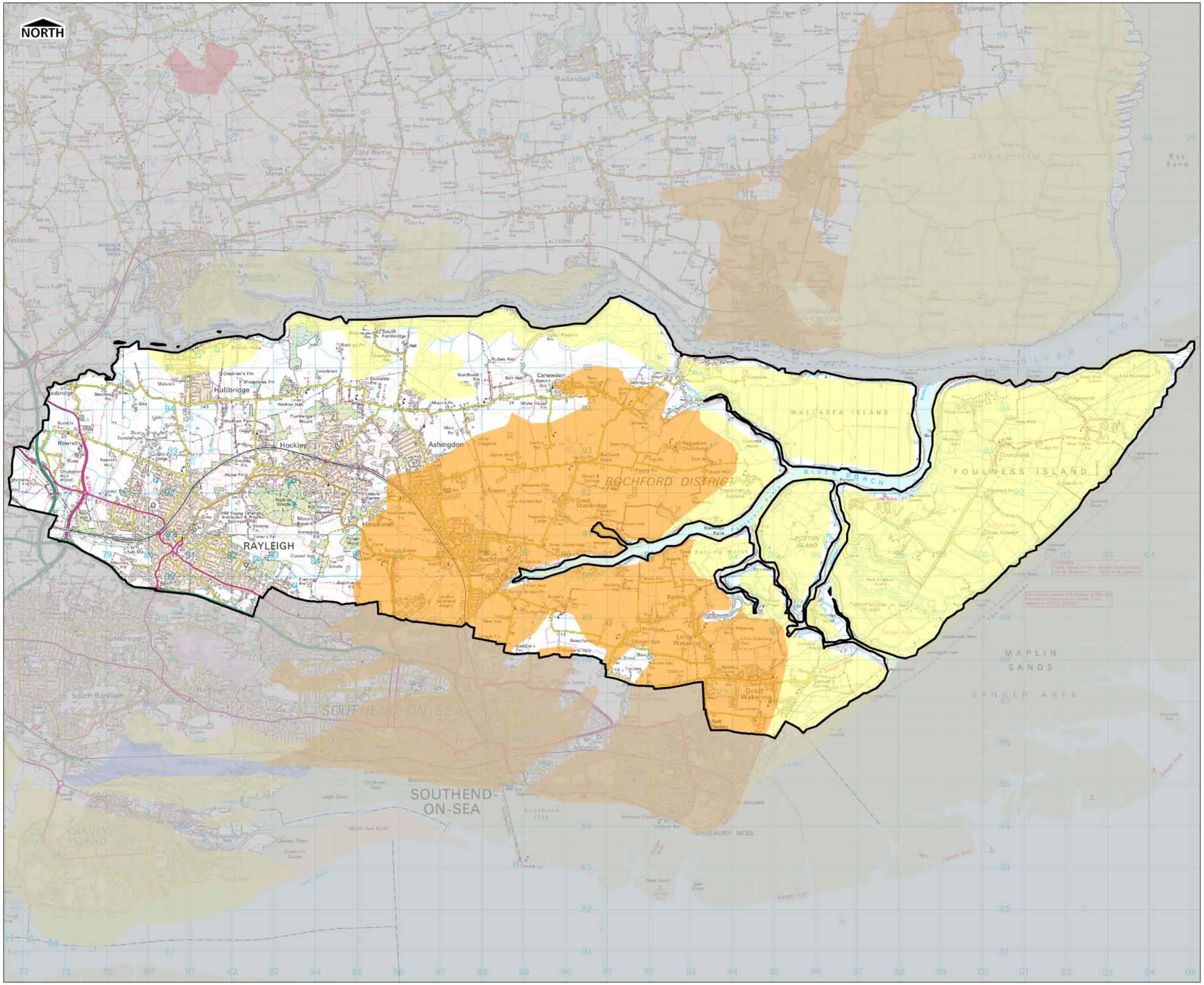
FIGURE A-3



KEY

- Rochford District Boundary

Superficial Geology

- Alluvium
- Brickearth
- River Terrace Deposits
- Sand and Gravel
- Glacial Sand and Gravel
- Landslip

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SL	EG	JR	OCT 2010

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

SUPERFICIAL GEOLOGY

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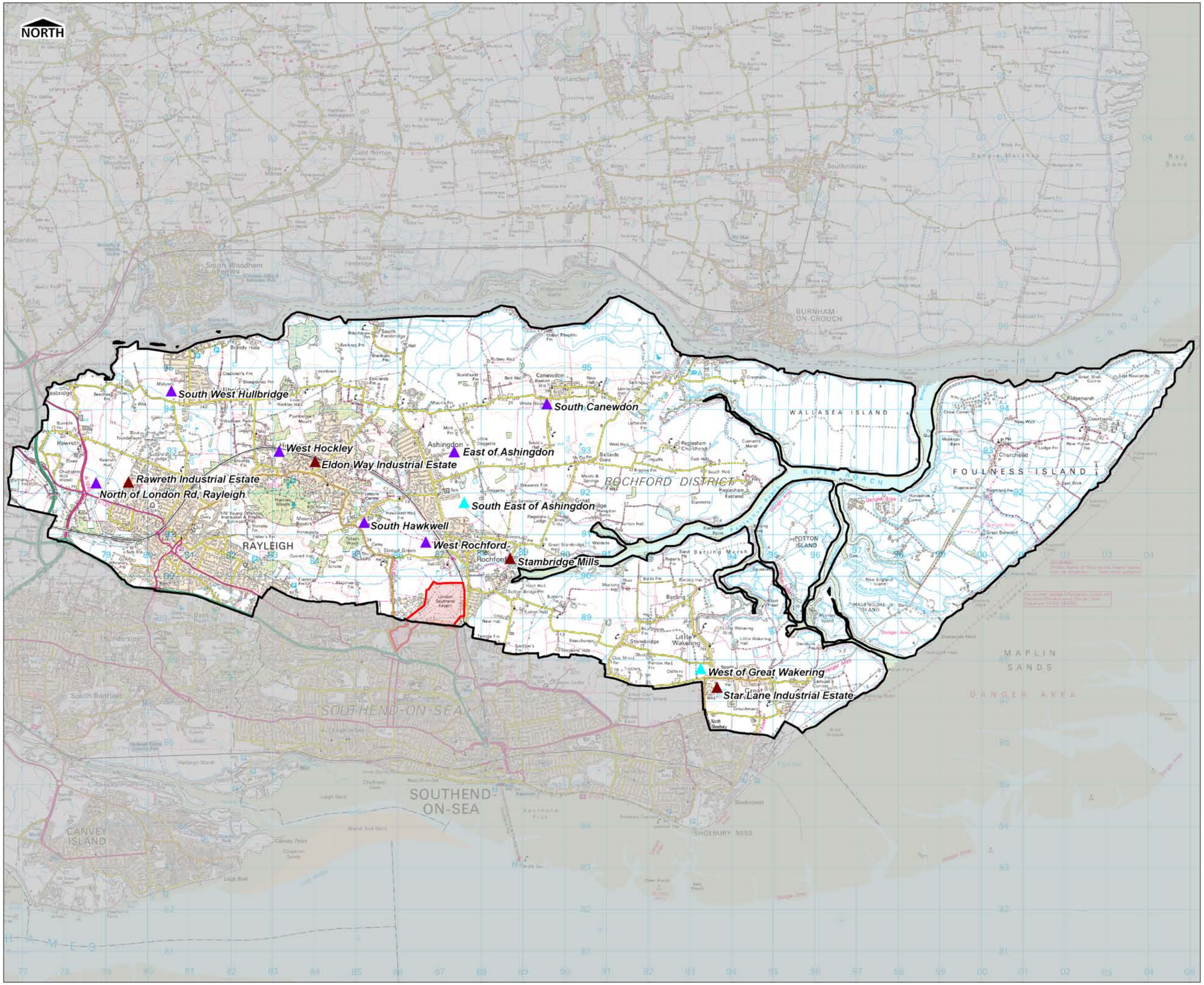
FIGURE A-4



KEY

- Rochford District Boundary

Core Strategy Development Locations

- Extensions to Residential Envelope pre-2021
- Extensions to the Residential Envelope post 2021
- Redevelopment of Employment Land for Residential Use
- London Southend Airport & Environs Joint Area Action Plan

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SL	EG	JR	OCT 2010

SCALE @ A3	ISSUING OFFICE
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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

CORE STRATEGY DEVELOPMENT LOCATIONS

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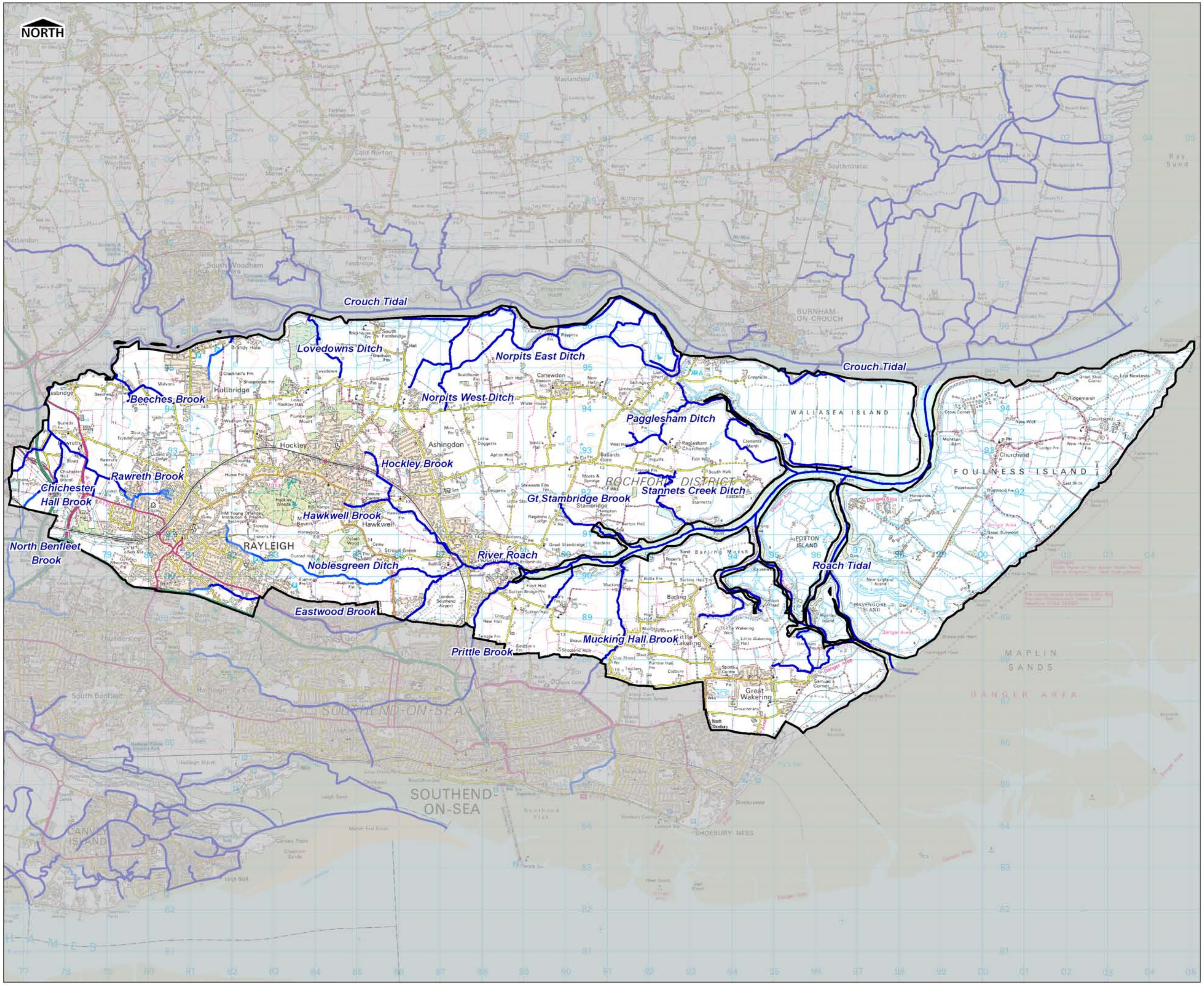
DRAWING NUMBER

FIGURE A-5



KEY

Rochford District Boundary

Environment Agency Main Rivers

Critical Ordinary Watercourses

DRAWN BY	CHECKED BY	PASSED BY	DATE
SL	EG	JR	OCT 2010

SCALE @ A3	ISSUING OFFICE
1 : 90,000	London

THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

EA MAIN RIVERS & CRITICAL
ORDINARY WATERCOURSES

Basildon Council castlepoint Rochford District Council

Scott Wilson
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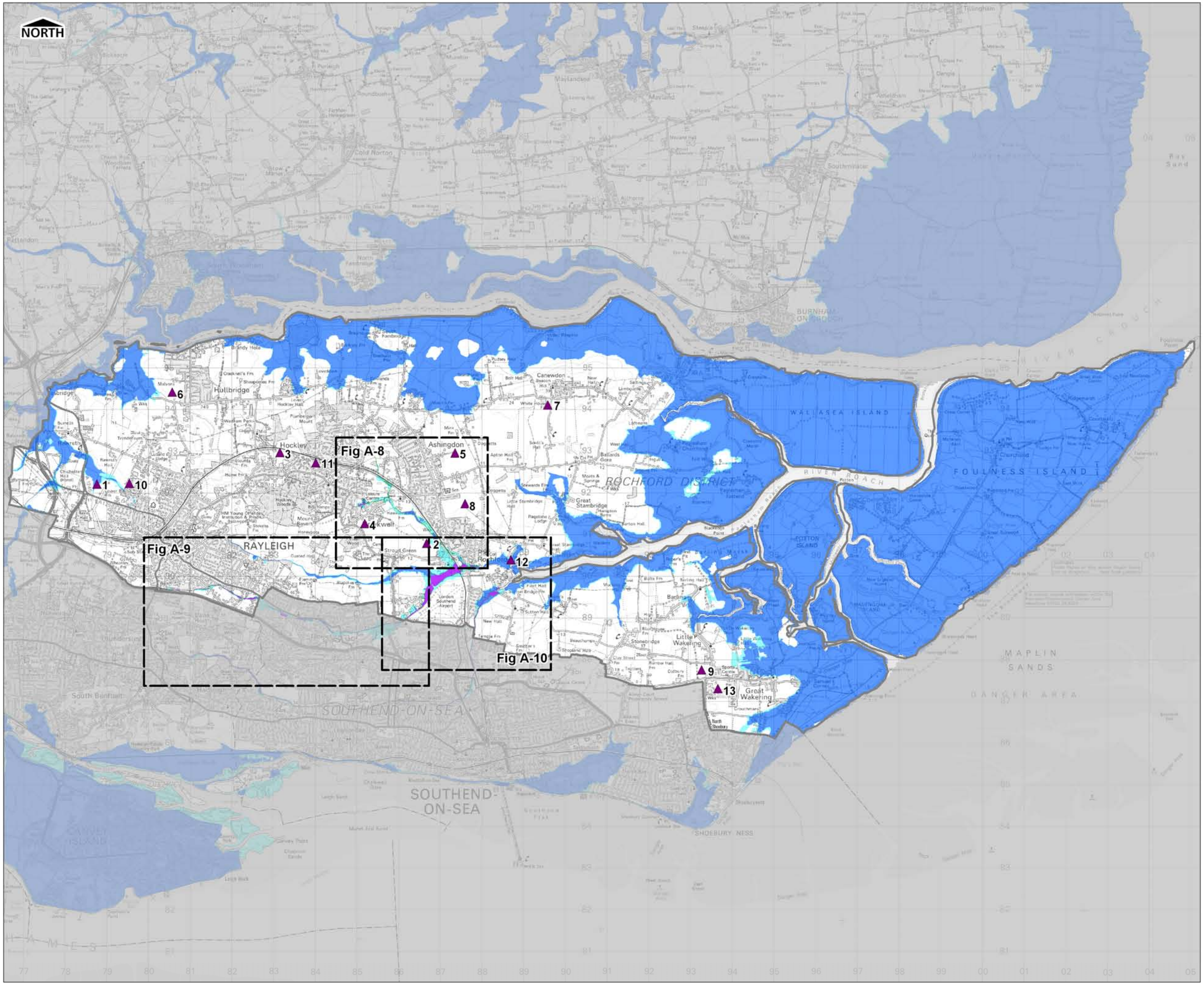
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE A-6



KEY

Rochford District Boundary

Flood Zones

FZ 2 - Low Probability

FZ 3a - High Probability

FZ 3a including Climate Change

FZ 3b - Functional Floodplain

Core Strategy Development Areas

1 North of London Rd, Rayleigh
2 West Rochford
3 West Hockley
4 South Hawkwell
5 East Ashingdon
6 South West Hullbridge
7 South Canewdon
8 South East Ashingdon
9 West Great Wakering
10 Rawreth Lane Industrial Estate
11 Eldon Way / Foundry Industrial Estate
12 Stambridge Mill
13 Star Lane Industrial Estate

USER NOTE
Flood Zones have been provided by the Environment Agency's Flood Risk and Mapping Department for the watercourses where modelling is available.
The Main Report of the SFRA should be consulted to identify the source of the flood outlines and the modelled return periods used to delineate each flood zone.

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

FLOOD ZONES

Basildon Council castlepoint Rochford District Council

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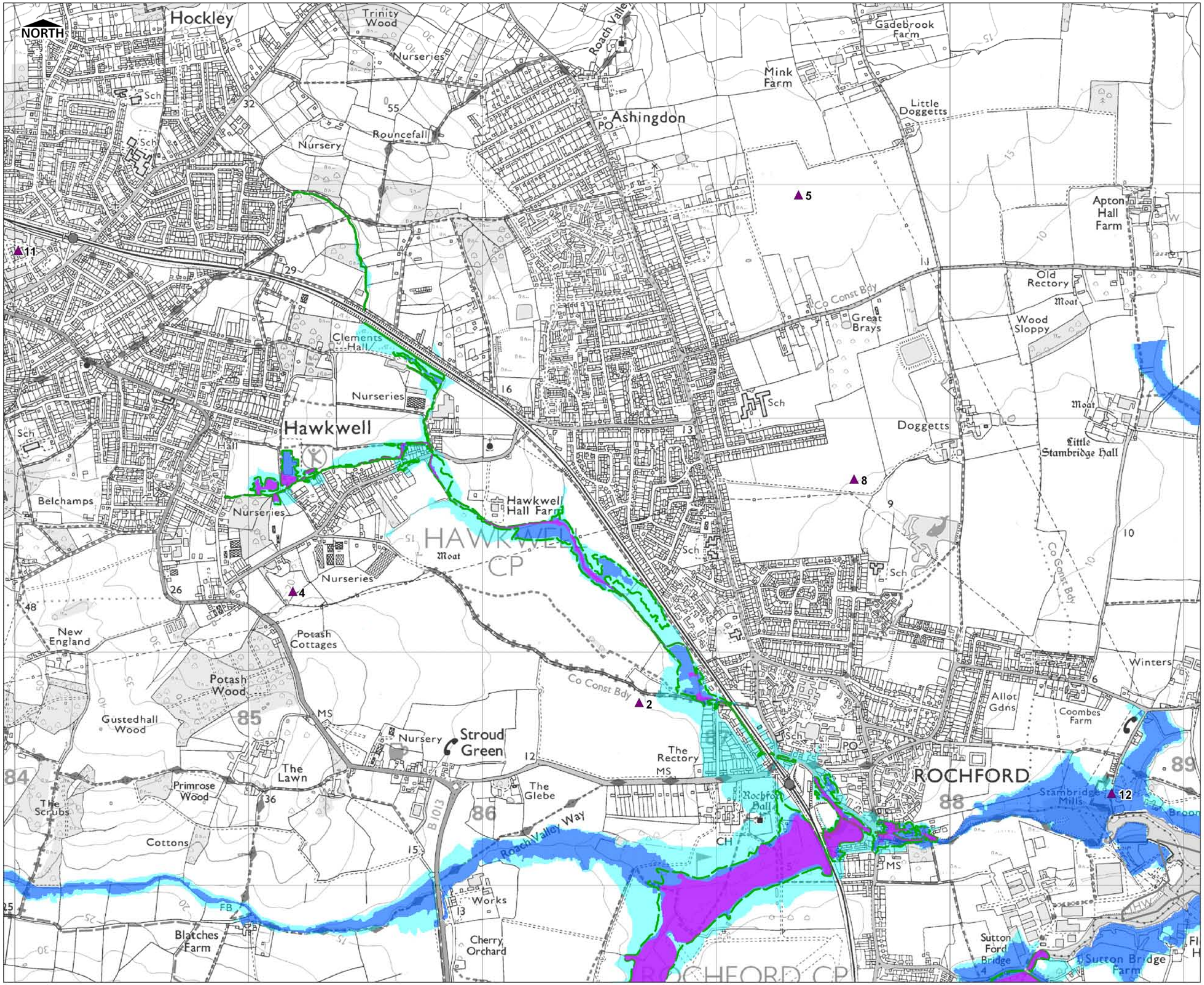
FIGURE A-7



KEY

Rochford District Boundary

Flood Zones

FZ 2 - Low Probability

FZ 3a - High Probability

FZ 3a including Climate Change

FZ 3b - Functional Floodplain

Core Strategy Development Areas

1 North of London Rd, Rayleigh
2 West Rochford
3 West Hockley
4 South Hawkwell
5 East Ashingdon
6 South West Hullbridge
7 South Canewdon
8 South East Ashingdon
9 West Great Wakering
10 Rawreth Lane Industrial Estate
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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

FLOOD ZONES - HAWKWELL

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Tel: (020) 7798 5000

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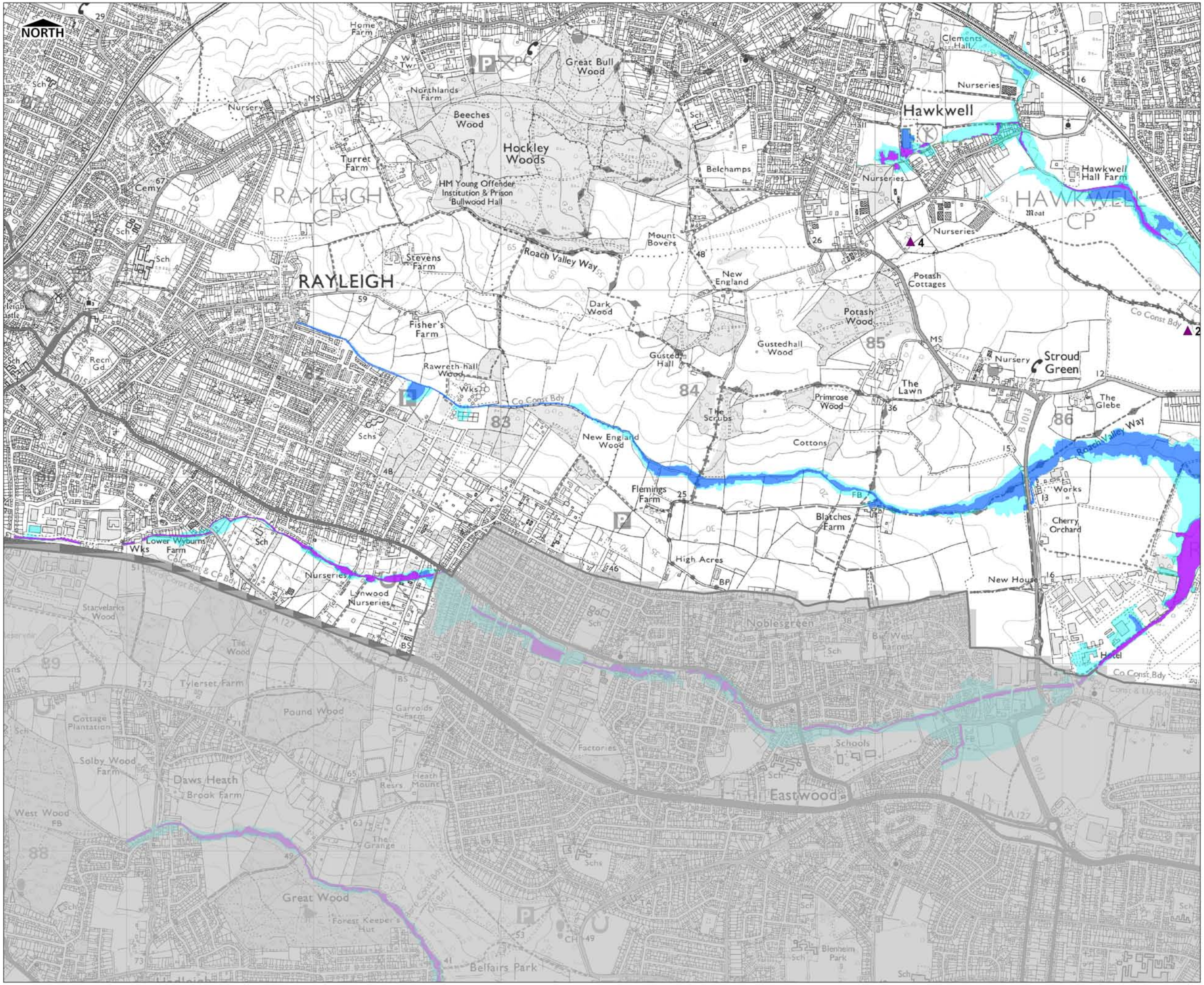
FIGURE A-8



KEY

Rochford District Boundary

Flood Zones

- FZ 2 - Low Probability
- FZ 3a - High Probability
- FZ 3a including Climate Change
- FZ 3b - Functional Floodplain

Core Strategy Development Areas

1. North of London Rd, Rayleigh
2. West Rochford
3. West Hockley
4. South Hawkwell
5. East Ashingdon
6. South West Hullbridge
7. South Canewdon
8. South East Ashingdon
9. West Great Wakering
10. Rawreth Lane Industrial Estate
11. Eldon Way / Foundry Industrial Estate
12. Stambridge Mill
13. Star Lane Industrial Estate

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

FLOOD ZONES - RAYLEIGH

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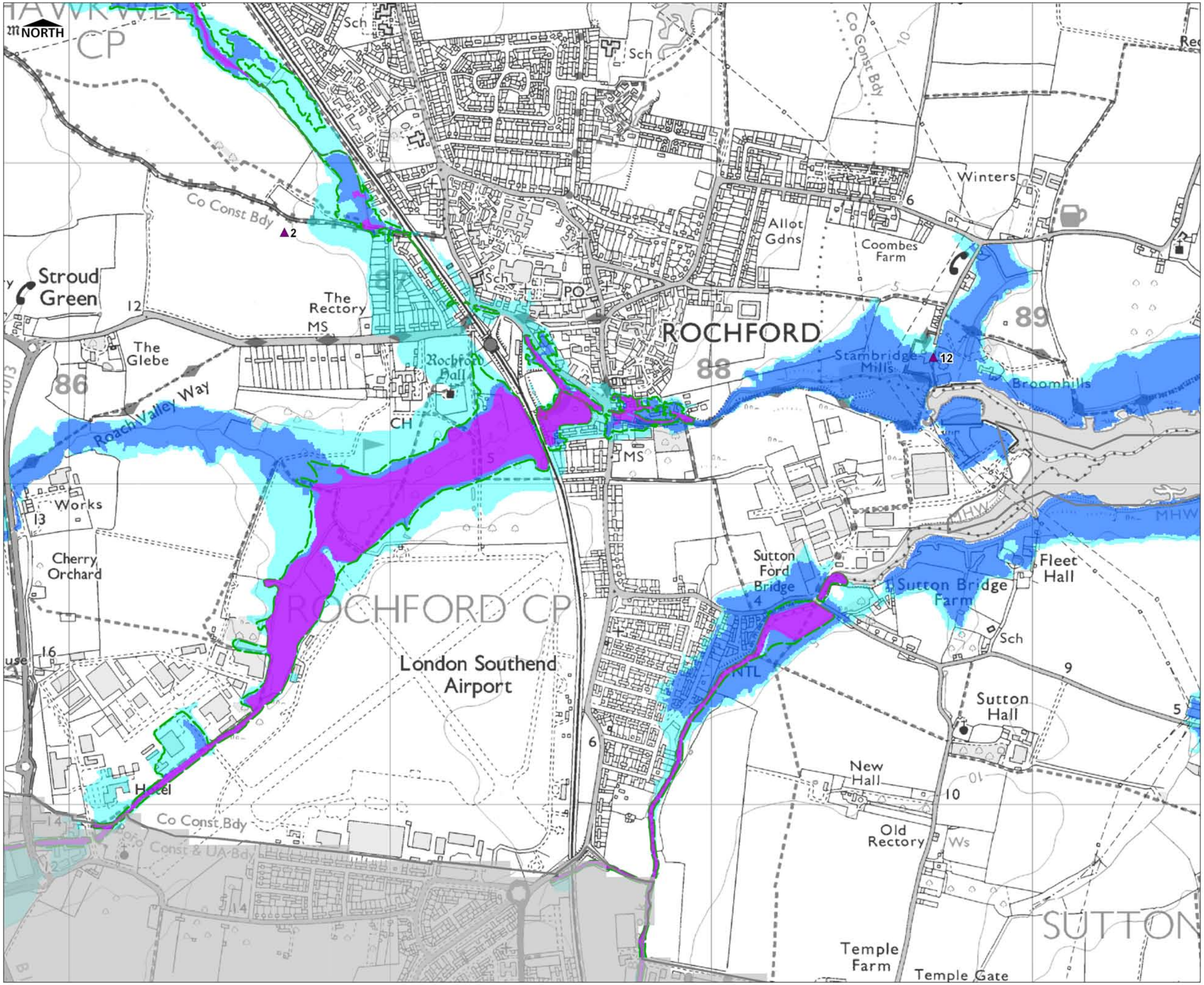
FIGURE A-9



KEY

Rochford District Boundary

Flood Zones

FZ 2 - Low Probability

FZ 3a - High Probability

FZ 3a including Climate Change

FZ 3b - Functional Floodplain

Core Strategy Development Areas

1 North of London Rd, Rayleigh
2 West Rochford
3 West Hockley
4 South Hawkwell
5 East Ashingdon
6 South West Hullbridge
7 South Canewdon
8 South East Ashingdon
9 West Great Wakering
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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

FLOOD ZONES - ROCHFORD

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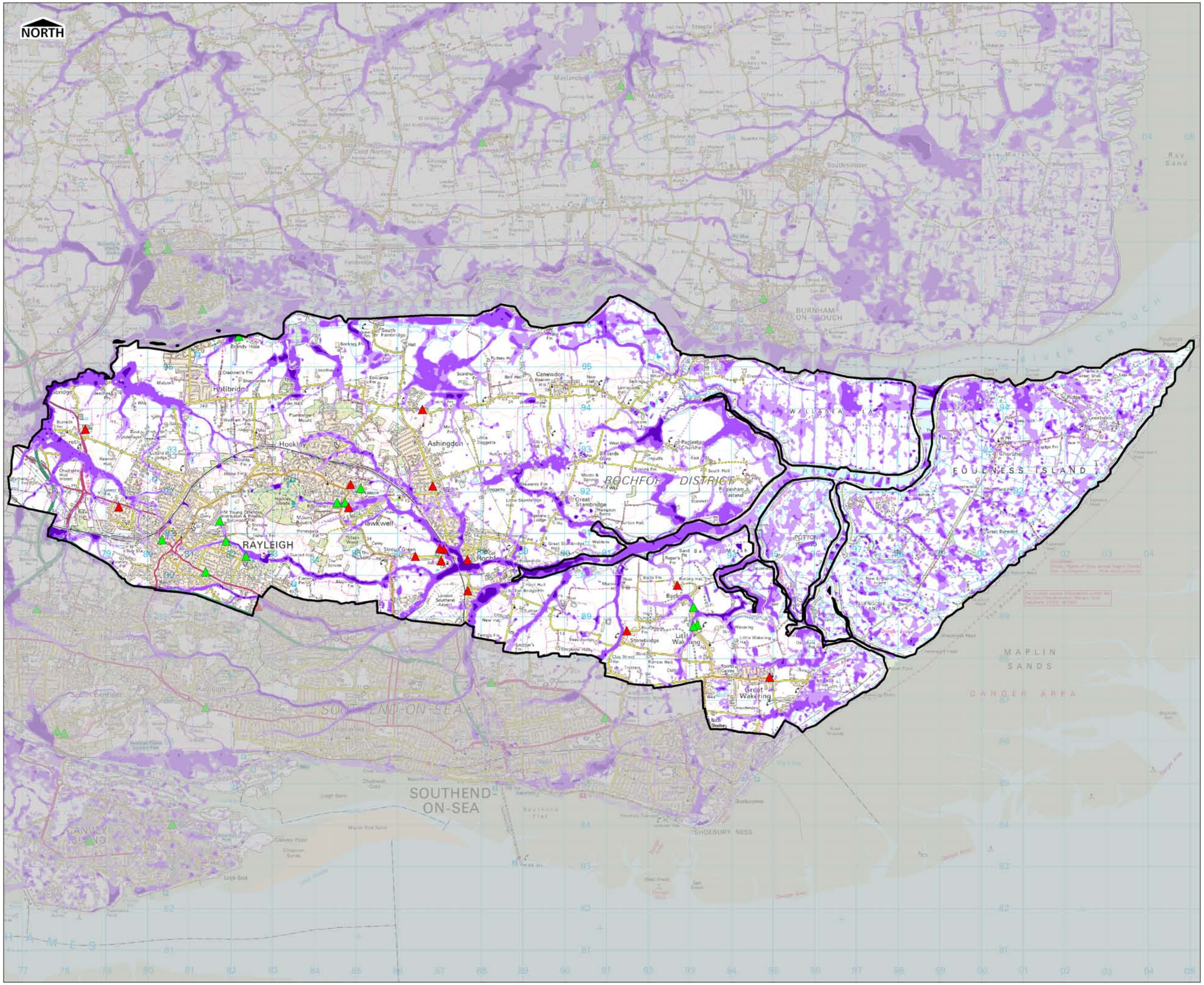
FIGURE A-10



KEY

Rochford District Boundary

Areas Susceptible to Surface Water Flooding (Environment Agency Dataset)

Less

Intermediate

More

Records of Flooding within Rochford DC

Sewer Flooding Records (Anglian Water DG5 Records)

USER NOTE

The Areas Susceptible to Surface Water Flooding dataset provides national coverage and has been produced using a highly simplified method that excludes urban sewerage and drainage systems, excludes buildings, and uses a single rainfall event. It is noted that this mapping is intended for use by the Local Resilience Forums solely to inform emergency planning and should not be used for spatial planning decisions. In addition, the Environment Agency strongly recommend that local knowledge is applied to assess the suitability of the mapping as an indicator of surface water flooding before emergency planners make decisions based upon it.

In line with these recommendations, incidents of flooding recorded by Rochford DC and records of sewer flooding supplied by Anglian Water from their DG5 register have been used to verify the ASTSW dataset.

The surface water flow paths follow the general topography of the area, as shown in Figure A-2, and the predominant flow paths from the modelling correlate with the tributaries of the Rivers Roach and Crouch.

Incidents of surface water and sewer flooding recorded in Rochford, Rayleigh and Hawkwell correlate well with the modelled dataset. In addition, incidents recorded in Little Wakering also correlate with the modelling.

There are fewer incidents recorded to the north of the River Roach, which is to be expected given the lower concentration of urban development in this area.

Further assessment of surface water across the district will be completed as part of the Surface Water Management Plan for the Rochford DC.

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

AREAS SUSCEPTIBLE TO SURFACE WATER FLOODING

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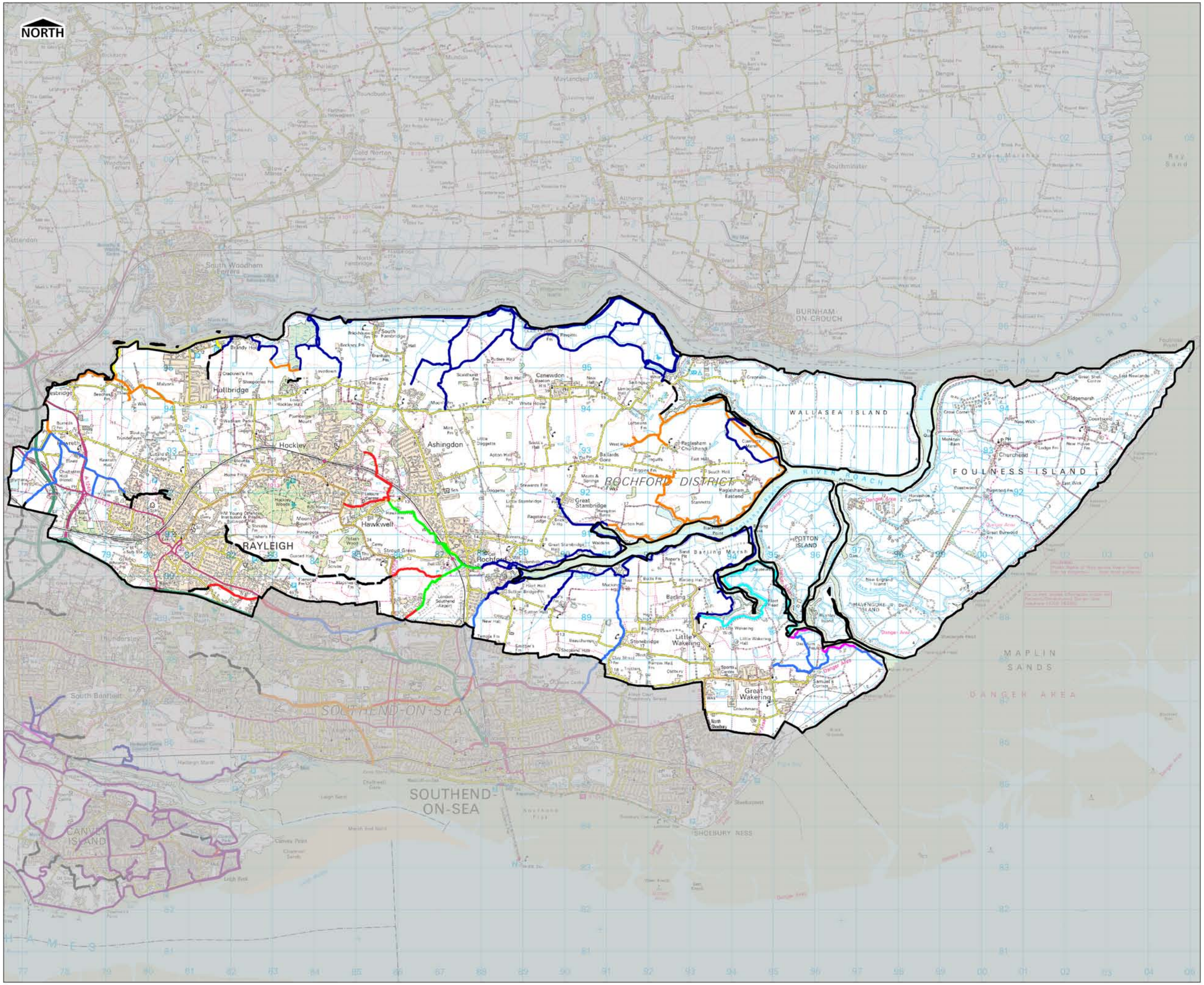
FIGURE A-11



KEY

Rochford District Boundary

Defence Design Standard [NFCDD Dataset]

- 1000yr
- 200 - 1000yr
- 100 - 200yr
- 50 - 100yr
- 40 - 50yr
- 30 - 40yr
- 20 - 30yr
- 10 - 20yr
- 0 -10yr
- Unknown

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

FLOOD DEFENCE DESIGN STANDARD [NFCDD]

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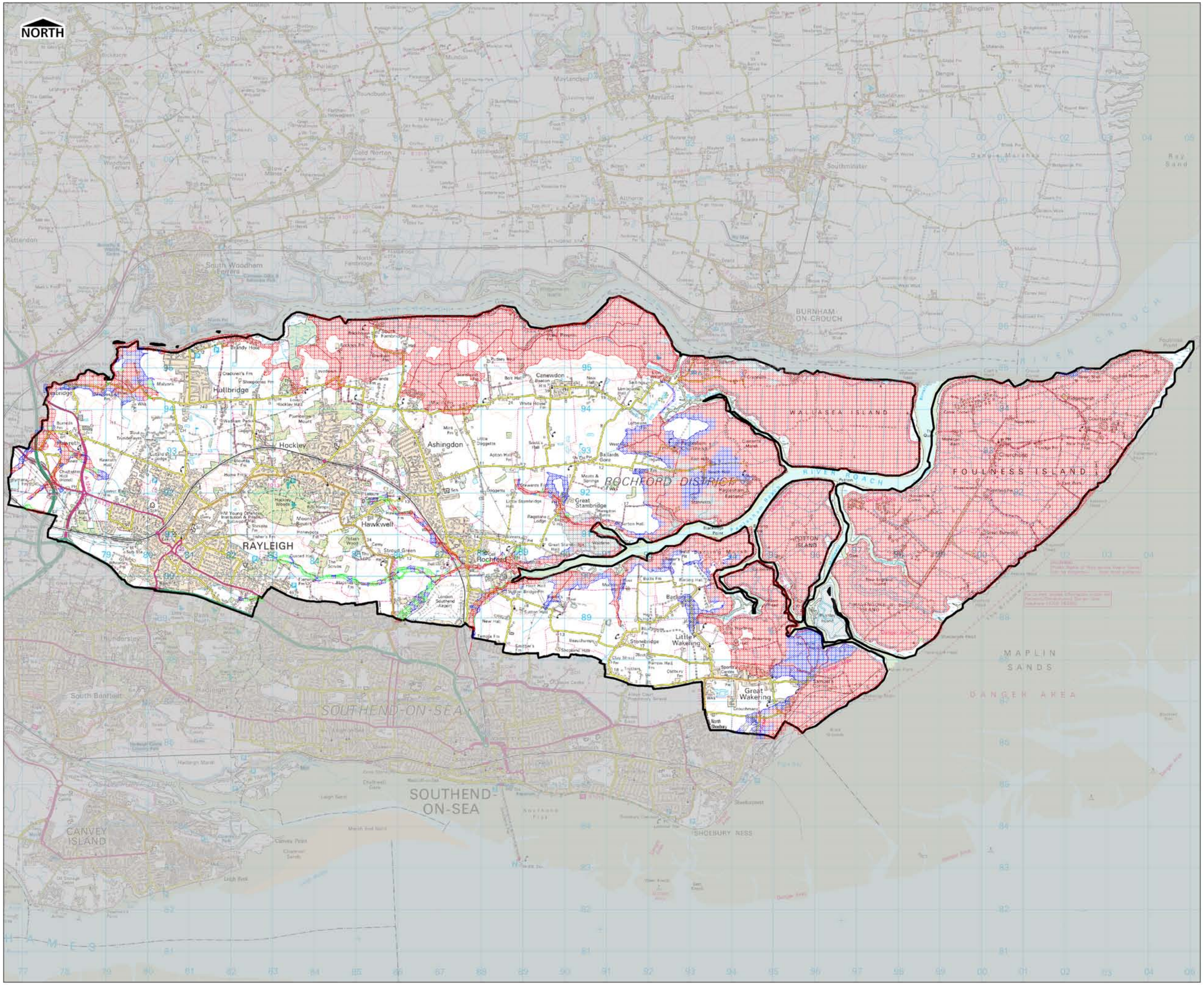
FIGURE A-12



KEY

Rochford District Boundary

National Flood Risk Assessment (NaFRA) Probability Bandings

Low (1 in 200 chance or less, in any given year)

Moderate (1 in 75 - 1 in 200 chance, in any given year)

Significant (> 1 in 75 chance in any given year)

No Result

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

NATIONAL FLOOD RISK ASSESSMENT [NaFRA]

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FIGURE A-13

Appendix B: Depth Mapping

Residual Risk – Composite of Breach Results and Overtopping
(Composite Results for all breaches; ROC01, ROC02, ROC03, ROC04, ROC05, ROC06, ROC07)

B1 (View 1-3) Maximum Flood Depth from Breaches & Overtopping (1 in 0200yr event, 2010)

B2 (View 1-3) Maximum Flood Depth from Breaches & Overtopping (1 in 1000yr event, 2010)

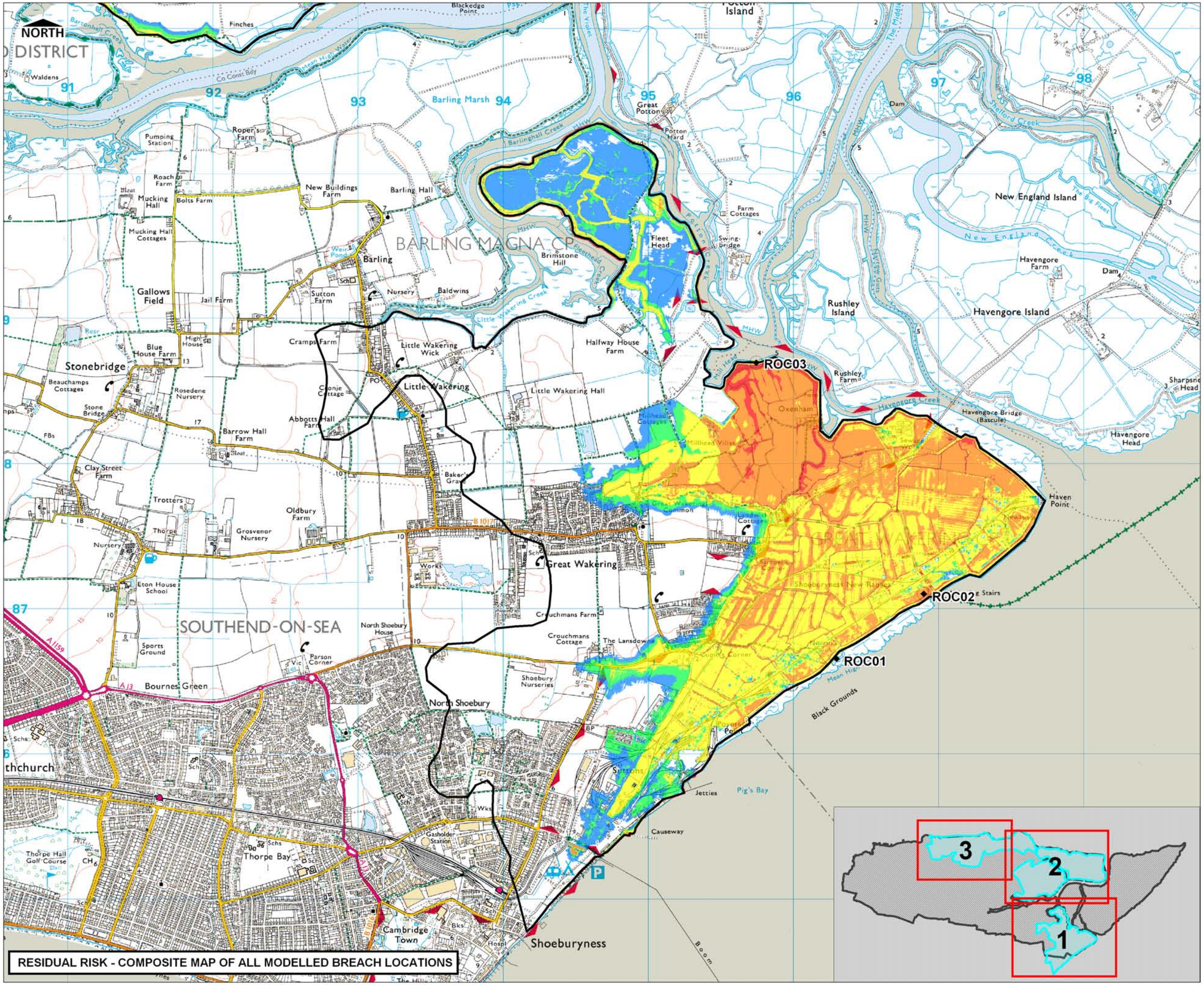
B3 (View 1-3) Maximum Flood Depth from Breaches & Overtopping (1 in 0200yr event, 2110 incl. CC)

B4 (View 1-3) Maximum Flood Depth from Breaches & Overtopping (1 in 1000yr event, 2110 incl. CC)

Potential Impact of Overtopping of Defences

B5 (View 1-3) Maximum Flood Depth from Overtopping (1 in 0200yr event, 2110 incl. CC)

B6 (View 1-3) Maximum Flood Depth from Overtopping (1 in 1000yr event, 2110 incl. CC)



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

Hydraulic modelling has been undertaken using 2-D hydraulic modelling software MIKE21-HDFM (ver. 2009), to assess the effect of breaches at specified points and/or overtopping of defences.
The model simulates 3 tidal cycles with the peak level occurring on the second peak and two slightly smaller peaks either side.
Breaches in the defence walls are modelled to occur immediately before the peak tidal level to assess the potential impact of rapid inundation of floodwater.
The maximum flood depth is calculated by subtracting the LiDAR topographic data from the peak water level achieved at each element in the model throughout the simulation.
When using flood depth maps, it should be noted that they represent the flood depth arising from one or more specified breach locations, and that the depth will almost certainly vary spatially if the breach locations are in different local areas. Changes in inundation extent or maximum depth are non-linear to changes in breach location.
It should be noted that the breach width and depth, though based on EA guidance, are arbitrary and do not necessarily represent the actual dimensions of a potential breach at a given location.
A thorough description of methodology and assumptions is included within the SFRA Main Report.

USER NOTE

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FLOODABLE AREAS NOT SHOWN

Land adjacent to watercourses not included within this study. Areas susceptible to drainage system inadequacies or localised ponding. Areas flooded due to debris blockage unless shown for specific structures. Areas flooded from breaches not included in this study.

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH 0200YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council · castlepoint · Rochford District Council

Scott Wilson
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London, SW1P 1PL
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FIGURE B-1 (View 1)

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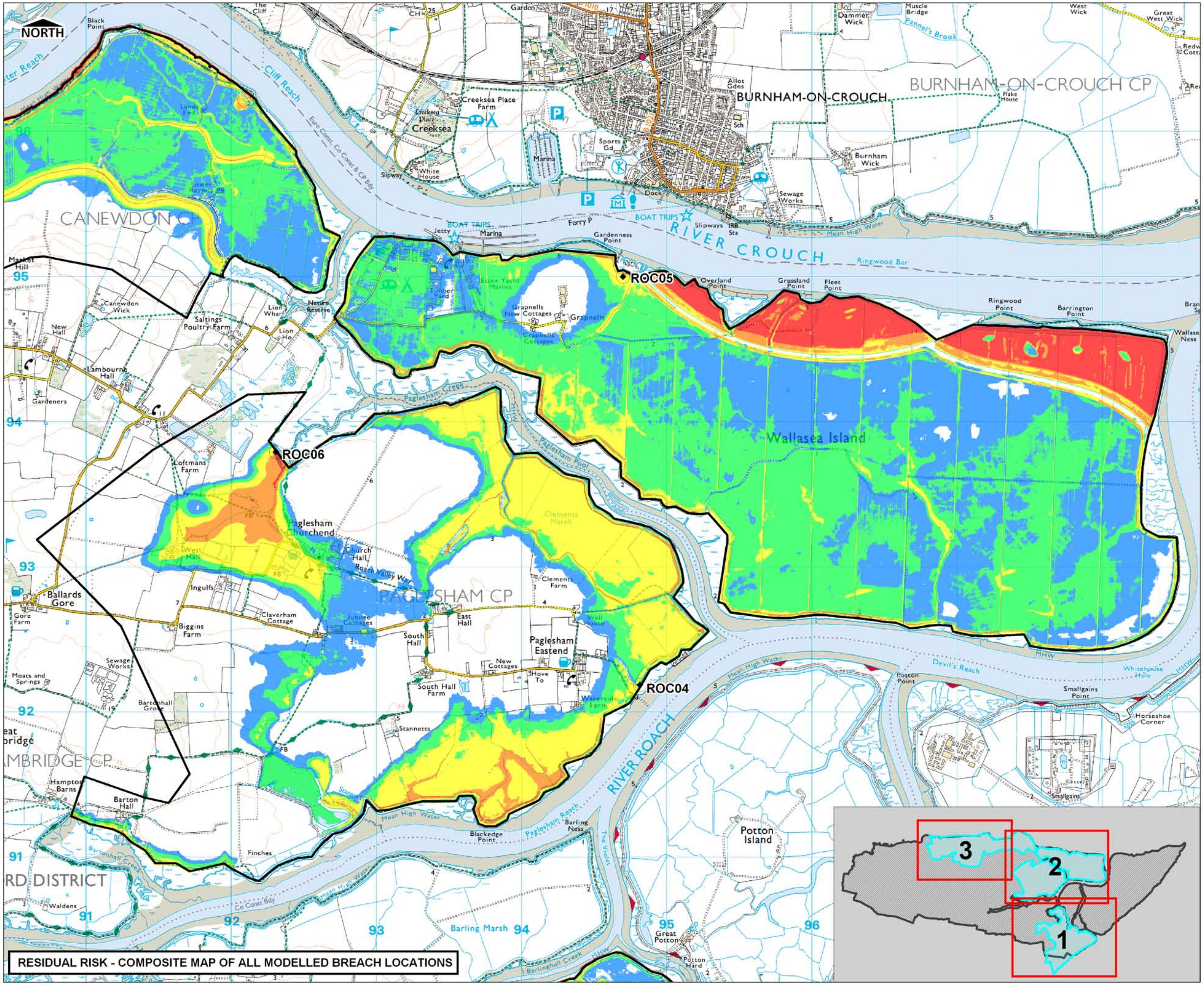

KEY

Flood Cells

Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

Hydraulic modelling has been undertaken using 2-D hydraulic modelling software MIKE21-HDFM (ver. 2009), to assess the effect of breaches at specified points and/or overtopping of defences.
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH
0200YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE B-1 (View 2)

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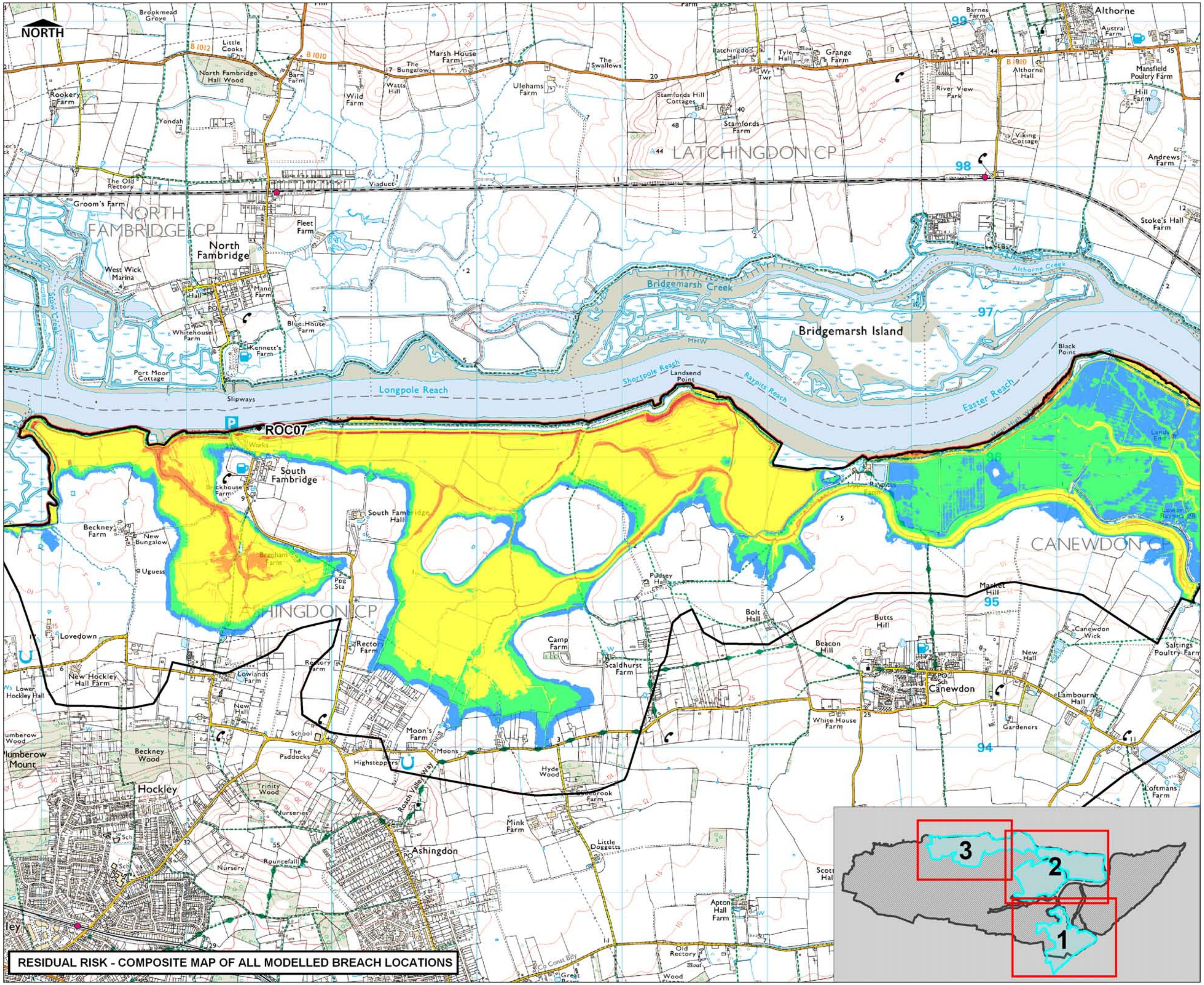

KEY

- Flood Cells
- Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

Hydraulic modelling has been undertaken using 2-D hydraulic modelling software MIKE21-HDFM (ver. 2009), to assess the effect of breaches at specified points and/or overtopping of defences.
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH 0200YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council castlepoint Rochford District Council

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FIGURE B-1 (View 3)

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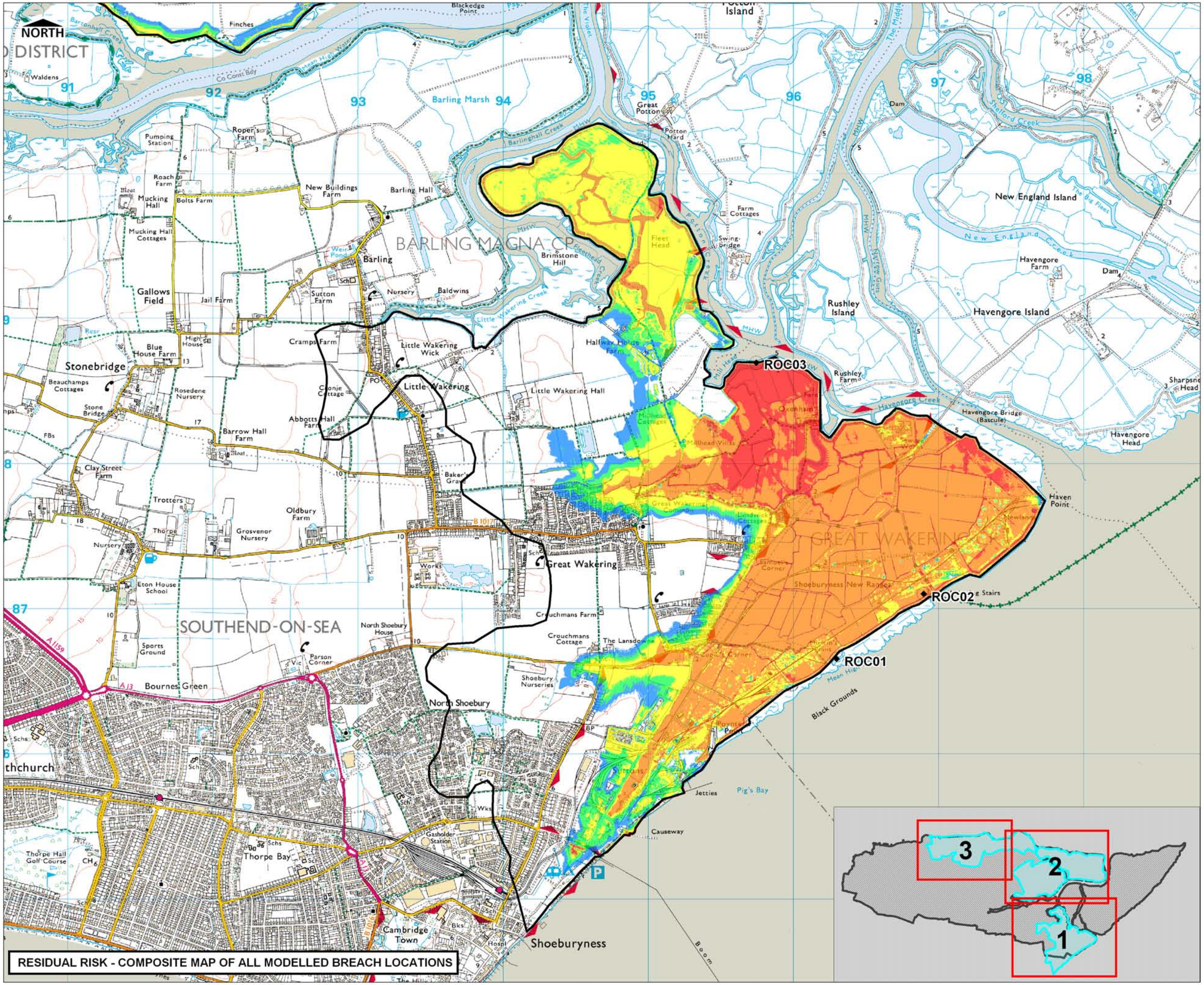

KEY

- Flood Cells
- Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH 1000YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE B-2 (View 1)

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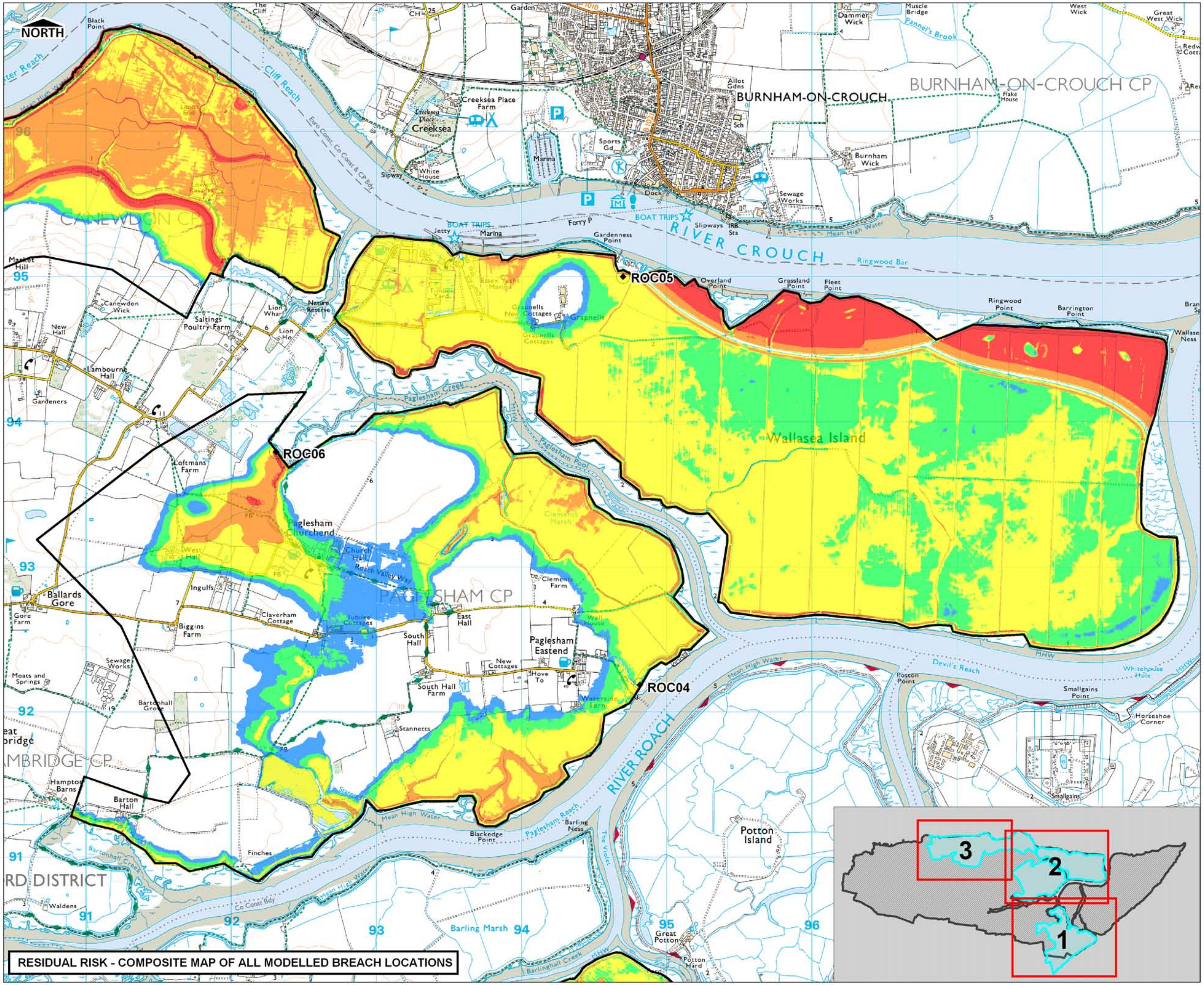

KEY

Flood Cells

Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH
1000YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE B-2 (View 2)

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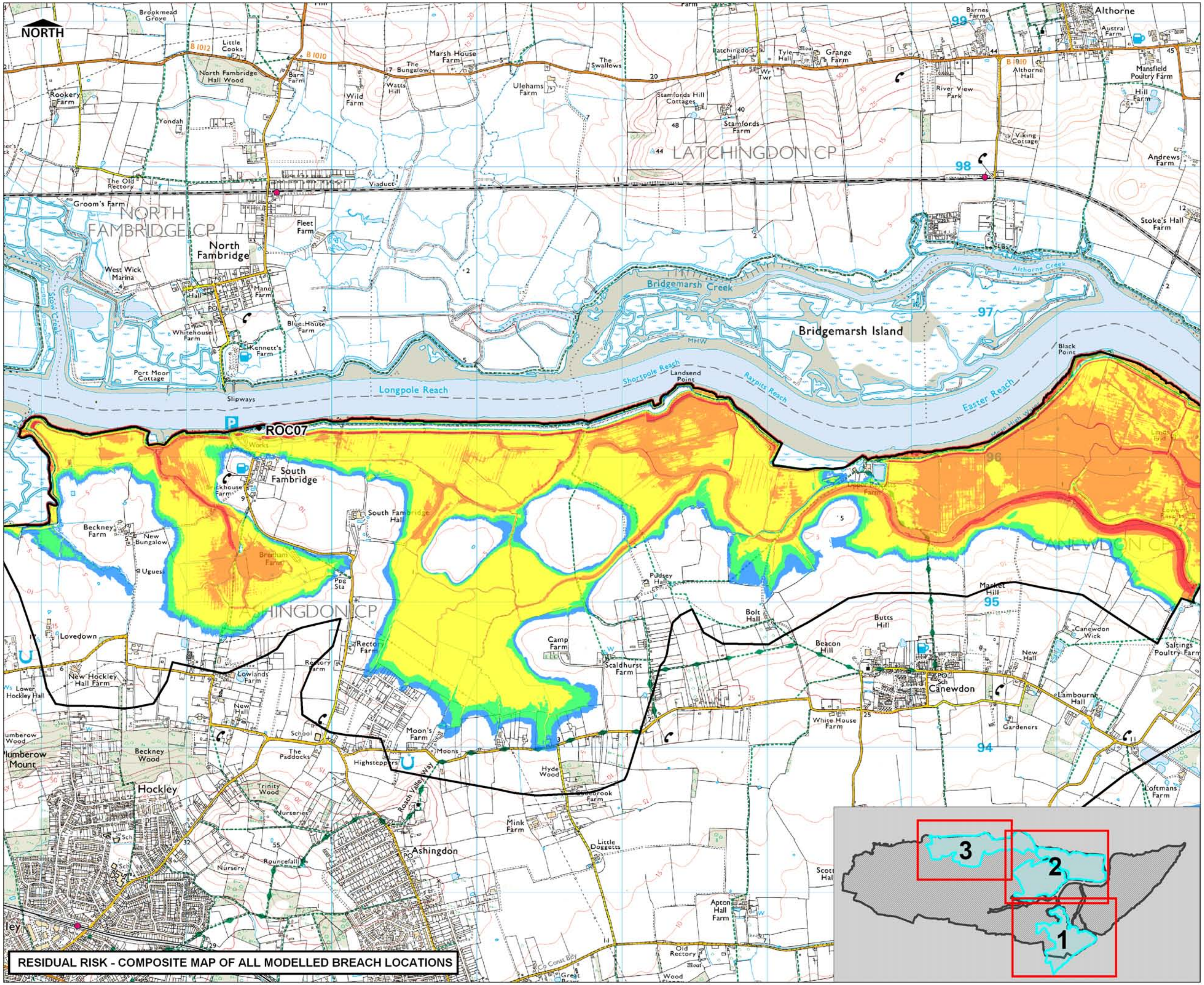

KEY

Flood Cells

Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH 1000YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE B-2 (View 3)

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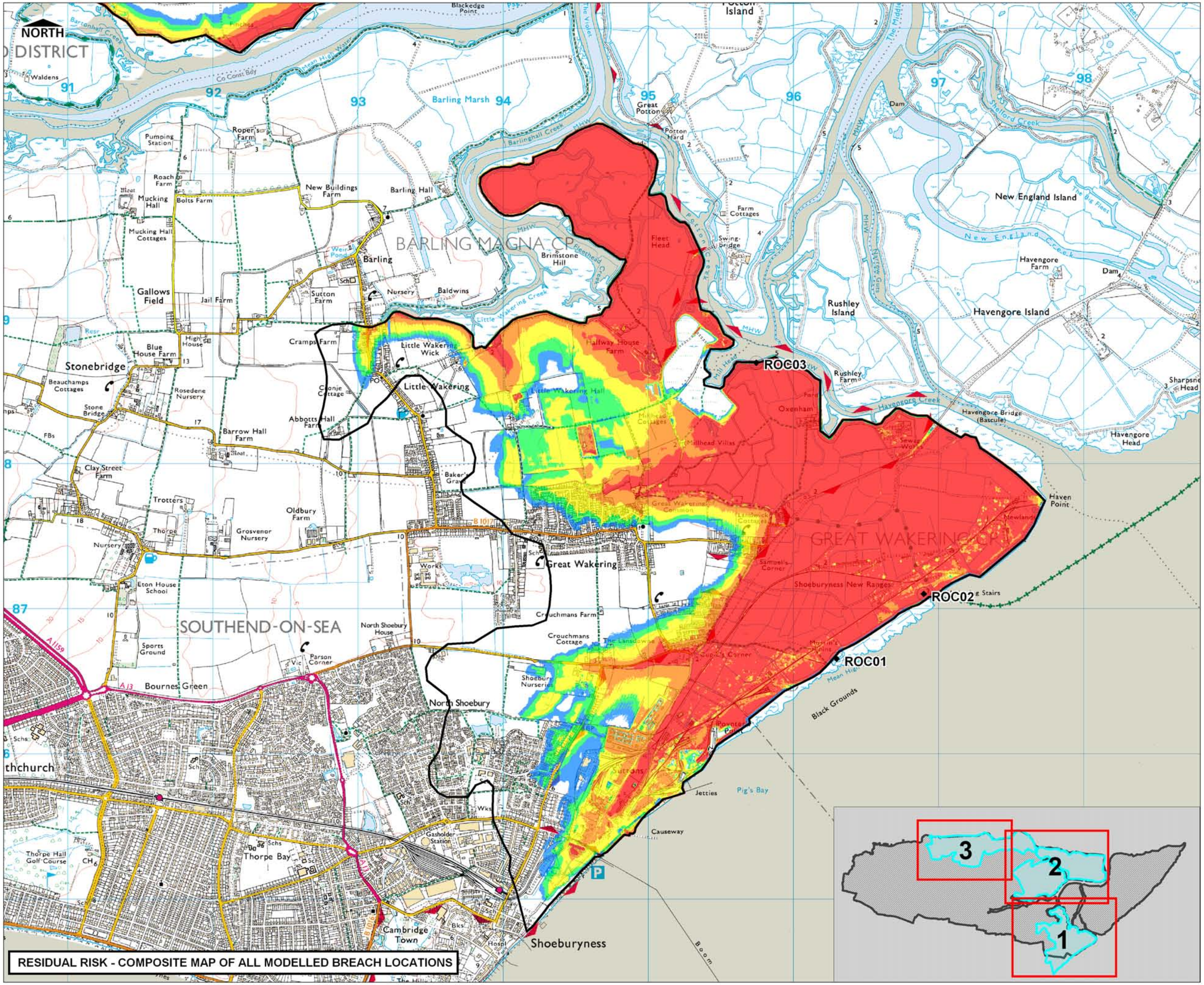

KEY

Flood Cells

Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

Hydraulic modelling has been undertaken using 2-D hydraulic modelling software MIKE21-HDFM (ver. 2009), to assess the effect of breaches at specified points and/or overtopping of defences.
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It should be noted that the breach width and depth, though based on EA guidance, are arbitrary and do not necessarily represent the actual dimensions of a potential breach at a given location.
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH
0200YR (2110)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council | castlepoint | Rochford District Council

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6-8 Greencoat Place
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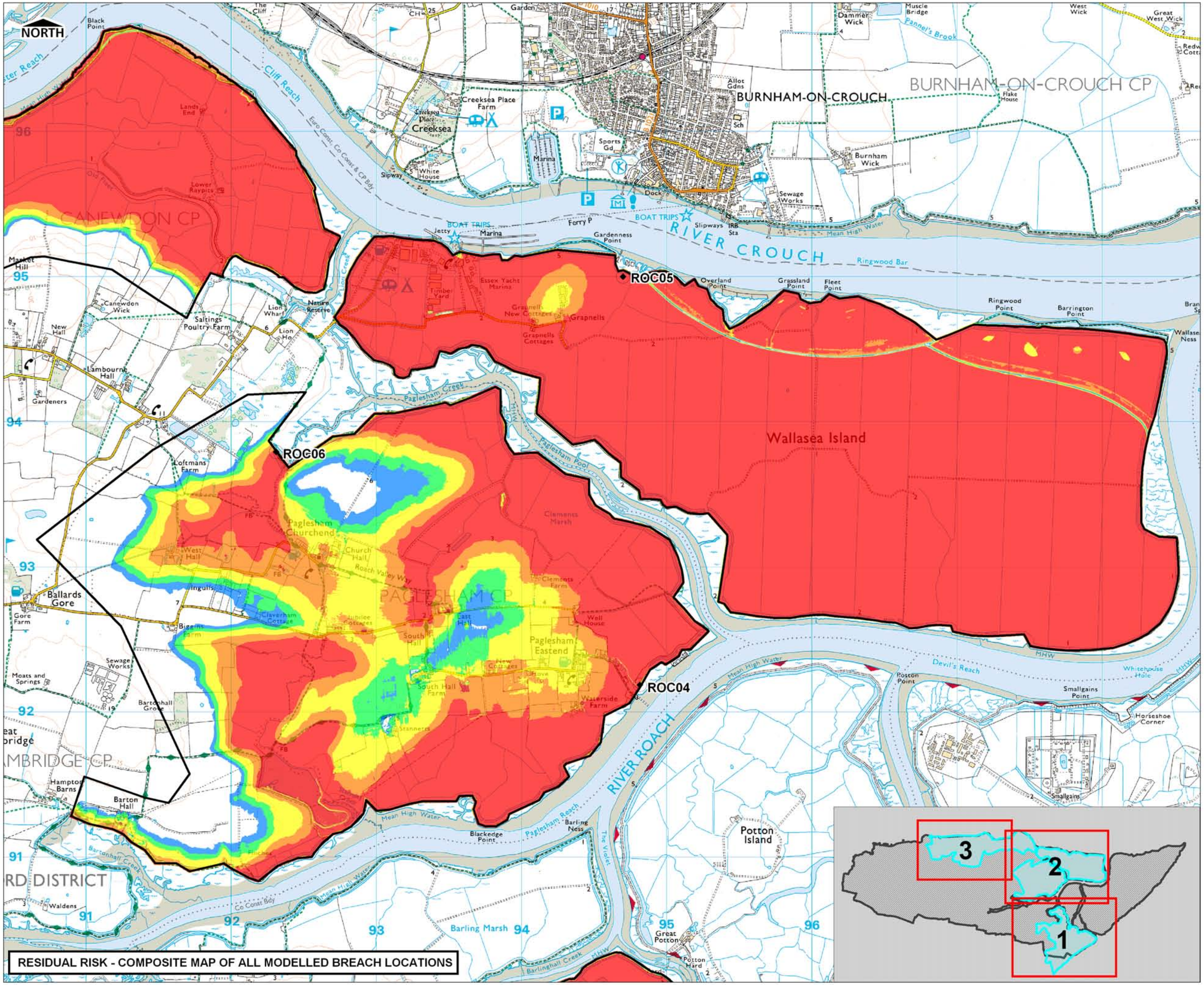
FIGURE B-3 (View 1)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

Flood Cells
Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH
0200YR (2110)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE B-3 (View 2)

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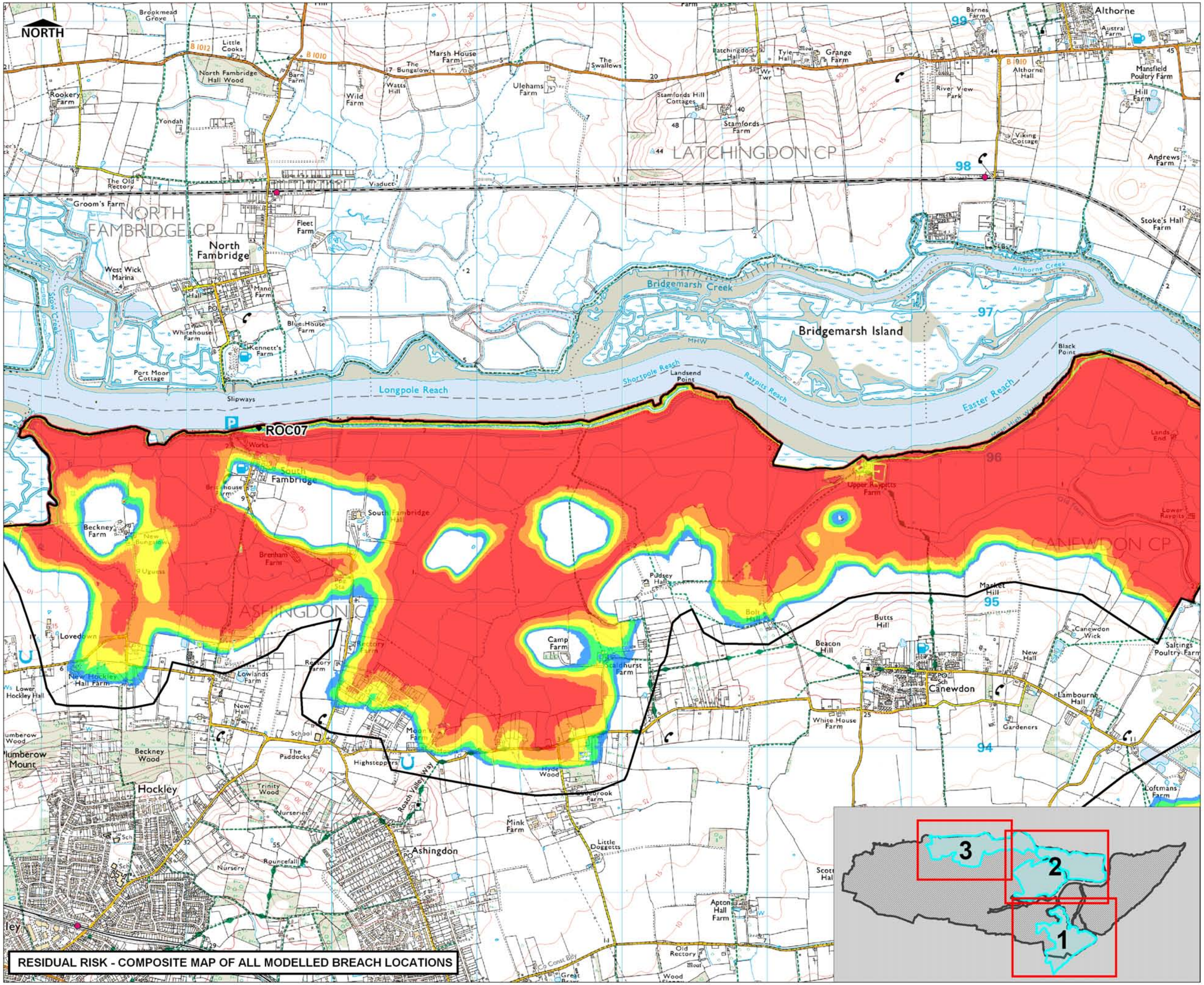

KEY

Flood Cells

Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

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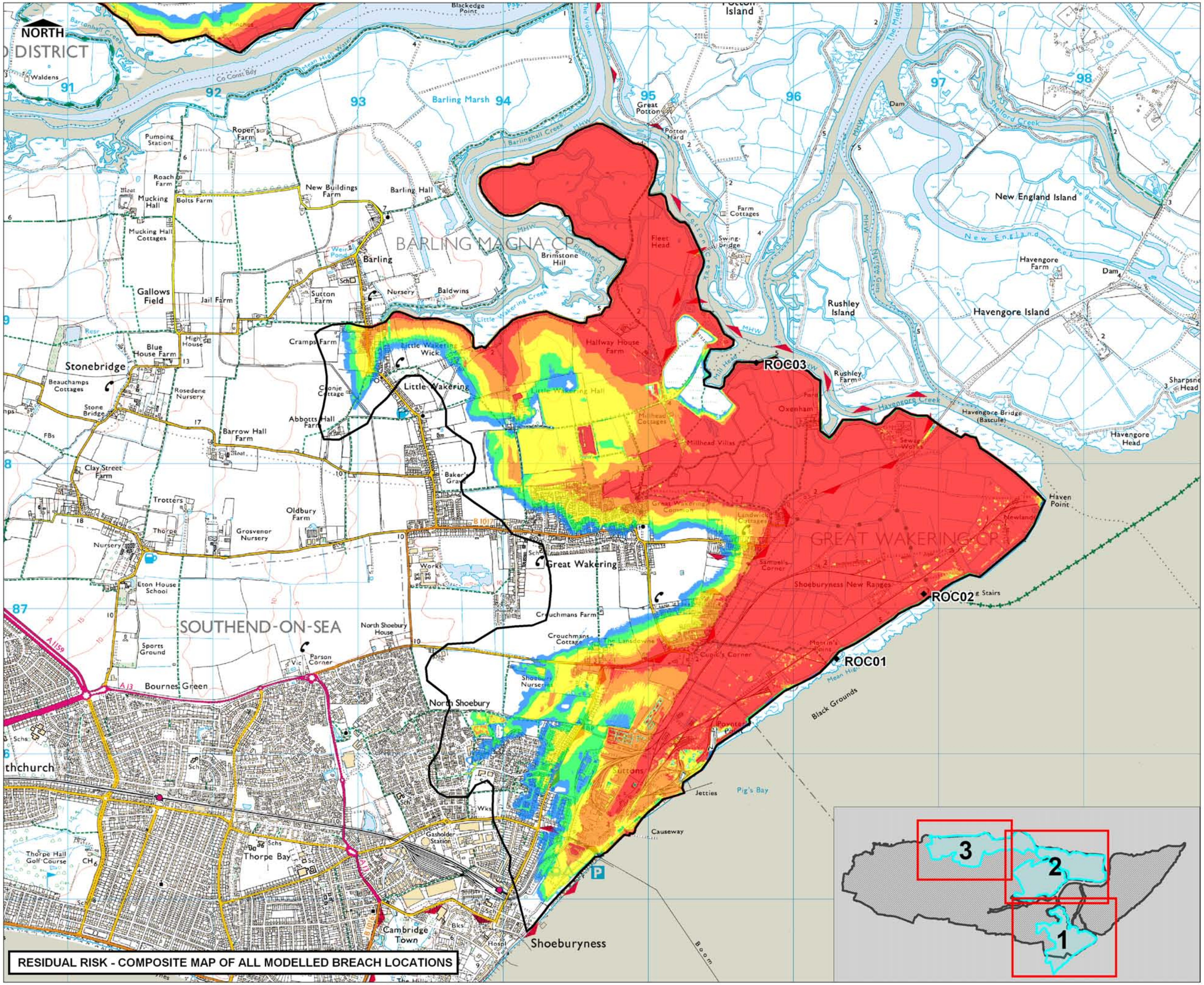
FIGURE B-3 (View 3)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
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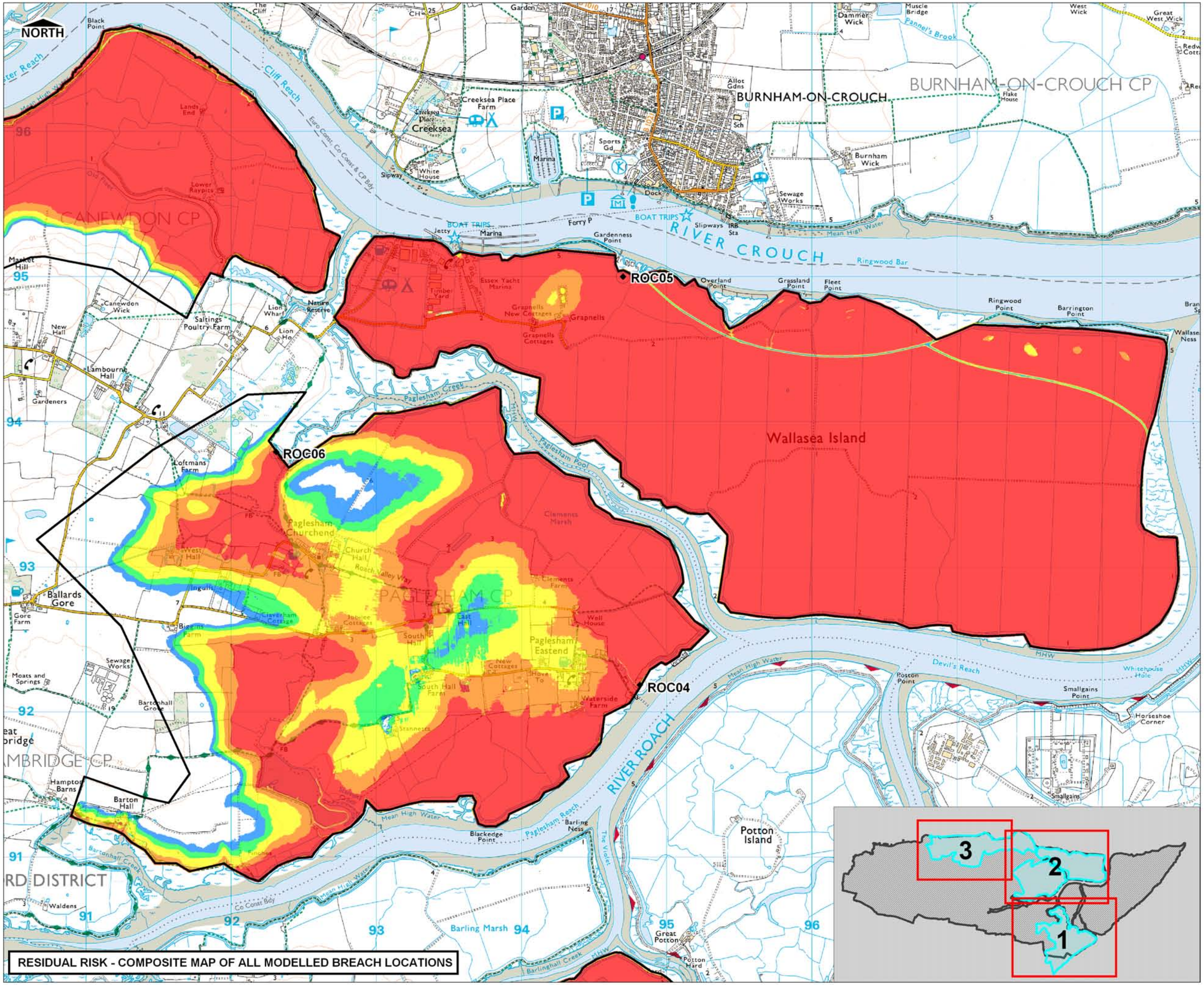
FIGURE B-4 (View 1)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

Flood Cells
Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
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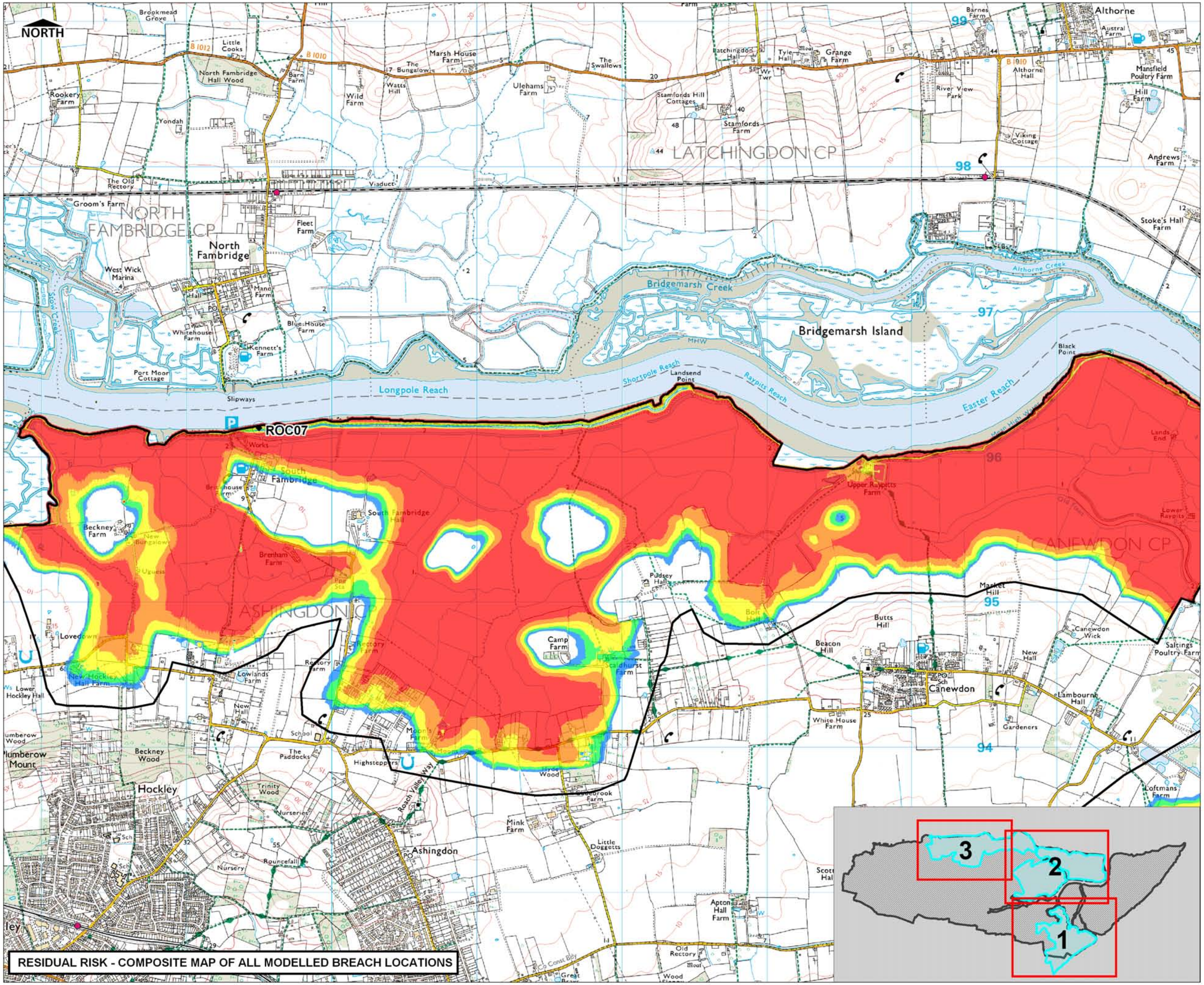
FIGURE B-4 (View 2)

REV 02



KEY

- Flood Cells
- Breach Location

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

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FIGURE B-4 (View 3)

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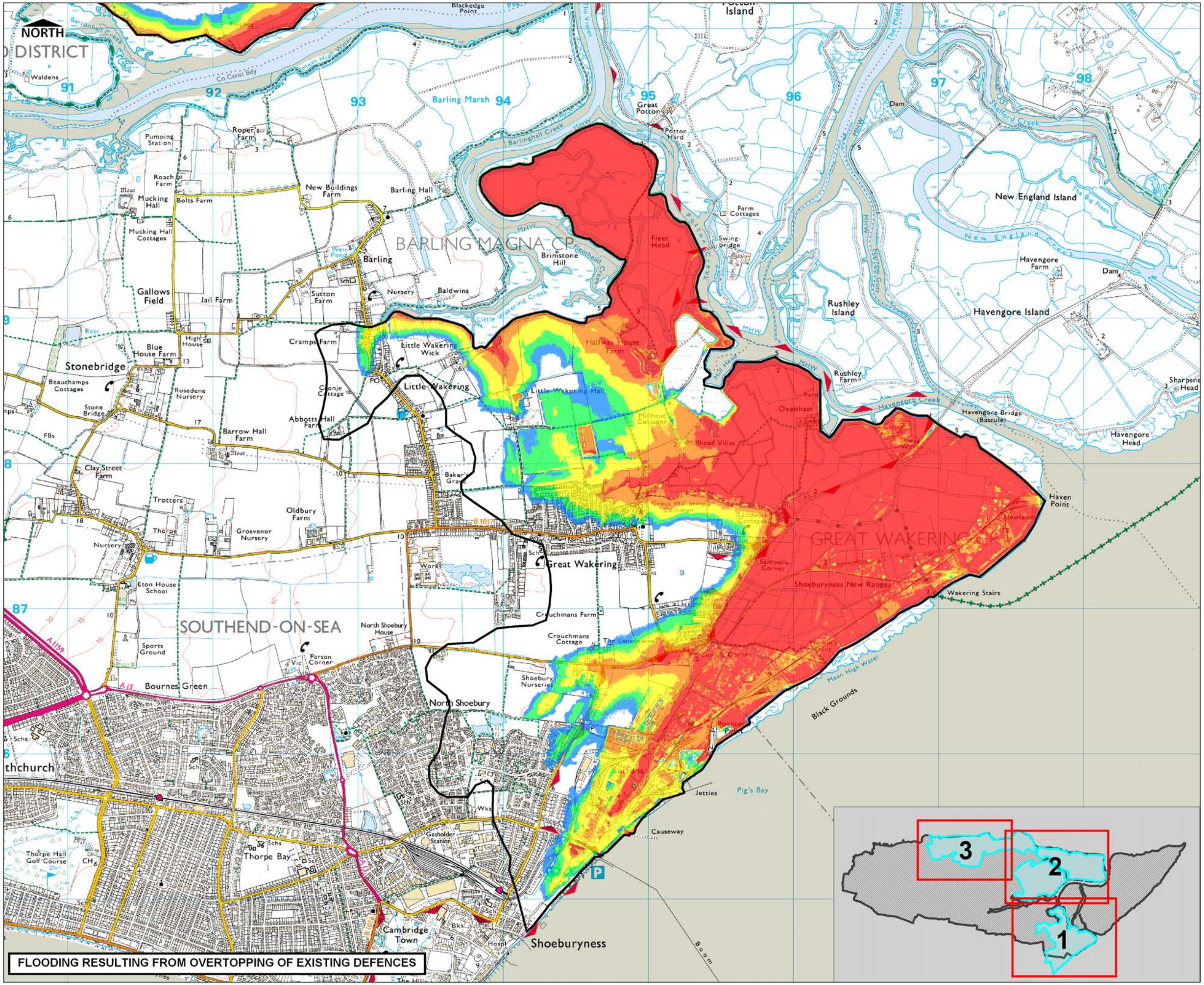

FLOODING RESULTING FROM OVERTOPPING OF EXISTING DEFENCES

KEY

Flood Cells

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 5.0m and greater

TECHNICAL NOTE

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0200YR (2110)
OVERTOPPING

Basildon Council · castlepoint · Rochford District Council

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6-8 Greencoat Place
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FIGURE B-5 (View 1)

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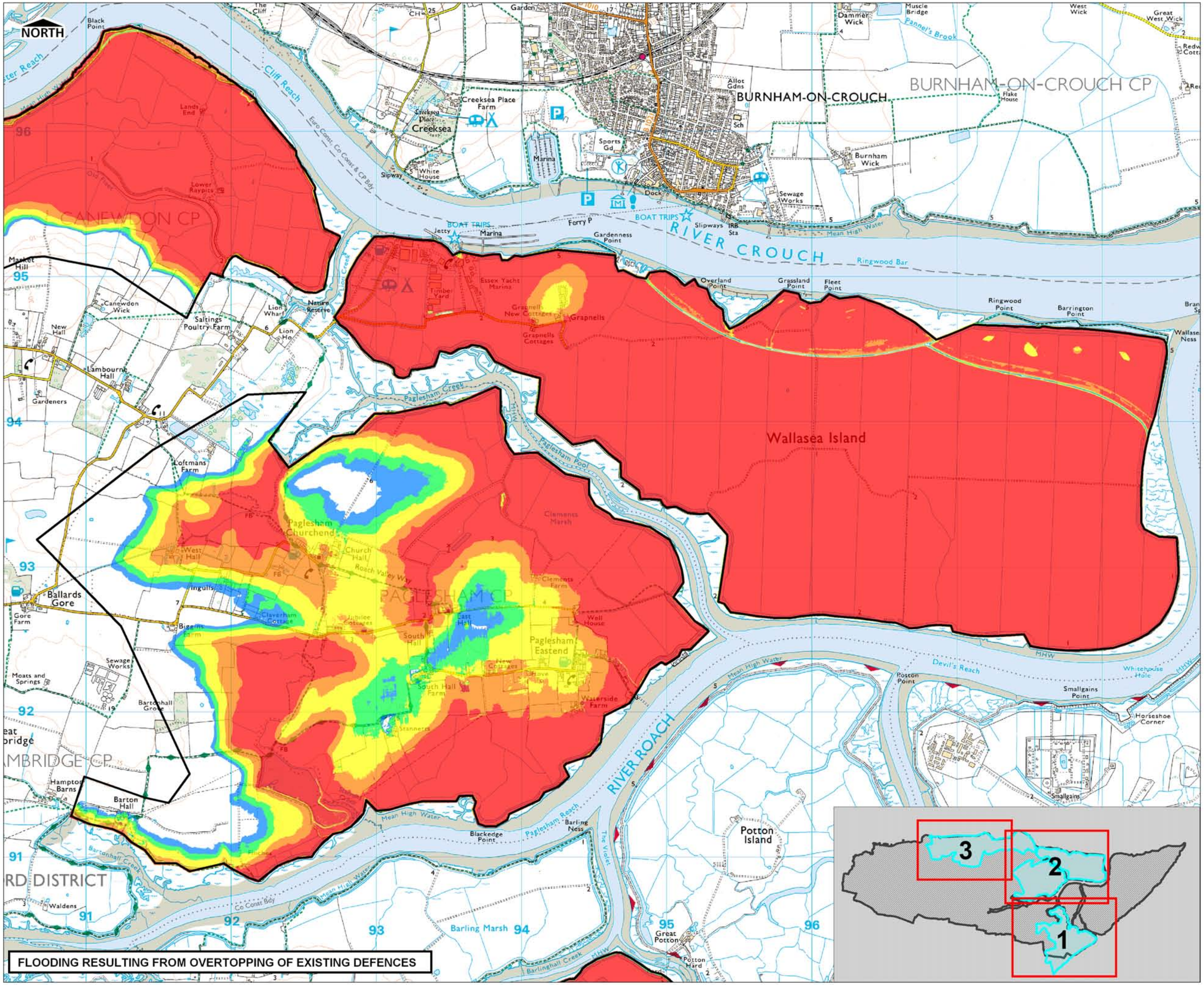

KEY

Flood Cells

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
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OVERTOPPING

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FIGURE B-5 (View 2)

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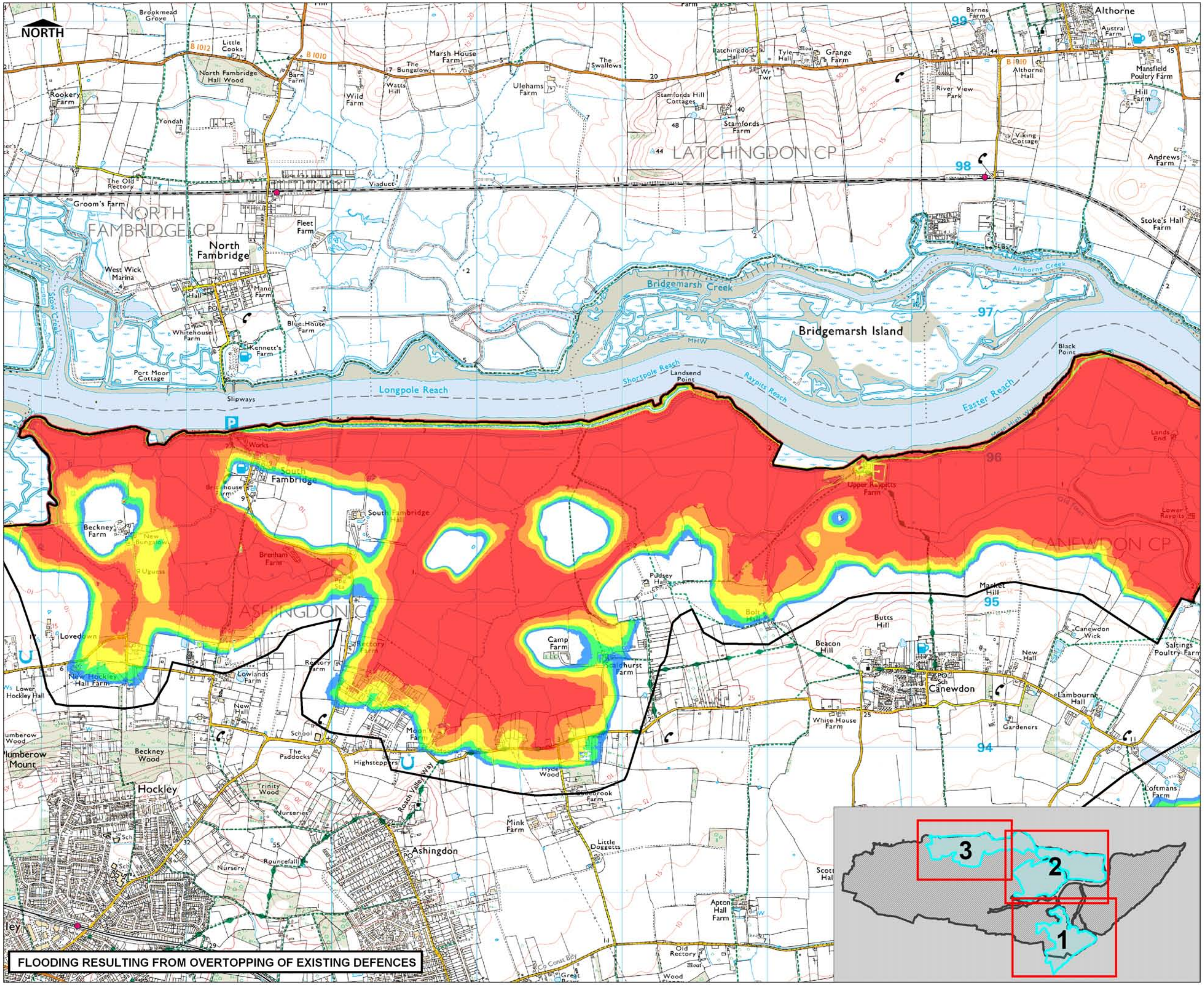

KEY

Flood Cells

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
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OVERTOPPING

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FIGURE B-5 (View 3)

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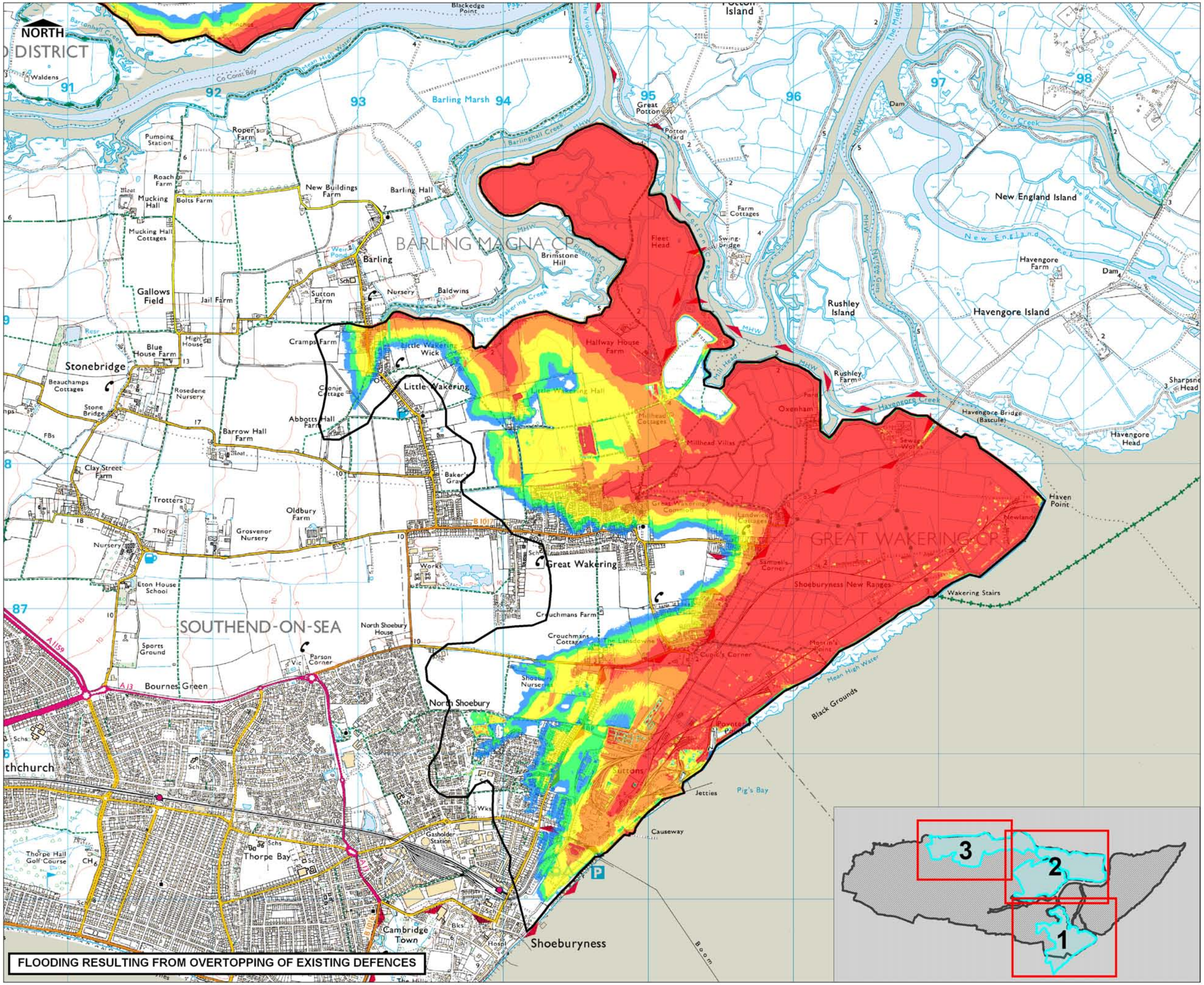

KEY

Flood Cells

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
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FIGURE B-6 (View 1)

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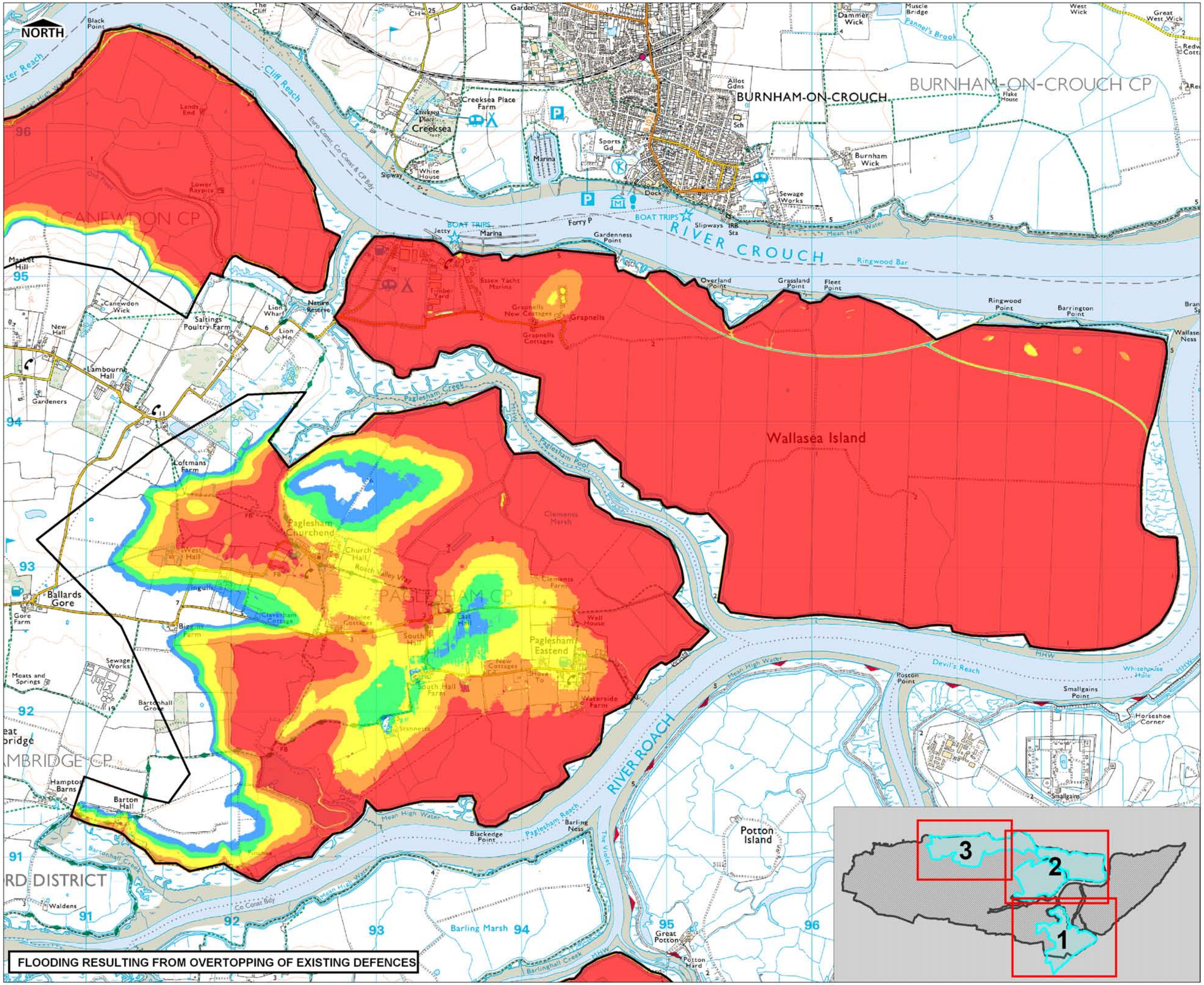

KEY

- Flood Cells

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
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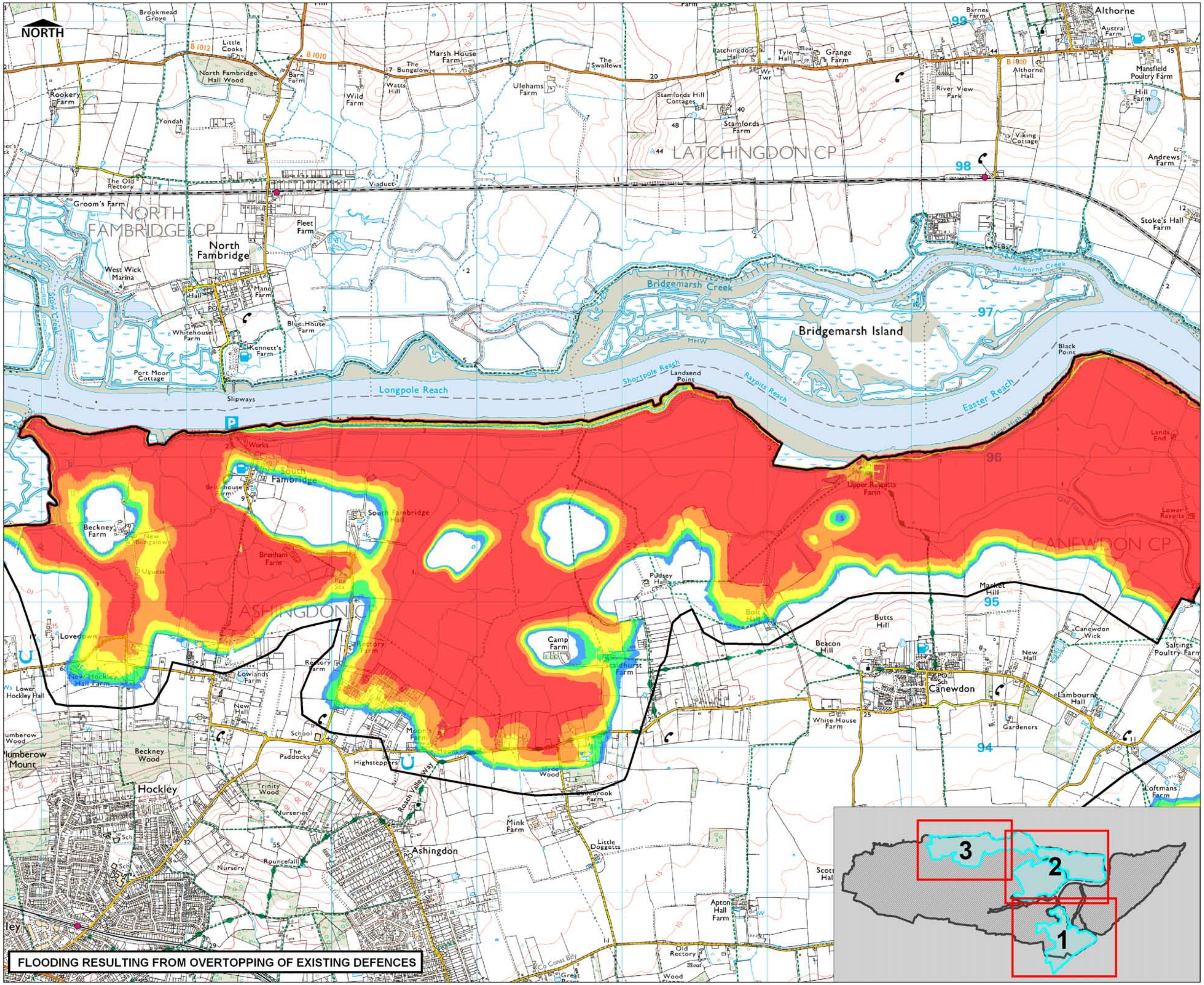
DRAWING NUMBER

FIGURE B-6 (View 2)

REV 02



KEY

Flood Cells

Maximum Flood Depth [m]

- 0.0m to 0.5m
- 0.5m to 1.0m
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- 3.0m to 5.0m and greater

TECHNICAL NOTE

Hydraulic modelling has been undertaken using 2-D hydraulic modelling software MIKE21-HDFM (ver. 2009), to assess the effect of overtopping of defences.
The model simulates 3 tidal cycles with the peak level occurring on the second peak and two slightly smaller peaks either side.

The mapped scenario shows the actual risk of flooding; that resulting solely from overtopping of existing defences.

The maximum flood depth is calculated by subtracting the LIDAR topographic data from the peak water level achieved at each element in the model throughout the simulation.

A thorough description of methodology and assumptions is included within the SFRA Main Report.

USER NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE MAXIMUM FLOOD DEPTH 1000YR (2110)

OVERTOPPING

Basildon Council · castlepoint · Rochford District Council

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FIGURE B-6 (View 3)

REV 02

Appendix C: Hazard Mapping

Residual Risk – Composite of Breach Results and Overtopping
(Composite Results for all breaches; ROC01, ROC02, ROC03, ROC04, ROC05, ROC06, ROC07)

C1 (View 1-3) Maximum Flood Hazard from Breaches & Overtopping (1 in 0200yr event, 2010)

C2 (View 1-3) Maximum Flood Hazard from Breaches & Overtopping (1 in 1000yr event, 2010)

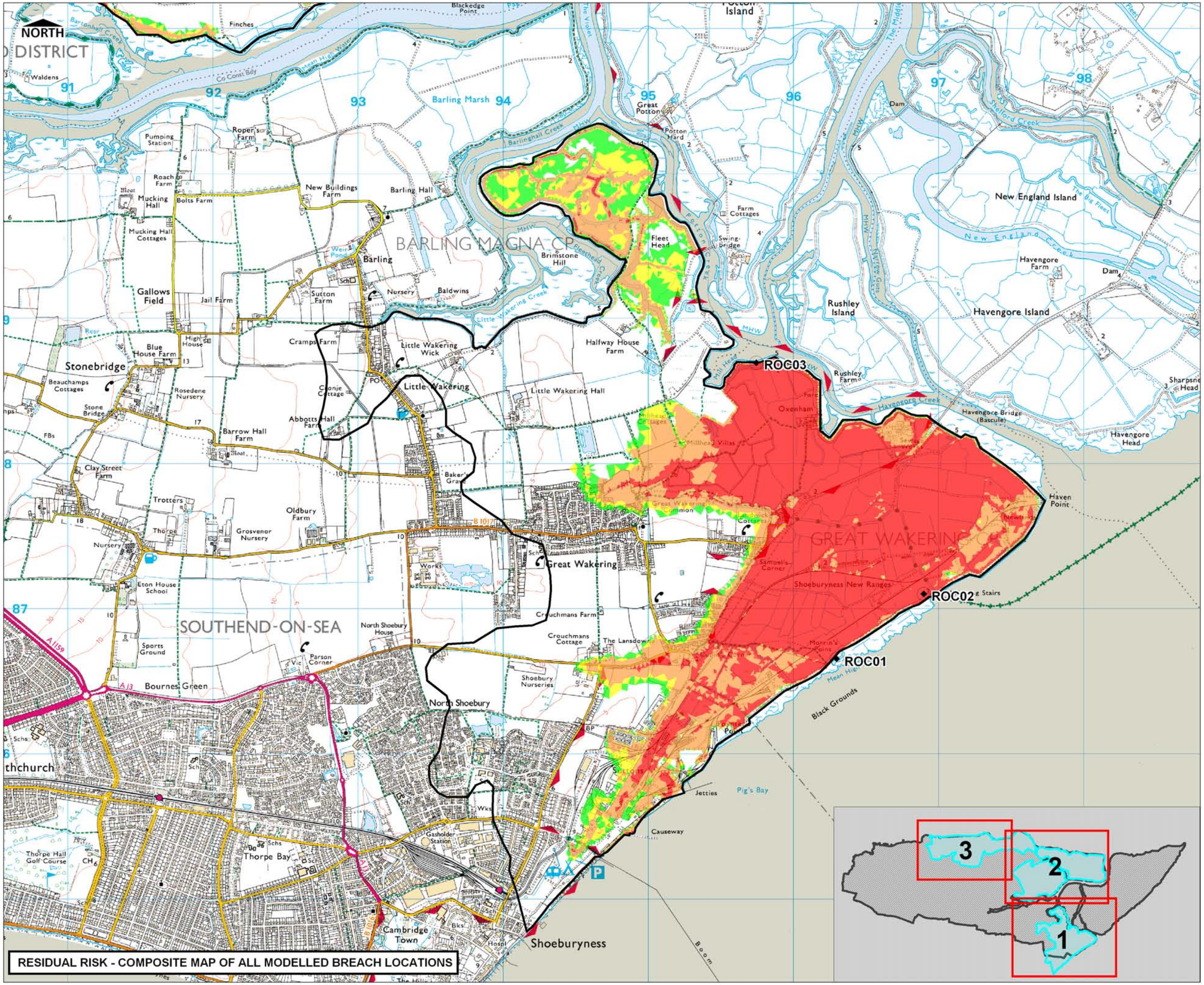
C3 (View 1-3) Maximum Flood Hazard from Breaches & Overtopping (1 in 0200yr event, 2110 incl. CC)

C4 (View 1-3) Maximum Flood Hazard from Breaches & Overtopping (1 in 1000yr event, 2110 incl. CC)

Potential Impact of Overtopping

C5 (View 1-3) Maximum Flood Hazard from Overtopping (1 in 0200yr event, 2110 incl. CC)

C6 (View 1-3) Maximum Flood Hazard from Overtopping (1 in 1000yr event, 2110 incl. CC)



KEY

Flood Cells

Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
- Significant Hazard (Danger for Most)
- Extreme Hazard (Danger for All)

TECHNICAL NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
0200YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council castlepoint Rochford District Council

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FIGURE C-1 (View 1)

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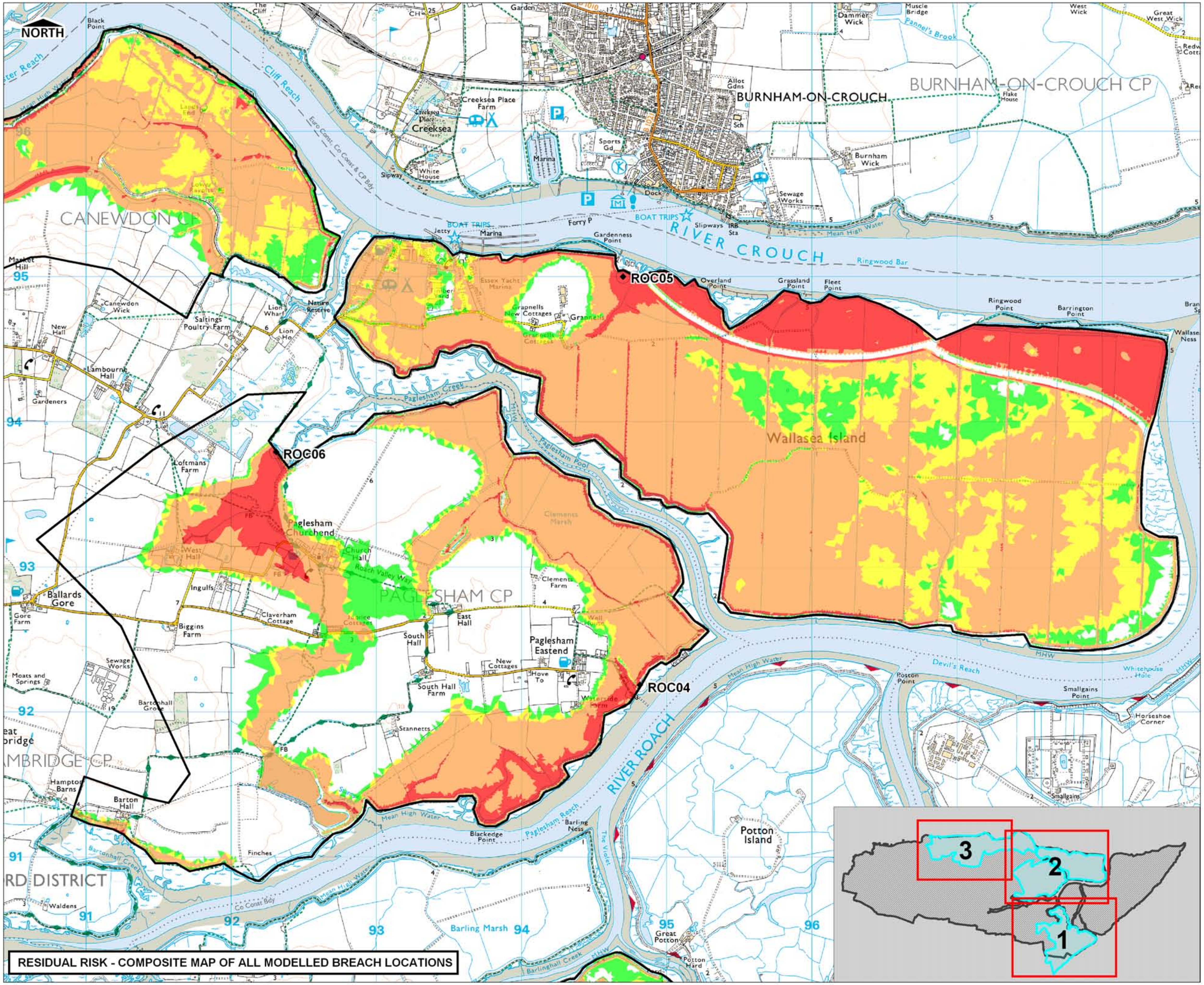

KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
- Significant Hazard (Danger for Most)
- Extreme Hazard (Danger for All)

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COMPOSITE FLOOD HAZARD RATING
0200YR (2010)
ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE C-1 (View 2)

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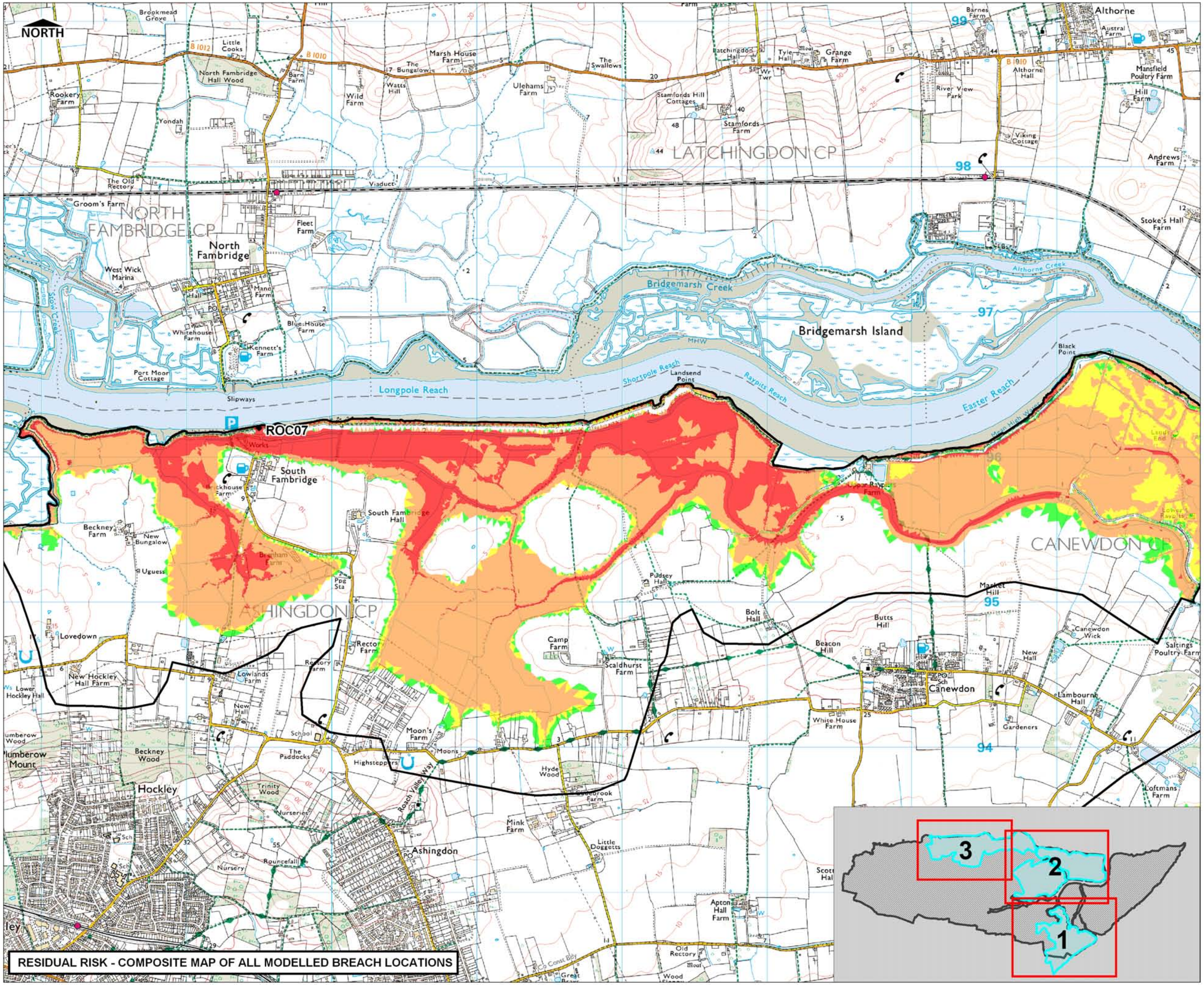

RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

- Low Hazard
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COMPOSITE FLOOD HAZARD RATING
0200YR (2010)
ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE C-1 (View 3)

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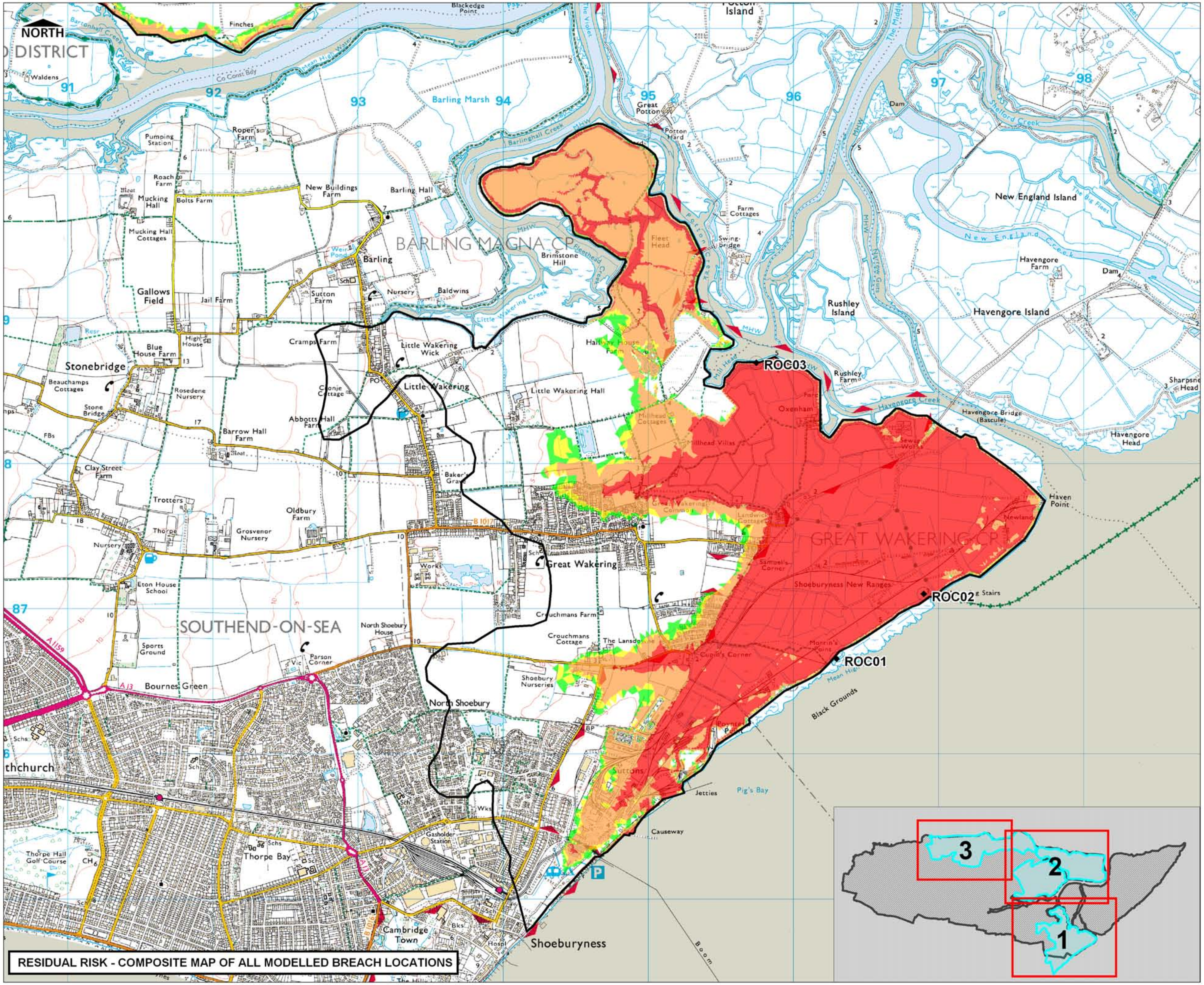

KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

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- Moderate Hazard (Danger for Some)
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING 1000YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE C-2 (View 1)

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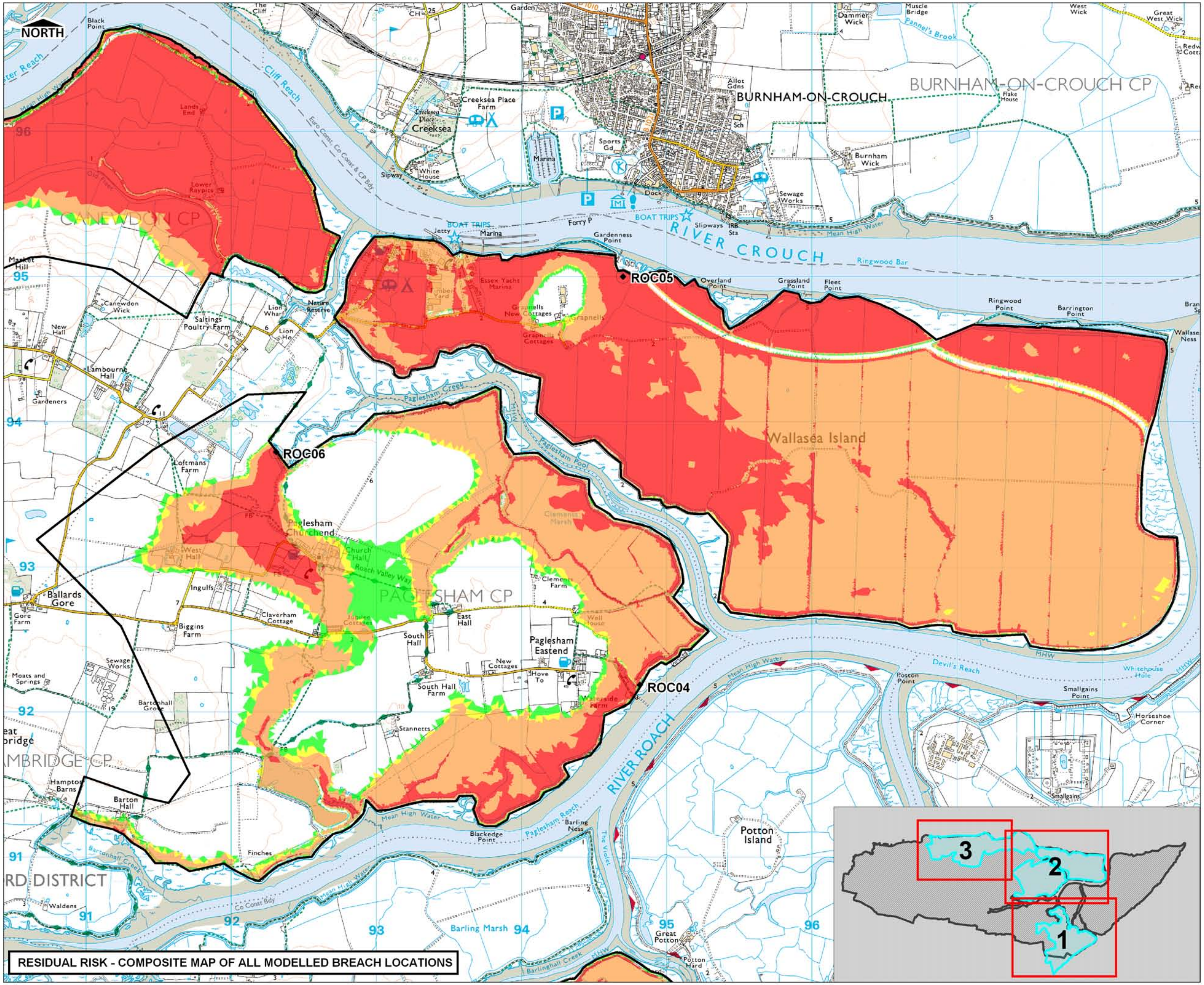

RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
- Significant Hazard (Danger for Most)
- Extreme Hazard (Danger for All)

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1000YR (2010)
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FIGURE C-2 (View 2)

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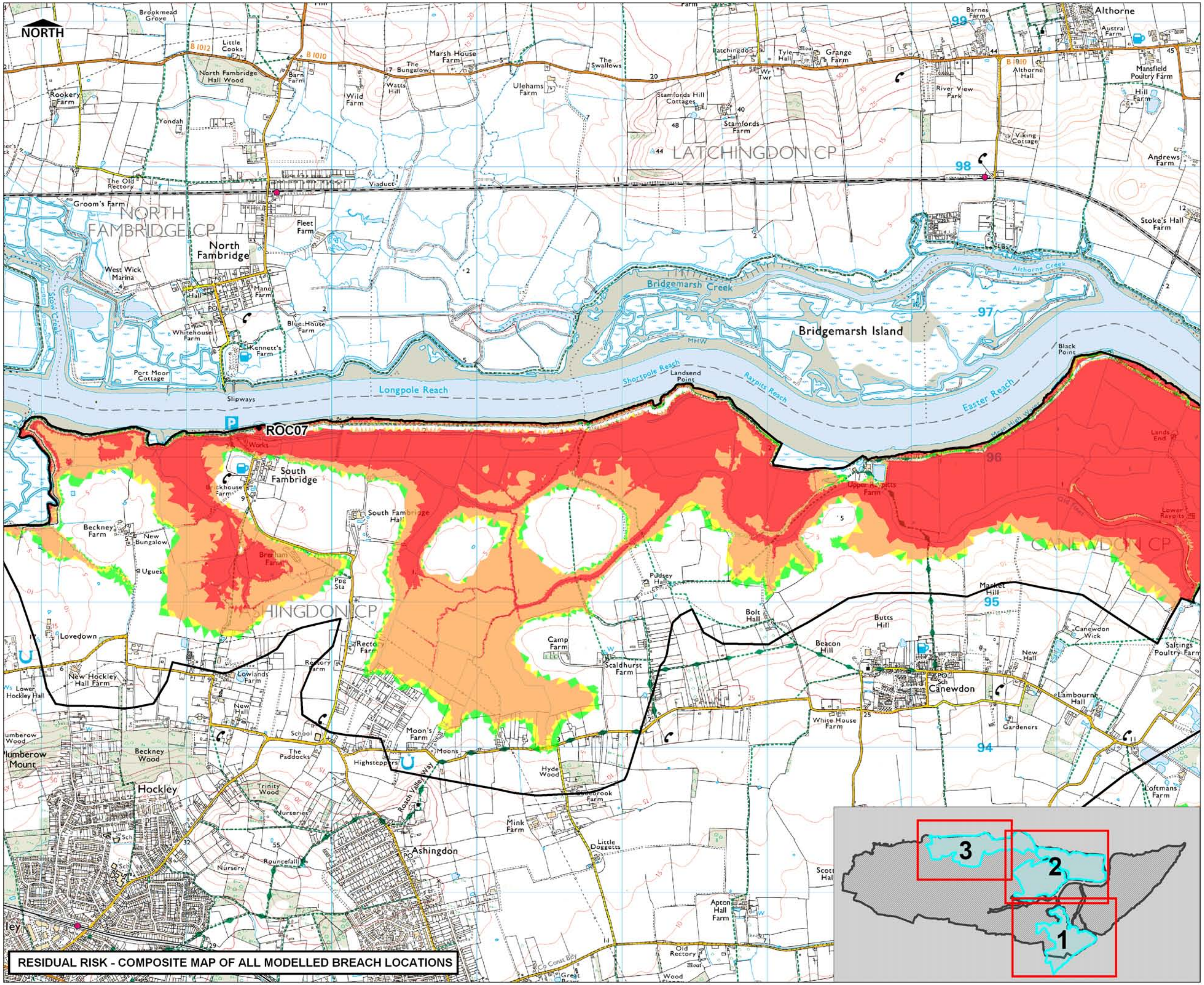

KEY

- Flood Cells
- Breach Location

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING 1000YR (2010)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council — castlepoint — Rochford District Council

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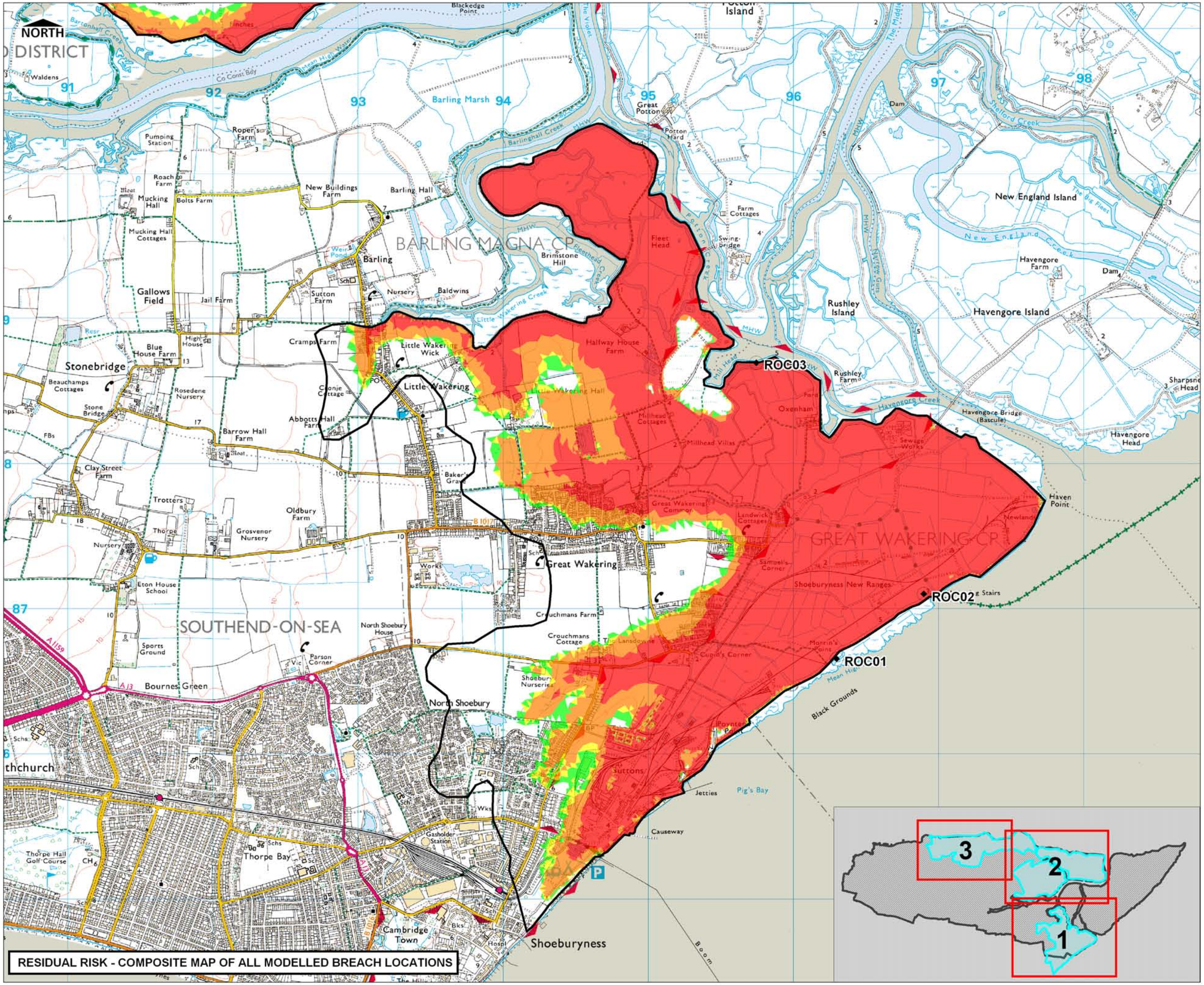
FIGURE C-2 (View 3)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
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COMPOSITE FLOOD HAZARD RATING
0200YR (2110)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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FIGURE C-3 (View 1)

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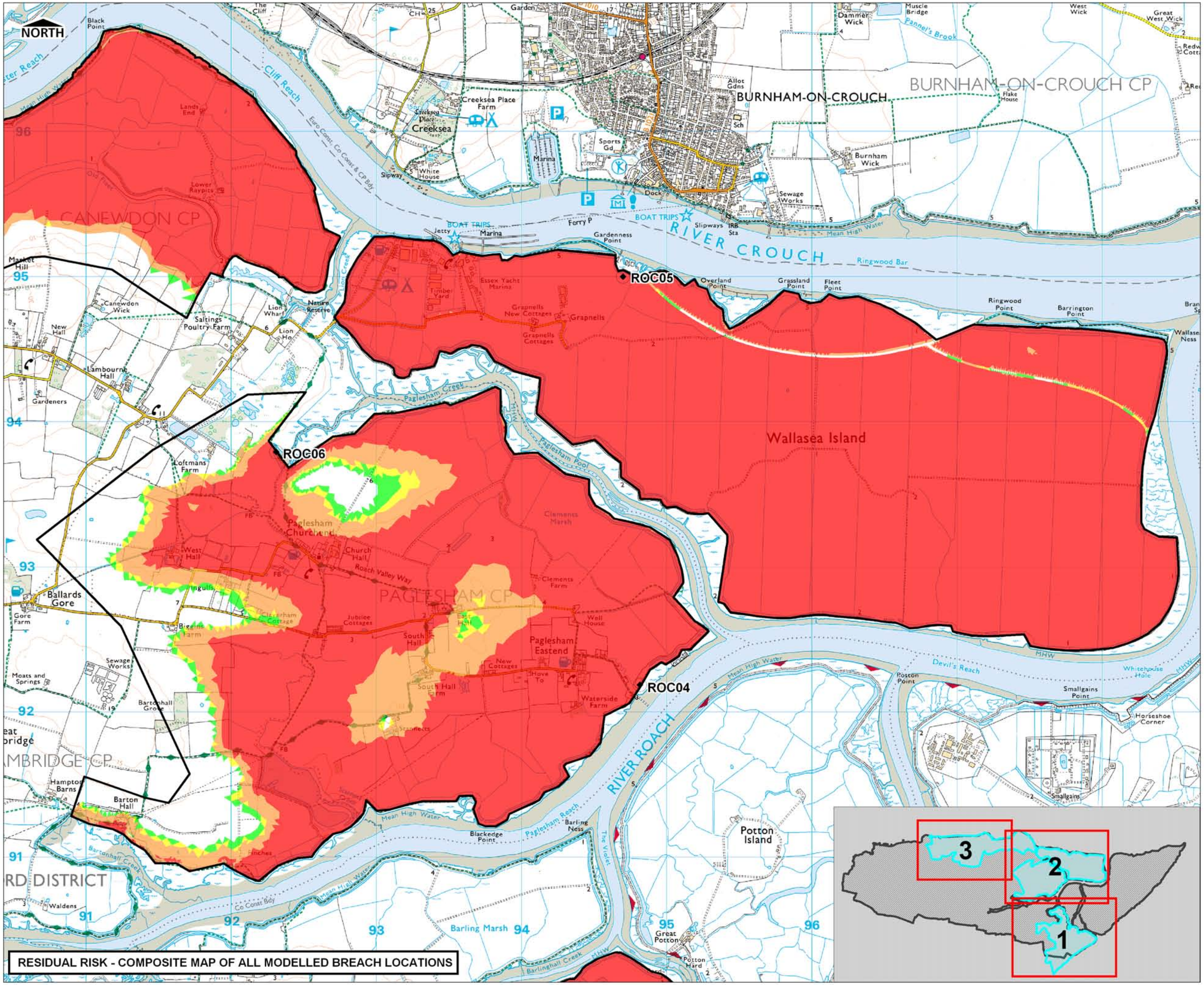

KEY

Flood Cells
Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
0200YR (2110)
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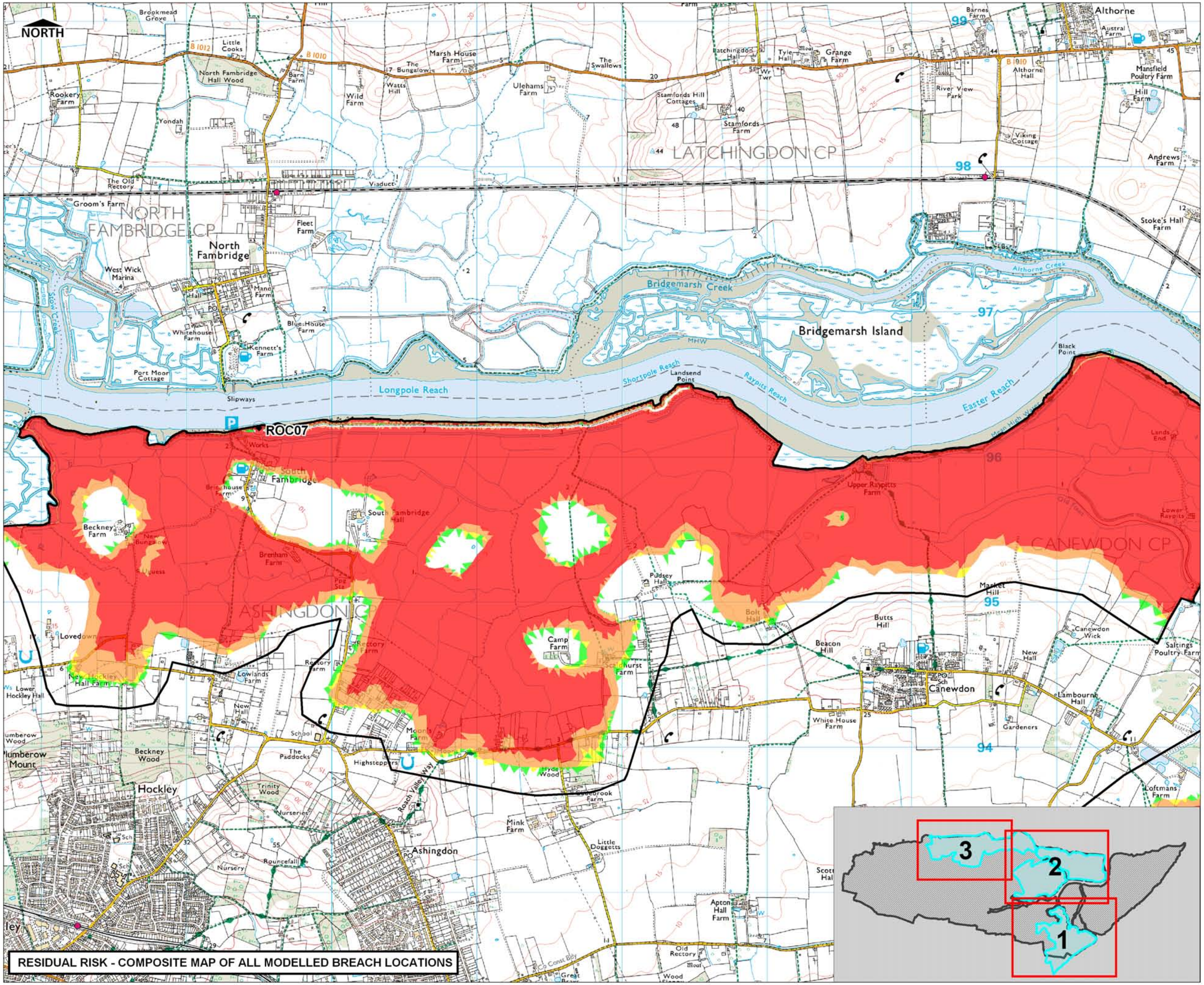
FIGURE C-3 (View 2)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
0200YR (2110)
ALL BREACHES (ROC01-ROC07) & OVERTOPPING

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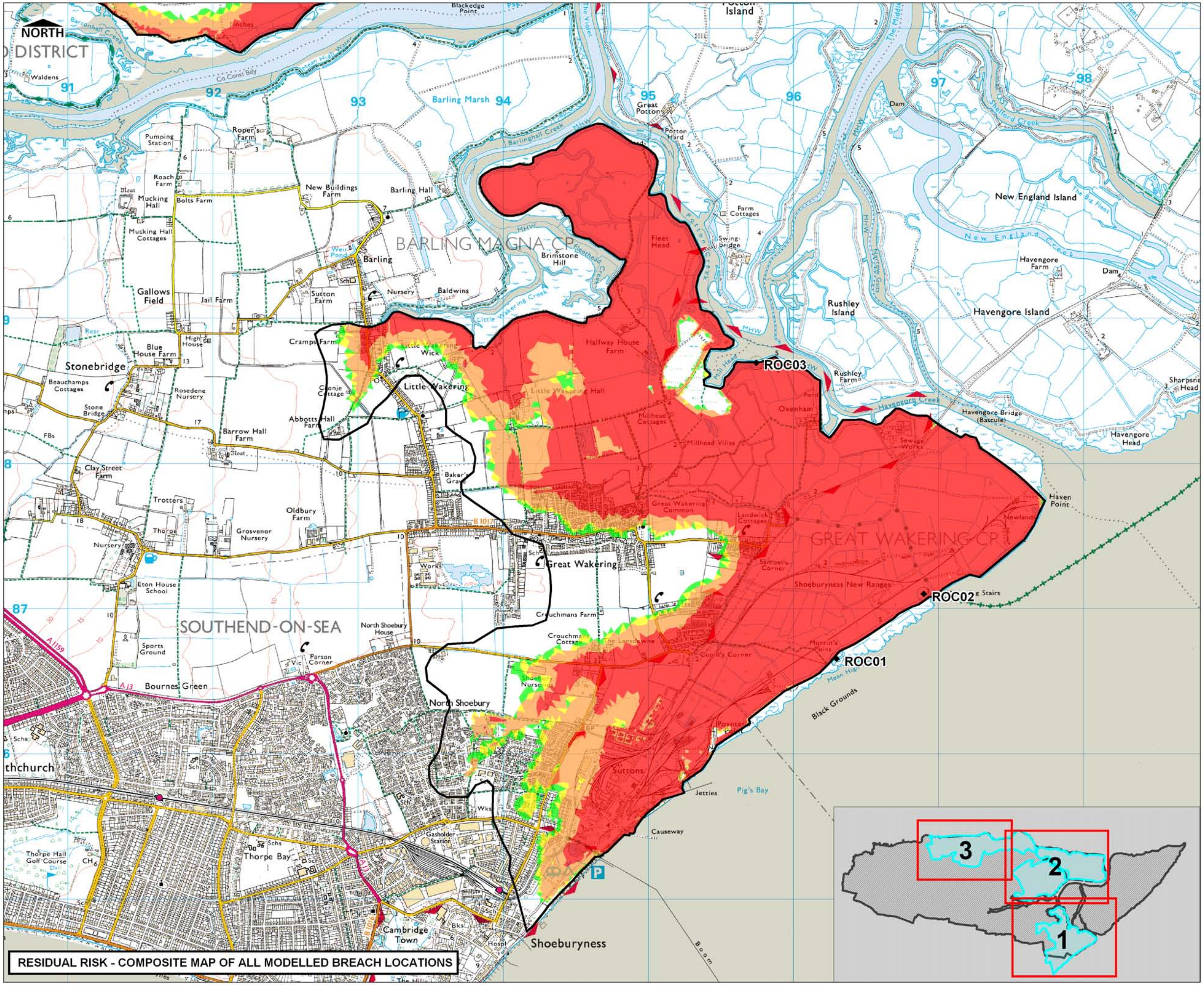
FIGURE C-3 (View 3)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
1000YR (2110)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council castlepoint Rochford District Council

Scott Wilson
6-8 Greencoat Place
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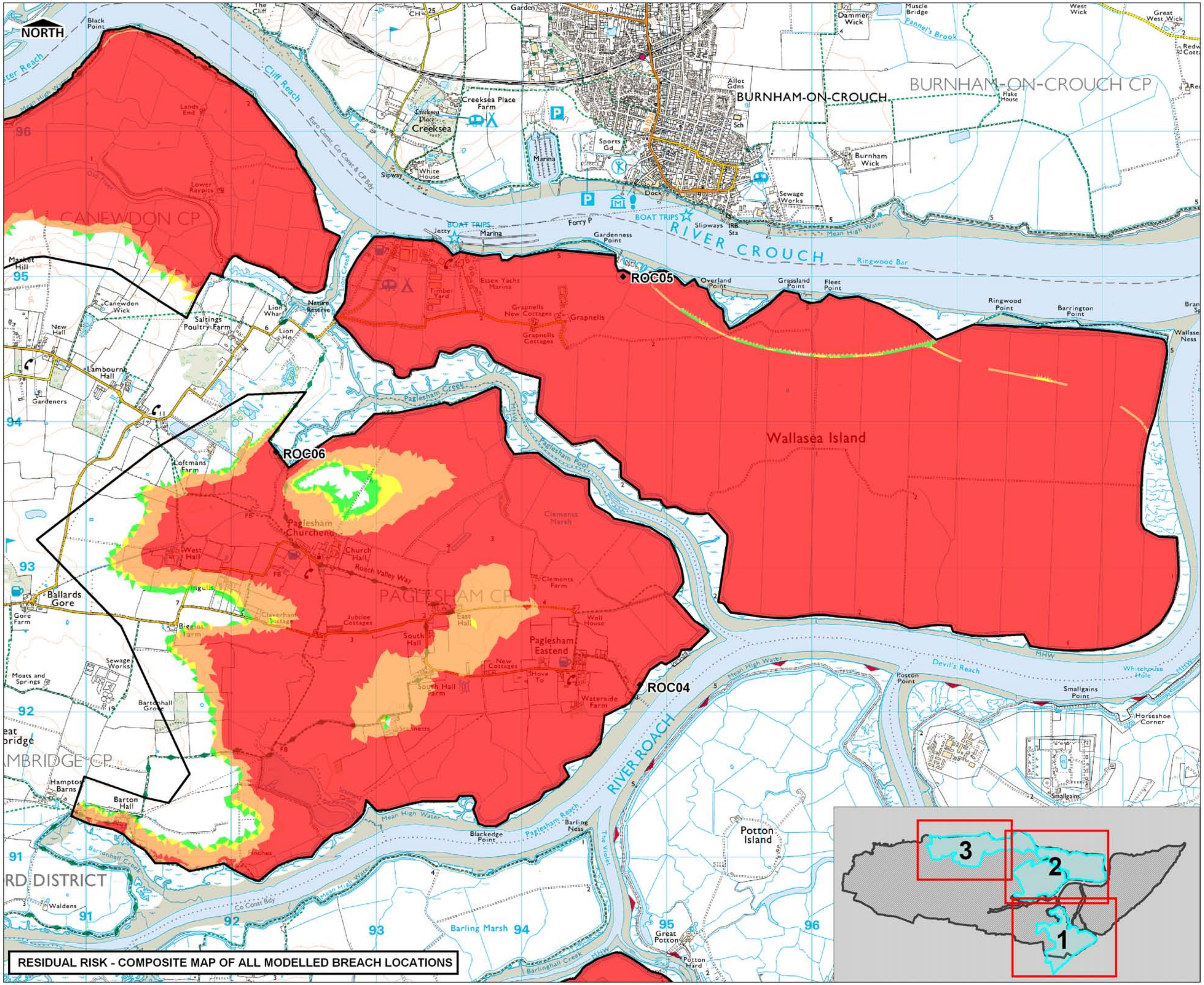
DRAWING NUMBER

FIGURE C-4 (View 1)

REV 02



KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
- Significant Hazard (Danger for Most)
- Extreme Hazard (Danger for All)

TECHNICAL NOTE

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
1000YR (2110)
ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council · castlepoint · Rochford District Council

Scott Wilson
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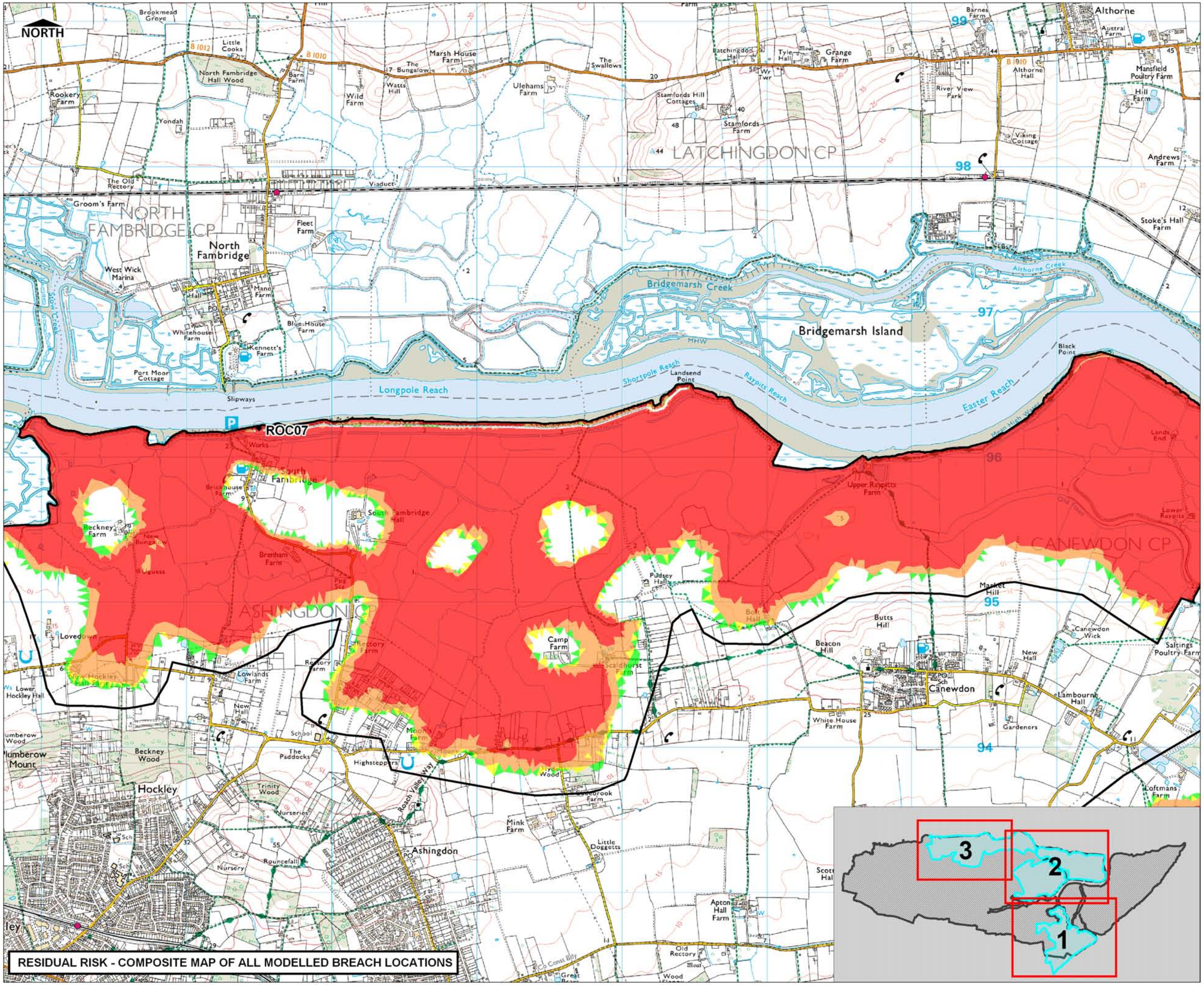
DRAWING NUMBER

FIGURE C-4 (View 2)

REV 02



RESIDUAL RISK - COMPOSITE MAP OF ALL MODELLED BREACH LOCATIONS

KEY

- Flood Cells
- Breach Location

Flood Hazard Rating

- Low Hazard
- Moderate Hazard (Danger for Some)
- Significant Hazard (Danger for Most)
- Extreme Hazard (Danger for All)

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COMPOSITE FLOOD HAZARD RATING
1000YR (2110)

ALL BREACHES (ROC01-ROC07) & OVERTOPPING

Basildon Council — castlepoint — Rochford District Council

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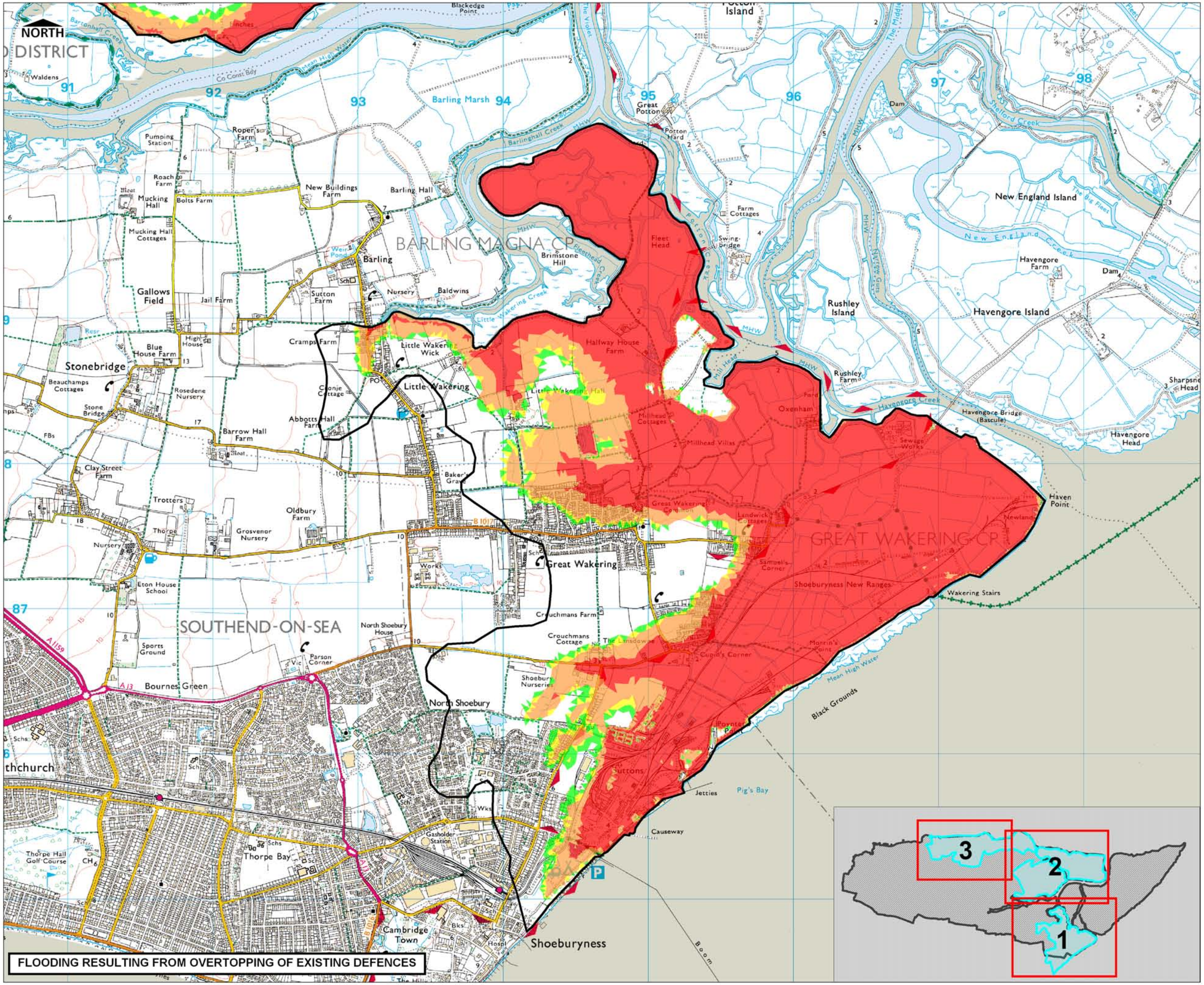
FIGURE C-4 (View 3)

REV 02



KEY

Flood Cells

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COMPOSITE FLOOD HAZARD RATING
0200YR (2110)
OVERTOPPING

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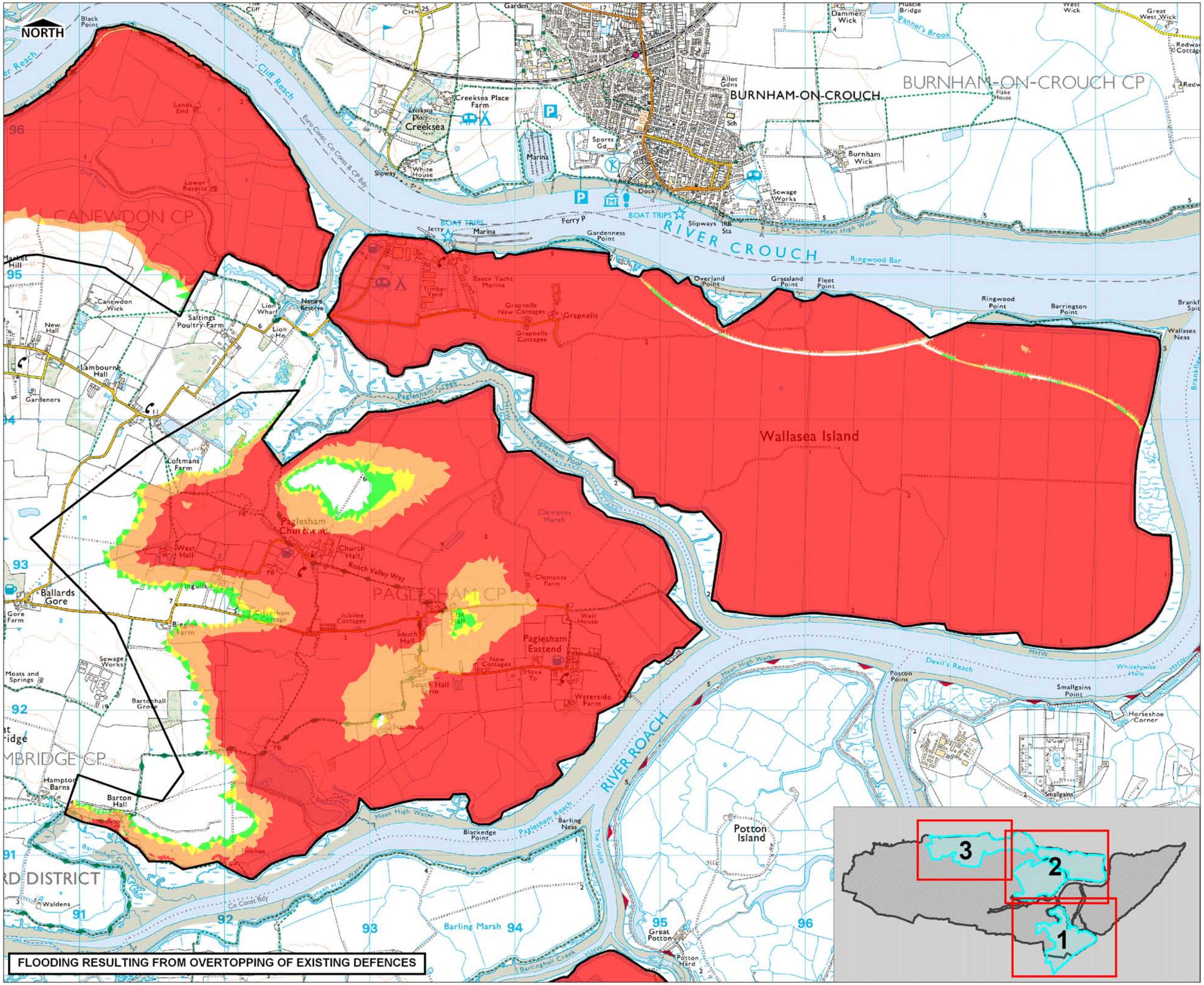
FIGURE C-5 (View 1)

REV 02



KEY

Flood Cells

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0200YR (2110)
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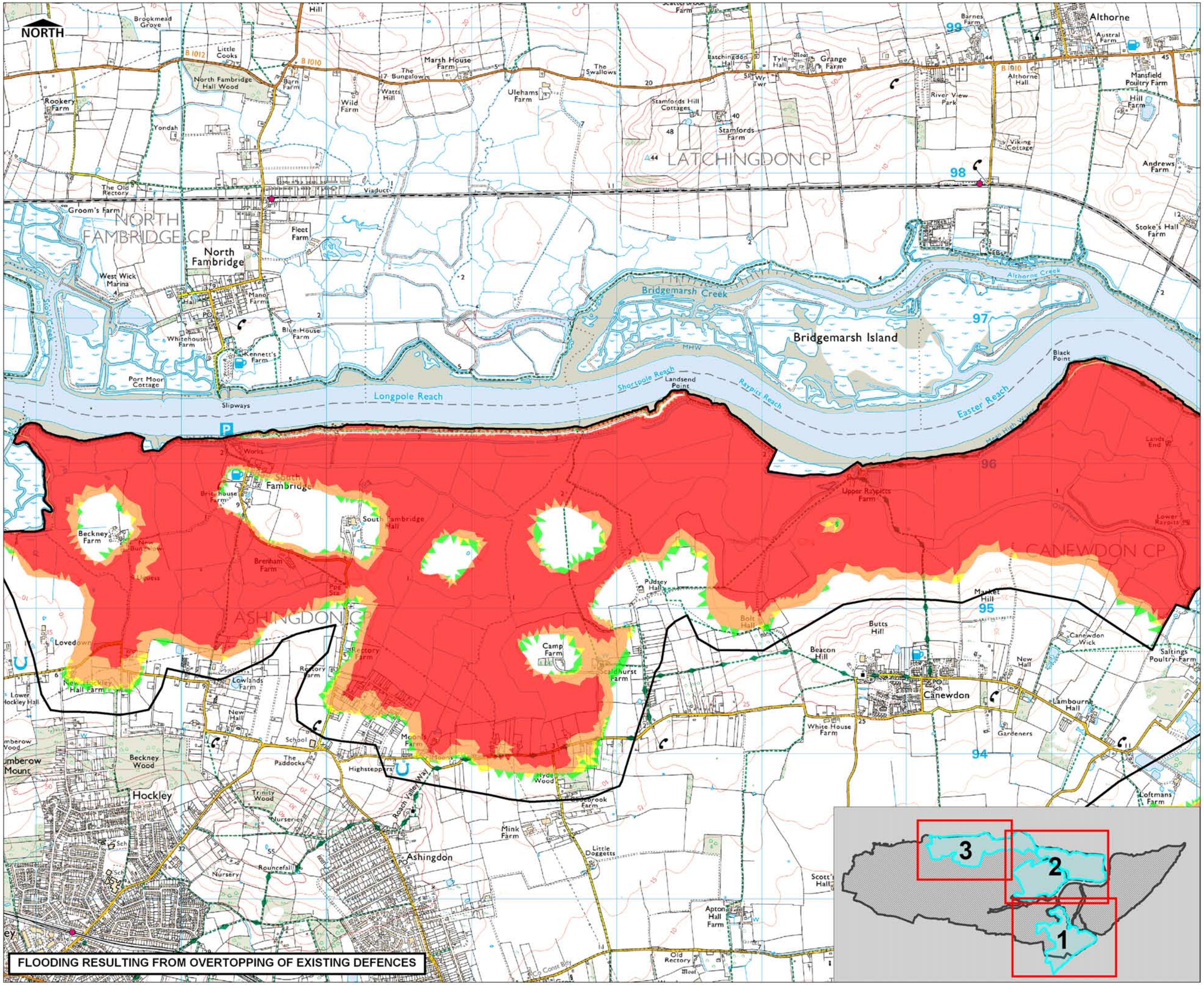
DRAWING NUMBER
FIGURE C-5 (View 2)

REV 02



KEY

Flood Cells

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COMPOSITE FLOOD HAZARD RATING
0200YR (2110)
OVERTOPPING

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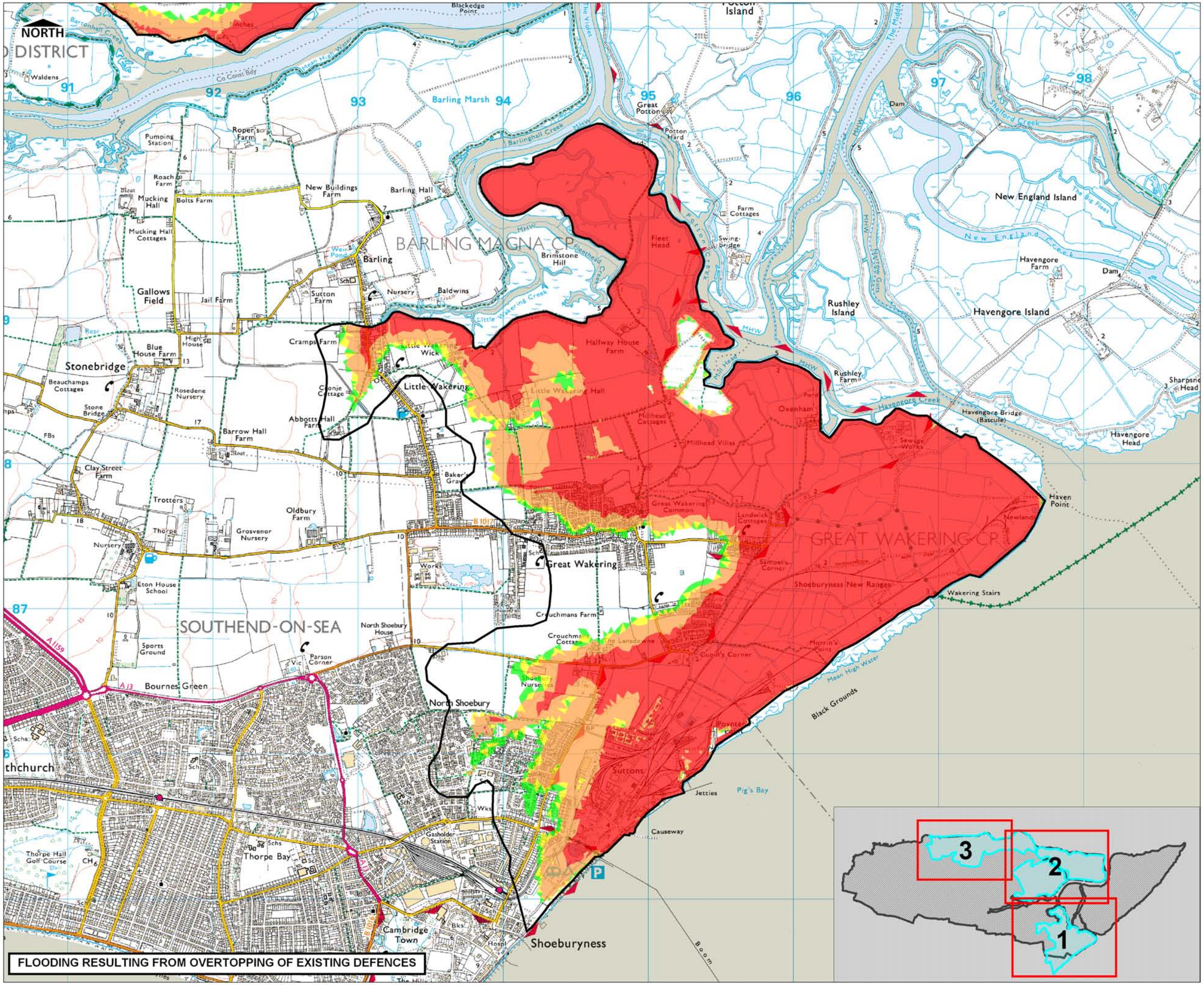
DRAWING NUMBER

FIGURE C-5 (View 3)

REV 02



KEY

Flood Cells

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
1000YR (2110)

OVERTOPPING

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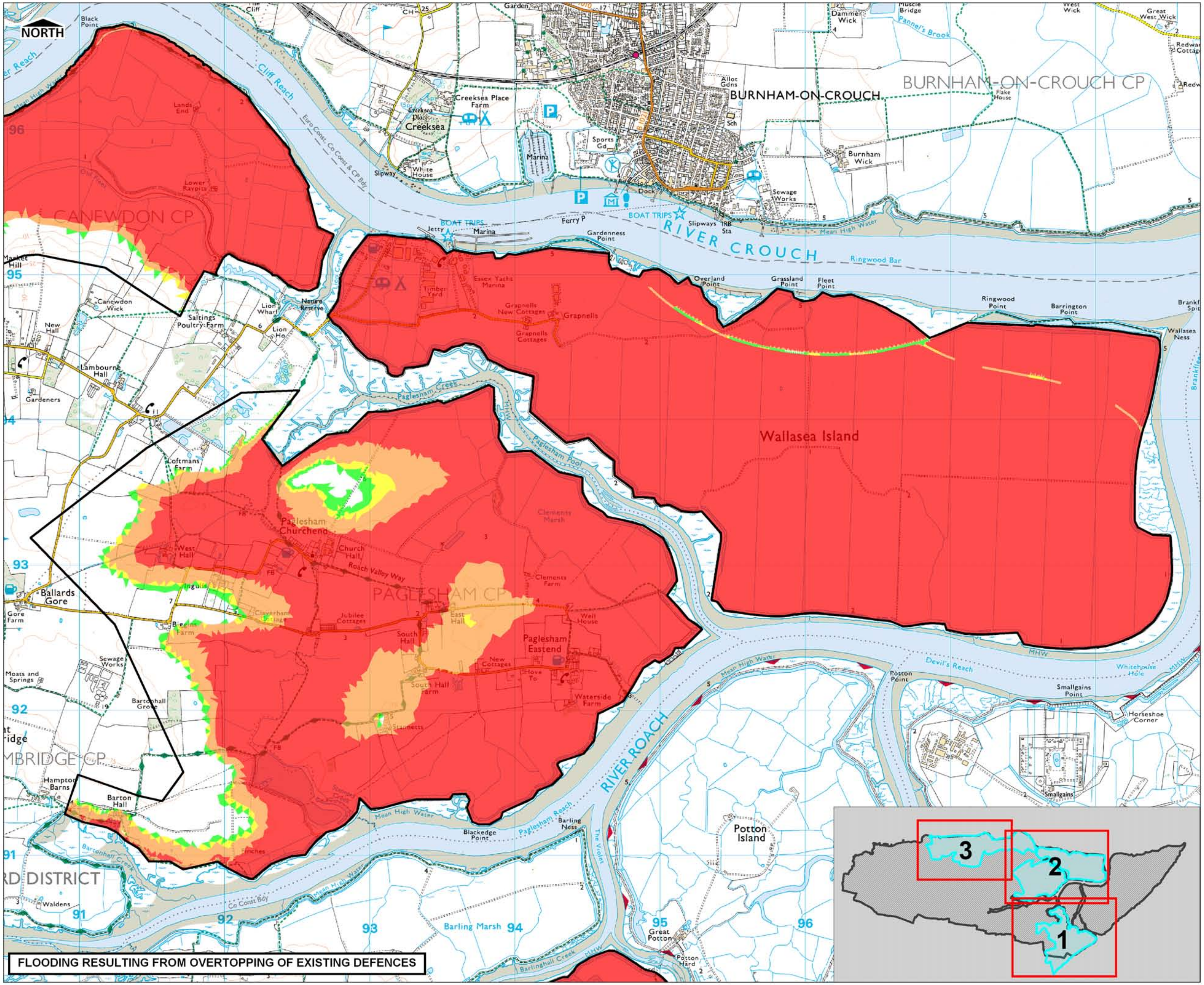
DRAWING NUMBER

FIGURE C-6 (View 1)

REV 02



KEY

- Flood Cells

Flood Hazard Rating

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STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
1000YR (2110)

OVERTOPPING

Basildon Council · castlepoint · Rochford District Council

Scott Wilson
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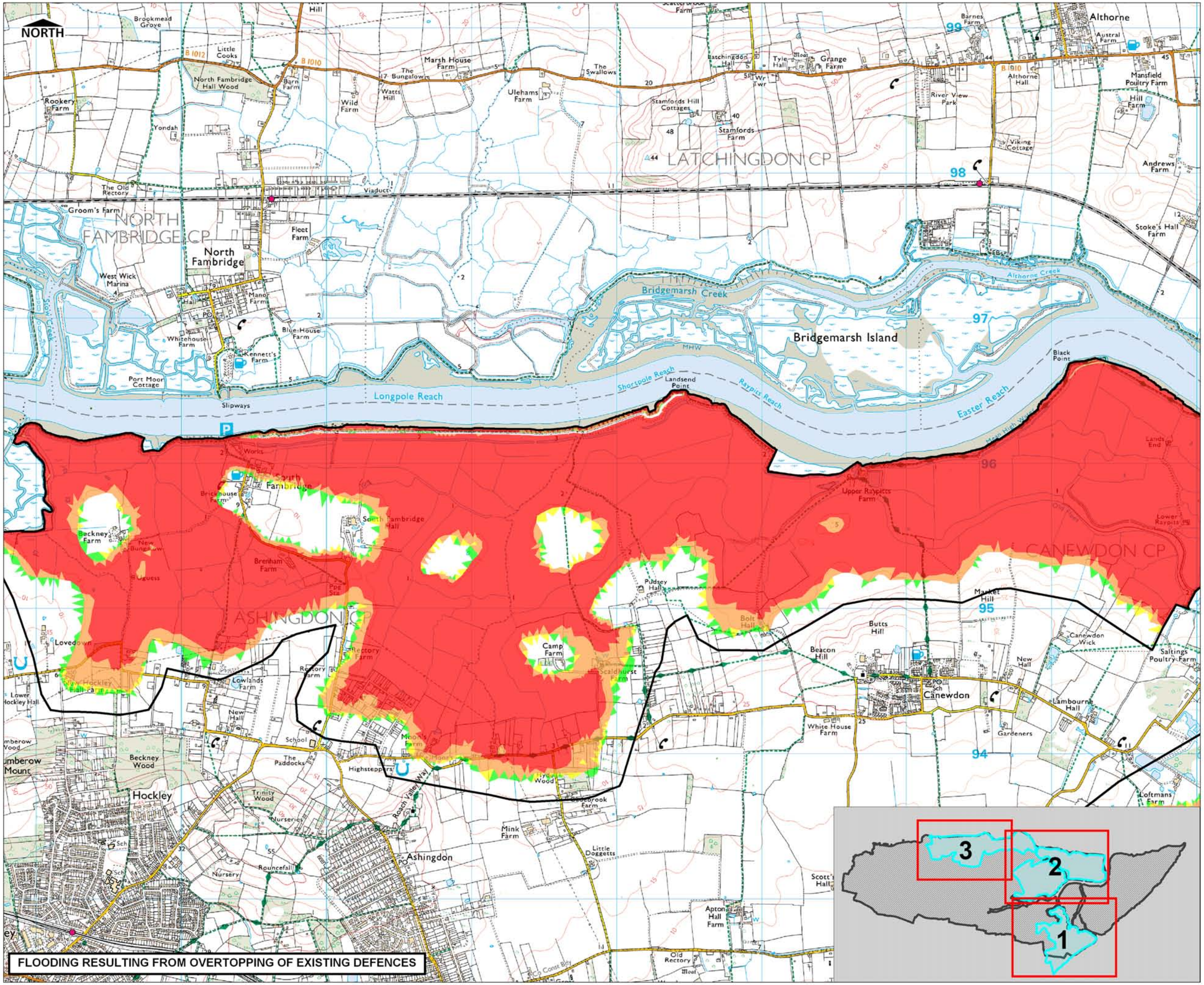
DRAWING NUMBER

FIGURE C-6 (View 2)

REV 02



KEY

Flood Cells

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

COMPOSITE FLOOD HAZARD RATING
1000YR (2110)

OVERTOPPING

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DRAWING NUMBER

FIGURE C-6 (View 3)

REV 02

Appendix D: Time to Inundation Mapping

Potential Impact of Breach & Overtopping

D-1	Breach ROC01 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-2	Breach ROC02 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-3	Breach ROC03 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-4	Breach ROC04 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-5	Breach ROC05 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-6	Breach ROC06 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-7	Breach ROC07 Time to Inundation (1 in 1000yr event, 2110 incl. CC)
D-8	Breach ROC01 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-9	Breach ROC02 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-10	Breach ROC03 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-11	Breach ROC04 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-12	Breach ROC05 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-13	Breach ROC06 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-14	Breach ROC07 Time to Inundation (1 in 0200yr event, 2110 incl. CC)
D-15	Breach ROC01 Time to Inundation (1 in 1000yr event, 2010)
D-16	Breach ROC02 Time to Inundation (1 in 1000yr event, 2010)
D-17	Breach ROC03 Time to Inundation (1 in 1000yr event, 2010)
D-18	Breach ROC04 Time to Inundation (1 in 1000yr event, 2010)
D-19	Breach ROC05 Time to Inundation (1 in 1000yr event, 2010)
D-20	Breach ROC06 Time to Inundation (1 in 1000yr event, 2010)
D-21	Breach ROC07 Time to Inundation (1 in 1000yr event, 2010)
D-22	Breach ROC01 Time to Inundation (1 in 0200yr event, 2010)
D-23	Breach ROC02 Time to Inundation (1 in 0200yr event, 2010)
D-24	Breach ROC03 Time to Inundation (1 in 0200yr event, 2010)
D-25	Breach ROC04 Time to Inundation (1 in 0200yr event, 2010)
D-26	Breach ROC05 Time to Inundation (1 in 0200yr event, 2010)
D-27	Breach ROC06 Time to Inundation (1 in 0200yr event, 2010)
D-28	Breach ROC07 Time to Inundation (1 in 0200yr event, 2010)

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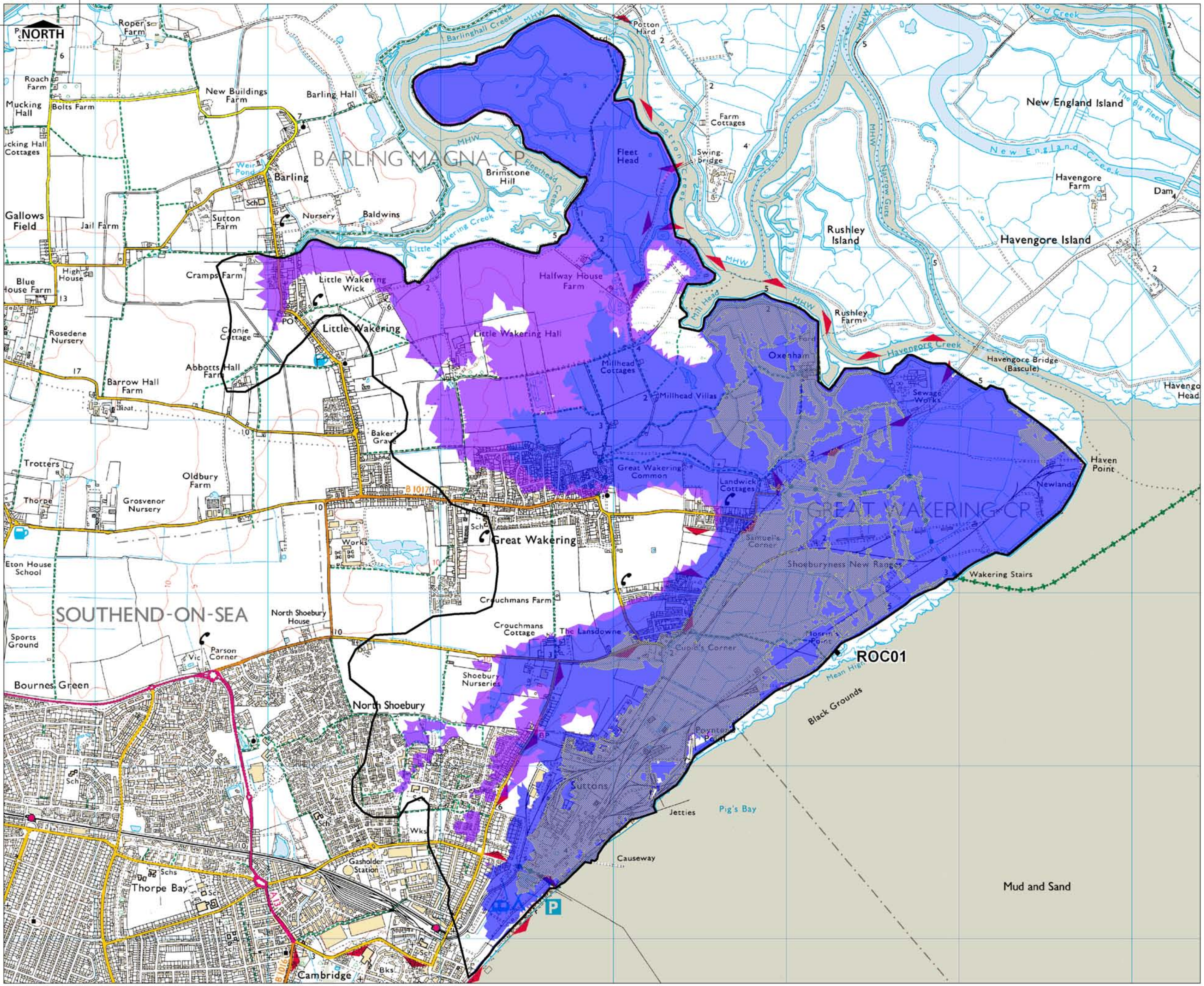

KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

Hydraulic modelling has been undertaken using 2-D hydraulic modelling software MIKE21-HDFM (ver. 2009), to assess the effect of breaches at specified points and/or overtopping of defences. The model simulates 3 tidal cycles with the peak level occurring on the second peak and two slightly smaller peaks either side. Breaches in the defence walls are modelled to occur immediately before the peak tidal level to assess the potential impact of rapid inundation of floodwater.
In order to map Time to Inundation, time 0 (zero) is designated as the time when tidal water enters the breach. The <1 hour band encompasses all areas that are inundated within the first hour of water passing through the breach and into the flood cell. Subsequent bands have been produced to show inundated cells for each 4 hour interval up to 20 hours. Areas that experience flooding as a result of overtopping of the defences prior to the breach event, are shown as hatched areas.
Time to inundation maps represent the onset of flooding from 1 specified breach. The rate will vary spatially if the breach locations are in different local areas. Changes in inundation extent or rate of onset of flooding are non-linear to changes in breach location.
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR + CC (2110)

BREACH ROC01

Basildon Council castlepoint Rochford District Council

Scott Wilson
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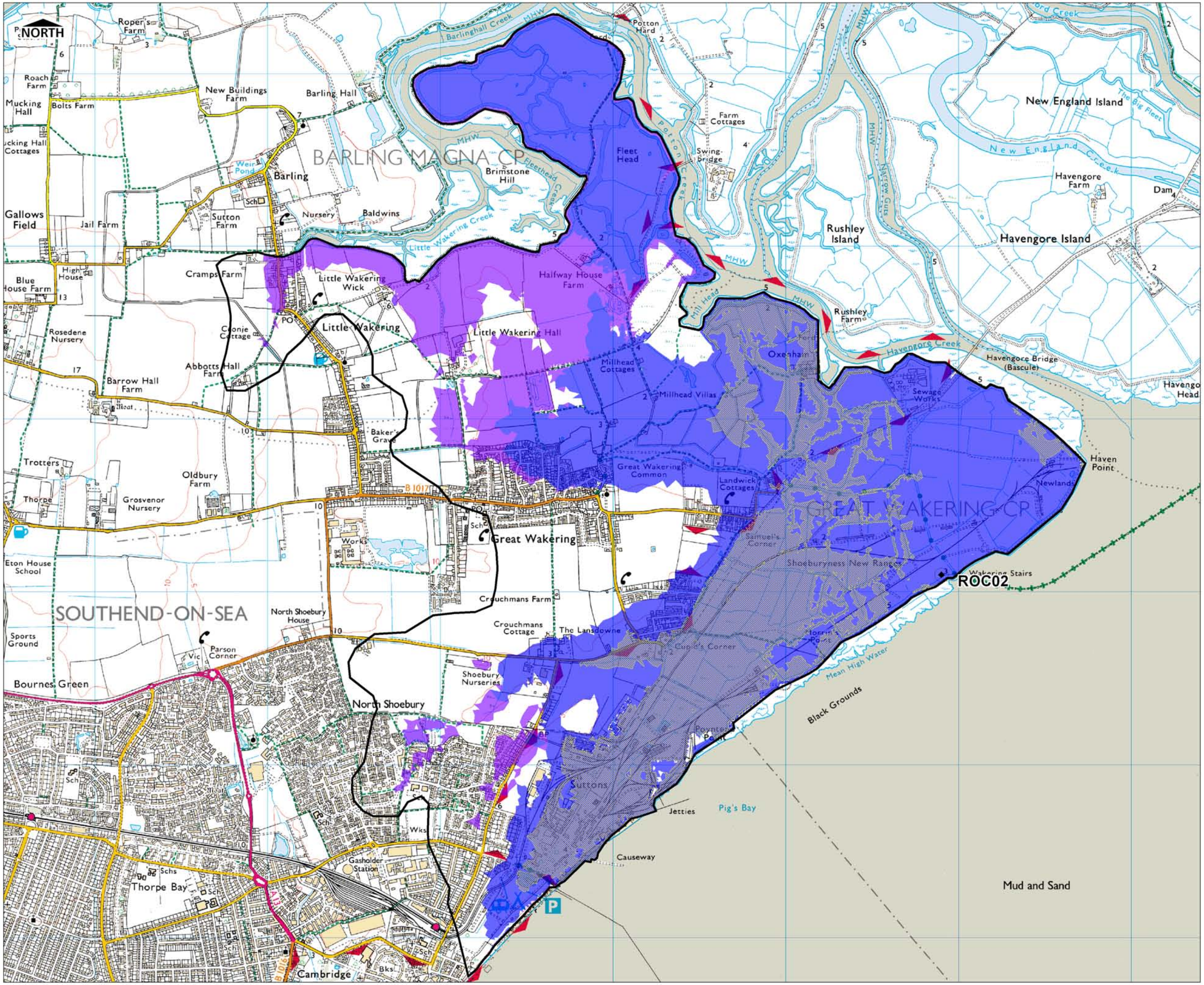
FIGURE D-1

REV 02



KEY

- Flood Cell
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR + CC (2110)
BREACH ROC02

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
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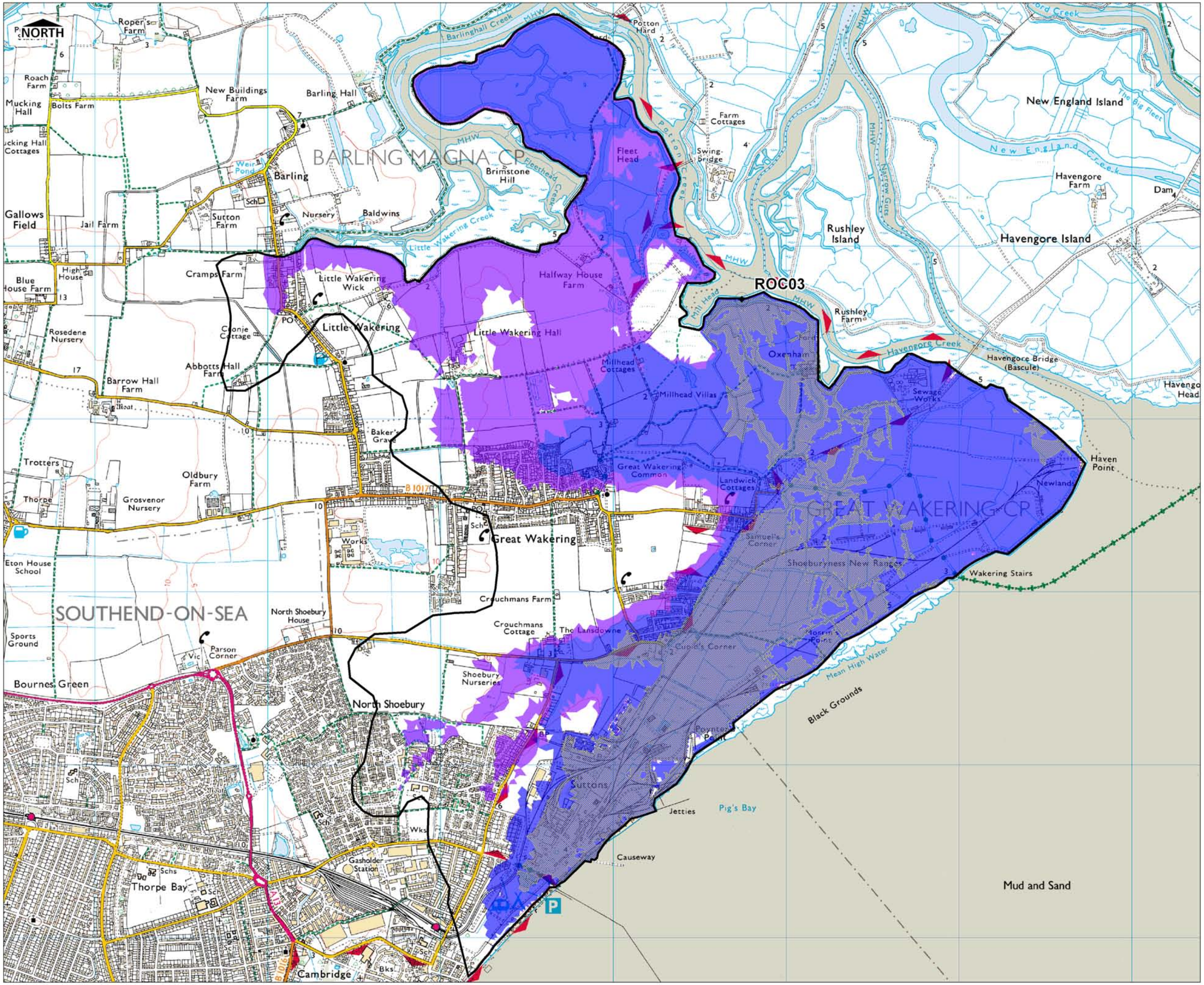
DRAWING NUMBER

FIGURE D-2

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR + CC (2110)
BREACH ROC03

Basildon Council · castlepoint · Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
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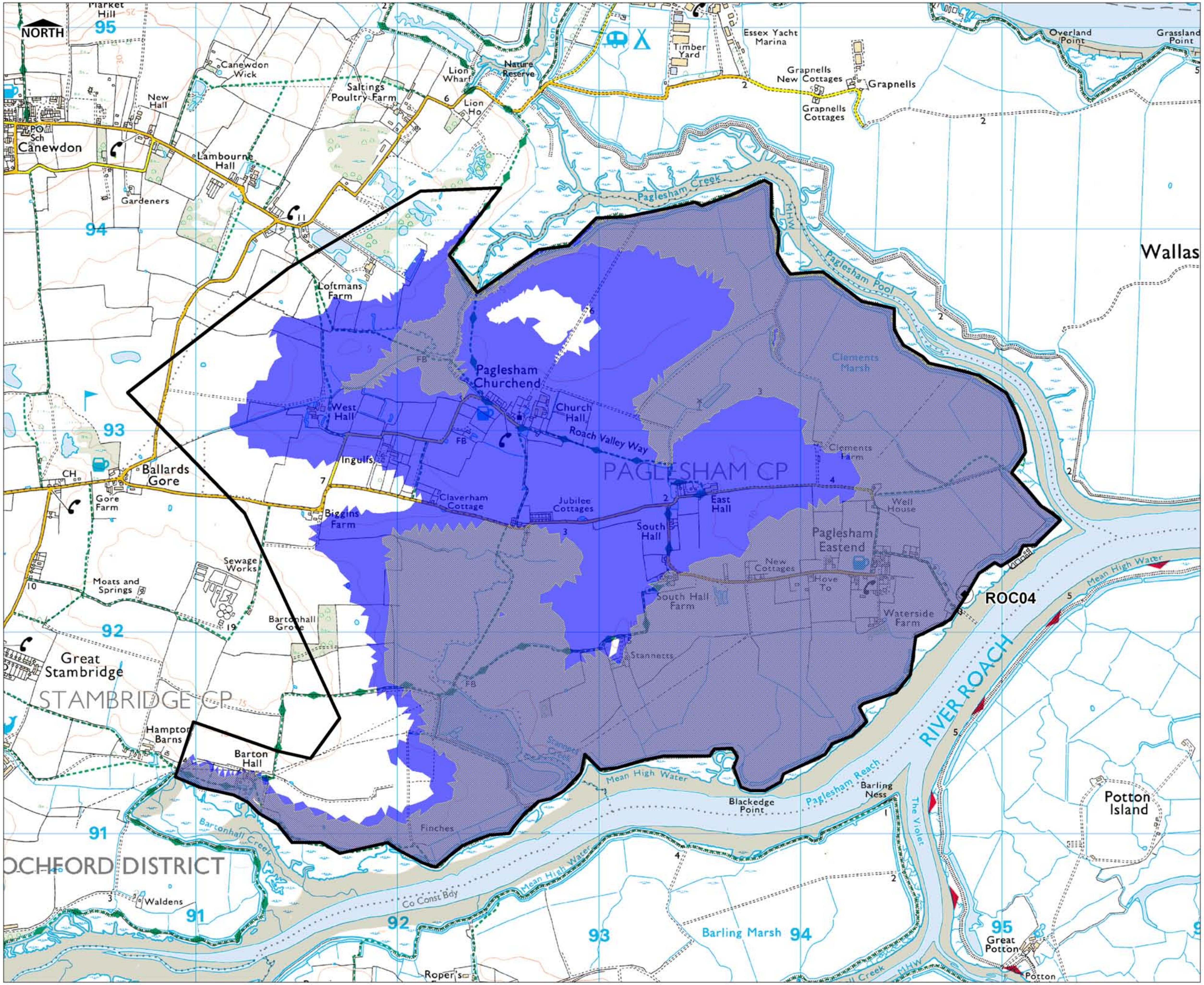
DRAWING NUMBER

FIGURE D-3

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR + CC (2110)

BREACH ROC04

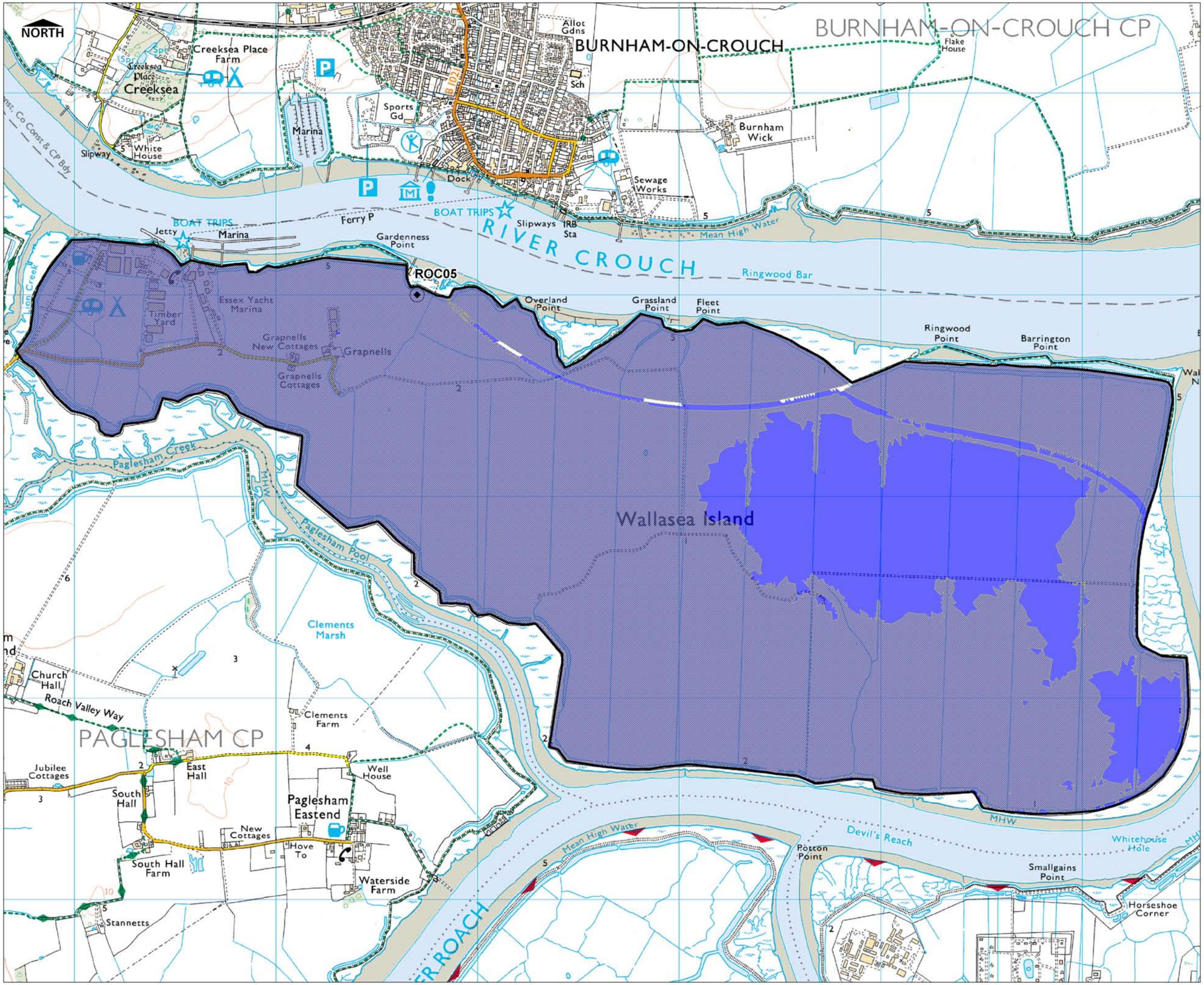
Basildon Council · castlepoint · Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-4

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR + CC (2110)

BREACH ROC05

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
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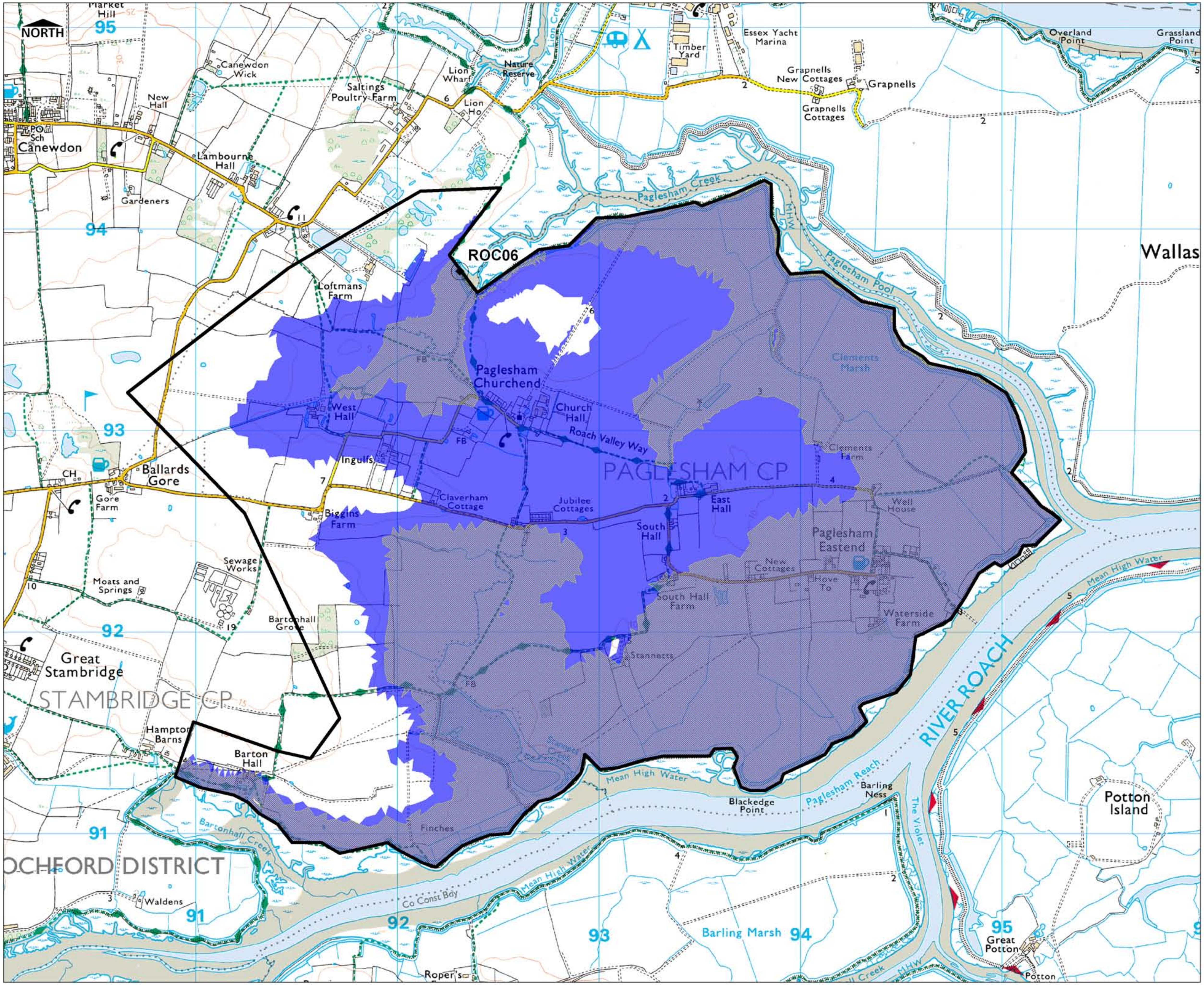
DRAWING NUMBER

FIGURE D-5

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR + CC (2110)

BREACH ROC06

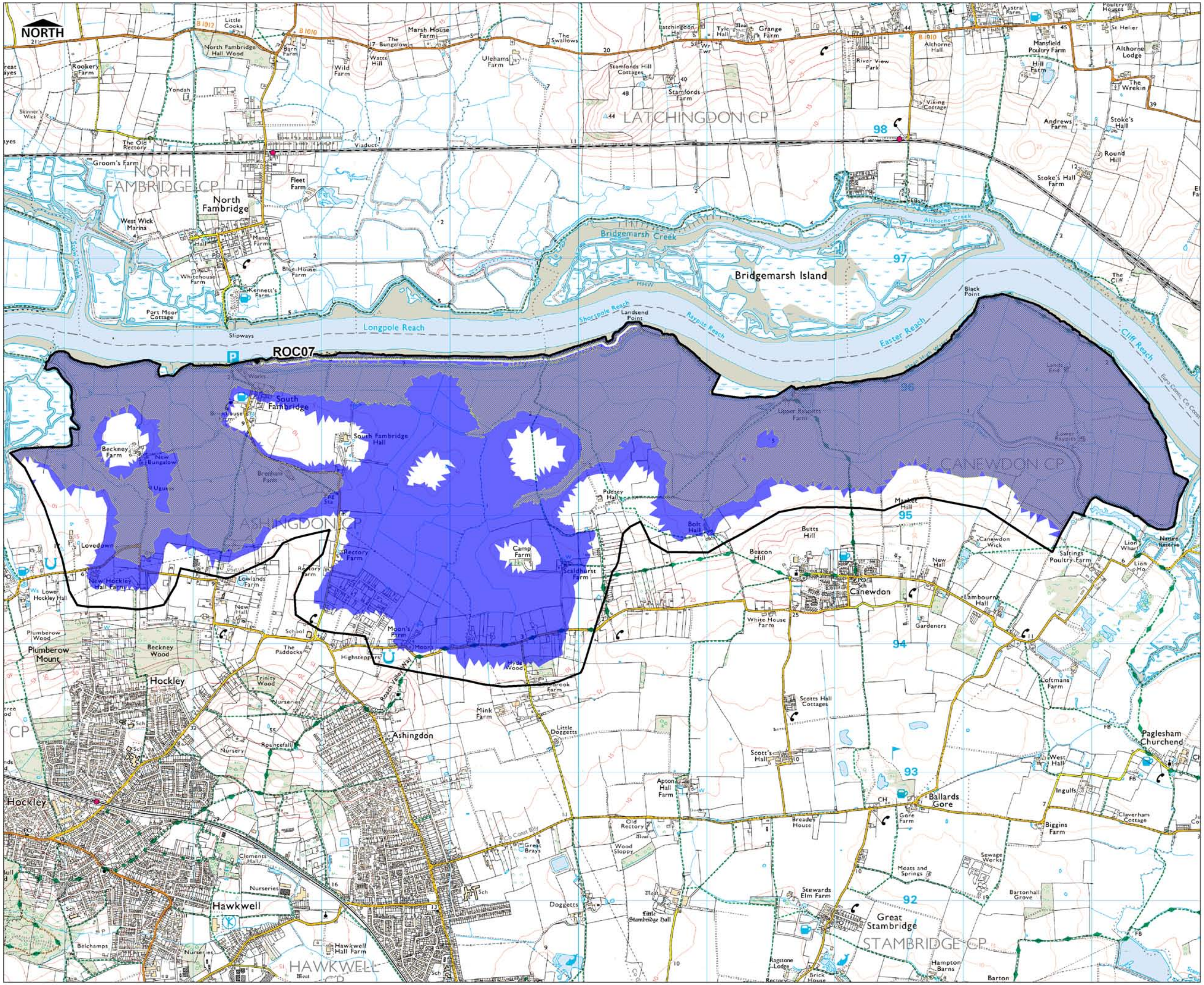
Basildon Council castlepoint Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-6

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION 1000YR + CC (2110)

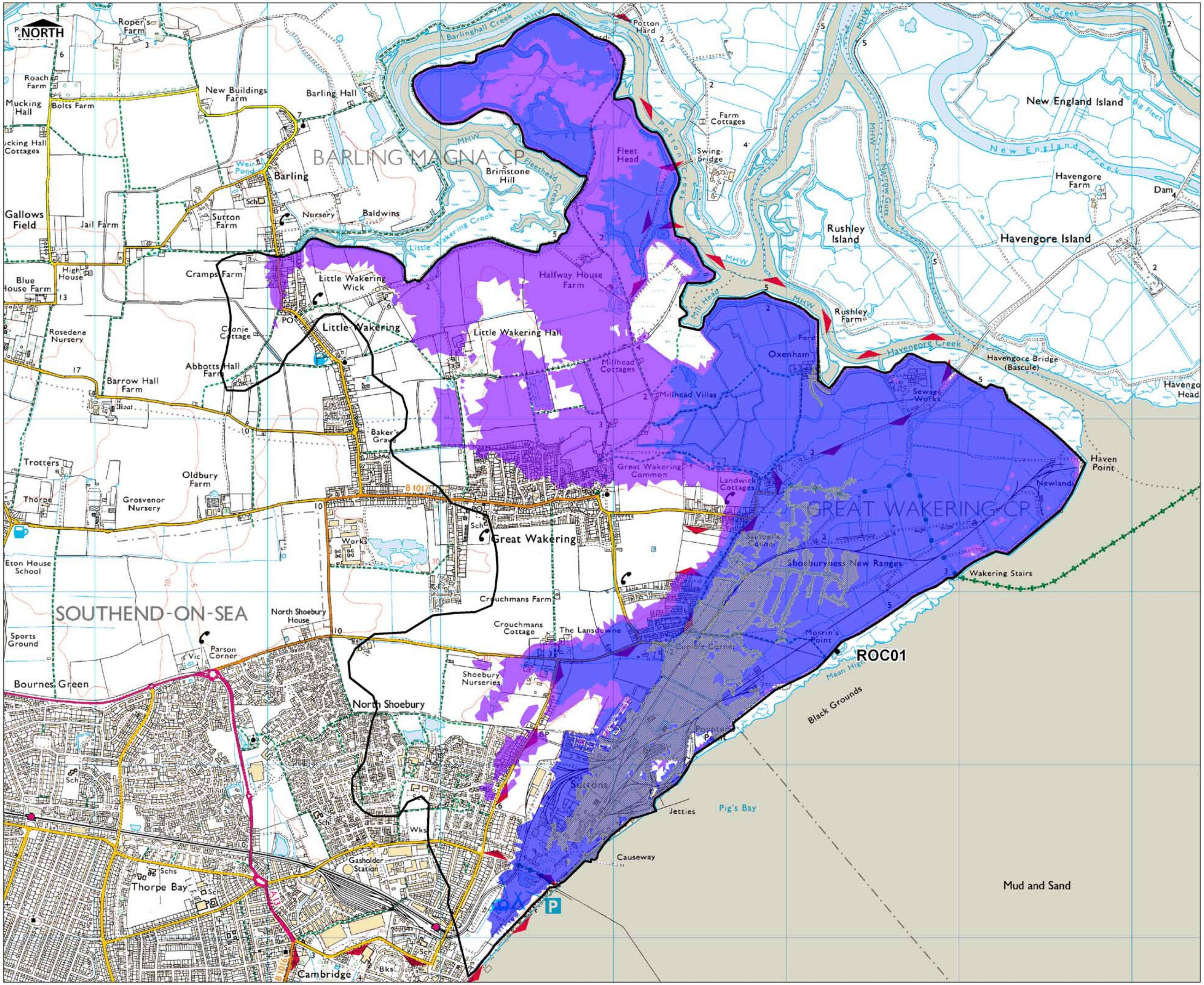
BREACH ROC07

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-7

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR + CC (2110)

BREACH ROC01

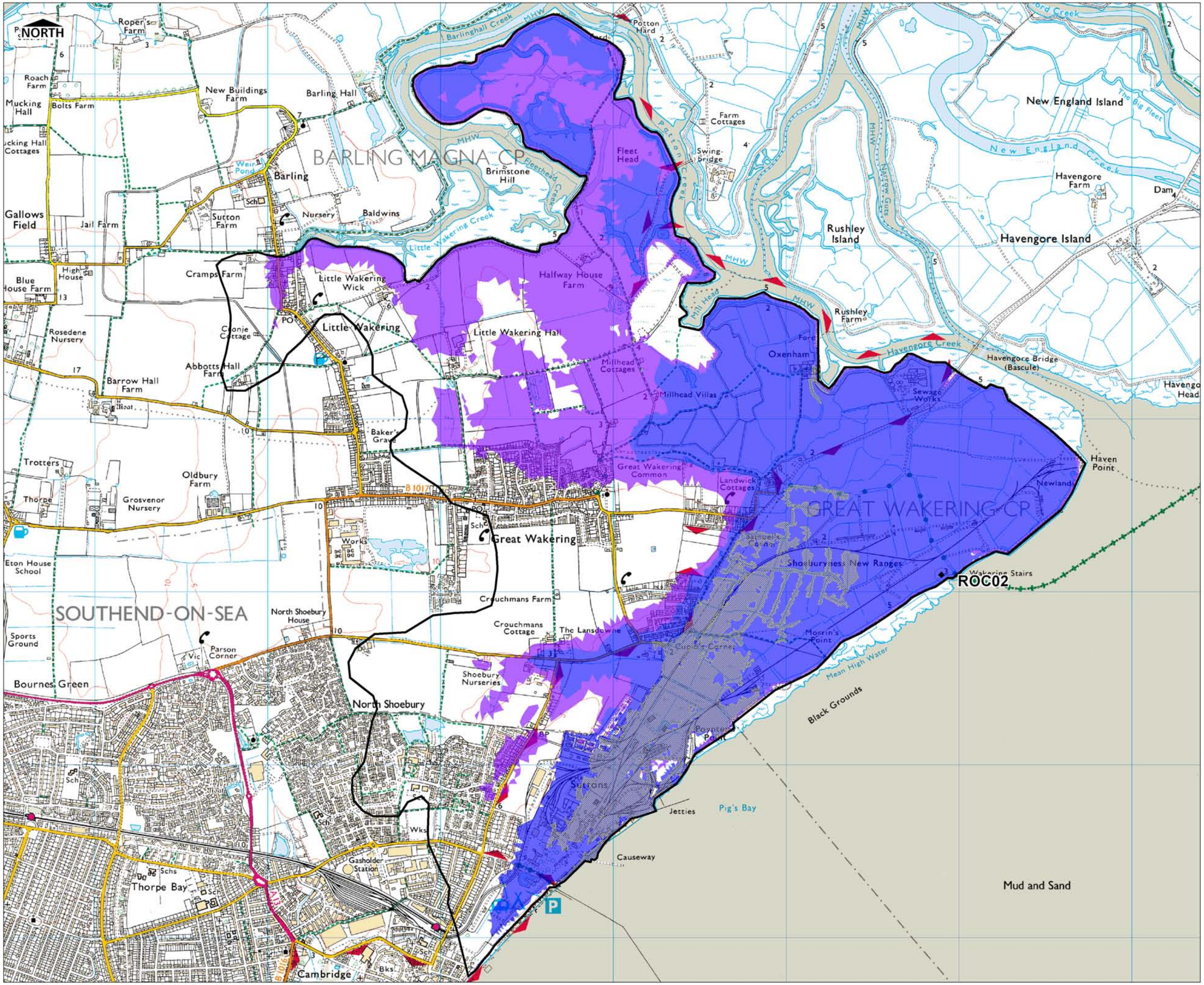
Basildon Council · castlepoint · Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-8

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR + CC (2110)

BREACH ROC02

Basildon Council · castlepoint · Rochford District Council

Scott Wilson
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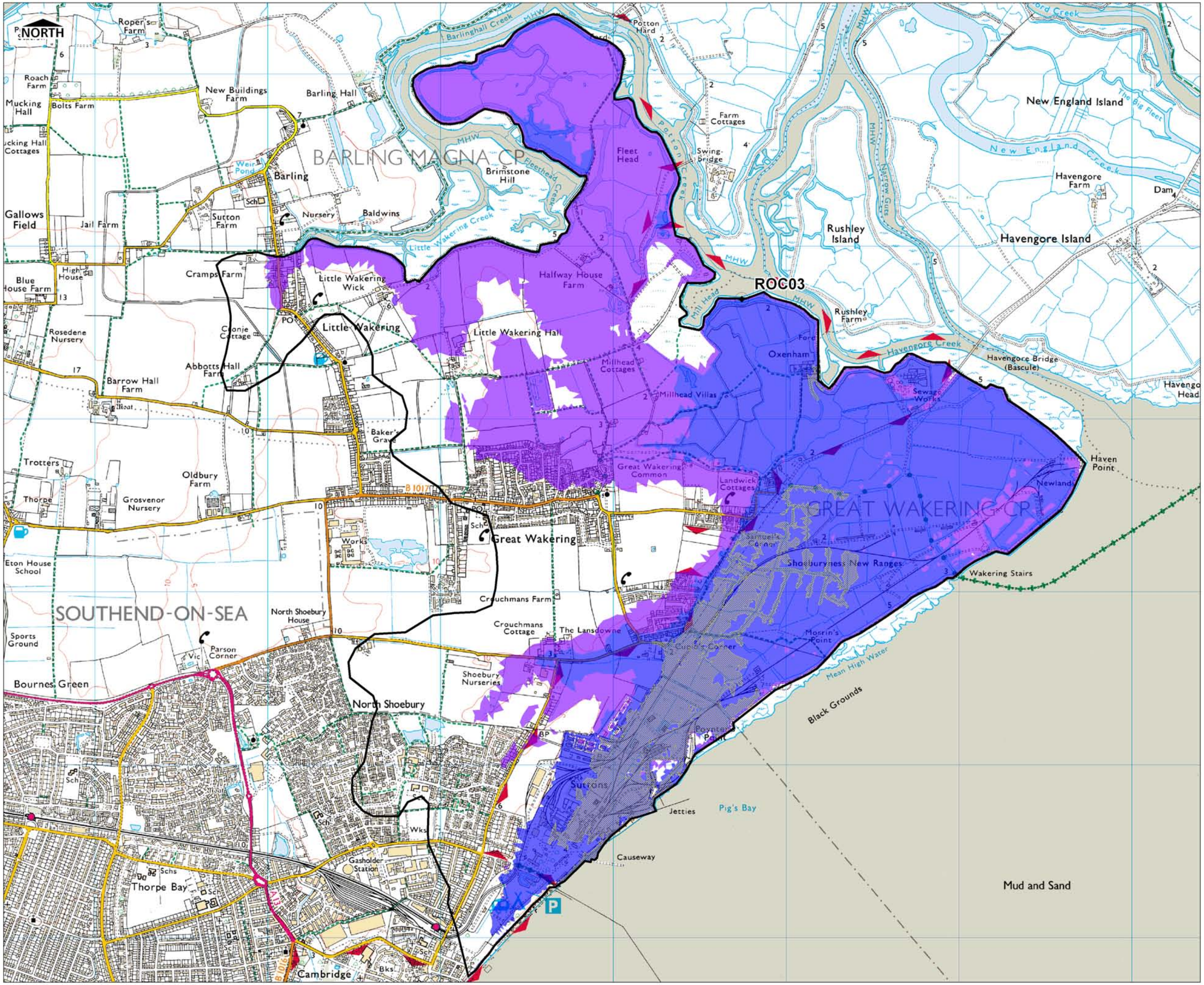
DRAWING NUMBER

FIGURE D-9

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
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TIME TO INUNDATION
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BREACH ROC03

BasildonCouncil castlepoint Rochford District Council

Scott Wilson
6-8 Greencoat Place
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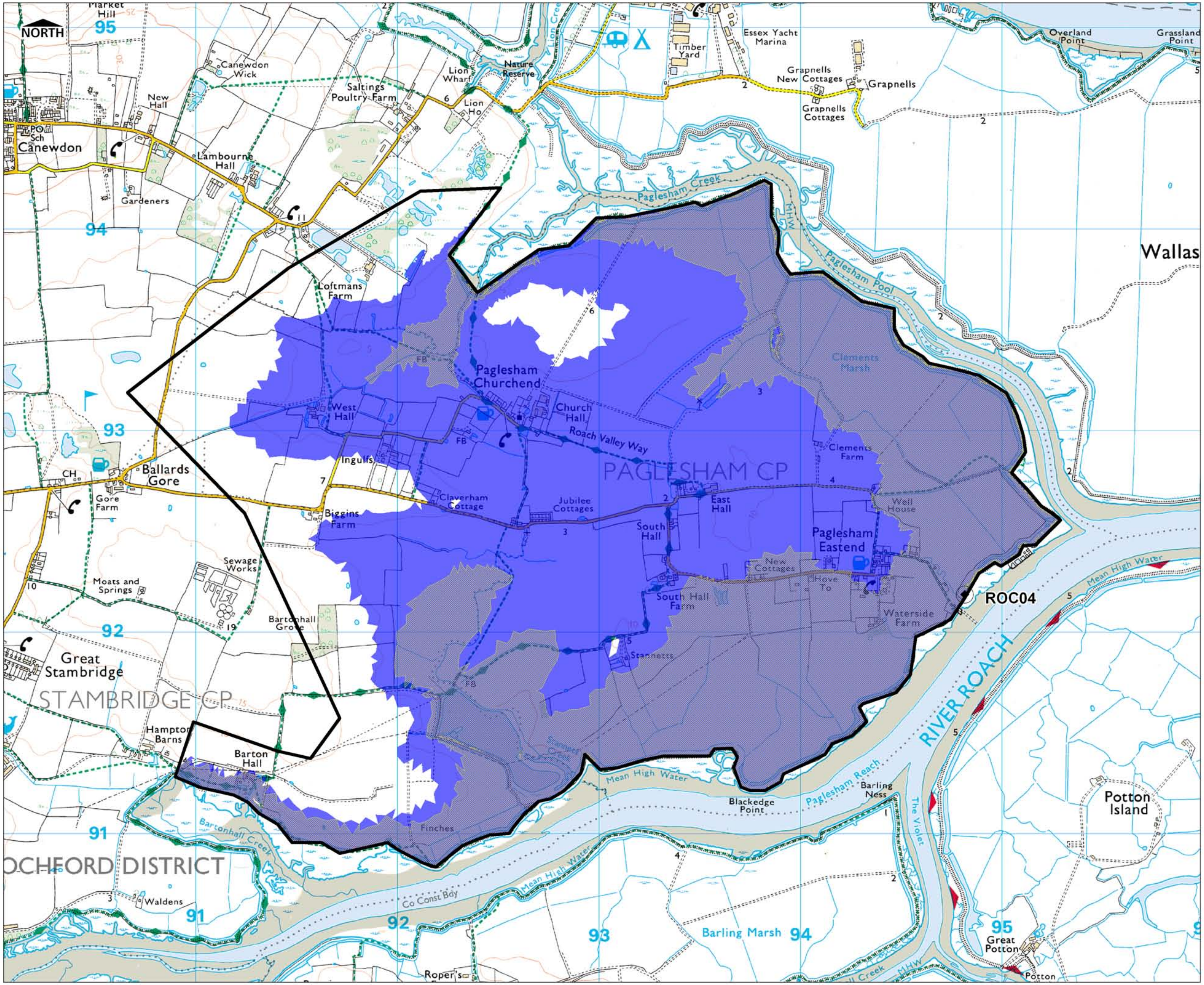
FIGURE D-10

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
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- 8 - 12 Hours
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TIME TO INUNDATION
0200YR + CC (2110)
BREACH ROC04

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
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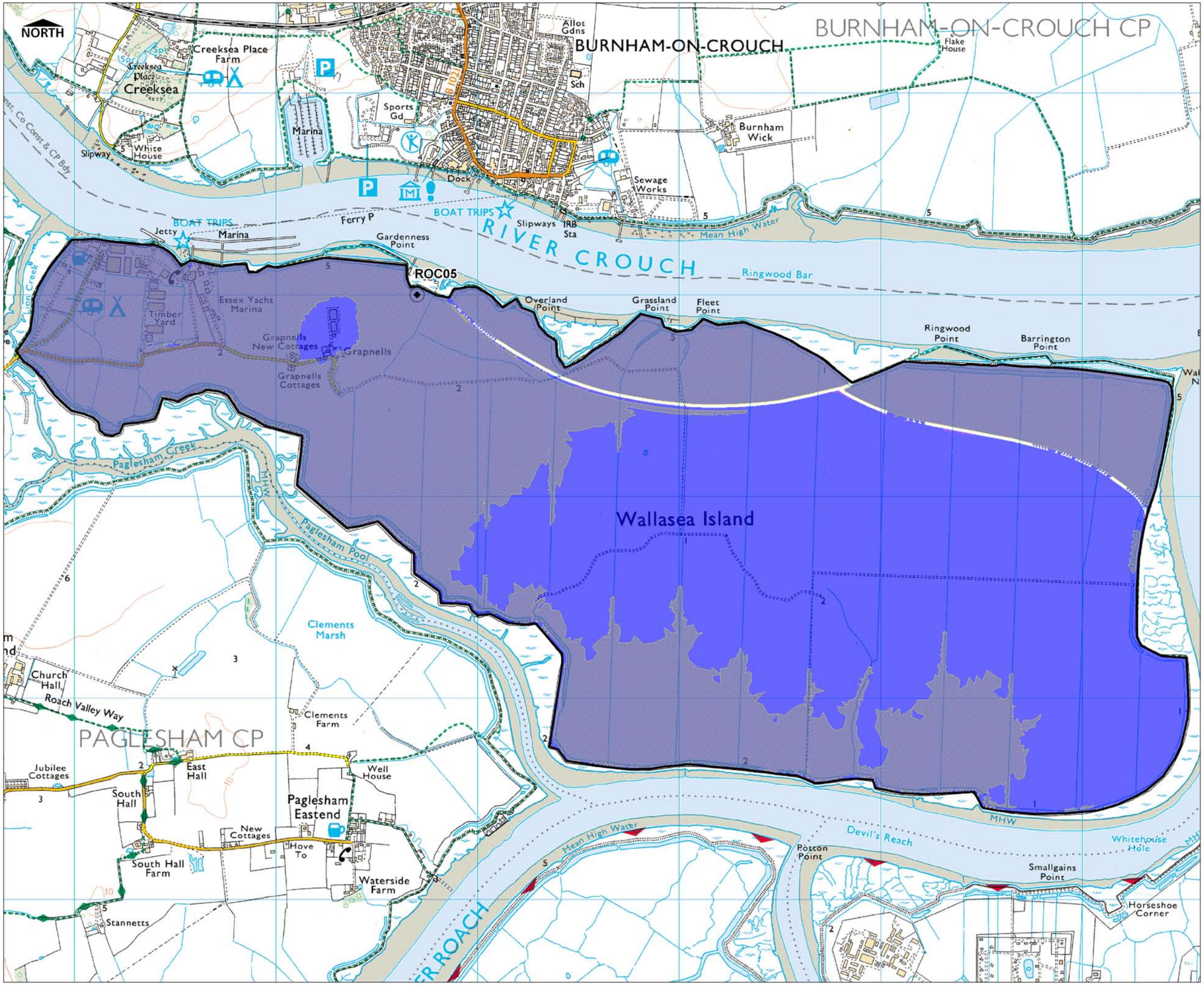
DRAWING NUMBER

FIGURE D-11

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
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- 8 - 12 Hours
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TIME TO INUNDATION
0200YR + CC (2110)
BREACH ROC05

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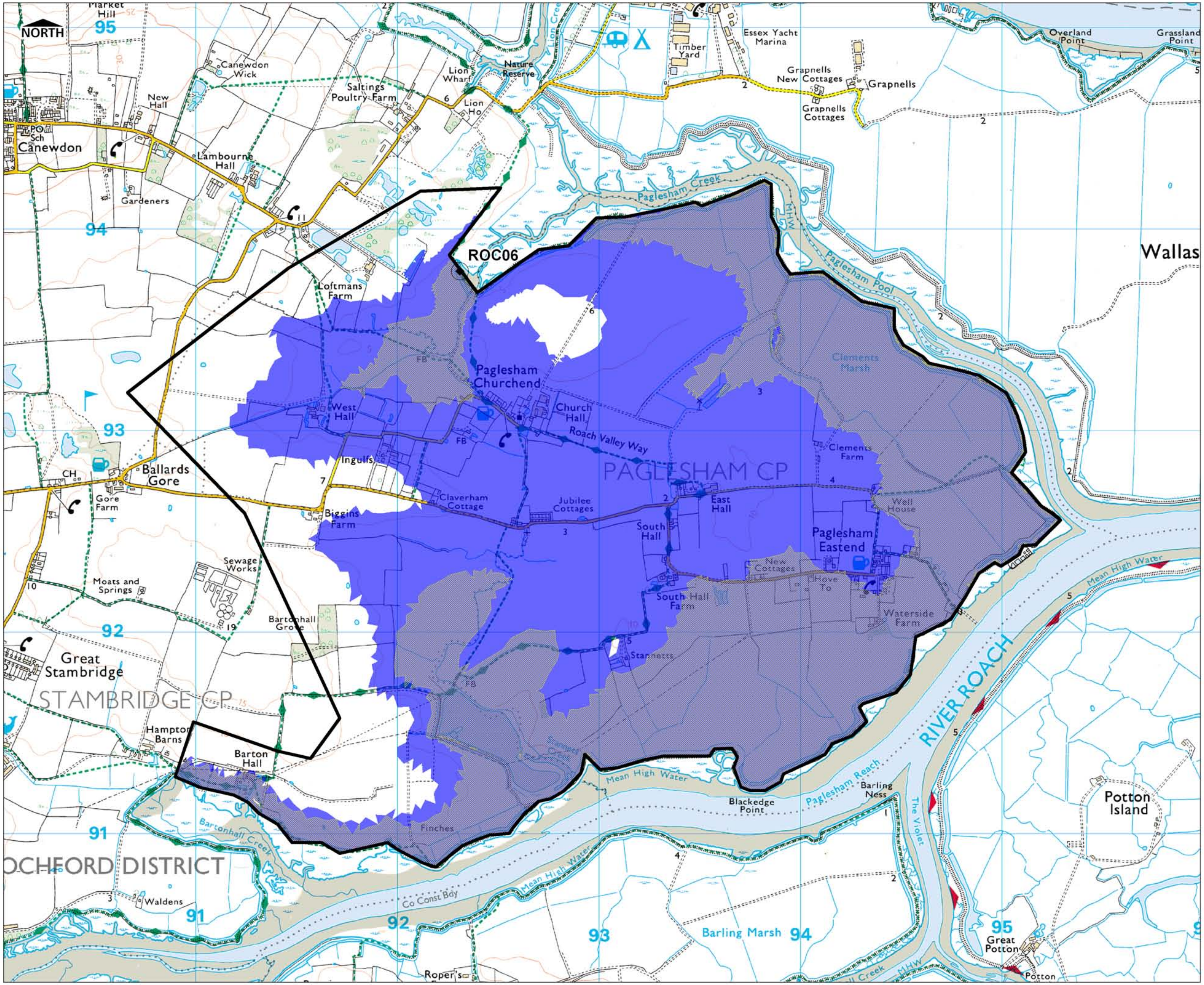
FIGURE D-12

REV 02



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
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- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR + CC (2110)

BREACH ROC06

Basildon Council · castlepoint · Rochford District Council

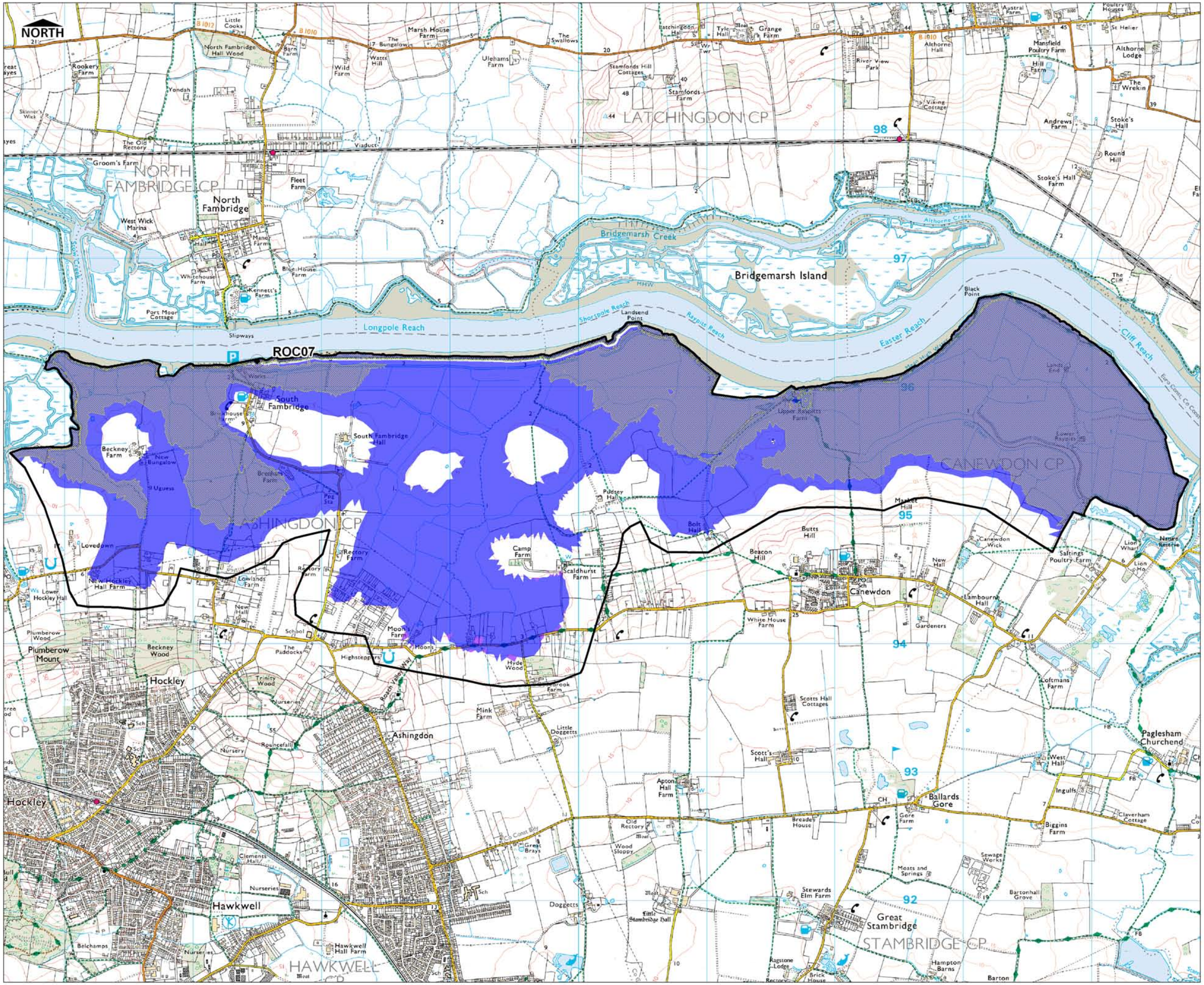
Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

Scott Wilson

DRAWING NUMBER

FIGURE D-13

REV 02



KEY

Flood Cell

Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR + CC (2110)

BREACH ROC07

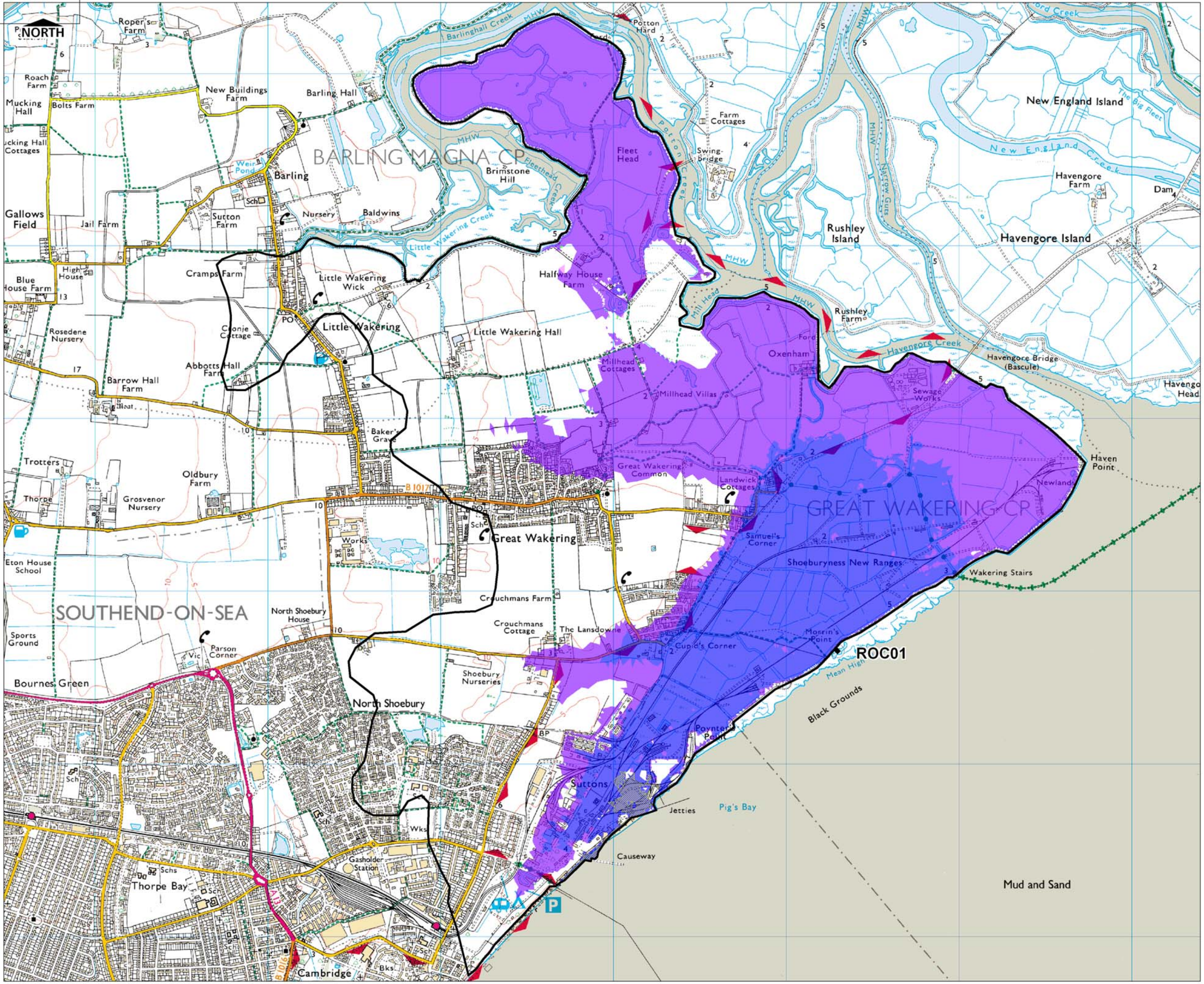
Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-14

REV 02

No Window



KEY

Flood Cell

Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR (2010)
BREACH ROC01

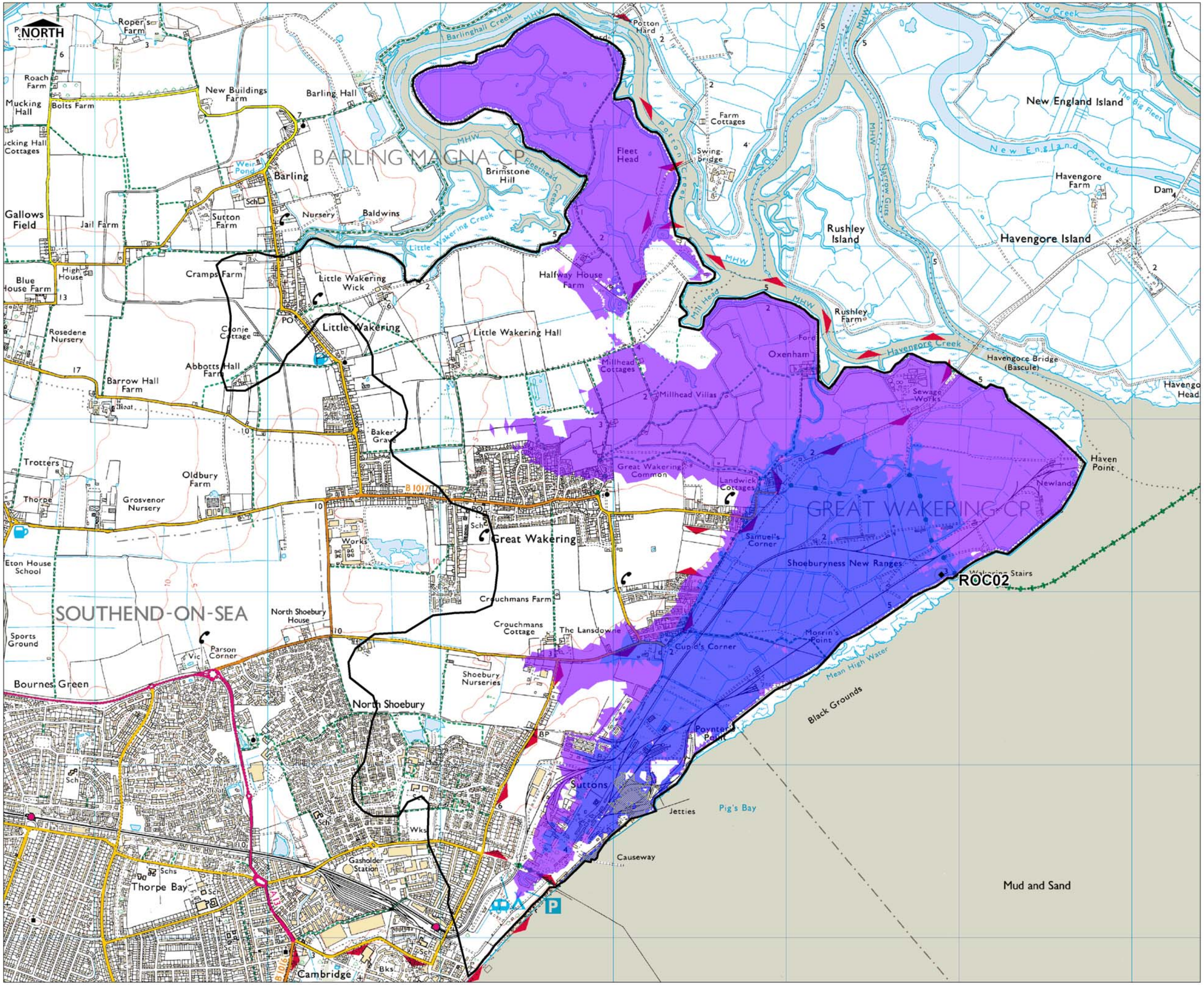
Basildon Council castlepoint Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-15

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

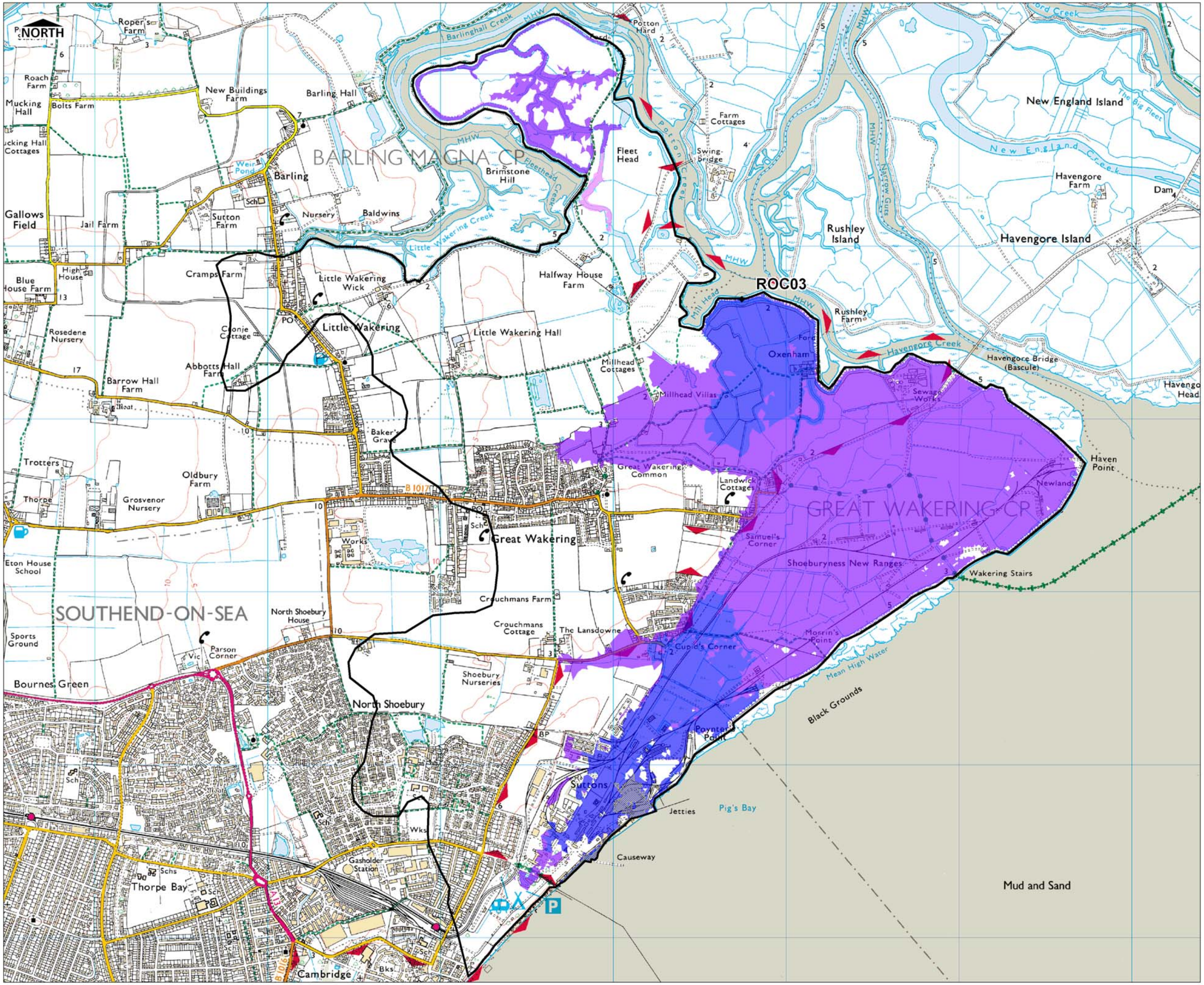
TIME TO INUNDATION
1000YR (2010)
BREACH ROC02

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-16

REV 01



KEY

Flood Cell

Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR (2010)

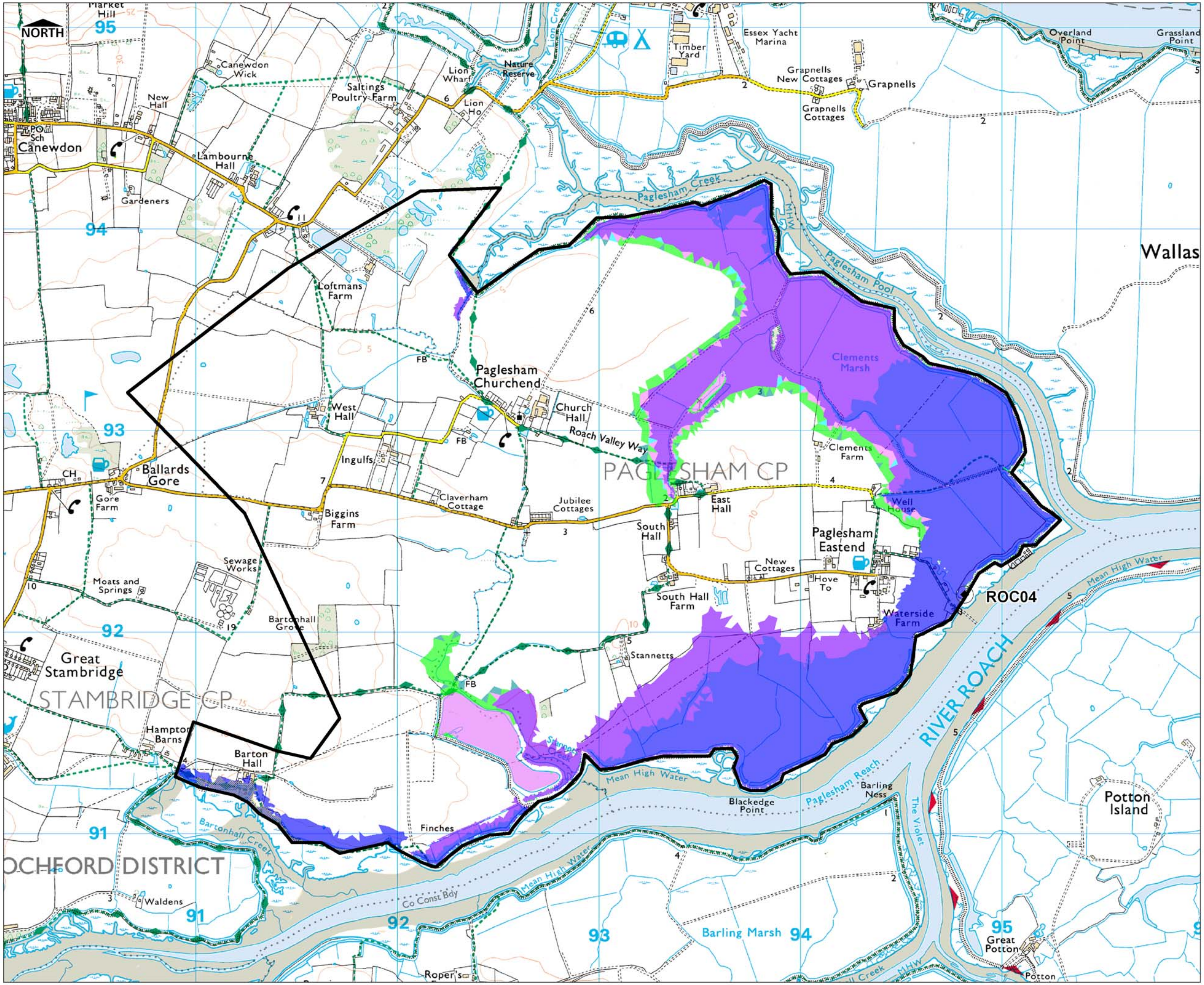
BREACH ROC03

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-17

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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STRATEGIC FLOOD RISK ASSESSMENT

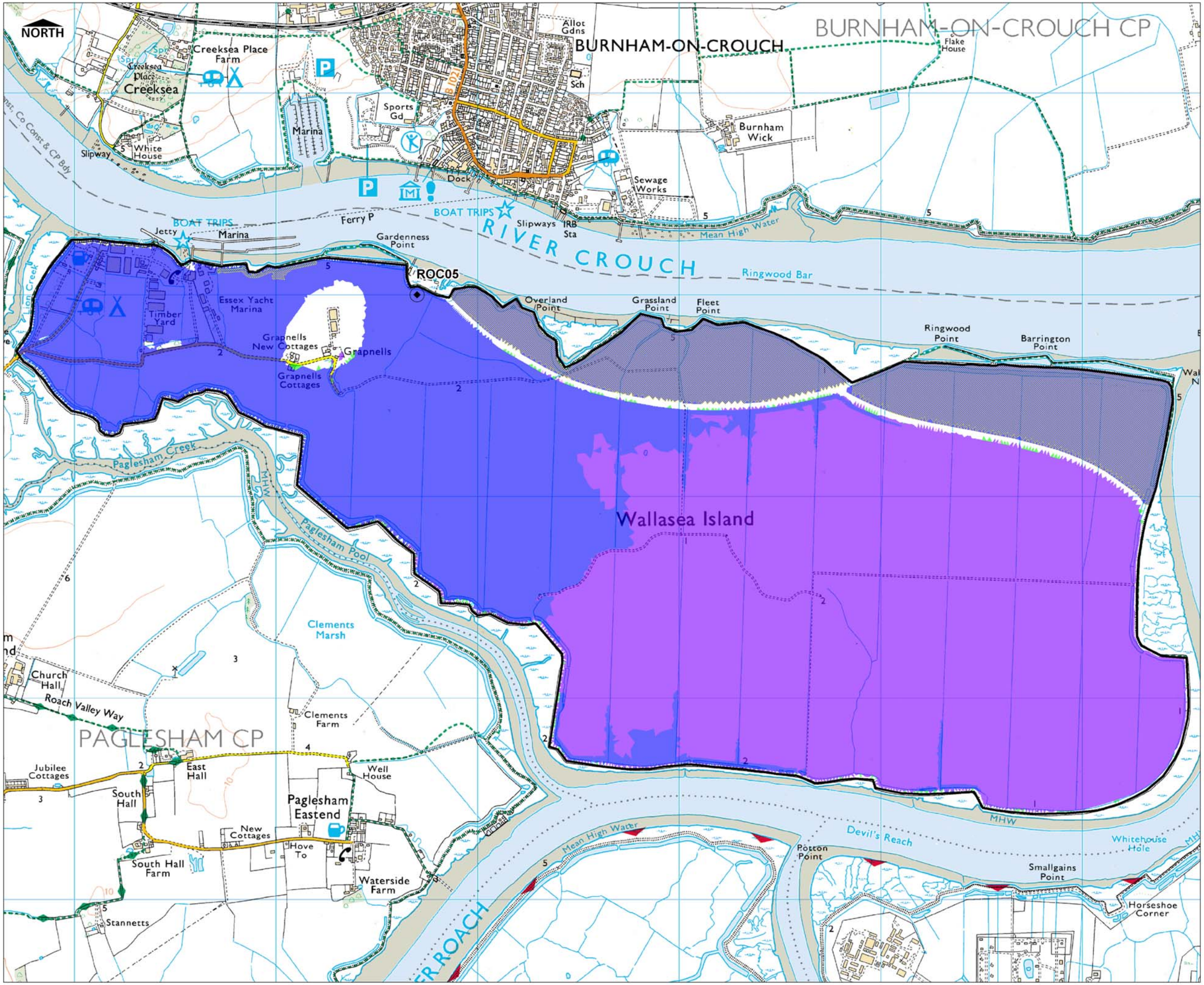
TIME TO INUNDATION
1000YR (2010)
BREACH ROC04

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-18

REV 01



KEY

- Flood Cell
- ◆ Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR (2010)
BREACH ROC05

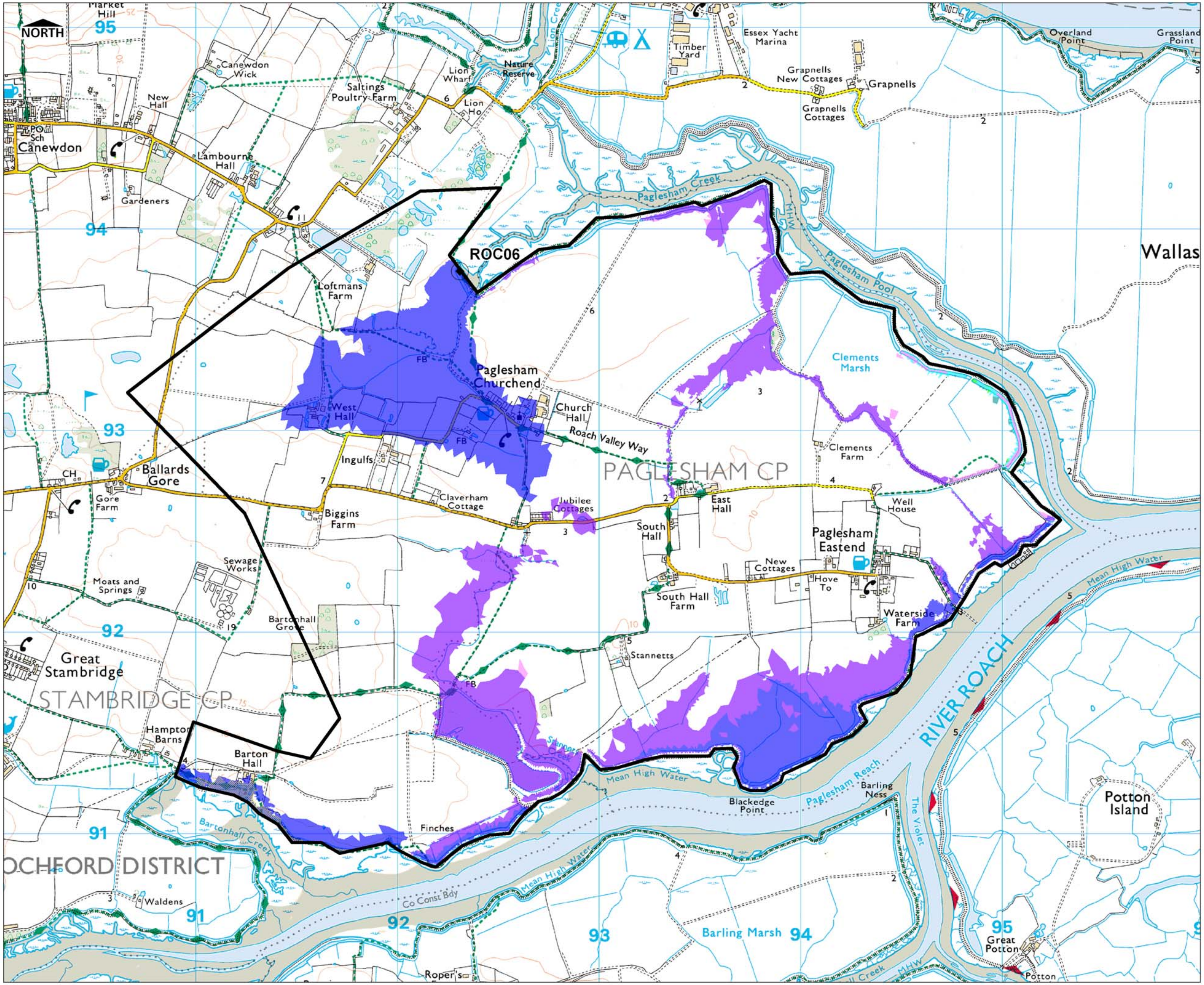
Basildon Council · castlepoint · Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-19

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR (2010)
BREACH ROC06

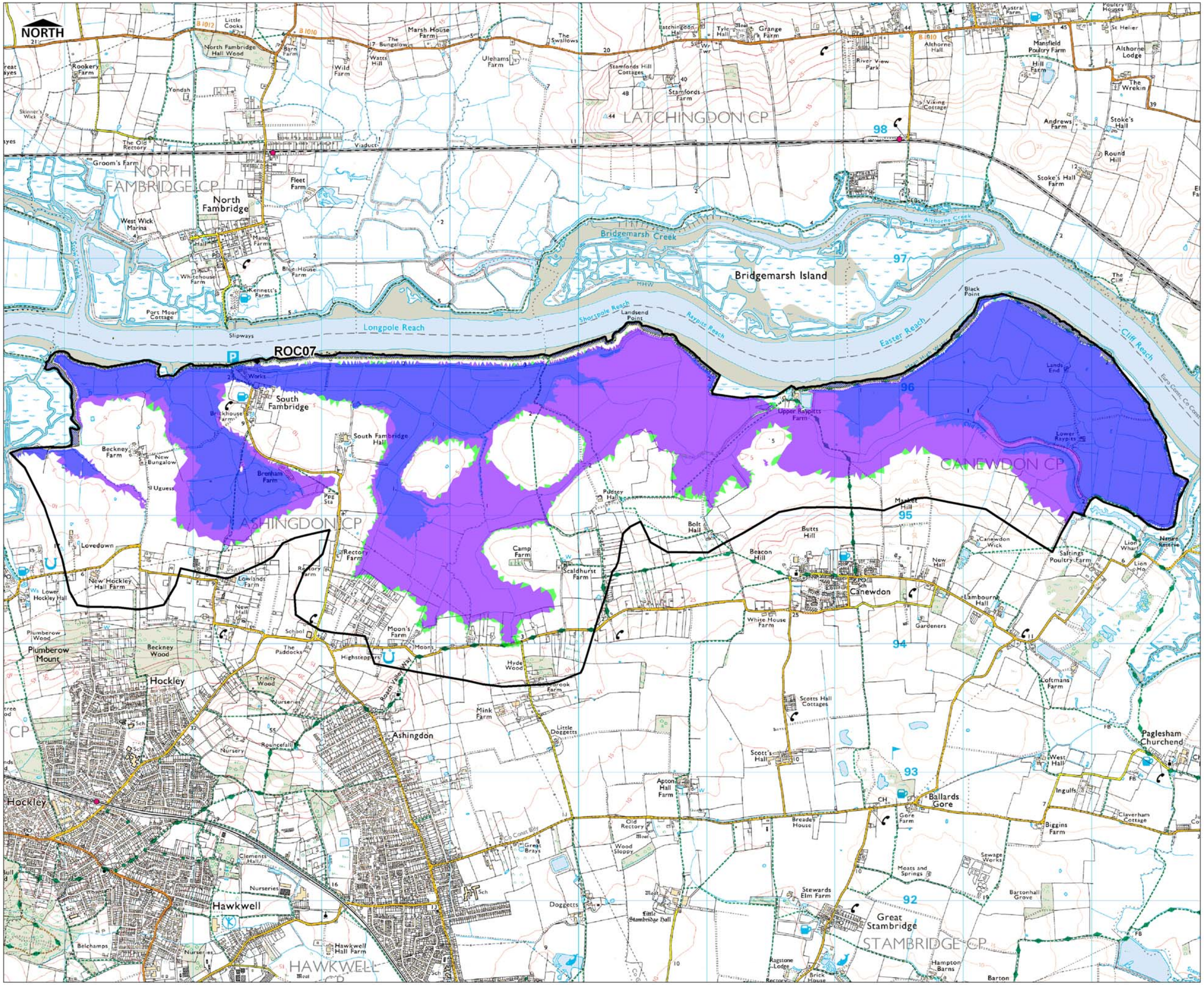
BasildonCouncil castlepoint Rochford District Council

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-20

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
1000YR (2010)

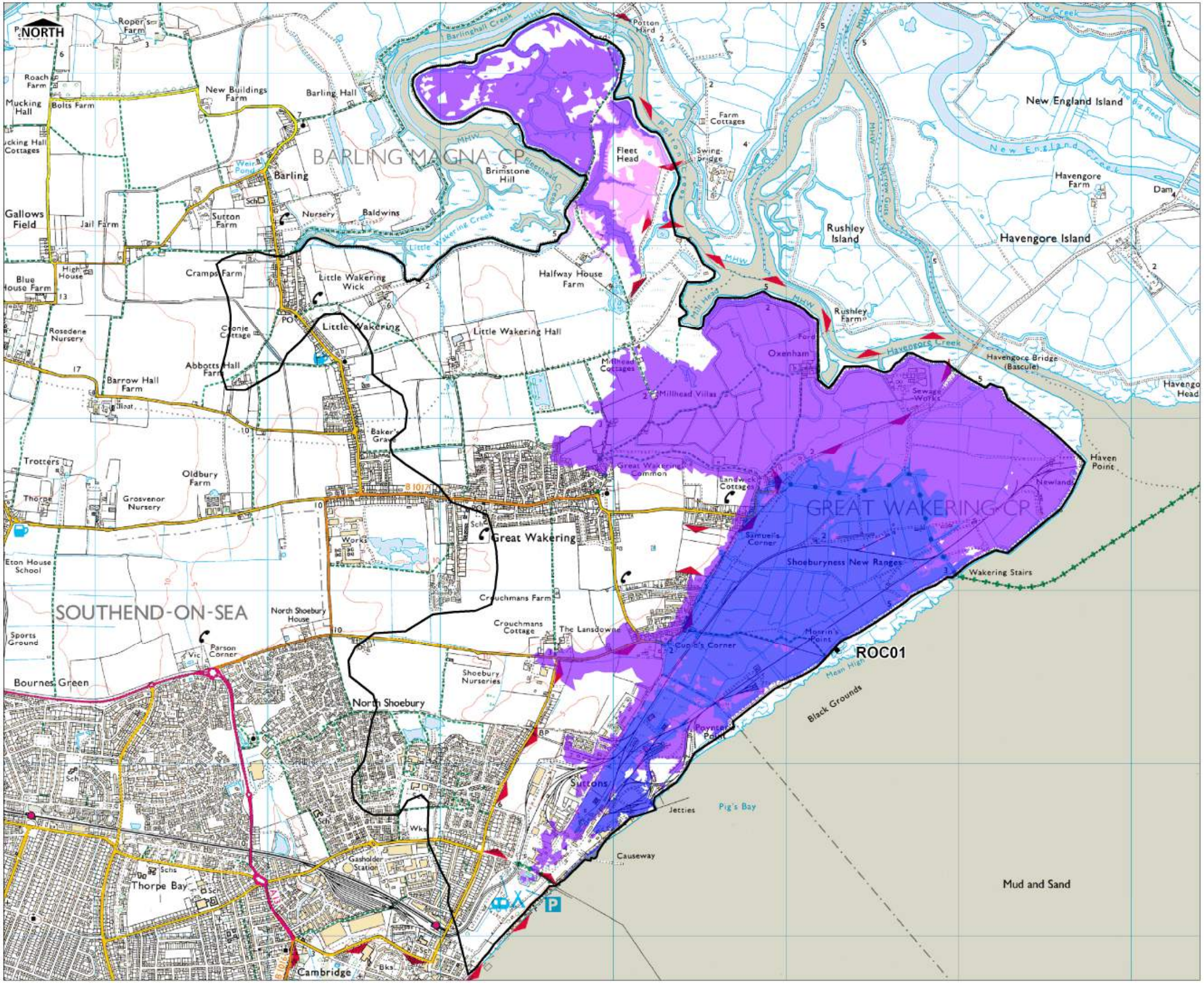
BREACH ROC07

Scott Wilson
6-8 Greencoat Place
London, SW1P 1PL
Tel: (020) 7798 5000

DRAWING NUMBER

FIGURE D-21

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR (2010)
BREACH ROC01

Basildon Council castlepoint Rochford District Council

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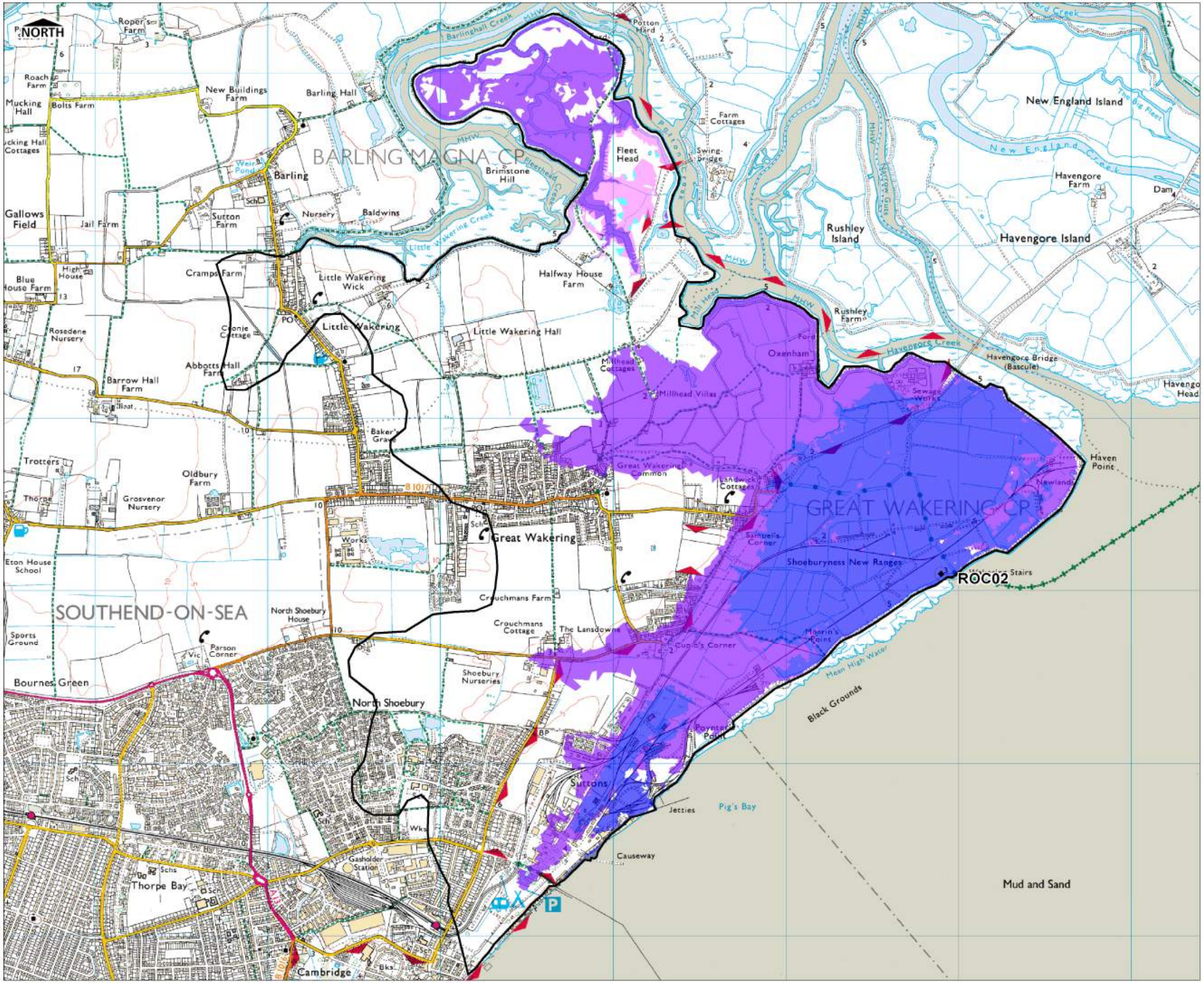
FIGURE D-22

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

TECHNICAL NOTE

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Time to inundation maps represent the onset of flooding from 1 specified breach. The rate will vary spatially if the breach locations are in different local areas. Changes in inundation extent or rate of onset of flooding are non-linear to changes in breach location.
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USER NOTE

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR (2010)
BREACH ROC02

Basildon Council castlepoint Rochford District Council

Scott Wilson
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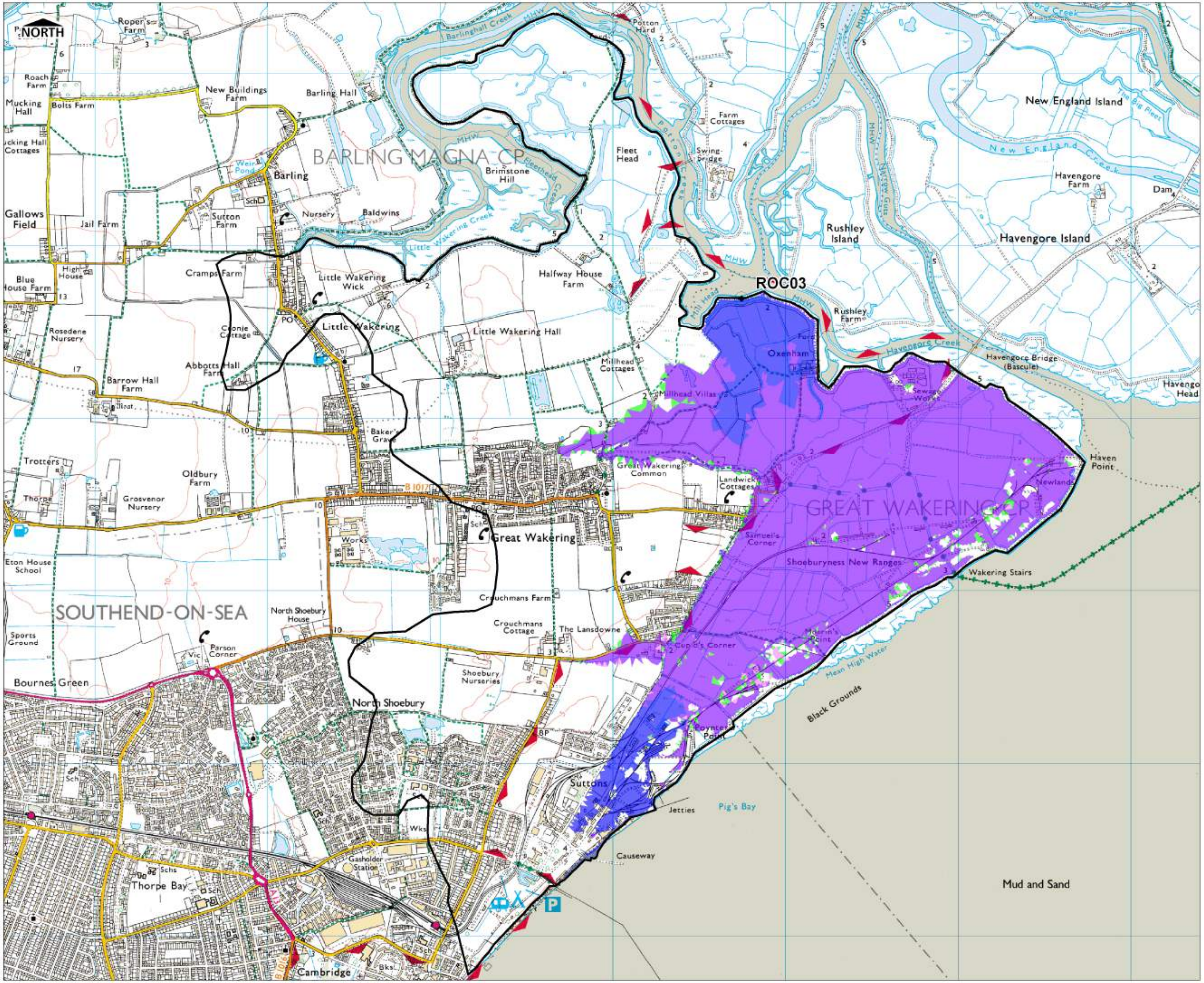
FIGURE D-23

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR (2010)
BREACH ROC03

Basildon Council castlepoint Rochford District Council

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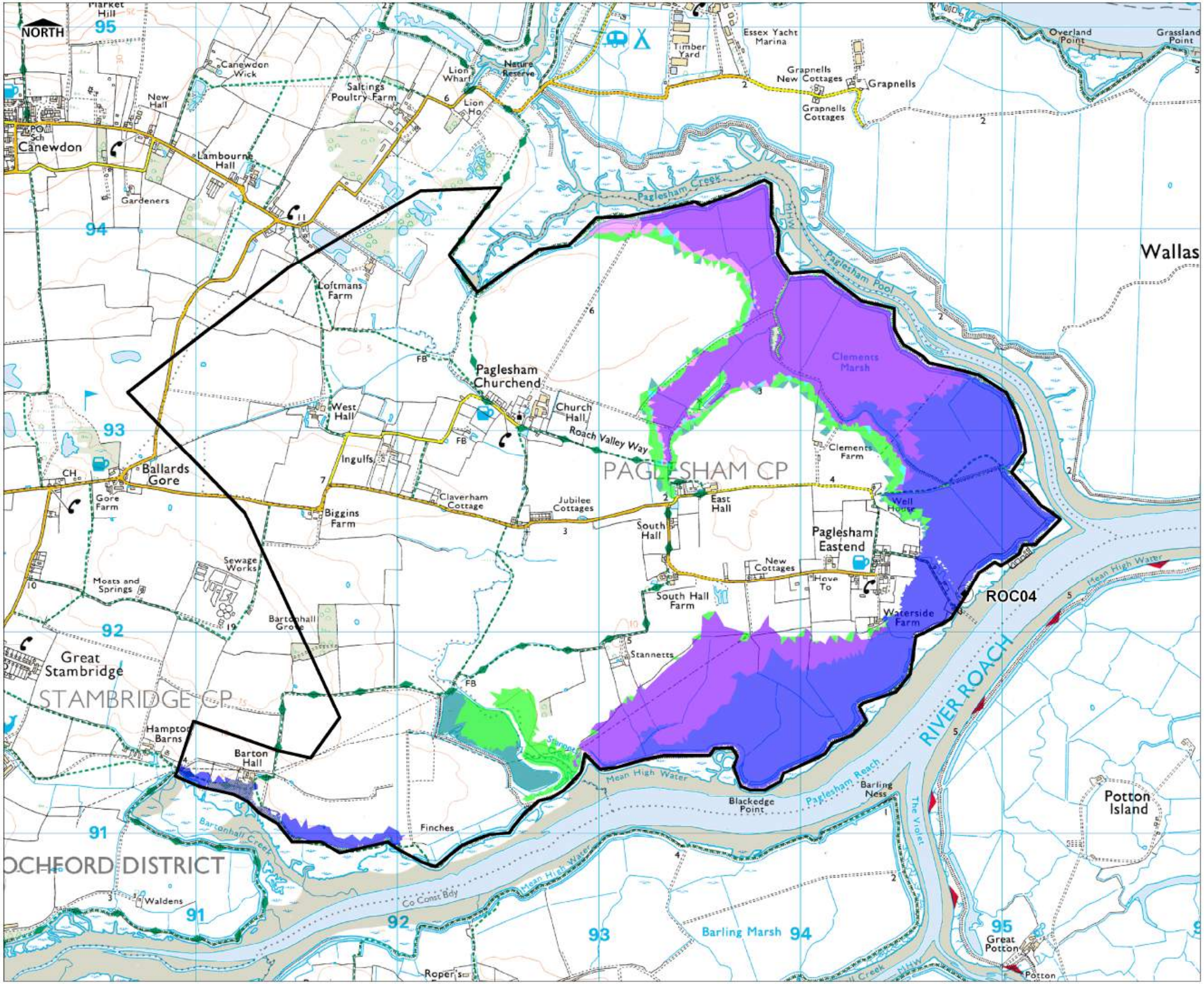
FIGURE D-24

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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THAMES GATEWAY SOUTH ESSEX STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR (2010)
BREACH ROC04

Basildon Council · castlepoint · Rochford District Council

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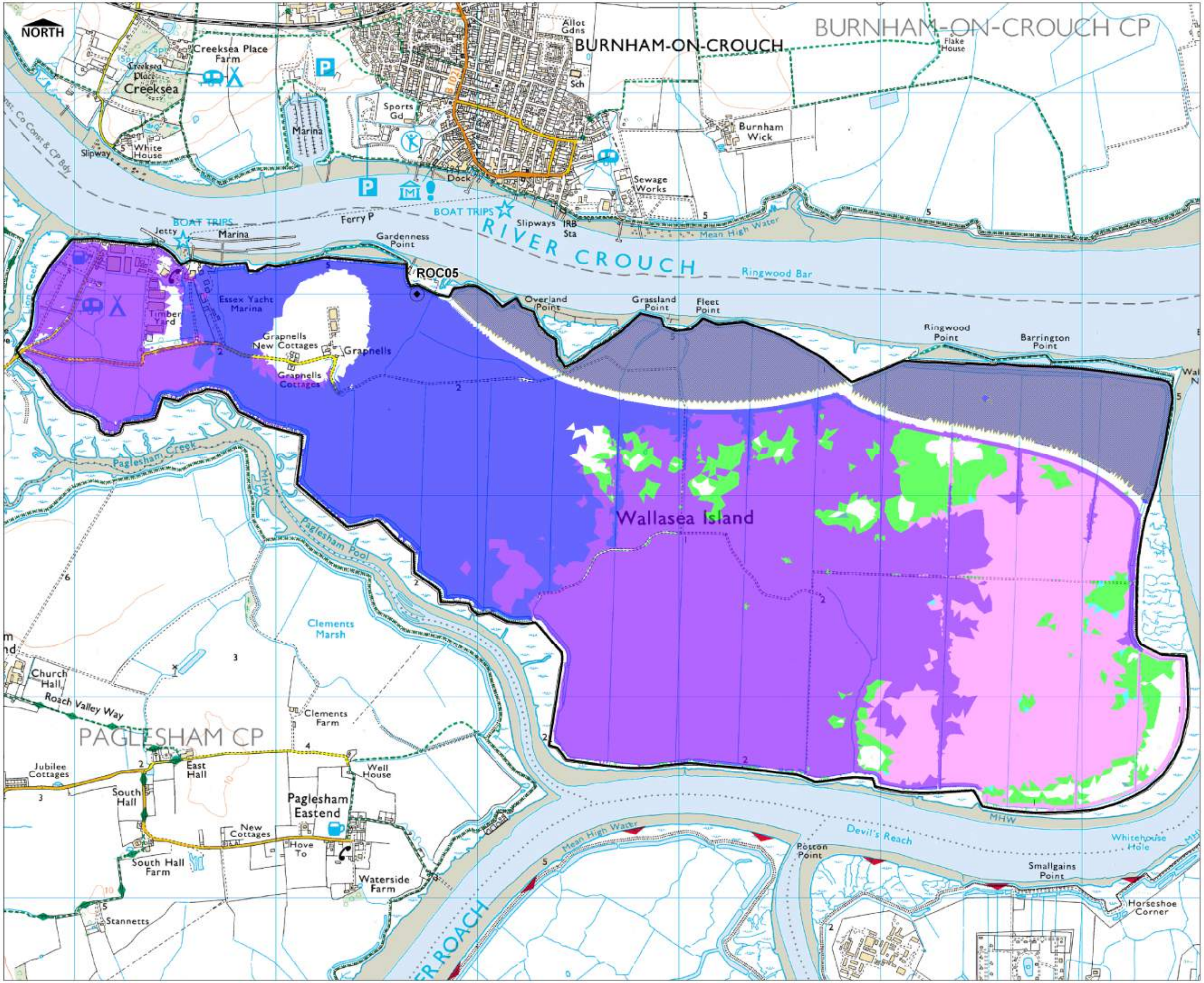
DRAWING NUMBER

FIGURE D-25

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR (2010)
BREACH ROC05

Basildon Council castlepoint Rochford District Council

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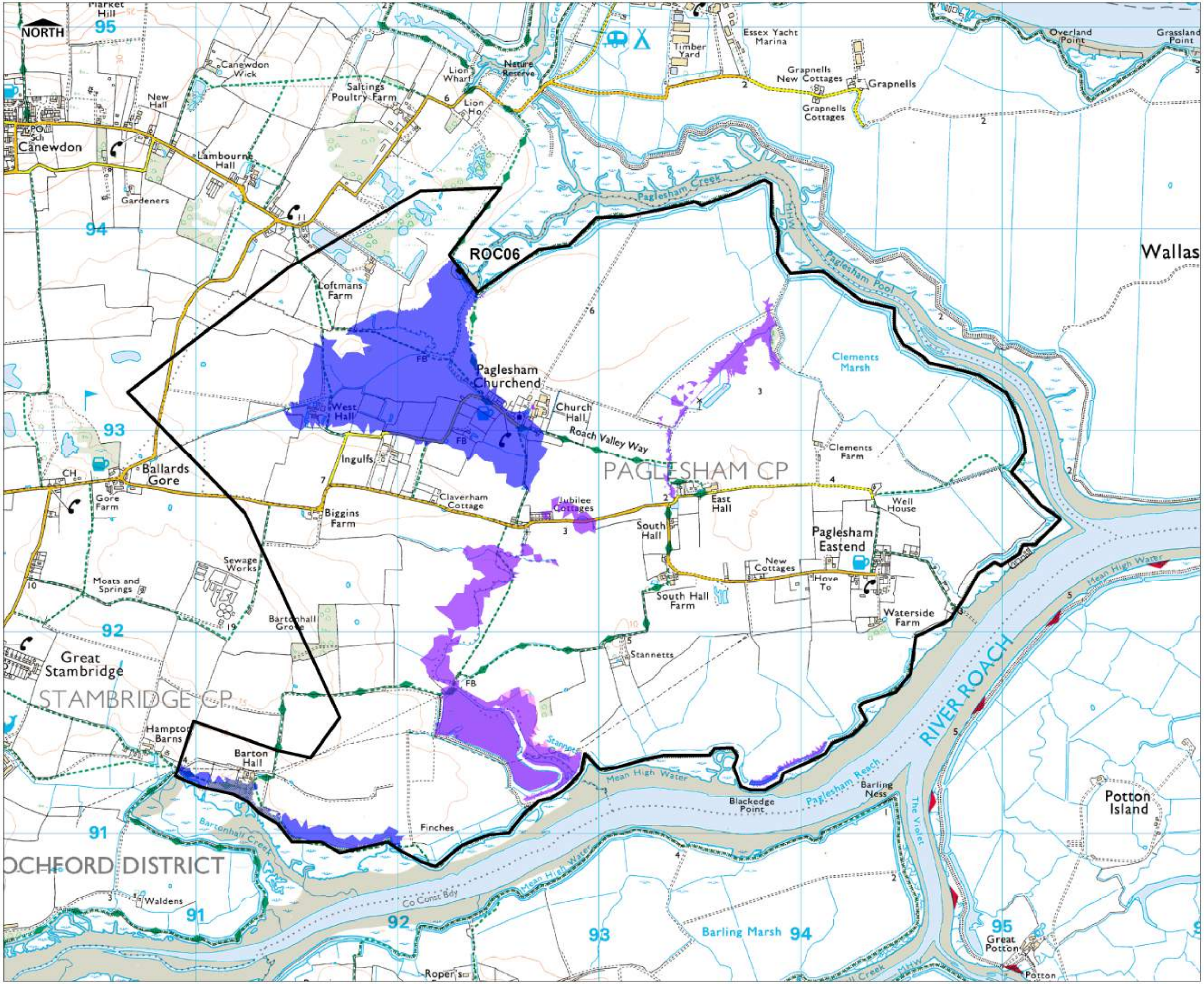
DRAWING NUMBER

FIGURE D-26

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
- 1 - 4 Hours
- 4 - 8 Hours
- 8 - 12 Hours
- 12 - 16 Hours
- 16 - 20 Hours
- Inundation from overtopping prior to breach

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TIME TO INUNDATION
0200YR (2010)
BREACH ROC06

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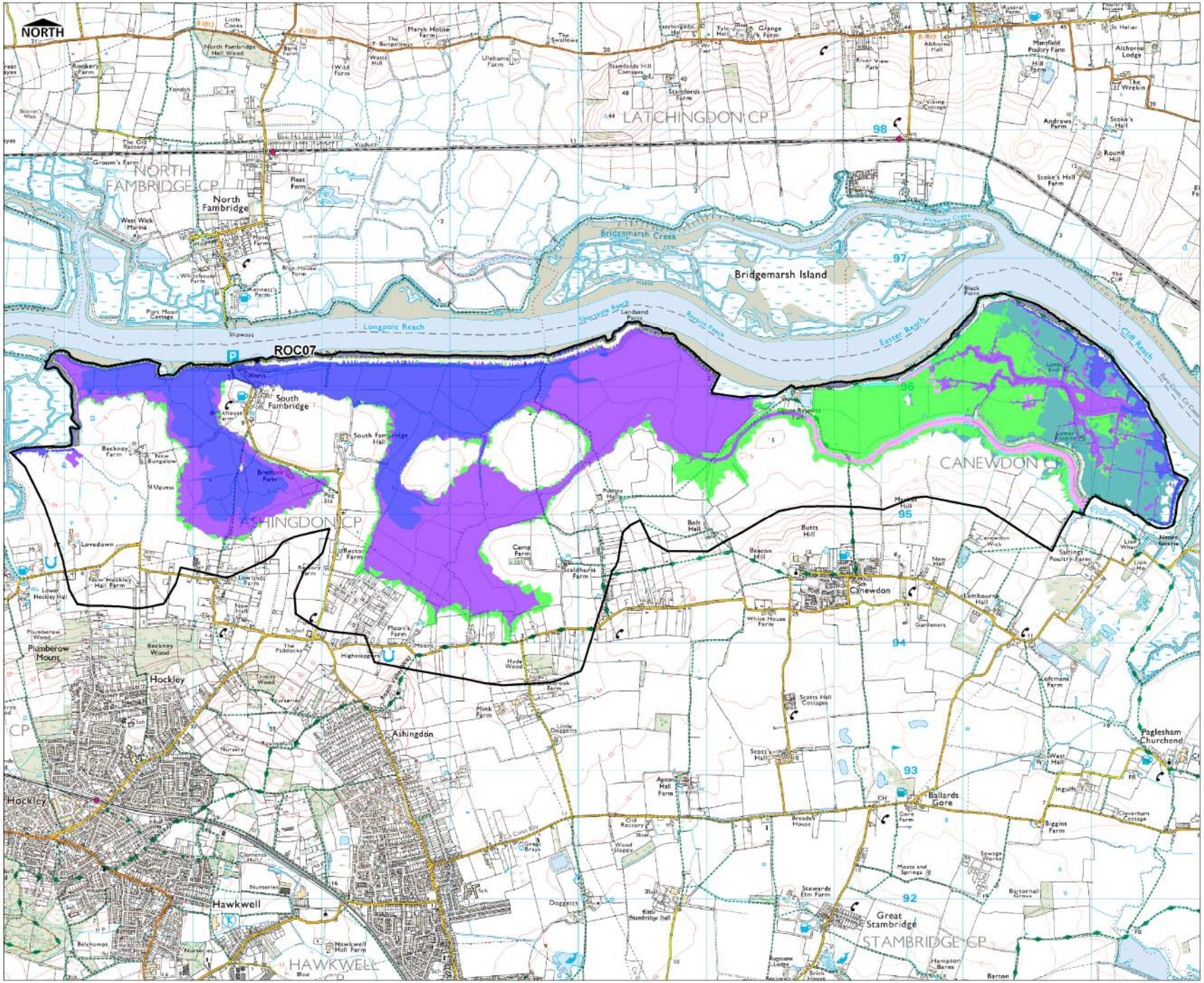
FIGURE D-27

REV 01



KEY

- Flood Cell
- Breach Location

Time To Inundation [Hours]

- < 1 Hour
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- 4 - 8 Hours
- 8 - 12 Hours
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THAMES GATEWAY SOUTH ESSEX
STRATEGIC FLOOD RISK ASSESSMENT

TIME TO INUNDATION
0200YR (2010)

BREACH ROC07

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FIGURE D-28

REV 01

Appendix E: Modelling Methodology

Appendix E: Hydrodynamic Breach Modelling Methodology

This appendix presents the methodologies used to develop modelling outputs, including maximum flood depth, hazard rating and time to inundation maps, for the Strategic Flood Risk Assessment.

Rapid Inundation Modelling

The modelling methodology used for this SFRA uses a 'breach at the peak' approach or 'rapid inundation' approach. Rapid inundation modelling simulates breaches that occur suddenly just before the peak tidal level. As the maximum force and volume of water behind the defences will occur at the peak of the simulated water level it was agreed that this modelling scenario would provide the most rapid inundation of the system. A greater volume of water would surge through the breach with more rapid and higher floodwater velocities simulated, particularly in the vicinity of the breaches. This would correspondingly produce the most severe time to inundation results in the area local to the breach position and hazard with velocity playing a large part in the determination of the flood hazard category in certain areas. The results from these scenarios could then be used to determine the minimum time to inundation for vulnerable locations in the flood cell, particularly for the more vulnerable properties located closer to the flood defences.

The total volume of water entering the system will be slightly less compared with a modelled situation where the breach is open throughout the modelled simulation (i.e. open flood gate situation), and inundation will be slightly lower in the outlying areas of the flood cell. The rapid inundation methodology will however more appropriately test the potential flooding in more vulnerable lower lying areas close to the breach. This methodology was agreed with the Environment Agency (EA) prior to the commencement of the project.

The modelling carried out for this SFRA was based on the previous modelling undertaken as part of the Thames Gateway SFRA. It should be noted that although many of these breach locations were previously identified, all of the breach modelling conducted within this study is original and does not use or incorporate any previous modelling; each breach cell has been reconstructed exclusively for this study. In addition, every breach location has been assessed for suitability to this study.

Site Visit

Initially each breach was investigated to determine the location of the breach, the defence type and height, the width of the breach and the invert level of the breach. This was informed by the previous SFRA and validated using aerial photography and topographic data in the form of LiDAR. This information was then sent to the EA for confirmation and comment prior to visiting the site to ensure any points for discussion and further investigation were highlighted prior to the visit.

This database was then confirmed by a site visit where all breach locations, (with the exception of the inaccessible ones: CAS01, ROC01 & ROC02), were visited prior to commencement of the modelling process. This site visit was undertaken to ensure each breach location was positioned sensibly and properly represented within the model, and equally importantly that the wider flood cell was adequately represented with any important features noted.

Topographic Data

A key component in the modelling process is the representation of topography throughout flood prone regions of the study area. For this purpose, a Digital Terrain Model (DTM) was derived for each of the modelled areas. A DTM is a three-dimensional 'playing field' on which the model simulations are run.

The platform used for the generation of the DTM was the GIS software package MapInfo Professional (version 8.5.2) and its daughter package Vertical Mapper (version 3.1).

The DTM is primarily based on filtered LiDAR data provided by the EA. LiDAR (Light Detection And Ranging) is a method of optical remote sensing, similar to the more primitive RADAR (which uses radio waves instead of light). Filtered LiDAR data represents the "bare earth" elevation with buildings, structures (such as bridges) and vegetation removed. In this case, the LiDAR surveys return data at a horizontal resolution of 2 metres, 1 metre and 0.25metres (that is, a unique elevation level is given every two/one/0.25 metres in both the north-south and east-west directions). The LiDAR was provided by the EA for this study and the following information is provided for completeness:

- All of the data is referenced using the British National Grid OSGB36, the Z value is metres above Ordnance Datum Newlyn.
- Data from different, overlapping surveys, at different resolutions, have been merged together. The newest, and highest resolution data, has had precedence in the merging process. If the input data was at a resolution finer than 2 metres, it was re-sampled to 2 metres using the bilinear interpolation method in ESRI's Spatial Analyst software.

During the compilation of the DTM it was realised that there were gaps in the LiDAR coverage. In order to accurately represent each flood cell complete topographic data was needed. Synthetic Aperture Radar or SAR was used to infill the gaps. SAR is generally less accurate and has a lower resolution (approximately 5m compared to the 2m LiDAR) so is used only in areas where LiDAR is not available.

The LiDAR data combined with SAR data was used to create a DTM grid covering the complete study area. In addition to the 2m LiDAR some 25cm LiDAR data was obtained. This is generally available for areas of specific interest only, such as along defences, so is patchy. As 25cm LiDAR is very accurate the files are extremely large. To allow reasonable working times, the 2m LiDAR was used as a basis for the modelling and where 25cm LiDAR was available this was used to override the 2m data. This provided a more accurate representation of the topography within the flood cell.

Flood Cell Definition

Sixteen breach locations have been identified along the northern bank of the River Thames, and the Rivers Crouch and Roach within the Basildon Borough, Castle Point Borough and Rochford District Council administrative areas. Details are provided in Table E-1 and shown in Figure A-1.

Table E-1 Breach Characteristics

Code (TGSE update 2010)	Breach Name (TGSE update 2010)	Previous Code (TGSE SFRA 2006)	Previous Breach Name (TGSE SFRA 2006)	Easting	Northing
BAS01/CAS	Flood barrier, Fobbing Horse, Vange Creek	Cas09	Barrier Vange Creek	574044.7	184305.5
CAS01	Upper Horse	Cas01	Canvey Island 1	575200	183400
CAS02	Canvey Village, Lower Horse	Cas02	Canvey Island 2	577100	182600
CAS03	STW	Cas03	Canvey Island 3	578100	182000
CAS04	Canvey Island Golf Course	Cas04	Canvey Island 4	579437.5	182463
CAS05	Leigh Beck	Cas05	Canvey Island 5	581600	182700
CAS06	Sunken Marsh	Cas06	Canvey Island 6	580900	184300
CAS07	Castle Point Golf Course	Cas07	Canvey Island 7	579008.6	185005
CAS08	Benfleet Creek Flood Barrier	Cas08	Benfleet Marshes	578067.6	185605
ROC01	Morrin's Point	Roc05	Morrin's Point	596298.3	186654.2
ROC02	Wakering Stairs	Roc04	Wakering Stairs	596900	187100
ROC03	Oxenham Farm	Roc06	Oxenham Farm	595745	188694.5
ROC04	Paglesham Eastend	Roc03	Paglesham East End	594767.5	192116.8
ROC05	Grapnells, Wallasea Island	Roc01	Wallasea Island	594700	195000
ROC06	Loftmans Farm, Paglesham Creek	Roc07	Paglesham Creek	592370.3	193694
ROC07	South Fambridge	Roc02	South Fambridge	585500	196200

Code (TGSE update 2010)	River	River Classification	Defence Type	Breach Width (m)*	Breach Invert Level (m)	Crest Height APPROX (m)
BAS01/CAS	Vange Creek, Thames Estuary - Estuary	Estuary	hard defence - barrier	width of barrier-45	1	6.5
CAS01	Holehaven Creek, Thames Estuary	Estuary	hard defence with earth embankment	20	2.4	6.4
CAS02	Holehaven Creek (mouth), Thames Estuary	Estuary	hard defence with earth embankment	20	2.3	6.5
CAS03	Thames Estuary	Estuary	hard defence with earth embankment	20	2	6.9
CAS04	Thames Estuary	Estuary	hard defence with earth embankment	20	1.7	6.8
CAS05	Thames Estuary	Estuary	hard defence with earth embankment (breach at flood gate)	20	1.5	6.3
CAS06	Benfleet Creek, Thames Estuary	Estuary	hard defence with earth embankment	20	2.7	6.5
CAS07	Benfleet Creek, Thames Estuary	Estuary	hard defence with earth embankment	20	3.2	6.3
CAS08	Benfleet Creek, Thames Estuary	Estuary	hard defence - barrier	width of barrier-50	2.5	7.5
ROC01	Thames Estuary - Open Sea	Open Coast	earth embankment	200	1.7	5.1-5.3
ROC02	Thames Estuary - Open Sea	Open Coast	earth embankment	200	1.7	4.9-5.4
ROC03	The Middleway	Tidal river	earth embankment	50	1.5	4.8
ROC04	River Roach	Tidal river	flood gate	50	2.3	4.5
ROC05	River Crouch	Tidal river	earth embankment	50	1.5	4.4-4.3
ROC06	Paglesham Creek, River Roach	Tidal river	earth embankment	50	1.8	4.6
ROC07	River Crouch - River	Tidal river	earth embankment	50	1.2	5.6

Code (TGSE update 2010)	Source of water level info	200 year	200 year with 100 years of Climate Change allowance	1000 year	100 year with 100 years of Climate Change allowance
BAS01/CAS	Thames Estuary Extreme Water Levels (2008)	5.15	6.25	5.68	6.77
CAS01	Thames Estuary Extreme Water Levels (2008)	5.15	6.25	5.68	6.77
CAS02	Thames Estuary Extreme Water Levels (2008)	5.12	6.22	5.63	6.75
CAS03	Thames Estuary Extreme Water Levels (2008)	5.12	6.22	5.63	6.75
CAS04	Thames Estuary Extreme Water Levels (2008)	5.05	6.14	5.54	6.65
CAS05	Thames Estuary Extreme Water Levels (2008)	5.02	6.12	5.51	6.62
CAS06	Thames Estuary Extreme Water Levels (2008)	4.95	6.05	5.43	6.55
CAS07	Thames Estuary Extreme Water Levels (2008)	4.95	6.05	5.43	6.55
CAS08	Thames Estuary Extreme Water Levels (2008)	4.95	6.05	5.43	6.55
ROC01	Anglian Region Extreme Tide Levels (2007)	4.49	5.54	4.83	5.88
ROC02	Anglian Region Extreme Tide Levels (2007)	4.48	5.53	4.82	5.87
ROC03	Anglian Region Extreme Tide Levels (2007)	4.46	5.51	4.81	5.86
ROC04	Anglian Region Extreme Tide Levels (2007)	4.43	5.48	4.58	5.63
ROC05	Anglian Region Extreme Tide Levels (2007)	4.36	5.41	4.64	5.69
ROC06	Anglian Region Extreme Tide Levels (2007)	4.43	5.48	4.58	5.63
ROC07	Anglian Region Extreme Tide Levels (2007)	4.40	5.45	4.64	5.69

Once the DTM grids and breach locations were obtained and confirmed, the flood cell for each model must be defined. The flood cell is the geographical extent of the model; the area of the overall DTM that will be used in the model. While it would be possible to run each of the breach models using all of the derived DTM topographical data, it is far more sensible and computationally efficient to define a smaller area on which to run each scenario.

Flood cells are typically defined by considering the topography of the area inland of the breach and the peak levels of the tidal events to be tested. MapInfo can be used to show areas of potential flooding by only displaying areas of the DTM that are below the predicted peak inundation levels in the vicinity of the breach, plus a freeboard. Areas of the DTM that are not shown (that is, areas that are well above the tidal levels of interest) do not need to be considered in the model.

Where the local topography does not clearly define an enclosed flood cell it may be necessary to artificially enclose certain parts of the flood cell. This should only be done for areas that are distant from the breach or any important areas of the model, and will typically be outlying or empty areas of the flood cell. For example, estuaries or flat, open fields at the far end of the flood cell. Since the model treats the boundaries of flood cells as 'glass walls' it is vital that any artificial boundaries do not affect levels in the important areas of the flood cell. This is typically not an issue in models where the inflows are based on tidal levels rather than a specific volume, as in this case.

Within this study there were a number of flood cells that had to be artificially constrained (notably ROC05 and ROC07 flood cells). In these cases local features as well as topography were used to inform the decision as to where to terminate the flood cell. In the case of the Rochford flood cells, natural water courses were used as these were thought to provide a natural break in the topography.

Extreme Water Level Derivation

Water levels were taken from *Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008* preferentially where available and appropriate for particular breach locations. Where this study did not cover particular breach locations *Environment Agency, Anglian Region, Eastern and Central Areas Report on Extreme Tidal Levels, 2007* was used to obtain water level information. Where modelled nodes were present within close proximity to specific breach locations unmodified water levels were used. Where a significant distance was present between the modelled nodes and the breach locations, modelled water levels were factored based on chainage to provide more realistic water levels.

Climate Change

PPS25 recommended contingency allowances have been applied to the extreme water levels obtained from the above studies in order to simulate climate change scenarios (100 years of climate change simulated up to 2110). Where climate change modelled runs were undertaken as part of the above studies, PPS25 allowances were applied to the closest run scenario to obtain 2110 water levels (i.e. for the *Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008* a model run was undertaken for 2107, so only three years of the appropriate PPS25 climate change contingency need be added).

Breach Modelling

Sixteen breach locations have been identified; eleven along the northern bank of the River Thames, two on the River Crouch and three on the River Roach. These are all located within the TGSE area of Castle Point, Basildon and Rochford administrative areas as shown in Figure A-1 and Table E-1.

To assess flood propagation in events where the flood defences are breached, a hydraulic modelling analysis has been undertaken using the two-dimensional hydraulic modelling software MIKE21-HDFM (Release 2009, Service Pack 4). This section discusses the modelling methodology that has been applied for the hydraulic modelling analysis of the breach events. The choice of model is discussed, the model schematisation is described and the boundary conditions used are presented.

Model and Software Selection

To achieve the study objectives, the model used to estimate the maximum flood conditions was required to:

- Accommodate the effects of a flood flow (propagation of a flood wave and continuous change of water level);
- Simulate the hydraulics of the flow that breach/overtop the flood defences; and
- Generate detailed information on the localised hydraulic conditions over the flooded area in order to evaluate flood hazard.

MIKE21-HDFM was developed by the Danish Hydraulic Institute (DHI) Water and Environment and simulates water level variations and flows for depth-averaged unsteady two-dimensional free-surface flows. Release 2009, Service Pack 3 was used for this study. It is specifically oriented towards establishing flow patterns in complex water systems, such as coastal waters, estuaries and floodplains using a flexible mesh (FM) approach. The flexible mesh model has the advantage that the resolution of the model can be varied across the model area. The model utilises the numerical solution of two-dimensional shallow water equations.

Model Extent and Resolution

Flexible meshes were developed to define the topography of the land within each flood cell, using the MIKE21 program's mesh generator application which creates a mesh of triangular elements covering the defined 'flood cell' - the land that has an elevation below the peak tidal level with the potential to flood (see above).

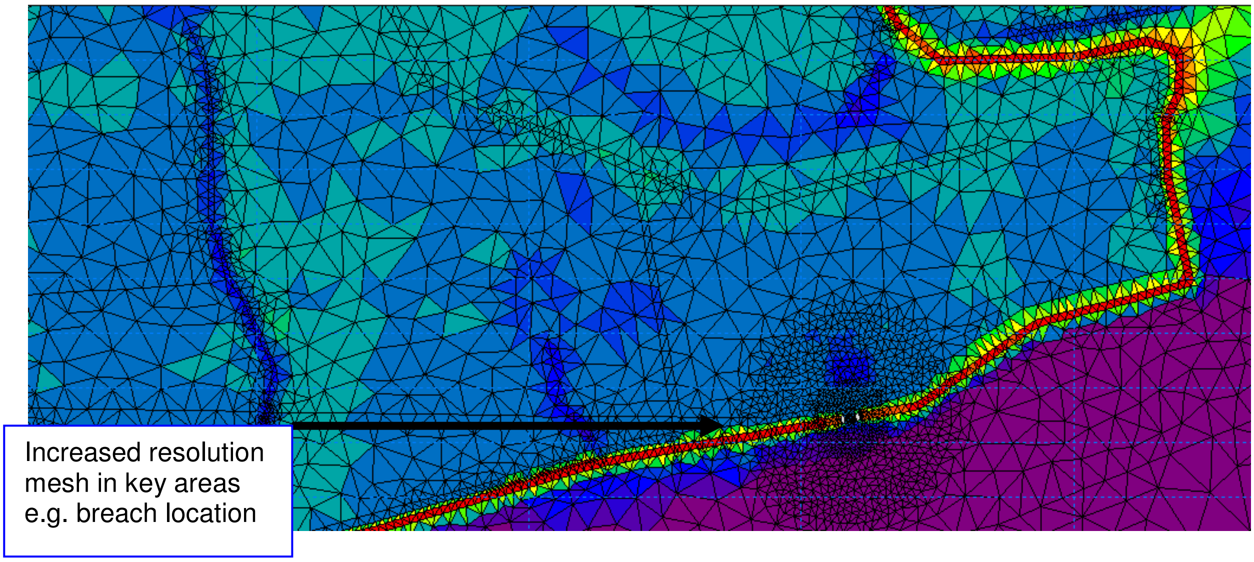
One of the advantages of the flexible mesh application is that the element size within the mesh can be varied depending upon the complexity of the floodplain, features of interest, and the location of topographic features which are thought to have a significant impact on flood propagation. By adding 'control lines' during the development of the mesh, the triangles or elements are forced to follow the alignment of the features ensuring the elevations of important features are picked up during the mesh generation. For example, control lines would be placed along each side of a road/ditch/topographic feature. In this way, the mesh is 'forced' to follow the features accurately and use level values at very specific points.

It was decided that considering these models are for strategic and not site specific purposes that small features such as culverts and small drainage ditches will not be included within the mesh. Taking into account the size of the study areas, the determination of all culverts and small features was outside the scope of the study.

In order to accurately represent the hydraulics around the breach locations a comparatively small element size has been specified in the vicinity of the breaches. The breach itself is represented with a minimum of four elements across its width.

Once the final mesh is developed and the triangles generated, elevation values are imported into the mesh at each triangle vertex from the previously created DTM, utilising the 2m LiDAR data and where available the 25cm LiDAR. This then provides the 3-dimensional 'playing field' for simulating the breach scenario.

Figure E-1 Example of MIKE 21 HD Flexible Mesh



Breach Specifications

The breach width and exposure duration are determined by the type of defences and the nature of the adjacent water body. Flood defences are categorised as either 'Hard Defences[1]' or 'Earth Embankments'. According to EA guidance (Environment Agency SFRA Guidance[2]), the breach width adopted for the above categories is 20 metres and 50 metres respectively for tidal rivers/estuary and 50 metres and 200 metres respectively for open coast (see Table E-2).

[1] The EA consider revetted clay walls to be a hard defence. For many clay walls, either revetted or not, the main cause of failure is from overtopping and the back of the defence being compromised. Once failure has commenced, the structure will be rapidly washed out regardless of the face of the structure. The resulting gap will, by consequence of the construction, be much wider than a solid structure such as piles or concrete

[2] Agency Management System Document: Uncontrolled When Printed [10/01/07]

Table E-2 Environment Agency Breach Guidelines

Location	Defence Type	Breach width (m)
Open Coast	Earth bank	200
	Dunes	100
	Hard	50
	Sluice	Sluice width
Estuary	Earth bank	50
	Hard	20
Tidal River	Earth bank	50
	Hard	20
Fluvial River	Earth bank	40
	Hard	20

The land water boundary along Canvey Island, Castle Point and Southend-on-Sea is classified as tidal river/estuary to Shoeburyness point and as open coast to the east of this point. The Rivers Crouch and Roach are considered as river/estuary (Table E-1).

Within this study there are breaches in hard defences, earth embankments and flood barriers/gates.

The repair time required to close a breach is assumed to be 20.5 hours, covering two tidal cycles. In the hydraulic modelling undertaken for this study, the breach in the flood defence wall occurs prior to the peak tidal level occurring on the second peak and remains open for the remainder of the simulation. This total simulation corresponds to approximately three tidal cycles, with two smaller peaks either side of the maximum peak. This allows any potential overtopping to occur on the first tidal cycle prior to the breach and a subsequent tidal cycle after the peak to allow water to enter through the open breach in the second cycle.

Defences

The defences along the coastline are variable in standard. There are lengths of defence that fall below the 1 in 200 year design standard. As such, models including the potential for overtopping as well as breaching have been constructed. These models allow a breach to be forced through a section of chosen defence but also allow overtopping of the defences to occur where the defences are lower than the simulated water level. In addition to this, an overtopping scenario was also run where no breach occurs. This gives a flood water extent from overtopping alone, or 'actual' flood risk.

Defence heights have been determine from the most appropriate and accurate supplied data. In the main this has been LiDAR data, 25cm taking precedence over 2m LiDAR data. On Canvey Island, and stretches of the coastline in Castle Point data was supplied by the EA as points with associated levels. This data was triangulated and used to determine the height of the defences in the areas where available. The EA were also contacted on a number of occasions regarding the height of the defences and for clarification on the supplied levels.

The Easthaven and Benfleet barriers were confirmed to have a crest height of 6.65m AOD with adjacent defence crest heights at 6.6mAOD. The East Haven Barrier tie in defence has a crest height of 6.7mAOD (concrete cap at 6.7mAOD and sheet pile to 6.6mAOD). This information has been used to update the supplied point data where relevant. Ideally, the defence crest heights would have been surveyed and this data used to set crest heights within the model. As this was not available the best supplied data has been used but it should be recognised that this introduces a limitation to the modelling process and results.

Hydraulic Roughness used in Modelling

Hydraulic roughness represents the conveyance capacity of the land or riverbed where flows are occurring. Within the MIKE21 model, hydraulic roughness is defined by the dimensionless Manning's 'n' roughness coefficient.

A number of material roughness classifications have been identified within the study area, for example water - 0.03 (for the river), urbanised - 0.08, rural/non-urbanised land - 0.04, road - 0.02, and rail - 0.03. The distribution of these factors has been defined using aerial photography, OS maps and knowledge gained by the site visit in order to vary the conveyance rates throughout the flood cell domain.

Tidal Model Boundary Conditions

Within the MIKE21 model, tidal water level boundary files (in this case located in the Rivers Thames, Crouch and Roach) are used to provide the important input of water volumes to the mesh. The tidal water level is defined in the river and determines the flow entering the flood cell through the breach.

The water level boundary file consists of real-time tide curves, using the tidal peak levels derived from the report *Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008* and *Environment Agency, Anglian Region, Eastern and Central Areas Report on Extreme Tidal Levels, 2007* for the present day and with climate change allowances.

Boundary conditions have been applied along the middle of the River Thames, and the opposite banks of the Crouch and Roach. This was simulated to ensure a true representation of the modelled water levels were applied at the breach locations. In locations where smaller watercourses propagate flood water from the main river to the specific breach location, water levels will naturally be modified by the funnelling process of water travelling up a smaller watercourse.

Model Simulations Undertaken

The following flood events were simulated for each breach location;

- A tidal flood event with a return period of 1 in 200 years (present day 2010) breach and overtopping;
- A tidal flood event with a return period of 1 in 200 years (with climate change 2110) breach and overtopping;
- A tidal flood event with a return period of 1 in 200 years (with climate change 2110) overtopping only[3];
- A tidal flood event with a return period of 1 in 1000 years (present day 2010) breach and overtopping;
- A tidal flood event with a return period of 1 in 1000 years (with climate change 2110) breach and overtopping;
- A tidal flood event with a return period of 1 in 1000 years (with climate change 2110) overtopping only[4].

[3] In the case of Canvey Island, two overtopping simulations were run: one where the Easthaven and Benfleet Barriers were operational and one where these defences failed
[4] In the case of Canvey Island, two overtopping simulations were run: one where the Easthaven and Benfleet Barriers were operational and one where these defences failed

Breach Time

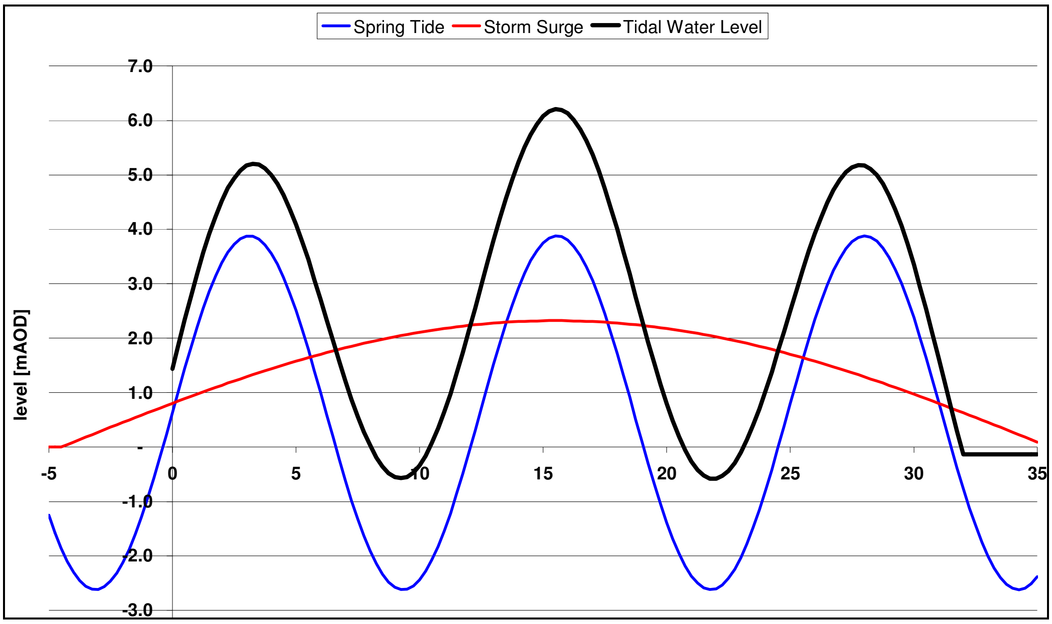
The water levels during a tidal flood event are generated by a summation of the astronomical tide levels and the storm surge residual, as shown in Figure E-2.

In terms of speed and force of floodwaters, the worst time for a breach to occur is when the maximum hydrostatic force has built up behind the flood defences. Therefore, the modelling undertaken for this study was run where the flood defences suddenly breach just before the tidal level acting on the flood defences is at a maximum.

A one hour 'lead-time' prior to the maximum flood level was included to ensure that, once the breach had occurred, the water level continued to rise and the maximum volume of water possible was able to travel through the breach at the maximum water level. This was seen as a compromise between the breach open method and the breach at peak method and the corresponding results.

The models were run for 36 hours. This allowed the potential for overtopping before the breach, during the first tidal cycle and ensured water could enter the model through the breach for the second and third tidal cycles.

Figure E-2 Example of Tidal Curve with Breach Time



Modelling Outputs

Modelling analysis presents data to identify the residual risk and actual risk of flooding from a failure or overtopping of local defences. The mapping of the model outputs as flood depth, flood hazard and time to inundation within the study area provides the three councils with flood risk information to enable more detailed consideration of the risk of flood water inundation, the Sequential Test and PPS25 vulnerability classifications within Flood Zone 3a.

Once the meshes were defined and the models run (by flooding the meshes, through the breaches/overtopping, with the tidal events using the 2D hydrodynamic modelling programme Mike21), the results were processed to produce the above outputs. GIS processing and mapping tasks have been performed using MapInfo Professional (Version 8.5.2) with the Vertical Mapper spatial analysis add-on (Version 3.1).

Maximum Flood Depth

The maximum flood depth is obtained from the water level achieved at each point in the model, minus the LiDAR topographic level at that point. This has been processed for all scenarios run. Composite depth maps were also created taking the maximum depth at each point where breaches coincided.

Hazard Rating

Flood hazard is a function of both flood depth and flow velocity. Due to this dependence on velocity, it is common during tidal flood events for the maximum flood hazard at a certain location to occur before the maximum floodwater level occurs, i.e. while floodwaters are flowing and the velocities are higher.

In order to assess the maximum flood hazard during a flood event, the hazard level at each element of the MIKE21 mesh is assessed at every time step of the model simulation.

Each element within the model is assigned one of four hazard categories ‘Extreme Hazard’, ‘Significant Hazard’, ‘Moderate Hazard’, and ‘Low Hazard’.

The derivation of these categories is based on Flood Risks to People FD2320 (DEFRA & EA, 2005), using the following equation:

$$\text{Flood Hazard Rating} = ((v+0.5)*D) + DF \qquad \text{Where } v = \text{velocity (m/s)}$$

$$D = \text{depth (m)}$$

$$DF = \text{debris factor}$$

The depth and velocity outputs from the 2D hydrodynamic modelling are used in this equation, along with a suitable debris factor. For this SFRA, a precautionary approach has been adopted inline with FD2320; a debris factor of 0.5 has been used for depths less than and equal to 0.25m, and a debris factor of 1.0 has been used for depths greater than 0.25m.

Table E-3 Hazard categories based on FD2320, DEFRA & Environment Agency 2005

Flood Hazard			Description
	$HR < 0.75$	**Low**	**Caution** – Flood zone with shallow flowing water or deep standing water
	$0.75 \geq HR \leq 1.25$	**Moderate**	**Dangerous for some** (i.e. children) – Danger: flood zone with deep or fast flowing water
	$1.25 > HR \leq 2.0$	**Significant**	**Dangerous for most people** – Danger: flood zone with deep fast flowing water
	$HR > 2.0$	**Extreme**	**Dangerous for all** – Extreme danger: flood zone with deep fast flowing water

A flood hazard rating grid was created for each of the breach locations for all flooding scenarios. A composite grid was then created for appropriate overlapping areas by extracting the maximum flood hazard rating value (where applicable) for each point, considering all relevant model output grids.

Time to Inundation

As previously stated, a breach was simulated in the models one hour before the peak tidal level. Flows then tended to pass through the breach, inundating the flood cell, for approximately five to six hours, after which the tide level had again retreated well below the breach invert. After another six hours (11 to 12 hours after the breach) the next high tide would again push water through the breach causing further flooding for a further five to six hours.

From examining the results it was decided that the vast majority of land that was inundated by the model was inundated within six hours of the breach occurring. Some of the outlying areas (some distance from the breach) were affected by the second peak.

The MIKE21 application 'Data Extraction FM' was used to extract 'snapshots' of the model results Time 0 is set to the time when tidal water enters the breach. This means that the <1 hour band encompasses all areas that are inundated (wet) within the first hour of water travelling through the breach and into the flood cell. Further bands have been produced to show wet cells at: 1-4 hours, 4-8 hours, 8-12 hours, 12-16 hours and 16-20. Where overtopping occurred prior to the opening of the breach, this has been classified as such using a hatching.

For each model run, a mesh of polygons was derived in GIS (in this case, MapInfo format), each containing the approximate time of inundation for each triangular element composing the model mesh. All empty (zero) elements were then deleted and a 3-dimensional grid file (using the time of inundation as the vertical z-value) was created to define the time to inundation for each model simulation.

These grid files could be used as the final output of the time to inundation process. However, the results are 'patchy' and complicated in places, mainly due to a finite number of breach locations being used (sixteen in this case). Ideally, a very high number of breach locations would have been used in the modelling (for example every few hundred metres or more) but this is impractical considering the computing power and time that would be required. This should be noted by the reader for all output results, i.e. results are from a discrete number of breach locations and therefore may be subject to change if the breach location were to change.

As overtopping is possible at any point where the defences are below the water level (due to the variable defence standard), some overtopping will be classified within the time to inundation bands from the breach event. This is particularly noticeable in areas a significant distance from the breach that are shown as inundated within the first hour of the breach event (i.e. water would not have time to flow from the breach to these locations within the first hour). This should be considered by the user.

Appendix F: Data Register

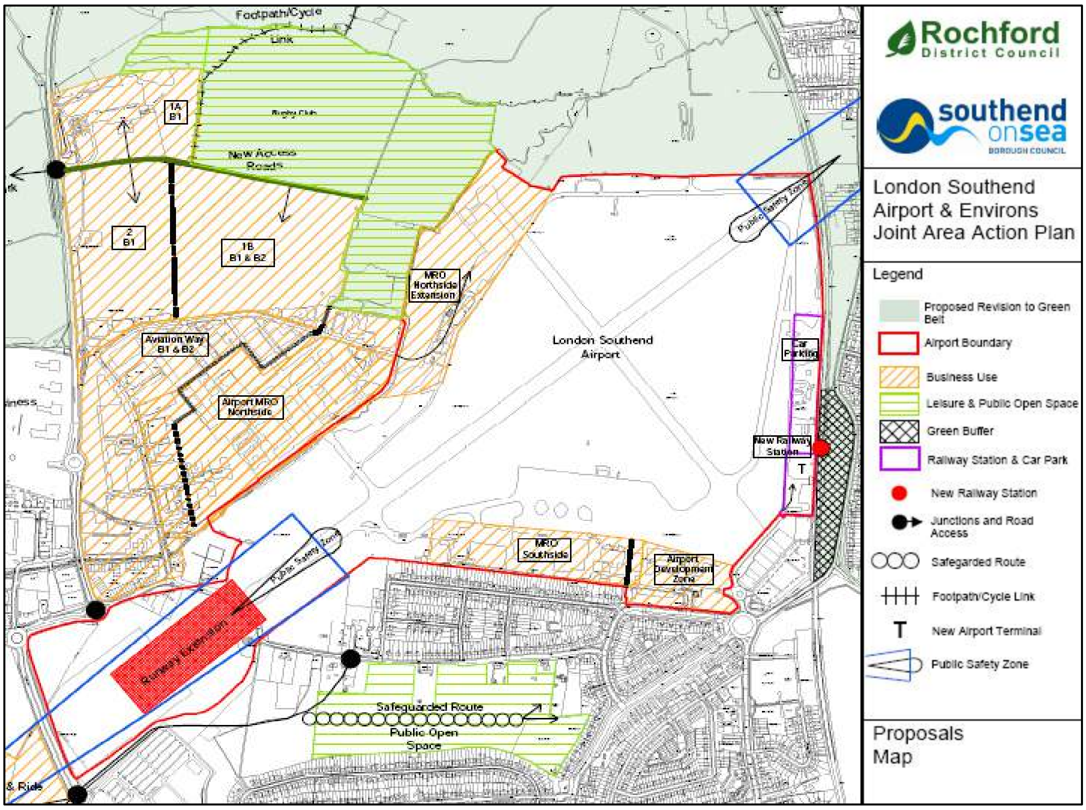
Appendix F - Data Register

Project Type	**Project**		**Supply Project**			
SFRA Review	Thames Gateway South Essex Strategic Flood Risk Assessment Review (Level 1 or 2)		Sheet Number	1		
Date updated	08/10/2010		Job Number	D130256		
Filename	Description	To - Name	From - Name	Medium	Confidence	Date of Issue
council_extent_rochford.tab	Rochford District Boundary	Emily Blanco (SW)	Sam Hollingworth (RDC)	CD		1-Jun-10
nat_floodzone2_v3_14.shp	GIS outline of Flood Zone 2	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
nat_floodzone3_v3_14.shp	GIS outline of Flood Zone 3	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Prittle_20yr.shp	GIS outline of 1 in 20yr return period for Prittle Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Prittle_100yr.shp	GIS outline of 1 in 100yr return period for Prittle Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Prittle_100yrCC.shp	GIS outline of 1 in 100yr return period including allowances for climate change for Prittle Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Prittle_1000yr.shp	GIS outline of 1 in 1000 year return period for Prittle Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Eastwood_20yr.shp	GIS outline of 1 in 20yr return period for Eastwood Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Eastwood_75yr.shp	GIS outline of 1 in 75yr return period for Eastwood Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Eastwood_100yr.shp	GIS outline of 1 in 100yr return period for Eastwood Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Eastwood_100yrCC.shp	GIS outline of 1 in 20yr return period for Eastwood Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Eastwood_1000yr.shp	GIS outline of 1 in 100yr return period for Eastwood Brook	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Eastwood_nodes.shp	GIS layer of nodes along Eastwood Brook model	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Defence_01_polyline.shp	Extract from the National Flood and Coastal Defence Database for the study area	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
20100406 Rochford DC multi-agency flood plan.doc	Flood plan for Rochford DC	Emily Blanco (SW)	Sam Hollingworth (RDC)	Project Space		1-Jun-10
625k_V5_BEDROCK_Geology_Polygons.shp	GIS layer of Bedrock geology across study area (1:625,000 Mapping)	Emily Blanco (SW)	British Geological Survey	Downloaded freely from BGS website		1-Jun-10
625k_V5_DYKES_Geology_Polygons.shp	GIS layer of dykes across study area (1:625,000 Mapping)	Emily Blanco (SW)	British Geological Survey	Downloaded freely from BGS website		1-Jun-10
625k_V5_FAULT_Geology_Lines.shp	GIS layer of geological faults across study area (1:625,000 Mapping)	Emily Blanco (SW)	British Geological Survey	Downloaded freely from BGS website		1-Jun-10
UK_625k_SUPERFICIAL_Geology_Polygons.shp	GIS layer of Superficial geology across study area (1:625,000 Mapping)	Emily Blanco (SW)	British Geological Survey	Downloaded freely from BGS website		1-Jun-10
OS_1_50_000_scale_colour_raster_108849_139928.tif	1:50,000 Ordnance Survey Mapping of study area	Sarah Littlewood (SW)	EmapSite	Downloaded freely from Emap website		1-Jun-10
TQ68.TIF and similar…	1:25,000 Ordnance Survey Mapping of study area	Emily Blanco (SW)	Sam Hollingworth (RDC)	CD		1-Jun-10
Less susceptible to surface flooding.shp	Areas Susceptible to Surface Water Flooding Dataset: GIS layer of areas LESS susceptible	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
Medium susceptibility to surface flooding.shp	Areas Susceptible to Surface Water Flooding Dataset: GIS layer of areas with MEDIUM susceptibility	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
More susceptible to surface flooding.shp	Areas Susceptible to Surface Water Flooding Dataset: GIS layer of areas MORE susceptible	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
connecting_cows.shp	GIS layer of connecting critical ordinary watercourses	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
cows.shp	GIS layer of critical ordinary watercourses	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
Main_Rivers.shp	GIS layer of Environment Agency Main Rivers	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
South_Benfleet_Location_Map.pdf	Map showing the extent of the South Benfleet Flood Storage Area (FSA)	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
South Essex CFMP.pdf	South Essex Catchment Flood Management Plan	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
Anglian RBMP.pdf	River Basin Management Plan for the Anglian River Basin District	Emily Blanco (SW)	Environment Agency	CD		1-Jun-10
DG5 Register postcodes Essex (Anglian Water).xls	Database of recorded incidents of sewer flooding across the study area	Sarah Littlewood (SW)	Anglian Water	Email		1-Jun-10
051FWCDV4D1.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV4D2.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV4D3.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV4D5.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV4D6.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV5A1.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV5B2.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWCDV5B3.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
051FWFEF7B.zip	GIS layer of Environment Agency Flood Warning Areas (FWAs)	Sarah Littlewood (SW)	Environment Agency	CD		1-Jun-10
Crouch_20yr.shp	GIS outline of 1 in 20yr return period for fluvial part of the River Crouch.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Crouch_100yr.shp	GIS outline of 1 in 100yr return period for fluvial part of the River Crouch.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Crouch_100yr_CC.shp	GIS outline of 1 in 100yr return period including allowances for Climate Change for fluvial part of the River Crouch.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Crouch_1000yr.shp	GIS outline of 1 in 1000yr return period for fluvial part of the River Crouch.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Roach_20yr.shp	GIS outline of 1 in 20yr return period for fluvial part of the River Roach.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Roach_100yr.shp	GIS outline of 1 in 100yr return period for fluvial part of the River Roach.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Roach_100yr_CC.shp	GIS outline of 1 in 100yr return period including allowances for Climate Change for fluvial part of the River Roach	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
Roach_1000yr.shp	GIS outline of 1 in 1000yr return period for fluvial part of the River Roach.	Sarah Littlewood (SW)	Environment Agency	CD		1-Oct-10
RDC Core Strategy Submission FINAL.pdf	Core Strategy Document	Emily Blanco (SW)	Sam Hollingworth (RDC)	Project Space		1-Jun-10

Appendix G: London Southend Airport & Environ JAAP

Southend-on-Sea Borough Council and Rochford District Council are in the process of preparing a planning framework to guide development at the proposed London Southend Airport and the neighbouring employment areas. This planning framework is known as the Joint Area Action Plan (JAAP) and is illustrated in Figure G-1 below. The two Councils have published their 'Preferred Option' for development which has been used as a basis to make a strategic assessment of flood risk which is described below.

Figure G-1 London Southend Airport JAAP



Fluvial Flood Risk

Environment Agency Flood Zones

The Eastwood Brook is a Main River which flows in a south west to north east direction to the north west of the Southend Airport JAAP area as illustrated in Figure G-2 below.

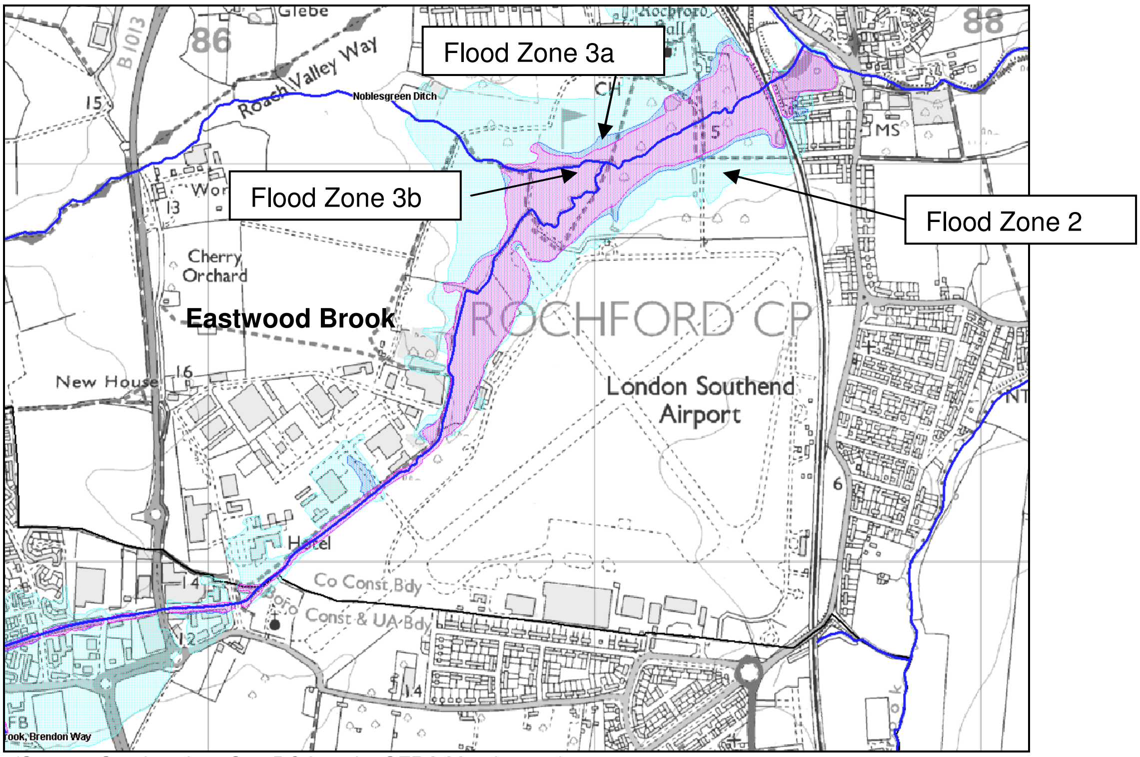
The JAAP outlines development for business uses to the north west of the airport adjacent to the Eastwood Brook (MRO Northside Extension). This area is currently shown to lie within Flood Zone 3b associated with the Eastwood Brook. Flood Zone 3b is defined as the functional floodplain and only water-compatible (mainly water-based) uses and essential infrastructure, as defined by Table D2 of PPS25, are considered appropriate in this location.

Airport MRO Northside is also proposed for business use. A small section of the potential development area adjacent to the Eastwood Brook is located in Flood Zone 3b, with small pockets of Flood Zone 3a and Flood Zone 2. A sequential approach to the development layout would have to be applied in this location to ensure that no development is located in Flood Zone 3b, and less vulnerable uses are located in Flood Zone 3a and Flood Zone 2.

The northern half of Aviation Way B1 and B2 is located within Flood Zone 1. However, the southern half of this plot, adjacent to the Eastwood Brook contains some small pockets of Flood Zone 2, 3a and 3b. A sequential approach to the development layout would have to be applied in order to steer development into the lower areas of flood risk.

A detailed FRA will be required for all development located in Flood Zone 2, 3a or 3b including Aviation Way, Airport MRO Northside and MRO Northside Extension.

Figure G-2 Environment Agency modelled Flood Outlines – Eastwood Brook.



(Source: Southend-on-Sea BC Level 1 SFRA March 2010)

Environment Agency Modelled Fluvial Flood Depths

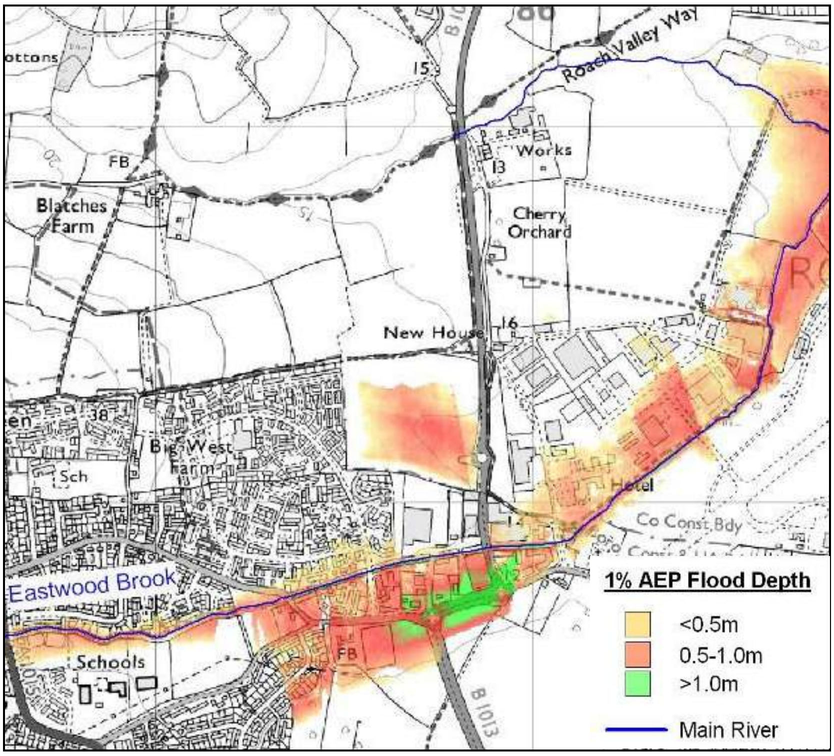
The Environment Agency has recently completed a flood risk study for the Eastwood Brook. The flooding mechanism for this watercourse is described as *'overtopping of river banks leading to low velocity flooding in most areas with flood depths ranging between 0.3m and 0.5m'* (Table 3.17 included in the Catchment Flood Management Plan).

The Environment Agency has assigned this watercourse a 'high priority' natural channel maintenance regime and they provide flood warning with a 2 hour lead time.

With reference to the fluvial flood depth map for Eastwood reproduced in Figure G-3 below and Figure G-1 Development Layout, it can be seen that flood depths may reach 1.0m within the proposed 'Airport MRO Northside' development area. Depth modelling is not included in the CFMP for the northern extent of the JAAP but Figure G-3 suggests that depths may also be greater than 1.0m in the area identified for the 'MRO Northside Extension'.

It should be noted that the airport has previously experienced flooding from the Eastwood Brook including in 1981 when the brook burst its banks leading to flooding of the airport hanger.

Figure G-3 Fluvial flood extent and depth for Eastwood (1% or 1 in 100 year probability)



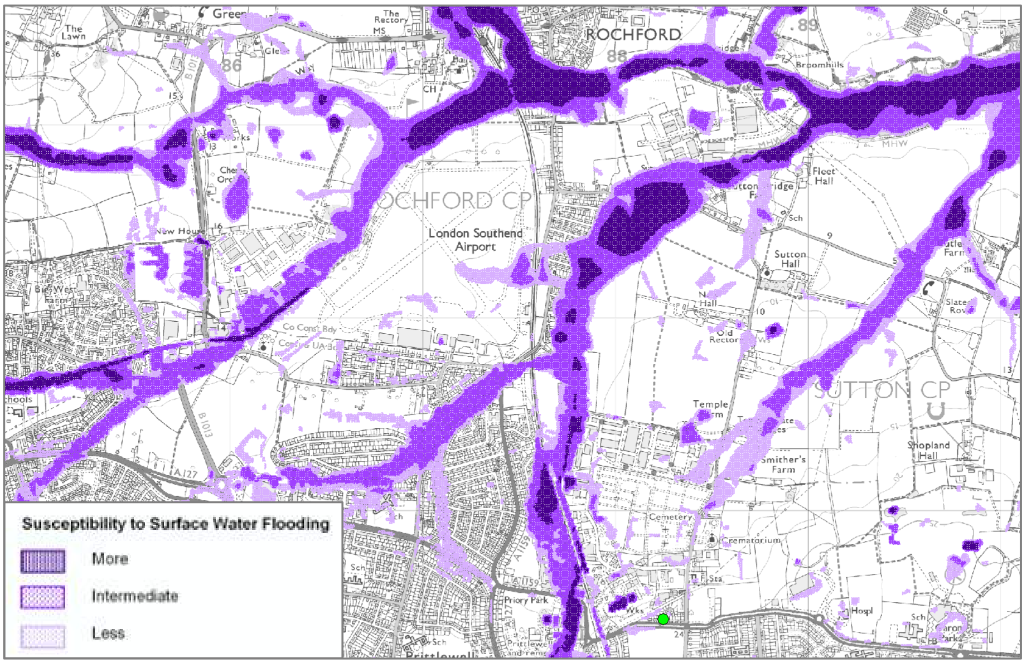
(Source South Essex CFMP – Final Plan August 2008, EA.)

Surface Water Flood Risk

The Environment Agency published maps to illustrate 'Areas Susceptible to Surface Water Flooding' in July 2009. This data has been created to provide an overview to where the potential for flooding from surface water needs particular assessment.

The Environment Agency Areas Susceptible to Flood Risk maps (extract included in Figure G-4) highlight that surface water flooding may be an issue to the north west of the JAAP including the proposed development at Aviation Way, Airport MRO Northside and MRO Northside Extension. The surface water flood maps use ground levels in the modelling, therefore, areas of potential surface water flooding often follow river corridors. This is the case at the airport JAAP where the Eastwood Brook and Prittle Brook corridor is highlighted as being at surface water flood risk. In addition, there are smaller pockets of potential risk illustrated to the east of the runway, local to the proposed new railway station building.

Figure G-4 Environment Agency Areas Susceptible to Surface Water Flooding



(Source Southend-on-Sea BC Level 1 SFRA, September 2010)

Tidal Flood Risk

Detailed breach and overtopping modelling has been considered for tidal sources at 9 locations along the Southend seafront and 7 locations along the Rochford frontage. These identify the flood risks associated with a failure in the flood defence, through a breach and by overtopping. Modelling at all locations has highlighted that the London Southend Airport site is not at risk of tidal flooding from the Thames Estuary or North Sea.

Groundwater Flood Risk

The South Essex Catchment Flood Management Plan states that groundwater flooding is not a major issue in this area. The presence of London clay reduces the risk of groundwater flooding as it creates an impermeable barrier between the ground surface and the underlying aquifer (where present).

The Southend Airport JAAP is underlain by river terrace deposits of silt and clay, with sand and gravel river terrace deposits following the Eastwood Brook corridor to the west of the JAAP. There have been no groundwater flooding incidents reported to the Environment Agency or the Council within the Southend Airport JAAP area.

There is little recorded information currently available on groundwater flooding. The proposed Phase 2, 3 and 4 Surface Water Management Plan (anticipated in Spring 2011) may provide a greater level of detail and should be referred to as part of a site-specific FRA.

Flood Risk Assessment Guidance – Southend Airport JAAP

A site-specific FRA should include details of the proposed surface water drainage system including storm water storage. As the Eastwood Brook is adjacent to the proposed development area in the north west, it seems logical that surface water drainage be discharged to this watercourse. It should be noted that there is potential that if a rainfall event co-insides with the Eastwood Brook being in flood, the outfall for the development drainage system may become surcharged. This could cause surface water to back up into the development site causing surface water flooding.

Any discharge to a main river watercourse will require consent from the Environment Agency and will require attenuation to discharge at a flow rate to be confirmed with the Environment Agency (potentially Greenfield runoff rate).

As part of a site-specific FRA, historic flood records where available should be referred to in order to verify the potential surface water flood risk. A site visit should also be used to assess and ground truth the data.